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Taylor Wimpey Strategic Land
Wimblebury Road – Regulation 19 Consultation
Cannock
Flood Risk and Drainage Technical Note

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1. INTRODUCTION

1.1 This Flood Risk and Drainage Technical Note (FRDTN) provides an update on the possible sources of flood risk and drainage constraints at a potential development at Wimblebury Road, Cannock.

1.2 Several studies have been previously undertaken on the wider site (WRC-BWB-ZZ-XX-RP-YE-0001, WRC-BWB-ZZ-XX-RP-YE-0002 and WRC-BWB-ZZ-XX-RP-YE-0004) which have included conceptual surface water drainage strategies and flood risk constraints plans.

1.3 This FRDTN provides an update to the flood risk constraints and conceptual drainage strategy based on the site allocation, namely; *SH2 Land east of Wimblebury Road, Heath Hayes* and *Site S1 Safeguarded Land*.

1.4 The report is based on the readily available information. Consultations have been requested from the Environment Agency (EA) and Lead Local Flood Authority (LLFA). However, at the time of writing a response is yet to be received from the EA or LLFA.

Site Details

1.5 Site *SH2* is located approximately 3.7km east of Cannock town centre and is bound to the north and east by woodland, to the south by Heath Hayes Park and to the west by Wimblebury Road. Site *S1* is located approximately 3.9km east of Cannock town centre and is bound to the north and west by woodland, to the east by open agricultural land and to the south by Cannock Road (A5190). Both sites are greenfield, generally comprising agricultural land. The site's location is illustrated within Figure 1.1.

1.6 A topographical survey has been undertaken and is included as Appendix 1. SH2 is shown to generally fall in a southerly and south easterly direction with levels ranging from approximately 206.5m Above Ordnance Datum (AOD) in the north to approximately 180.6m AOD in the south east.

1.7 Site *S1* is shown to generally fall in a south westerly direction with levels ranging from approximately 193.3m AOD in the north east to approximately 171.1m AOD in the south west.

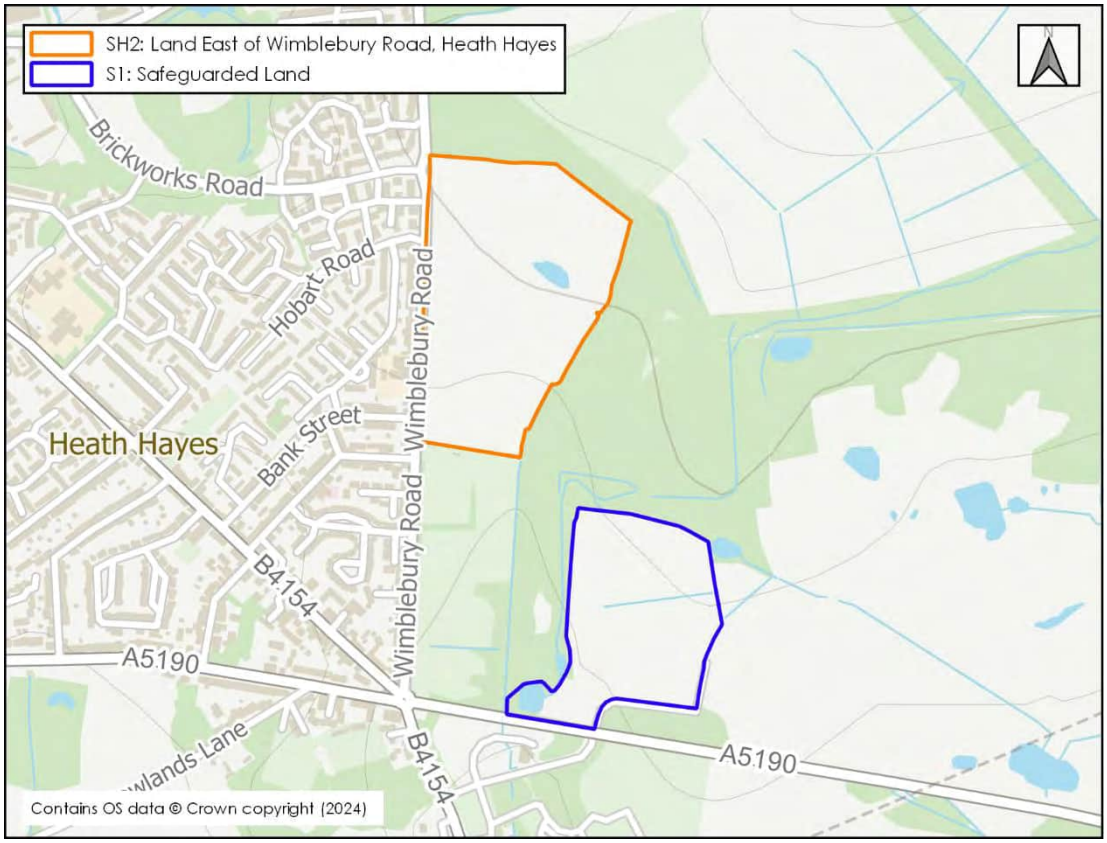

Figure 1.1: Site Location

1.8 The topographical survey shows ditches and drains to be located within and adjacent to both *SH2* and *S1*. The features located within site *SH2* were observed during a site visit undertaken by BWB Consulting Ltd in July 2021 as shown in Figure 1.2 and Figure 1.3.

1.9 Culverts were observed to outfall to the ditch, however, the other feature is considered to be a drain as no additional drainage is understood to outfall to it.

Figure 1.2: Ditch within site SH2

Figure 1.3: Drain within site SH2

2. PRELIMINARY FLOOD RISK REVIEW

Flood Risk Guidance Review

Strategic Flood Risk Assessment

2.1 A Strategic Flood Risk Assessment (SFRA) is a study carried out by one or more local planning authorities to assess the risk to an area from flooding from all sources, now and in the future.

2.2 The Southern Staffordshire Councils Level 1 SFRA[1] has been reviewed in the production of this FRDTN. The SFRA provides information specific to the site location in the form of fluvial, surface water and groundwater flood risk mapping, as well as records of historic flooding. Information from the Level 1 SFRA will be referenced within this report where applicable.

Preliminary Flood Risk Assessment

2.3 A Preliminary Flood Risk Assessment (PFRA) is an assessment of floods that have taken place in the past and floods that could take place in the future. It generally considers flooding from surface water runoff, groundwater and ordinary watercourses, and is prepared by the Lead Local Flood Authorities.

2.4 The Staffordshire County Council PFRA[2] considers flooding from surface water runoff, groundwater, ordinary watercourses and canals. However, no historical instances of flooding at the site are referenced. Information from the PFRA will be referenced within this report where applicable.

Local Flood Risk Management Strategy

2.5 A Local Flood Risk Management Strategy (LFRMS) is prepared by a Lead Local Flood Authority to help understand and manage flood risk at a local level.

2.6 The LFRMS aims to ensure that the knowledge of local flood risk issues is communicated effectively so that they can be better managed. The LFRMS also aims to promote sustainable development and environmental protection.

2.7 The Staffordshire LFRMS Update[3] has been reviewed and will be referenced within this report where applicable.

[1] Level 1 Strategic Flood Risk Assessment (JBA Consulting, October 2019)
[2] Preliminary Flood Risk Assessment (Staffordshire County Council, March 2011)
[3] Local Flood Risk Management Strategy 2024 Update (Staffordshire County Council, 2024)

Surface Water Management Plan

2.8 A Surface Water Management Plan (SWMP) is a study to understand the flood risks that arise from local flooding. The purpose of a SWMP is to identify what the local flood risk issues are, what options there may be to prevent them or the damage they cause and who should take these options forward.

2.9 A Phase 1 SWMP for the Southern Staffordshire Councils was produced in 2010 and an addendum[4] published in 2011. A Phase 2 SWMP study[5] was undertaken following the identification of 5 key settlements which were highlighted as 'red' with regards to overall surface water flooding.

2.10 The Phase 1 SWMP and addendum[6] has been reviewed and will be referenced within this report where applicable. The Phase 2 Cannock Town SWMP has been reviewed as the site is shown to be partially located within the area identified.

Local Plan

2.11 The Cannock Chase Local Plan (Part 1)[7] aims to help shape the way in which the physical, economic, social and environment characteristics of Cannock Chase District will change between 2006 and 2028.

2.12 Policy *CP16 – Climate Change and Sustainable Resource Use*, notes that development in high flood risk areas should be avoided and the water environment should be protected through Sustainable Drainage.

2.13 It is noted that Land East of Wimblebury Road will continue to be safeguarded for potential development beyond the plan period subject to consideration within the Local Plan and/or Local Plan review or replacement.

2.14 Cannock Chase has published the Cannock Chase Local Plan Pre-Submission Regulation 19 Document[8] for public consultation. The Local Plan is designed to guide and manage the development of the District and is intended to replace the existing Cannock Chase Local Plan 2014.

2.15 The site is proposed for allocation of residential development under *Policy SH2: Land East of Wimblebury Road, Heath Hayes*. This proposed allocation comprises approximately 400 dwellings located on 17.9ha of land which comprises 6.4ha of safeguarded land identified in the 2014 Local Plan and an adjacent 11.5ha of land will be released from the Green Belt (Site S1).

[4] Phase 1 Surface Water Management Plan (Stafford Borough, Lichfield District, Tamworth Borough, South Staffordshire District and Cannock Chase District Councils, July 2010)
[5] Phase 2 Surface Water Management Plan – Cannock Town (Stafford Borough, Lichfield District, Tamworth Borough, South Staffordshire District and Cannock Chase District Councils, July 2011)
[6] Phase 1 Addendum Surface Water Management Plan (Stafford Borough, Lichfield District, Tamworth Borough, South Staffordshire District and Cannock Chase District Councils, April 2011)
[7] Local Plan (Part 1) (Cannock Chase District Council, 2014)
[8] Cannock Chase District Local Plan Pre-Submission (Regulation 19) (Cannock Chase District Council, December 2023)

2.16 The allocation notes state:

- 'Development should have no significant adverse impact on the environmental quality of the Chasewater and Southern Coalfields Heaths SSSI or the water quality of Cannock Extension Canal SAC. The Planning Application will be supported by a Drainage Strategy which will outline necessary mitigation measures to avoid significant adverse impacts'.
- 'The development will incorporate new or enhanced attenuation ponds and SUDS features within the greenspace to provide sustainable drainage systems on the site and help with flood mitigation downstream in Norton Canes, subject to the findings of a site-specific flood risk assessment'.

2.17 *Policy SO8.4: Managing Flood Risk* notes that the Local Planning Authority will manage flood risk within the District by directing development away from areas at highest risk. It is outlined that all major development proposals will:

- Incorporate sustainable water management measures to reduce water use, and increase its reuse, minimise surface water runoff and ensure that it does not increase flood risks or impact water quality elsewhere.
- Reduce the risk of flooding and maximise flood protection by including features such as trees and planting, water bodies, retention ponds and filters beds, and permeable paving. Surface water drainage requirements should work with the local topography to create low maintenance sustainable drainage systems.

Fluvial Flood Risk

2.18 A representation of flood risk posed from fluvial sources using the EA's Flood Map for Planning is shown in Figure 2.1. Both *SH2* and *S1* are located entirely within Flood Zone 1 (Low Probability of flooding from rivers or the sea). The nearest Flood Zone extents are located approximately 1.8km north west of *SH2*, associated with the Ridings Brook, and 1.6km south east of *S1*, associated with Chasewater.

2.19 Consultation has previously been undertaken with the EA, however, they hold no information for the site due to its location in Flood Zone 1 and the lack of nearby Main Rivers. An updated request has been made, however, a response is yet to be received.

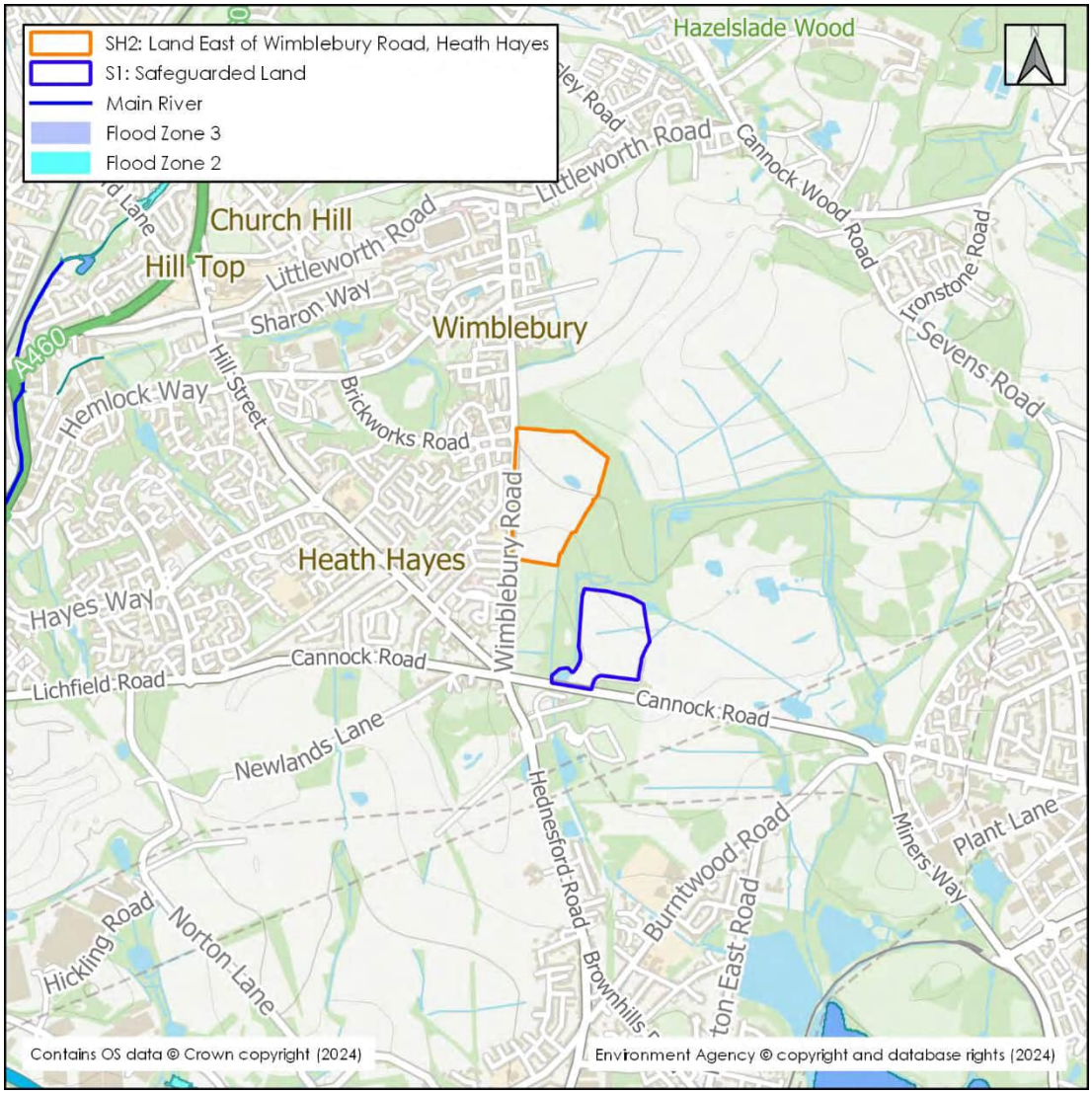

Figure 2.1: EA Flood Map for Planning

SH2 – Land East of Wimblebury Road, Heath Hayes

2.20 As part of the previous study and site walkover, ditches and drains were identified within the site, as shown in Figure 2.2. An ordinary watercourse is also shown to flow in a southerly direction to the east of the site where it then continues south past S1. Due to their small size, they are not represented within the Flood Map for Planning.

2.21 The northern ditch is shown to have a topographical high point within the centre of the channel and therefore the channel falls towards both the north west and the south east. Flows within the ditch are thought to be low due to the small catchment size, however, mitigation to protect against any residual risk of flooding should be assessed as part of any future Flood Risk Assessment (FRA).

2.22 Two culverts are shown on the topographical survey to outfall to the ditch adjacent to the ordinary watercourse. The alignment and connectivity of the culverts is not known, and they are not shown to be part of the public sewer network, so further investigation will be required.

2.23 The drain within the centre of the site was observed to be a less defined channel and is thought to serve as more of a land drainage feature.

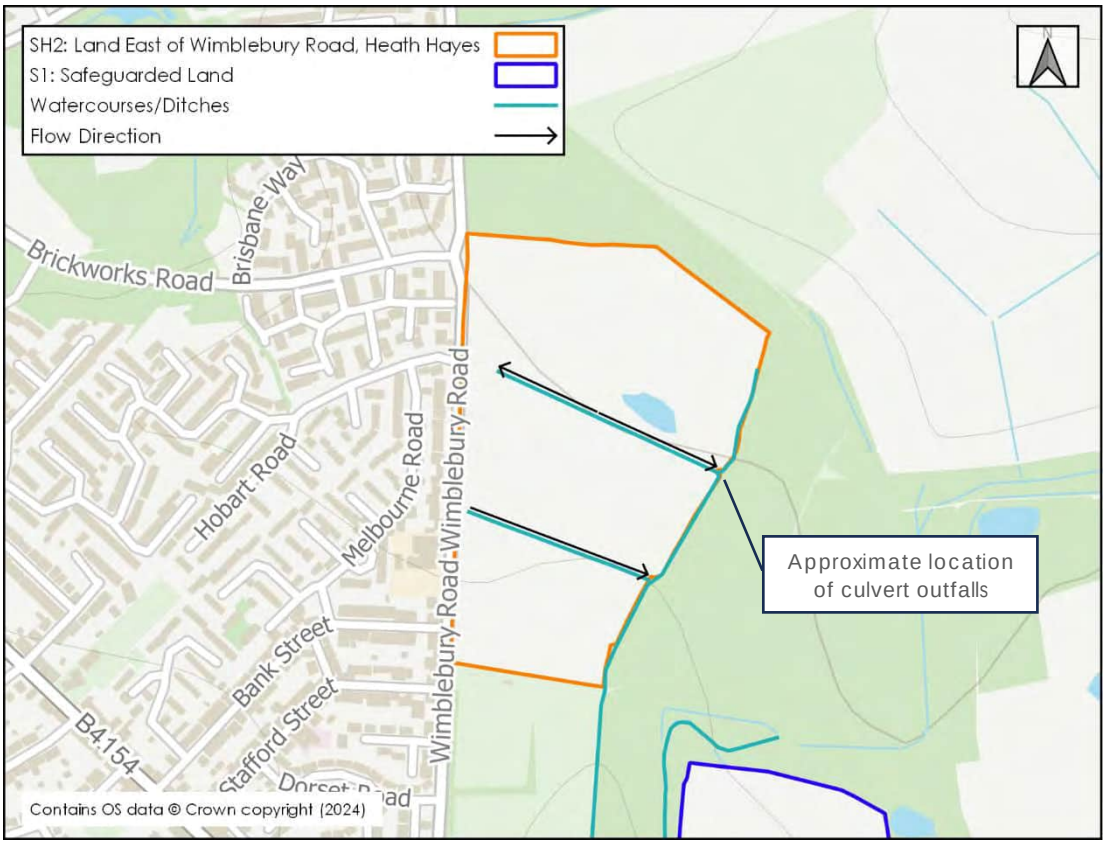

Figure 2.2: Watercourses and Ditches Observed within SH2

S1 – Safeguarded Land

2.24 As part of the previous study ditches and drains were identified within the site, as shown in Figure 2.3. An ordinary watercourse is also shown to flow from SH2 in a southerly direction to the west of the site where it then continues south beneath Cannock Road. Due to their small size, they are not represented within the Flood Map for Planning.

2.25 A ditch is located to the north west and west of the site and flows in a southerly direction where is outfalls to a pond to the west of the site. The ditch then flows from the pond in a south westerly direction to a larger pond located within the south west of the site. This has not been captured on the topographical survey due to dense vegetation. The larger pond in the south west of the site outfalls to the ordinary watercourse to the west of the site.

2.26 The site is shown to be raised between approximately 0.3m-1.8m above the ditch located to the west of the site.

2.27 OS mapping indicates a watercourse within the centre of the site, however, no feature was observed to be visible at the time of the topographical survey and it is therefore assumed to have been land drainage which no longer exists.

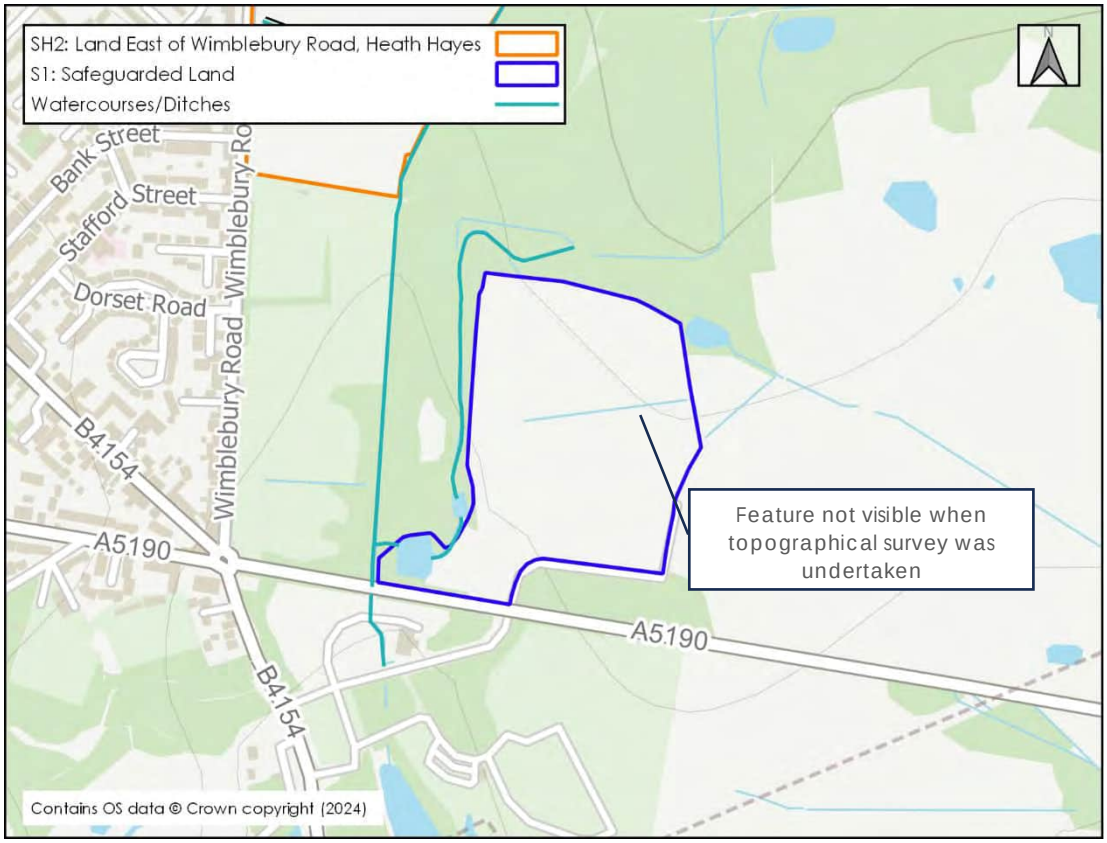

Figure 2.3: Watercourses and Ditches Observed within S1

2.28 The SFRA notes that there should be no built development within 8m from the top of a watercourse or main river. The ditches should be retained and maintained in order to allow water to drain from the site.

Pluvial Flood Risk

2.29 Mapping of surface water flood risk has been used to determine the risk of surface water flooding at the site, an excerpt of which is included within Figure 2.4. A limitation of the mapping is that it does not represent connectivity of culverts, and as such can lead to an exaggeration of the extent of surface water flooding.

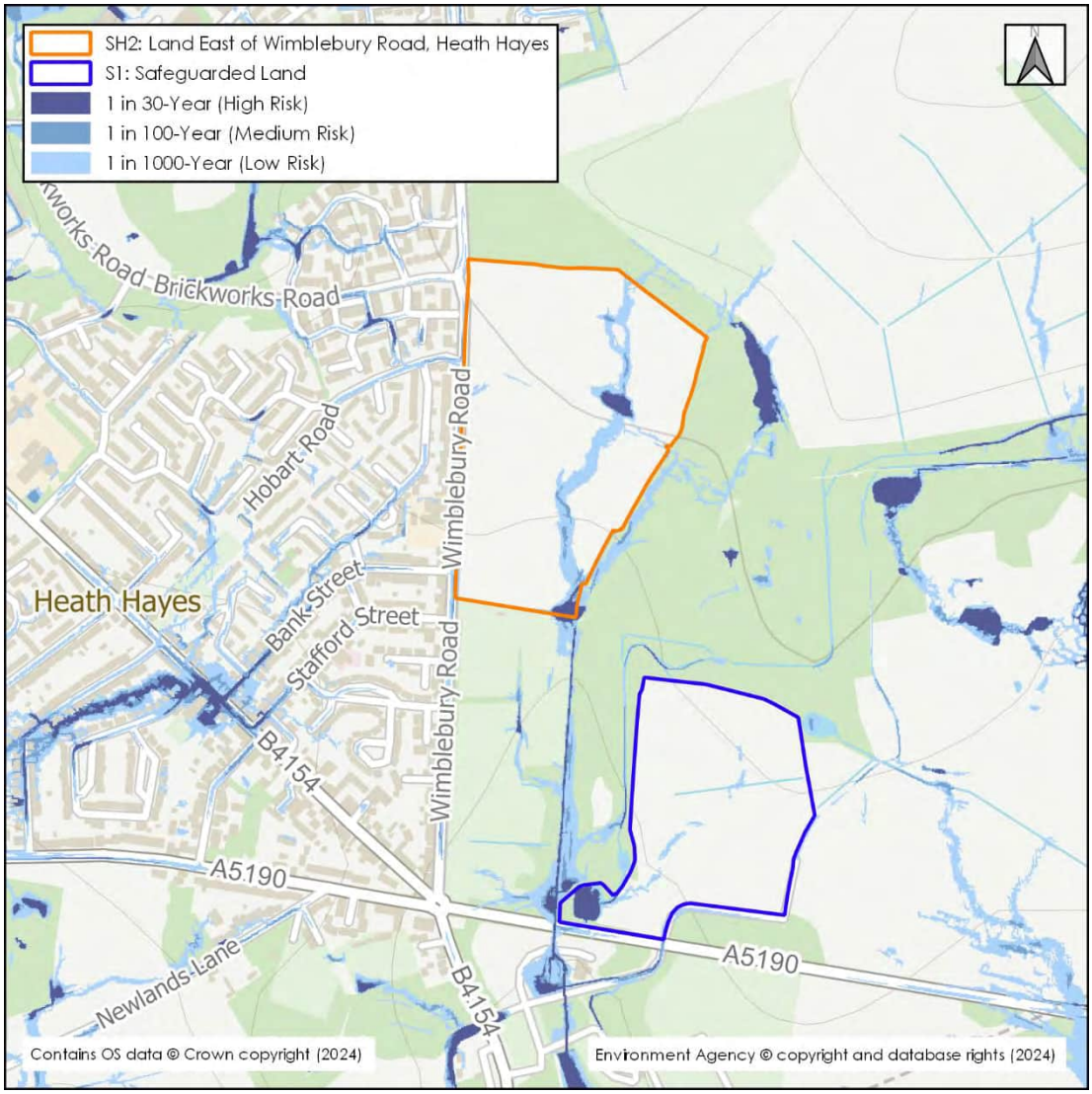

Figure 2.4: EA Surface Water Flood Risk Mapping

SH2 – Land East of Wimblebury Road, Heath Hayes

2.30 The existing on-site ditches are not represented within the LiDAR and therefore these features are not included within the surface water mapping. A bespoke site-specific pluvial hydraulic modelling exercise was undertaken in July 2022 to determine a more accurate representation of the surface water flow routes and flood risk present within the site.

2.31 The modelled pluvial floodplain extents are shown in Figure 2.5 and are summarised within the Hydraulic Model Report (reference: WRC-BWB-ZZ-XX-RP-YE-0003). The hydraulic modelling shows a reduction in flood extents across the site. This is thought to be attributed to improved conveyance, through the addition of in-channel structures, added floodplain features and improved model resolution.

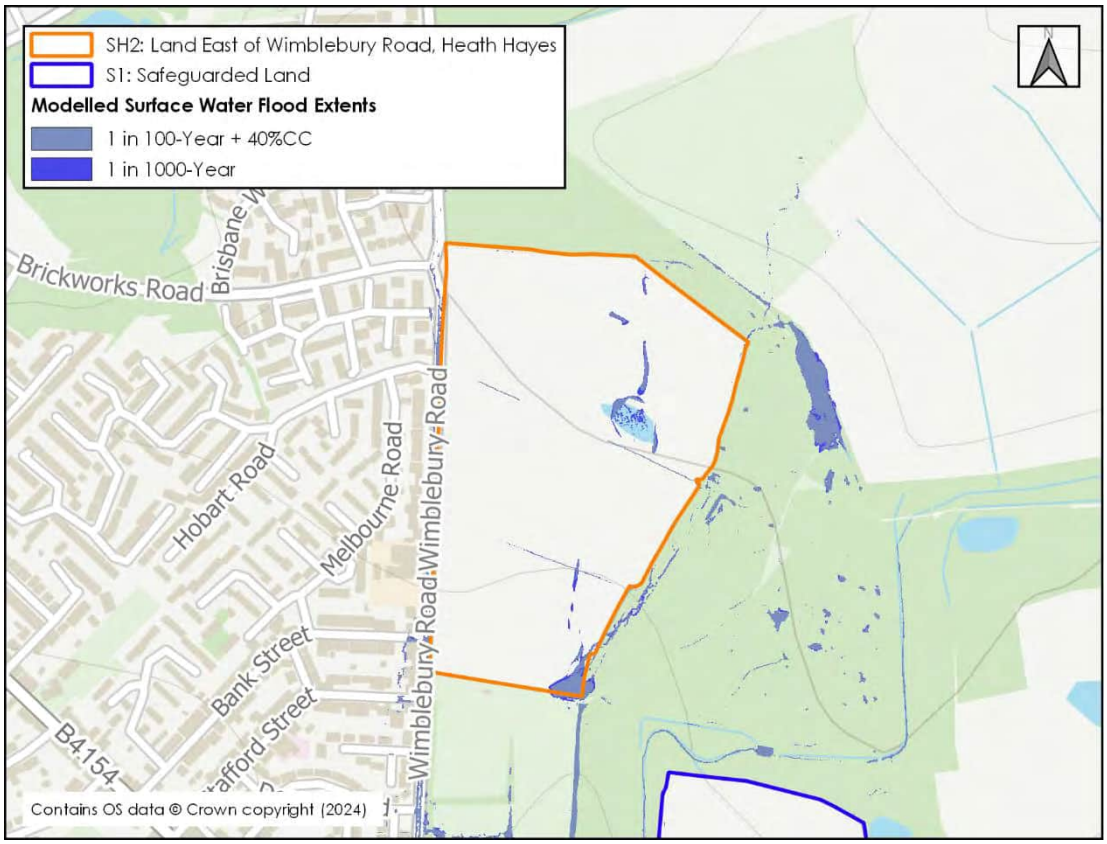

Figure 2.5: SH2 Modelled Surface Water Extents

S1 – Safeguarded Land

2.32 The modelled pluvial floodplain extents are shown in Figure 2.6. The hydraulic modelling shows a reduction in flood extents across the site. This is thought to be attributed to improved conveyance, through the addition of in-channel structures, added floodplain features and improved model resolution.

Figure 2.6: SH1 Modelled Surface Water Extents

2.33 It is recommended that development and surface water drainage basins are located outside of the 1 in 100-year + 40% climate change (CC) extents and that consideration of the 1 in 100-year + 40%CC event is given in the preparation of a masterplan.

Groundwater Flood Risk

2.34 British Geological Survey (BGS) mapping shows both SH2 and S1 to be underlain by Pennine Middle Coal Measures Formation (Mudstone, Siltstone and Sandstone).

2.35 Superficial deposits of Glaciofluvial Deposits, Devensian (Sand and Gravel) are shown to be present within SH2 with Till, Devensian (Diamicton) shown to be present within the south of S1.

2.36 The combined Phase 1 and 2 Report completed in December 2022 (reference: ST18772-0002) notes that groundwater was encountered within *SH2* within one windowless sample borehole (WS201) from 3m below ground level (bgl) and groundwater seepage was observed in two trial pits at depths of 3m (TP201) and 3.3m bgl (TP202). During the groundwater level monitoring, groundwater was encountered in 19 monitoring boreholes at a variety of depths ranging from surface level (WS225) to 4.64m bgl (WS222).

2.37 The combined Phase 1 and 2 Report completed in December 2022 (reference: ST19385-0001) notes that groundwater was encountered within *S1* within two windowless sample boreholes during drilling at 2.68m bgl (WS03) and 4m bgl (WS07). Seepage was observed within TP02, TP11 and TP12 at depths between 1.7m bgl and 3.8m bgl.

2.38 The SFRA mapping shows the majority SH2 to be located within an area considered to be at a greater than or equal to 25% but less than 50% susceptibility to groundwater flooding. The north east of *SH2* is shown to be at a less than 25% susceptibility to groundwater flooding.

2.39 The SFRA mapping shows the majority of S1 to be at a less than 25% susceptibility to groundwater flooding. The western portion is shown to be at a greater than or equal to 25% but less than 50% susceptibility to groundwater flooding and a portion to the south is shown to be at a greater than or equal to 50% but less than 75% susceptibility to groundwater flooding.

2.40 Based on this data, and because watercourse and land drainage features are present in close proximity to the site, groundwater flood risk is not expected to be a constraint at this stage. However, there may be a higher risk of shallow groundwater close to the existing watercourses. This would be addressed by applying the recommended 8m standoff from watercourses.

Other Sources of Flood Risk

2.41 There are no canals within the vicinity of the site and the site is shown to be located outside of the floodplain of any reservoir failure. Therefore, these sources of flooding are not considered to preclude future development at this location.

2.42 There are no Severn Trent Water (STW) public sewer assets within the site, as shown in Appendix 2. The topographical survey shows several manholes to be located within the northern portion of *SH2* and therefore it is likely that they are either private drainage features, or public drainage features that not recorded on STW records. It is recommended that a CCTV survey is undertaken to determine whether sewers, drains and/or culverts are located within the site and establish the path and connectivity. These features may require consideration within the masterplan via diversions or easements.

3. PRELIMINARY DRAINAGE REVIEW

Sustainable Drainage Guidance

3.1 Sustainable Drainage Systems (SuDS) aim to reduce the impact of development by replicating the natural runoff regime in a sustainable, cost-effective manner, whilst protecting water quality and reducing pollution. The four key objectives of SuDS design are to achieve improvements in water quantity, water quality, amenity provision and biodiversity.

Peak Rainfall Climate Change Allowances

3.2 Predicted future changes in peak rainfall intensity caused by climate change are provided by the EA. Table 2 from the EA's 'Flood risk assessments: climate change allowances'[9], included as Table 3.1, shows the anticipated changes in peak rainfall intensity for the site. The site is located within both the Tame Anker and Mease Catchment and Trent Valley Staffordshire Management Catchment.

Table 3.1: Peak Rainfall Climate Change Allowances for the Tame Anker and Mease Management Catchment and the Trent Valley Staffordshire Management Catchment

Allowance Category	Total potential change anticipated for **the '2050s' epoch (2022 to 2060)**		Total potential change anticipated **for the '2070s' epoch (2061 to 2125)**	
	1 in 30-Year	1 in 100-Year	1 in 30-Year	1 in 100-Year
Tame Anker and Mease				
Upper End	35%	40%	35%	40%
Central	20%	20%	25%	25%
Trent Valley Staffordshire				
Upper End	35%	40%	35%	40%
Central	20%	25%	25%	25%

3.3 The future increase in rainfall will need to be considered when designing a development to ensure its drainage system is sufficient for its lifetime and that it does not increase flood risk elsewhere.

3.4 The EA's guidance on peak rainfall intensity climate change allowances states that residential development should be considered to have a minimum lifetime of 100 years. Therefore, the proposed development falls into the 2070s epoch and the 'Upper End' climate change allowance should be used.

[9] https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

3.5 Based on the guidance detailed above, a 40% climate change allowance will be applied to the 1 in 100-year rainfall event. It should be noted that the 1 in 30-year + climate change event will need to be considered in the detailed design stage.

Sustainable Drainage Systems (SuDS) Handbook

3.6 Staffordshire County Council in their role as LLFA, have published a Sustainable Drainage Systems (SuDS) Handbook[10]. The guidance notes:

i. For greenfield developments, the peak runoff rate from the development to any highway drain, sewer or surface water body for the 100% Annual Exceedance Probability rainfall event and the 1% Annual Exceedance Probability rainfall event should never exceed the peak greenfield runoff rate for the same event.

ii. An allowance for an increase in impermeable area will be expected, to accommodate urban creep as shown in Table 3.2.

iii. The LLFA will expect SuDS design to include an allowance for a 20-30% increase in rainfall for the 1% Annual Probability rainfall event. It is noted within the guidance that this is subject to change and therefore the most up to date must be referenced, therefore an allowance of 40% will be considered in line with the latest EA guidance.

iv. The LLFA will expect all surface water storage ponds to provide a 300mm freeboard above the predicted water level arising from a 1% Annual Exceedance Probability rainfall event inclusive of an allowance for climate change.

Table 3.2: Urban Creep Allowance

Residential Development Density, Dwellings per Hectare	Change Allowance % of Impermeable Area
≤ 25	10
30	8
35	6
45	4
≥ 50	2
Flats & Apartments	0

[10] Sustainable Drainage Systems (SuDS) Handbook (Staffordshire County Council, February 2017)

Surface Water Management

Existing Conditions

3.7 The total area of *SH2* is approximately 17.9ha and the total area of *S1* is approximately 11.1ha. It is expected that both sites currently drain through a combination of limited localised infiltration into the ground, followed by rapid surface water runoff when the infiltration potential is exceeded. The levels generally fall towards drains and watercourses located within and adjacent to the sites.

3.8 An assessment of the equivalent greenfield surface water runoff rates per hectare has been undertaken and is summarised within Table 3.3 and included as Appendix 3.

Table 3.3: Existing Greenfield Runoff Rate per Hectare

Return Period (Yrs.)	Runoff Rate (l/s/ha)
1	4.0
Mean Annual Flow Rate (QBAR)	4.8
30	9.4
100	12.4

Drainage Hierarchy

3.9 National policy and guidance identify that surface water runoff should be disposed of as high up the following hierarchy as possible:

i. Infiltration into the Ground
ii. Discharge to a Watercourse
iii. Discharge to a Surface Water Sewer or Highway Drainage
iv. Discharge to a Combined Sewer

3.10 The site is shown to be underlain by Pennine Middle Coal Measures Formation (Mudstone, Siltstone and Sandstone) with superficial deposits of Glaciofluvial Deposits (Sand and Gravel) and Till, Devensian (Diamicton).

3.11 Site specific soakaway testing should be undertaken at the appropriate juncture, to determine whether infiltration is viable in this location. For the purpose of this assessment, it has been assumed that infiltration is not viable.

3.12 Due to the presence of an existing drain and watercourses within the site and the vicinity of the site, it is proposed to continue discharging surface water from the site to these, following development, in line with existing conditions.

Surface Water Drainage Concept

3.13 A total development area of approximately 14.33ha has been measured within *SH2* and a total development area of approximately 8.44ha has been measured within *S1*, based on a concept masterplan. Due to the topography of the site and existing site constraints, the site has been split into nine surface water drainage catchments, with the greenfield QBAR runoff rate calculated for the respective development area.

3.14 Catchment details are provided within Table 3.4. The catchment-based approach will treat and attenuate surface water runoff as close to its source as possible. It is assumed at this time that 65% of the developable area will be impermeable with a 10% allowance being applied to account for urban creep. 100% of the basin area has been included within the developable area and impermeable area. The spine road has been assumed to be 100% impermeable and the embankment 20% impermeable.

Table 3.4: Catchment Details

Site Name	Catchment Name	Development Area (ha)	Impermeable Area (ha)	Greenfield QBAR Runoff Rate (l/s)	Proposed Runoff Rate (l/s)
Site SH2: Land East of Wimblebury Road, Heath Hayes	Catchment 1	2.48	1.91	11.9	11.9
	Catchment 2	3.48	2.57	16.7	16.7
	Catchment 3	2.72	2.01	13.1	13.1
	Catchment 4	1.05	0.78	5.0	5.0
	Catchment 5	4.60	3.25	22.1	22.1
Site *S1:* Safeguarded Land	Catchment A	0.95	0.71	4.6	16.8
	Catchment B	2.55	1.88	12.2	
	Catchment C	2.90	2.14	13.9	23.7
	Catchment D	2.04	1.52	9.8	

3.15 Simulations have been run using Micro Drainage 'Source Control' to identify the necessary storage provision for each catchment. Using the restrictions detailed in Table 3.4, the volume of attenuated storage for each catchment has been calculated for storm events up to the 100-year + 40% climate change storm. The results are summarised in Table 3.5 and included as Appendix 4.

Table 3.5: Outline Attenuated Storage Requirements

Site Name	Rainfall Method	Critical Storm	Maximum Volume (m^3)	Proposed Runoff Rate (l/s)
SH2 Land East of Wimblebury Road, Heath Hayes	*Catchment 1*			
	Flood Estimation Handbook (FEH)	600 min Winter	1445	11.9
	Flood Studies Report (FSR)	600 min Winter	1204	
	Catchment 2			
	FEH	600 min Winter	1928	16.7
	FSR	600 min Winter	1604	
	Catchment 3			
	FEH	600 min Winter	1497	13.1
	FSR	600 min Winter	1245	
	Catchment 4			
	FEH	600 min Winter	579	5.0
	FSR	600 min Winter	480	
	Catchment 5			
	FEH	600 min Winter	2418	22.1
	FSR	600 min Winter	2012	
Site S1 Safeguarded Land	Catchment A			
	FEH	720 min Winter	558	16.8
	FSR	600 min Winter	453	
	Catchment B			
	FEH	600 min Winter	1403	12.2
	FSR	600 min Winter	1166	
	Catchment C			
	FEH	600 min Winter	1595	13.9
	FSR	600 min Winter	1326	
	Catchment D			
	FEH	600 min Winter	1160	23.7

	FSR	600 min Winter	965	

3.16 At this time it has been assumed that surface water will be stored within above ground detention basins at the lowest point of each catchment. A Conceptual Surface Water Drainage Strategy is included within Appendix 5 (reference: WRC-BWB-ZZ-XX-DR-CD-0013).

3.17 In the cases where one basin is proposed to discharge into another, prior to the outfall into the watercourse, a cascade has been modelled. In such a scenario the total runoff from the two catchments does not exceed the greenfield QBAR rate.

3.18 Surface water surface water drainage basins are located outside of the 1 in 100-year + 40%CC modelled surface water extents as per recommendations set out within the Hydraulic Modelling Report. Development is located outside of the modelled surface water flood extents however there are several proposed roads crossing the ditch, drain and watercourse to the east. It is recommended that any crossings clear span the channel or culverts are sized appropriate and account for sufficient freeboard. The potential proposed crossing in the south east should also consider the surface water flood extents.

3.19 Surface water extents are shown to be present within SH2, and therefore green corridors should be considered in these locations.

3.20 For the purpose of this high-level assessment, the basins have been designed to have a depth of 1.4m and include for a 400mm freeboard in the 1 in 100-year + 40%CC event to enable adoption by the local sewerage undertaker. The maximum water depth is therefore 1.0m.

3.21 The basins will outfall to a drain, ditch or watercourse either directly or via another catchment. All basins will outfall at a controlled rate a via a vortex flow control. A gravity outfall for each catchment should be achievable.

3.22 Due to the topography of the site, it is recommended that an earthworks exercise of the proposed basins is undertaken to determine the associated land take from the tie in batters.

3.23 For the purpose of this assessment, it has been assumed that the basins will accommodate all of the necessary storage provision, but it may be possible to redistribute a portion of the storage within other drainage components during the detailed design of the development (e.g. in the pipe network, swales, filter drains etc).

3.24 Water quality should be considered within the drainage strategy to capture any potential pollutants in the runoff from the development and the Simple Index Approach should be used to determine the pollution hazard indices based on land use to determine the SuDS features needed. Further features such as conveyance swales, bioretention areas and pervious pavements should be incorporated into the development and included within the detailed design.

3.25 Where possible, basins should be enhanced with low flow channels, variable depths and forebays, these have been illustrated within the Surface Water Drainage Strategy.

3.26 A greater focus is being placed upon sustainability and therefore it is strongly recommended that other SuDS features, in particular source control measures, are included in the masterplan as well, as opposed to just the traditional end of system basin.

3.27 As part of any future planning application, the conceptual drainage strategy should be developed into a more detailed drainage strategy, which should be created alongside the masterplan, to ensure that a suitable area is designated for SuDS in line with local and national guidance, whilst considering the four pillars of SuDS design (amenity, biodiversity, water quality and water quantity).

Foul Water Management

3.28 It is recommended that a Developer Enquiry is submitted to STW to determine the capacity of the surrounding network.

3.29 The levels of the site are such that it is unlikely that a gravity connection would be achievable for the entire site to the public foul water network. It is therefore expected that foul water will be able to outfall to the public network via gravity for Catchment 1, 2 and a portion of Catchment 3 and a foul pumping station will be required to serve the remainder of *SH2* and all of *S1*. The foul pumping station will be located at the lowest point within the development area and with a 15m cordon sanitaire where no habitable dwelling is permitted. The pumping station should have vehicular access appropriate for a tanker and be designed in accordance with the latest guidance. An indicative location is shown on the Conceptual Surface Water Drainage Strategy included within Appendix 5.

3.30 The foul pumping station should be sized appropriately to ensure it can accommodate future flows from a portion of Catchment C located within the wider site allocation. The remainder of the wider site allocation is expected to drain via gravity via Catchment 1 and therefore the pipe work may need to be sized to accommodate future development.

3.31 Further details on proposed layout considerations when foul water pumping station are required, are outlined within Section 4.

4. RECOMMENDATIONS AND FURTHER WORKS

4.1 An FRA and Sustainable Drainage Statement (SDS) will be required as part of any future planning application.

Flood Risk

Further Investigation of Existing Conditions

4.2 A CCTV/drainage connectivity survey of the culverts and existing manholes within the site should be undertaken to understand the path and connectivity of the culverts and sewers. This should also include a survey to determine the flow path and connectivity of the ditch located to the west of *S1*, between the two ponds

Development and Masterplan Considerations

4.3 The SFRA notes that there should be no built development within 8m from the top of a watercourse or main river. This will also apply to the culverted watercourses, which require confirmation of their route. Existing culverts and sewers may be able to be diverted around the site, subject to confirmation of their connectivity and purpose. Realistic opportunities to naturalise culverted sections of watercourses should be sought and the reinstatement of open waterways within the site should be promoted. This will provide biodiversity as well as amenity improvements.

4.4 The Hydraulic Model Report recommends that consideration will need to be given for the modelled 1 in 100-year + 40%CC surface water design event within the masterplan.

4.5 To mitigate against the residual risk of any shallow and slow-moving water, ground levels should be profiled to encourage pluvial runoff and overland flows away from built development and towards the nearest drainage point. It is recommended that finished floor levels are also raised 150mm above surrounding ground levels.

4.6 Proposed road crossings will need to consider the surface water flow routes and be clear span structures or suitably sized culverts with sufficient freeboard.

4.7 The SFRA notes that there should be no built development within 8m from the top of a watercourse or main river. However, the central drain is not considered to be a formal watercourse and therefore, it is recommended that a 2m maintenance buffer is applied. The ditches should be retained and maintained in order to allow water to drain from the site.

Surface Water and Foul Water

Further Investigation of Baseline Conditions

4.8 Infiltration testing should be undertaken in accordance with BRE 365 methodologies to confirm whether infiltration is viable at the site. It is recommended that groundwater levels are also established, as these can influence the feasibility of infiltration techniques.

4.9 A CCTV/drainage connectivity survey of the existing manholes within the sites should be undertaken to understand the path and connectivity of manholes. There may be easements associated with any drainage infrastructure found to be located within the site. This should also include a survey to determine the flow path and connectivity of the ditch located to the west of S1 between the two ponds.

4.10 Due to the topography of the site, it is recommended that an earthworks exercise of the proposed basins is undertaken to determine the associated land take from the tie in batters.

4.11 A Pre-Development Enquiry should be submitted to STW at the earliest possible convenience to better understand the capacity of the local sewer network.

Policy Considerations

4.12 A Section 106 agreement is required to connect to the public foul sewer. A Section 104 application would need to be submitted if the foul water and surface water assets within the site are intended to be put forward for adoption by STW. The proposals would need to meet the requirements set out in the Design and Construction Guidance[11].

4.13 Works affecting an ordinary watercourse may require consent from Staffordshire County Council.

4.14 A Surface Water Drainage Proforma should be submitted as part of a planning application to demonstrate that both the National Standards and Local Standards have been complied with. This is referred to as Appendix A within the Staffordshire County Council Sustainable Drainage Systems Handbook. Appendix C of the SuDS Handbook should also be completed if a hydraulic model has been used in support of a SuDS application as part of the planning application.

Development and Masterplan Considerations

4.15 A surface water drainage strategy which incorporates a range of SuDS into the development, in line with local and national requirements, should be implemented, in order to provide a range of benefits.

4.16 Any foul pumping stations within the site should be located at the lowest point within the developable area and will require a 15m cordon sanitaire. The pumping station should have vehicular access appropriate for a tanker and be designed in accordance with the latest guidance. The foul pumping station and gravity foul network should be sized appropriately to accommodate future development from the wider site allocation.

4.17 The LLFA will favour an approach with incorporates as many SuDS features as possible. Increasingly, LLFAs are requesting a "gully free" approach which utilises alternative features such as swales to convey runoff. This should be considered within the development aspirations.

[11] Design and Construction Guidance (March 2020)

4.18 It is recommended that the drains are maintained prior to development to ensure it is capable of conveying flows from the development.

APPENDICES

Appendix 1: Topographical Survey

Station Coordinates			
Station Name	Eastings (m)	Northings (m)	Height (m)
BWB01	402071.990	309845.597	181.897
BWB02	401986.088	309867.367	177.393
BWB03	401869.504	309878.975	171.839
BWB04	401803.423	309890.823	171.448

Notes

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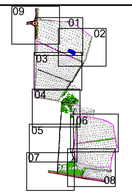
8. OS license number: 100022432

Key Plan



Legend

- OS Buildings
- Surveyed Buildings
- Building
- Wall
- Kerb Channel Line
- Top of Kerb
- Edge of Surface
- Top of Bank
- Bottom of Bank
- Canopy / Overhang
- Line Marking
- Centre Line
- Watercourse Centre Line
- Barrier
- Fence
- Gate
- Overhead Powerline
- Overhead Utilities
- Contour Lines
- Inspection Chamber
- Flow direction and pipe diameter (0.25 / 1)
- Station and Name (BH 1)
- Monitoring Borehole
- Tree / Bush / Sapling
- Area of Vegetation/ Extent of Tree Canopy
- Hedge
- Body of Water
- Body of Water from OS
- Spot Level (50.00)
- Assumed Surface Water Drainage Line
- Surface Water Drainage Line

AP	Anchor Point	FBW	Fence Barbed Wire	LB	Litter Bin
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Rev	Date	Details of issue / revision	Drw	Rev
P1	24.09.21	First Issue	SDS	DS

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Client

Taylor Wimpey Strategic Land

Project Title

Wimblebury Road, Cannock

Drawing Title

Existing Site Plan Sheet 1 of 9

Drawn:	S. D. Shreeves	Reviewed:	D. Smith	
BWB Ref:	BMW3009	Date:	24.09.21	Scale@A1: 1:500

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INFORMATION

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
WRC-BWB-00-01-DR-G-001	**S2**	**P1**

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BWB04	401803.423	309890.823	171.448

Track

Flooded Area

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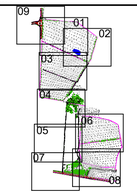

Legend

OS Buildings
Surveyed Buildings
Building
Wall
Kerb Channel Line
Top of Kerb
Edge of Surface
Top of Bank
Bottom of Bank
Canopy / Overhang
Line Marking
Centre Line
Watercourse Centre Line
Barrier
Fence
Gate
Overhead Powerline
Overhead Utilities

Contour Lines
Inspection Chamber
0.25 / 1 — Flow direction and pipe diameter
Station and Name
BH 1 — Monitoring Borehole
Tree / Bush / Sapling
Area of Vegetation/ Extent of Tree Canopy
Hedge
Body of Water
Body of Water from OS
+50.00 — Spot Level
Assumed Surface Water Drainage Line
Surface Water Drainage Line

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Rev	Date	Details of issue / revision	Drw	Rev
P1	24.09.21	First Issue	SDS	DS

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Taylor Wimpey Strategic Land

Project Title
Wimblebury Road, Cannock

Drawing Title
Existing Site Plan Sheet 2 of 9

Drawn:	S. D. Shreeves	Reviewed:	D. Smith	
BWB Ref:	BMW3009	Date:	24.09.21	Scale@A1: 1:500

Drawing Status
INFORMATION

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
WRC-BWB-00-02-DR-G-001	**S2**	**P1**

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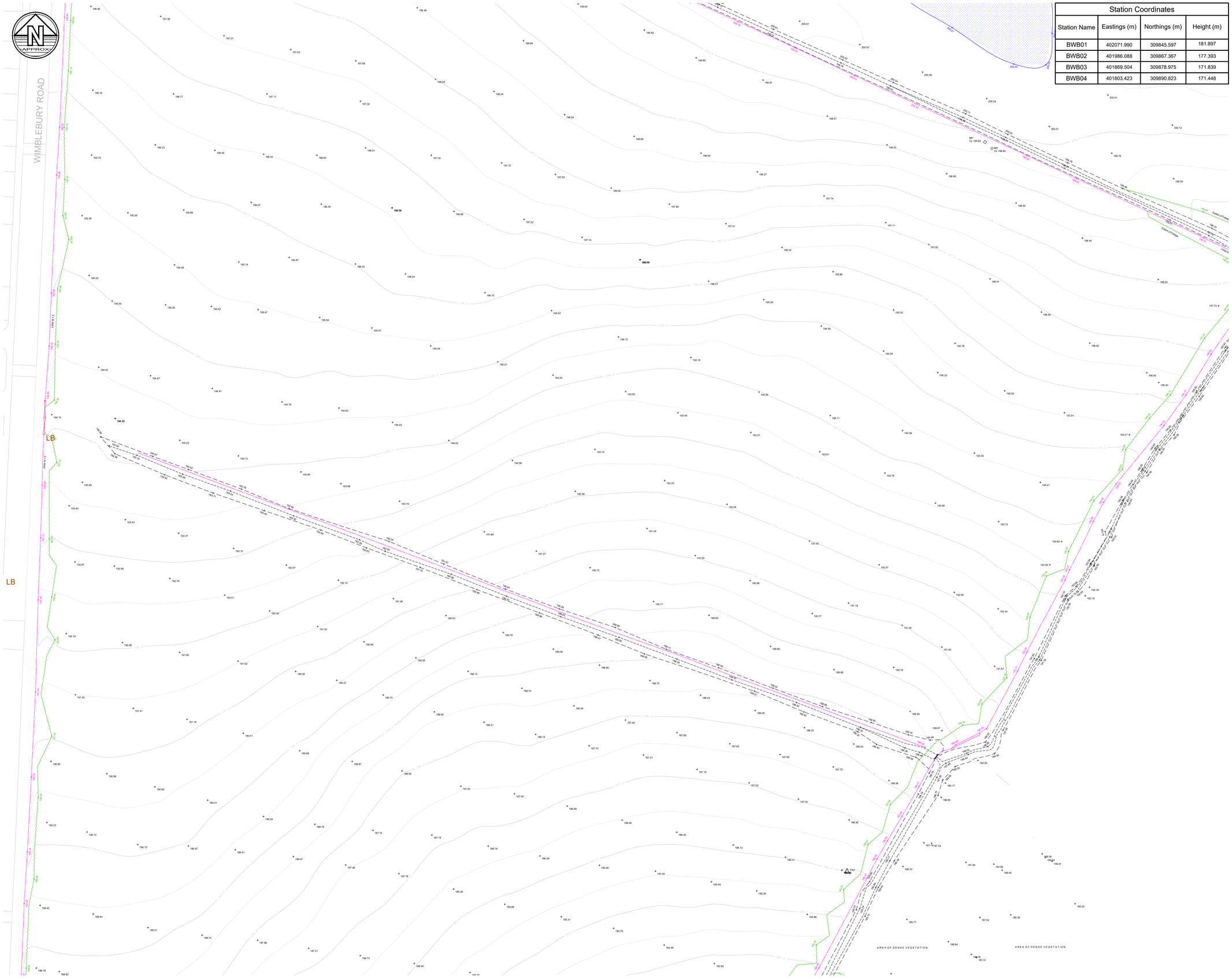

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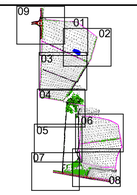

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Project Title

Wimblebury Road, Cannock

Drawing Title

Existing Site Plan Sheet 3 of 9

Drawn:	S. D. Shreeves	Reviewed:	D. Smith		
BWB Ref:	BMW3009	Date:	24.09.21	Scale@A1:	1:500

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INFORMATION

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
WRC-BWB-00-03-DR-G-001	**S2**	**P1**

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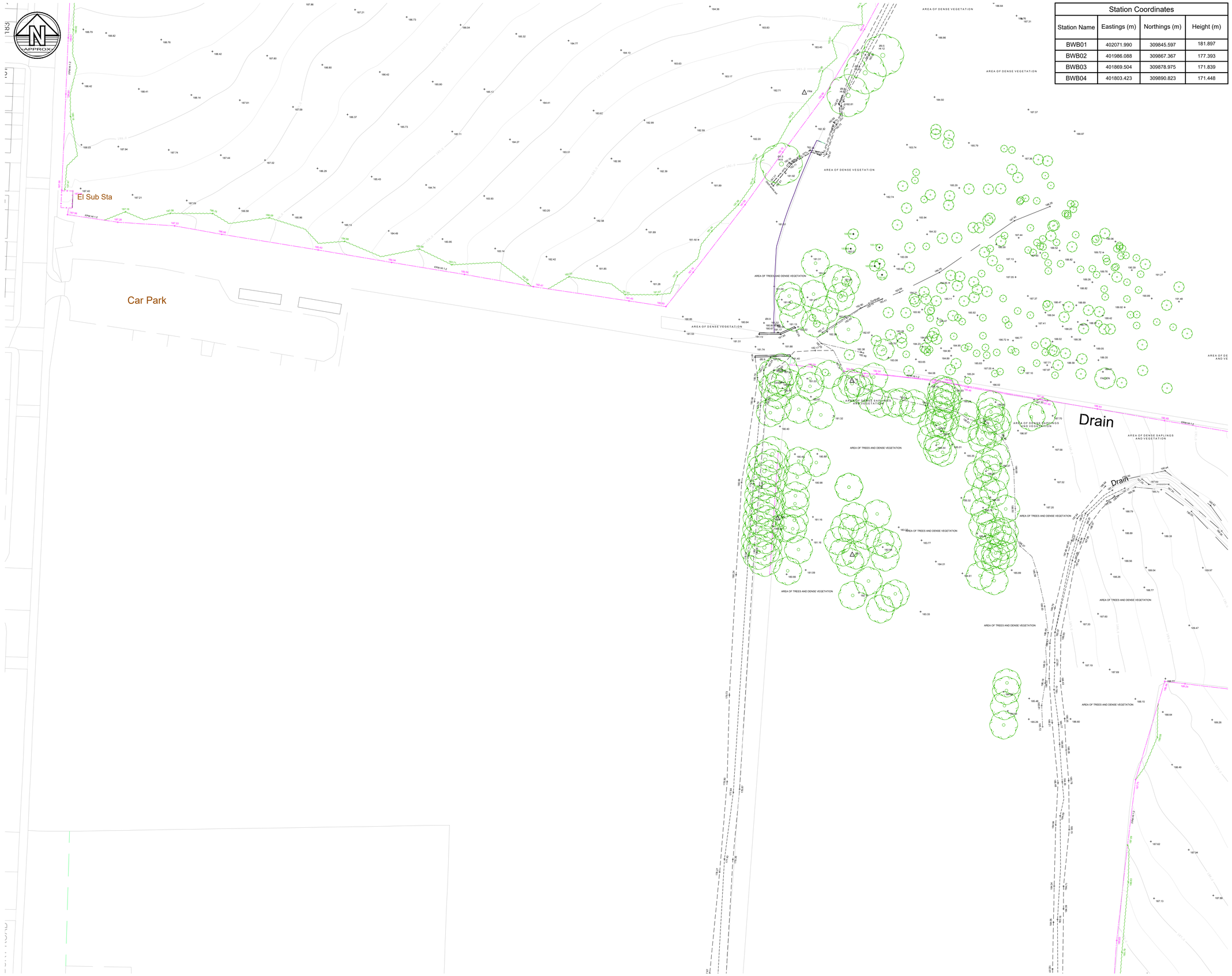

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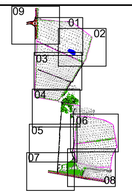

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Rev	Date	Details of issue / revision	Drw	Rev
P2	05.1.24	Survey Updated	IR	DS

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Project Title

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Drawing Title

Existing Site Plan Sheet 4 of 9

Drawn:	S. D. Shreeves	Reviewed:	D. Smith		
BWB Ref:	BMW3009	Date:	24.09.21	Scale@A1:	1:500

Drawing Status

INFORMATION

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
WRC-BWB-00-04-DR-G-001	**S2**	**P2**

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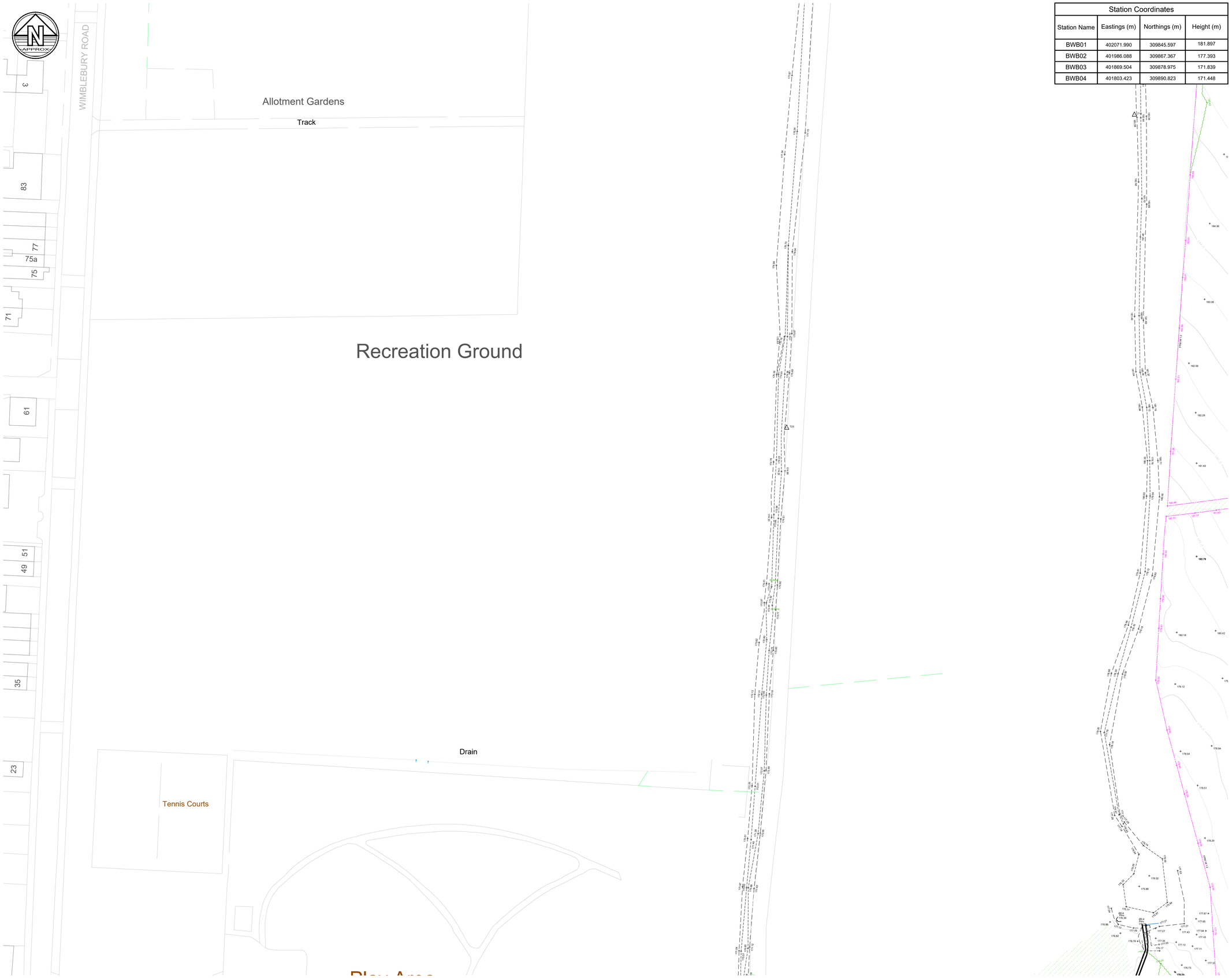

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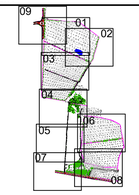

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- Body of Water from OS
- Spot Level (50.00)
- Assumed Surface Water Drainage Line
- Surface Water Drainage Line

AP	Anchor Point	FBW	Fence Barbed Wire	LB	Litter Bin
BG	Back Gully	FCB	Fence Closed Board	LP	Lamp Post
BO	Bollard	FCL	Fence Chain Link	MH	Manhole
BS	Bus Stop	FEL	Fence Electric	Mkr	Service Marker
BT	British Telecom	FMP	Fence Metal Panel	PB	Post Box
C	Crest	FMR	Fence Metal Railing	PT	Post
CL	Cover Level	FOB	Fence Open Board	RE	Rodding Eye
CMP	Cable Marker Post	FPW	Fence Post & Wire	SP	Sign Post
CCTV	Security Camera	FSP	Fence Steel Palisade	ST	Stop Tap
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DC	Drainage Channel	FFL	Finished Floor Level	TCB	Telephone Call Box
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ER	Earth Rod	Ht	Height	UTS	Unable to Survey
FH	Fire Hydrant	IC	Inspection Chamber	WL	Water Level
FL	Floodlight	IFL	Internal Floor Level	WM	Water Meter
		IL	Invert Level (as a reduced level)	WO	Wash Out

Rev	Date	Details of issue / revision	Drw	Rev
P1	24.09.21	First Issue	SDS	DS

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Client

Taylor Wimpey Strategic Land

Project Title

Wimblebury Road, Cannock

Drawing Title

Existing Site Plan Sheet 5 of 9

Drawn:	S. D. Shreeves		Reviewed:	D. Smith	
BWB Ref:	BMW3009	Date:	24.09.21	Scale@A1:	1:500

Drawing Status: **INFORMATION**

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
WRC-BWB-00-05-DR-G-001	**S2**	**P1**

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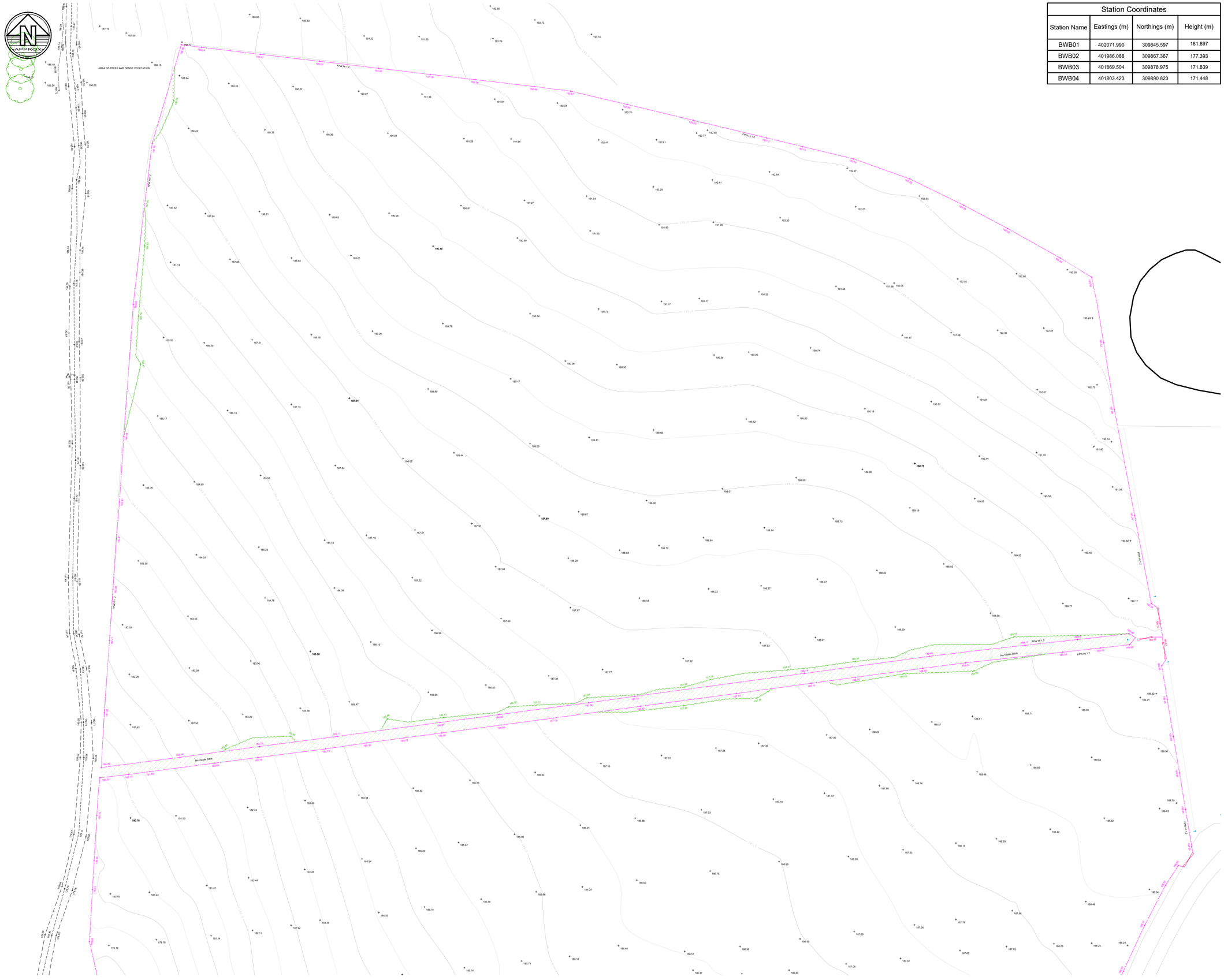

Station Coordinates			
Station Name	Eastings (m)	Northings (m)	Height (m)
BWB01	402071.990	309845.597	181.897
BWB02	401986.088	309867.367	177.393
BWB03	401869.504	309878.975	171.839
BWB04	401803.423	309890.823	171.448

Notes

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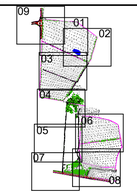
6. All coordinates and height data relate to OSGB36(15). Control stations are coordinated by means of GPS receiving real time corrections via OS smart net.
7. All manhole data is collected from ground level therefore discrepancies may occur. More accurate data is only achievable via confined space entry.
8. OS license number: 100022432

Key Plan



Legend

- OS Buildings
- Surveyed Buildings
- Building
- Wall
- Kerb Channel Line
- Top of Kerb
- Edge of Surface
- Top of Bank
- Bottom of Bank
- Canopy / Overhang
- Line Marking
- Centre Line
- Watercourse Centre Line
- Barrier
- Fence
- Gate
- Overhead Powerline
- Overhead Utilities
- Contour Lines
- Inspection Chamber
- Flow direction and pipe diameter (0.25 / 1)
- Station and Name
- Monitoring Borehole (BH 1)
- Tree / Bush / Sapling
- Area of Vegetation/ Extent of Tree Canopy
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Rev	Date	Details of issue / revision	Drw	Rev
P1	24.09.21	First Issue	SDS	DS

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Client

Taylor Wimpey Strategic Land

Project Title

Wimblebury Road, Cannock

Drawing Title

Existing Site Plan Sheet 6 of 9

Drawn:	S. D. Shreeves	Reviewed:	D. Smith	
BWB Ref:	BMW3009	Date:	24.09.21	Scale@A1: 1:500

Drawing Status

INFORMATION

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
WRC-BWB-00-06-DR-G-001	**S2**	**P1**

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Station Coordinates			
Station Name	Eastings (m)	Northings (m)	Height (m)
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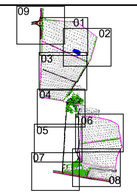
Key Plan



Legend

OS Buildings		Contour Lines	
Surveyed Buildings		Inspection Chamber	
Building		Flow direction and pipe diameter	0.25 / 1
Wall		Station and Name	
Kerb Channel Line		Monitoring Borehole	BH 1
Top of Kerb		Tree / Bush / Sapling	
Edge of Surface		Area of Vegetation/ Extent of Tree Canopy	
Top of Bank		Hedge	
Bottom of Bank		Body of Water	
Canopy / Overhang		Body of Water from OS	
Line Marking		Spot Level	50.00
Centre Line		Assumed Surface Water Drainage Line	
Watercourse Centre Line		Surface Water Drainage Line	
Barrier			
Fence			
Gate			
Overhead Powerline			
Overhead Utilities			

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FH	Fire Hydrant	IL	Invert Level (as a reduced level)	WO	Wash Out
FL	Floodlight				

Rev	Date	Details of issue / revision	Drw	Rev
P2	05.01.24	SURVEY UPDATED	IR	DS

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Client

Taylor Wimpey Strategic Land

Project Title

Wimblebury Road, Cannock

Drawing Title

Existing Site Plan Sheet 8 of 9

Drawn:	S. D. Shreeves	Reviewed:	D. Smith		
BWB Ref:	BMW3009	Date:	24.09.21	Scale@A1:	1:500

Drawing Status

INFORMATION

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
WRC-BWB-00-08-DR-G-001	**S2**	**P2**

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Wimblebury M

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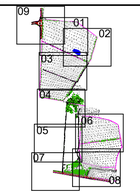

Legend

OS Buildings
Surveyed Buildings
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Wall
Kerb Channel Line
Top of Kerb
Edge of Surface
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Line Marking
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Rev	Date	Details of issue / revision	Drw	Rev
P1	05.01.24	Survey Updated	IR	DS

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Client

Taylor Wimpey Strategic Land

Project Title

Wimblebury Road, Cannock

Drawing Title

Existing Site Plan Sheet 8 of 9

Drawn:	S. D. Shreeves	Reviewed:	D. Smith		
BWB Ref:	BMW3009	Date:	24.09.21	Scale@A1:	1:500

Drawing Status

INFORMATION

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
WRC-BWB-00-08-DR-G-001	**S2**	**P1**

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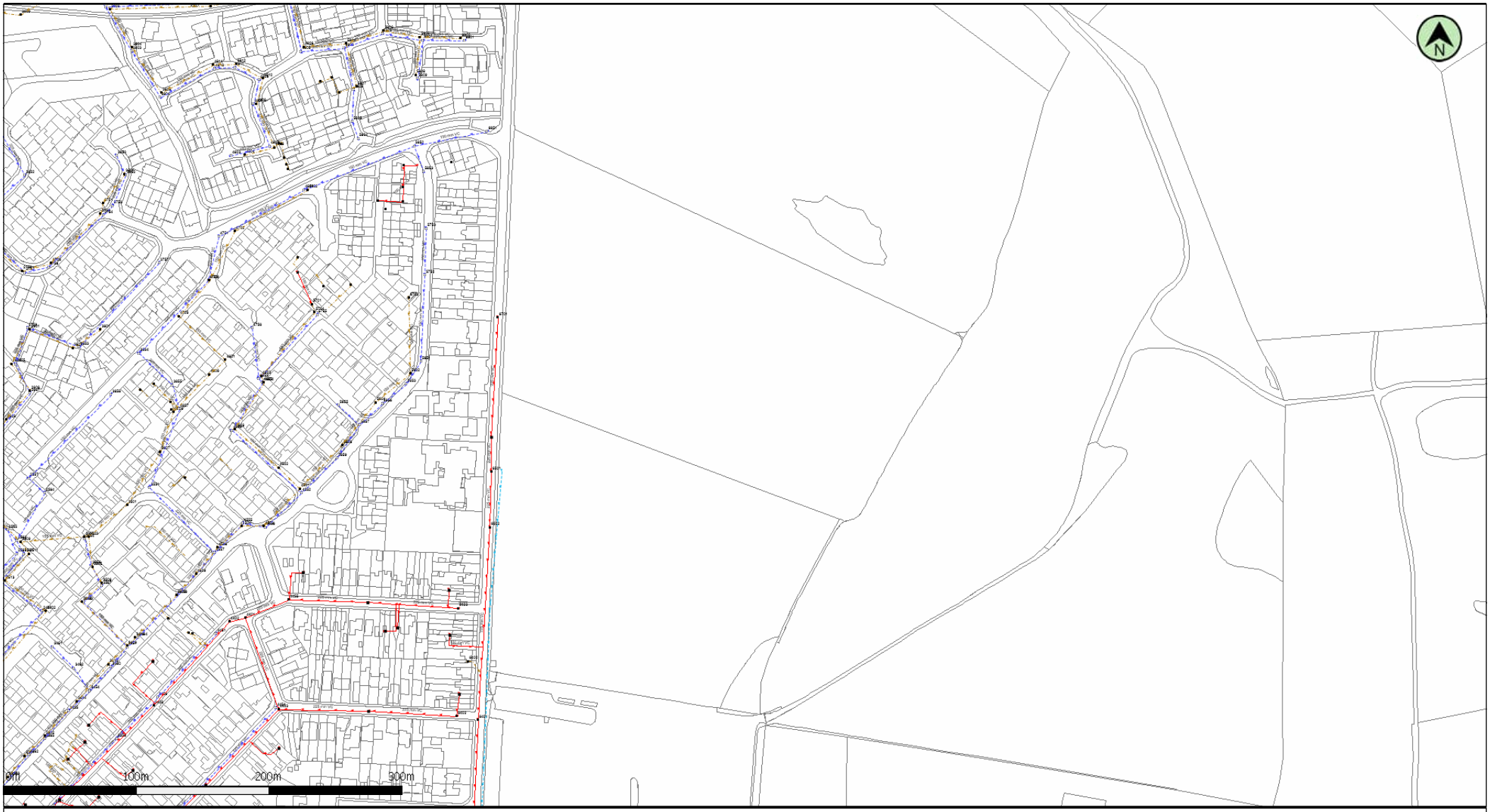
Appendix 2: Severn Trent Water Sewer Records



Date: 19/07/23 Scale: 1:4032 Map Centre: 401826,310642 Data updated: 14/07/23 Wastewater Plan A4

- Public Foul Gravity/Lateral Drain
- Public Combined Gravity/Lateral Drain
- Public Surface Water Gravity/Lateral Drain
- Pressure Foul
- Pressure Combined
- Pressure Surface Water
- Highway Drain
- Overflow Pipe
- Disposal Pipe
- Culverted Water Course
- Pumping Station
- Fitting
- Manhole Foul
- Manhole Surface
- Abandoned Pipe
- Chamber

Section 104 sewers are shown in green

Private sewers are shown in magenta

corinna.haill@bwbconsulting.com

SEVERN TRENT

GENERAL CONDITIONS AND PRECAUTIONS TO BE TAKEN WHEN CARRYING OUT WORK ADJACENT TO SEVERN TRENT WATER'S APPARATUS

Please ensure that a copy of these conditions is passed to your representative and/or your contractor on site. If any damage is caused to Severn Trent Water Limited (STW) apparatus (defined below), the person, contractor or subcontractor responsible must inform STW immediately on:
0800 783 4444 (24 hours)

a) These general conditions and precautions apply to the public sewerage, water distribution and cables in ducts including (but not limited to) sewers which are the subject of an Agreement under Section 104 of the Water Industry Act 1991(a legal agreement between a developer and STW, where a developer agrees to build sewers to an agreed standard, which STW will then adopt); mains installed in accordance with an agreement for the self-construction of water mains entered into with STW and the assets described at condition b) of these general conditions and precautions. Such apparatus is referred to as “STW Apparatus” in these general conditions and precautions.

b) Please be aware that due to The Private Sewers Transfer Regulations June 2011, the number of public sewers has increased, but many of these are not shown on the public sewer record. However, some idea of their positions may be obtained from the position of inspection covers and their existence must be anticipated.

c) On request, STW will issue a copy of the plan showing the approximate locations of STW Apparatus although in certain instances a charge will be made. The position of private drains, private sewers and water service pipes to properties are not normally shown but their presence must be anticipated. This plan and the information supplied with it is furnished as a general guide only and STW does not guarantee its accuracy.

d) STW does not update these plans on a regular basis. Therefore the position and depth of STW Apparatus may change and this plan is issued subject to any such change. Before any works are carried out, you should confirm whether any changes to the plan have been made since it was issued.

e) The plan must not be relied upon in the event of excavations or other works in the vicinity of STW Apparatus. It is your responsibility to ascertain the precise location of any STW Apparatus prior to undertaking any development or other works (including but not limited to excavations).

f) No person or company shall be relieved from liability for loss and/or damage caused to STW Apparatus by reason of the actual position and/or depths of STW Apparatus being different from those shown on the plan.

In order to achieve safe working conditions adjacent to any STW Apparatus the following should be observed:

1. All STW Apparatus should be located by hand digging prior to the use of mechanical excavators.

2. All information set out in any plans received from us, or given by our staff at the site of the works, about the position and depth of the mains, is approximate. Every possible precaution should be taken to avoid damage to STW Apparatus. You or your contractor must ensure the safety of STW Apparatus and will be responsible for the cost of repairing any loss and/or damage caused (including without limitation replacement parts).

3. Water mains are normally laid at a depth of 900mm. No records are kept of customer service pipes which are normally laid at a depth of 750mm; but some idea of their positions may be obtained from the position of stop tap covers and their existence must be anticipated.

4. During construction work, where heavy plant will cross the line of STW Apparatus, specific crossing points must be agreed with STW and suitably reinforced where required. These crossing points should be clearly marked and crossing of the line of STW Apparatus at other locations must be prevented.

5. Where it is proposed to carry out piling or boring within 20 metres of any STW Apparatus, STW should be consulted to enable any affected STW Apparatus to be surveyed prior to the works commencing.

6. Where excavation of trenches adjacent to any STW Apparatus affects its support, the STW Apparatus must be supported to the satisfaction of STW. Water mains and some sewers are pressurised and can fail if excavation removes support to thrust blocks to bends and other fittings.

7. Where a trench is excavated crossing or parallel to the line of any STW Apparatus, the backfill should be adequately compacted to prevent any settlement which could subsequently cause damage to the STW Apparatus. In special cases, it may be necessary to provide permanent support to STW Apparatus which has been exposed over a length of the excavation before backfilling and reinstatement is carried out. There should be no concrete backfill in contact with the STW Apparatus.

8. No other apparatus should be laid along the line of STW Apparatus irrespective of clearance. Above ground apparatus must not be located within a minimum of 3 metres either side of the centre line of STW Apparatus for smaller sized pipes and 6 metres either side for larger sized pipes without prior approval. No manhole or chamber shall be built over or around any STW Apparatus.

9. A minimum radial clearance of 300 millimetres should be allowed between any plant or equipment being installed and existing STW Apparatus. We reserve the right to increase this distance where strategic assets are affected.

10. Where any STW Apparatus coated with a special wrapping is damaged, even to a minor extent, STW must be notified and the trench left open until the damage has been inspected and the necessary repairs have been carried out. In the case of any material damage to any STW Apparatus causing leakage, weakening of the mechanical strength of the pipe or corrosion-protection damage, the necessary remedial work will be recharged to you.

11. It may be necessary to adjust the finished level of any surface boxes which may fall within your proposed construction. Please ensure that these are not damaged, buried or otherwise rendered inaccessible as a result of the works and that all stop taps, valves, hydrants, etc. remain accessible and operable. Minor reduction in existing levels may result in conflict with STW Apparatus such as valve spindles or tops of hydrants housed under the surface boxes. Checks should be made during site investigations to ascertain the level of such STW Apparatus in order to determine any necessary alterations in advance of the works.

12. With regard to any proposed resurfacing works, you are required to contact STW on the number given above to arrange a site inspection to establish the condition of any STW Apparatus in the nature of surface boxes or manhole covers and frames affected by the works. STW will then advise on any measures to be taken, in the event of this a proportionate charge will be made.

13. You are advised that STW will not agree to either the erection of posts, directly over or within 1.0 metre of valves and hydrants,

14. No explosives are to be used in the vicinity of any STW Apparatus without prior consultation with STW.

TREE PLANTING RESTRICTIONS

There are many problems with the location of trees adjacent to sewers, water mains and other STW Apparatus and these can lead to the loss of trees and hence amenity to the area which many people may have become used to. It is best if the problem is not created in the first place. Set out below are the recommendations for tree planting in close proximity to public sewers, water mains and other STW Apparatus.

15. Please ensure that, in relation to STW Apparatus, the mature root systems and canopies of any tree planted do not and will not encroach within the recommended distances specified in the notes below.

16. Both Poplar and Willow trees have extensive root systems and should not be planted within 12 metres of a sewer, water main or other STW Apparatus.

17. The following trees and those of similar size, be they deciduous or evergreen, should not be planted within 6 metres of a sewer, water main or other STW Apparatus. E.g. Ash, Beech, Birch, most Conifers, Elm, Horse Chestnut, Lime, Oak, Sycamore, Apple and Pear. Asset Protection Statements Updated May2014

18. STW personnel require a clear path to conduct surveys etc. No shrubs or bushes should be planted within 2 metre of the centre line of a sewer, water main or other STW Apparatus.

19. In certain circumstances, both STW and landowners may wish to plant shrubs/bushes in close proximity to a sewer, water main of other STW Apparatus for screening purposes. The following are shallow rooting and are suitable for this purpose: Blackthorn, Broom, Cotoneaster, Elder, Hazel, Laurel, Privet, Quickthorn, Snowberry, and most ornamental flowering shrubs.

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert
	C			
	C			
	C			
	C			
	C			
3408	C	180.67	178.15	2.52
4401	C	183.75	181.17	2.58
4402	C	183.38	0	0
4403	C	183.93	181.73	2.2
4455	C	-	0	0
6401	C	186.49	184.88	1.61
6402	C	186.54	185.37	1.17
6403	C	188.81	186.46	2.35
6501	C	192.11	189.87	2.24
6502	C	191.02	188.79	2.23
6701	C	195.3	193.09	2.21
	F			
	F			
	F			
	F			
	F			
	F			
	F			
	F			
	F			
	F			
	F			
	F			
	F			
	F			
	F			
	F			

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert
	F			
	F			
	F			
	F			
	F			
2310	F	-	0	0
2311	F	177.47	175.64	1.83
2312	F	178.75	176.38	2.37
2509	F	184.03	182.19	1.84
2511	F	183.9	181.9	2
2513	F	183.1	181.23	1.87
2601	F	189.93	187.33	2.6
2602	F	189.05	186.55	2.5
2606	F	188.44	186.37	2.07
2608	F	187.43	185.31	2.12
2706	F	191.14	189.04	2.1
3402	F	182.64	180.18	2.46
3403	F	181.26	179.26	2
3405	F	-	0	0
3413	F	180.67	178.52	2.15
3414	F	180.57	177.88	2.69
3415	F	181.98	179.83	2.15
3416	F	182.16	179.86	2.3
3501	F	185.43	184.18	1.25
3502	F	185.31	183.08	2.23
3503	F	184.09	182.45	1.64
3505	F	183.97	182.17	1.8
3506	F	182.69	180.52	2.17
3601	F	190.86	188.53	2.33
3602	F	190.65	188	2.65
3606	F	189.72	187.69	2.03
3607	F	187.99	185.84	2.15

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert
3701	F	192.18	189.87	2.31
3702	F	191.88	189.72	2.16
3705	F	190.97	189.29	1.68
3801	F	191.95	190.15	1.8
3805	F	188.59	186.48	2.11
3902	F	182.28	0	0
3904	F	187.17	184.33	2.84
3908	F	184.76	181.72	3.04
4501	F	187.4	185.48	1.92
4502	F	187.95	186	1.95
4503	F	185.6	183.81	1.79
4504	F	185.51	183.36	2.15
4508	F	184.59	182.78	1.81
4509	F	184.29	182.24	2.05
4601	F	191.5	189.35	2.15
4602	F	190.95	189.19	1.76
4604	F	190.85	188.99	1.86
4606	F	191.08	188.78	2.3
4608	F	188.6	186.87	1.73
4702	F	193.14	191.11	2.03
4704	F	192.31	190.43	1.88
4705	F	191.42	189.96	1.46
4802	F	193.79	192.04	1.75
4804	F	192.86	190.8	2.06
4806	F	193.44	190.65	2.79
4808	F	193.07	190.37	2.7
4810	F	192.87	190.1	2.77
4812	F	192.43	189.34	3.09
4814	F	191.54	188.42	3.12
4906	F	192.71	190.35	2.36
4908	F	190.17	186.63	3.54
5602	F	193.23	191.81	1.42

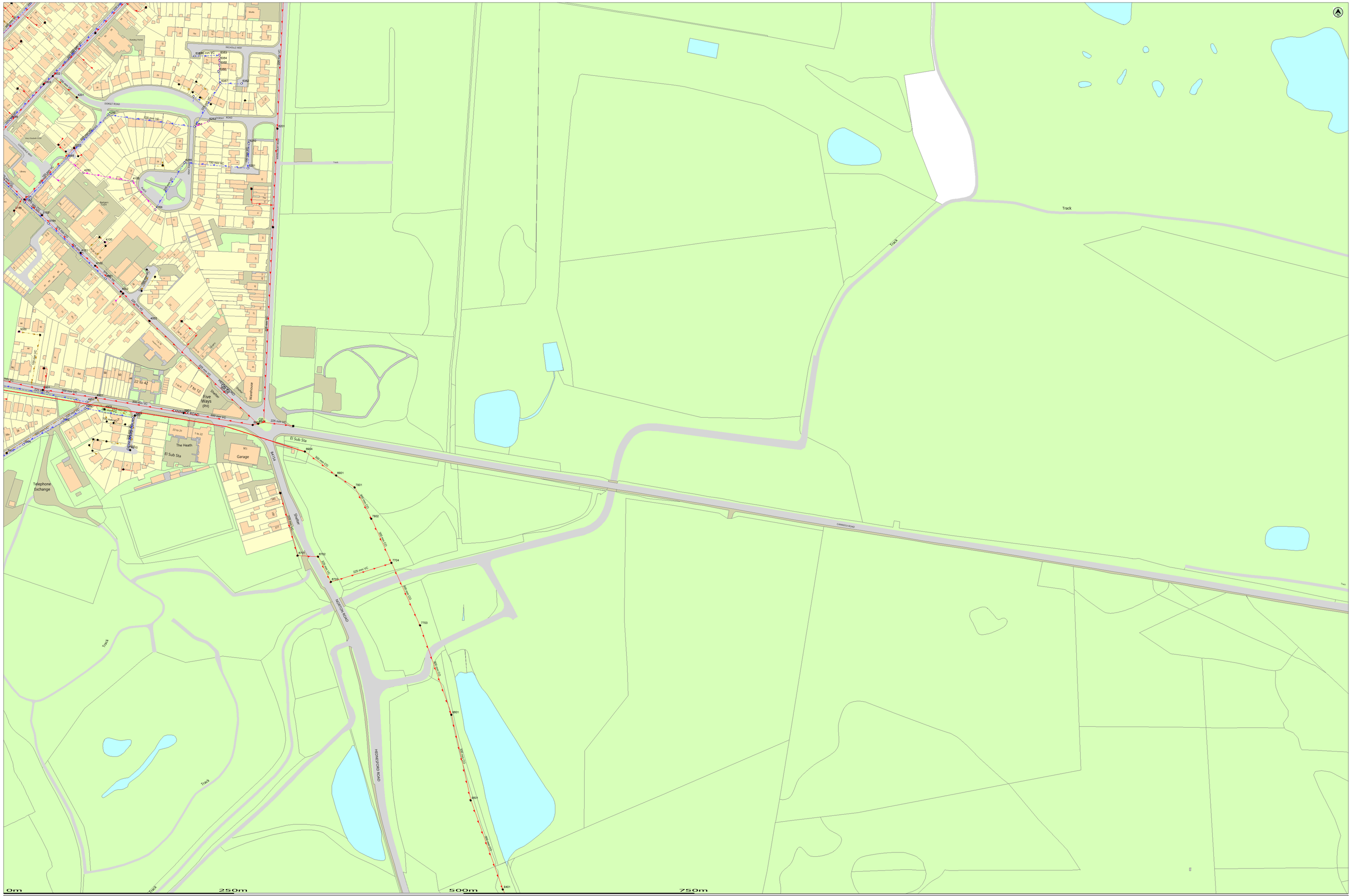
Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert
5604	F	191.93	189.94	1.99
5608	F	189.95	187.85	2.1
5701	F	193.04	191.36	1.68
5703	F	194.52	192.95	1.57
5704	F	193.14	191.35	1.79
5807	F	193.07	190.99	2.07
5808	F	194.85	192.92	1.93
5904	F	193.2	190.6	2.6
5906	F	194.4	191.47	2.93
5908	F	195.43	192.51	2.92
6400	F	-	0	0
6902	F	196.93	194.85	2.08
2362	S	177.71	175.27	2.44
2363	S	176.43	174.49	1.94
2365	S	178.97	176.32	2.65
2451	S	182.62	180.37	2.25
2555	S	184.49	183.07	1.42
2557	S	185.96	184.5	1.46
2561	S	183.83	182.26	1.57
2562	S	184.04	182.57	1.47
2564	S	185.68	183.81	1.87
2565	S	183.82	182.24	1.58
2655	S	189.13	187	2.13
2657	S	188.37	186.7	1.67
2757	S	191.11	189.48	1.63
2759	S	189.93	187.72	2.21
2852	S	191.62	189.28	2.34
3351	S	176.12	175.05	1.07
3359	S	179.42	178.15	1.27
3451	S	181.31	179.6	1.71
3454	S	180.65	178.34	2.31
3455	S	180.14	177.57	2.57

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert
3456	S	-	0	0
3458	S	180.84	179.64	1.2
3460	S	180.59	178.46	2.13
3461	S	181.43	180.13	1.3
3462	S	181.05	179.51	1.54
3463	S	181.99	180.05	1.94
3464	S	181.9	179.62	2.28
3551	S	186.03	184.44	1.59
3554	S	184.13	182.76	1.37
3556	S	184	182.52	1.48
3557	S	182.63	180.85	1.78
3653	S	190.66	188.36	2.3
3654	S	190.37	189.01	1.36
3655	S	189.85	188.37	1.48
3658	S	189.19	187.88	1.31
3753	S	192.18	190.27	1.91
3754	S	191.95	190.15	1.8
3756	S	190.95	189.76	1.19
3757	S	192.2	190.43	1.77
3804	S	188.59	186.91	1.68
3852	S	191.94	190.48	1.46
3853	S	191.69	190.71	0.98
3903	S	187.15	184.87	2.28
3907	S	184.54	182.31	2.23
4451	S	182.95	181.69	1.26
4454	S	183.98	182.86	1.12
4552	S	187.46	185.84	1.62
4555	S	185.43	183.54	1.89
4556	S	185.61	184.05	1.56
4557	S	184.47	182.68	1.79
4653	S	190.96	189.37	1.59
4655	S	190.82	189.22	1.6

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert
4657	S	189.89	187.48	2.41
4659	S	188.59	187.22	1.37
4751	S	193.16	191.41	1.75
4753	S	192.3	190.68	1.62
4756	S	192.14	190.79	1.35
4803	S	192.73	191.26	1.47
4805	S	193.37	191.08	2.29
4807	S	193.07	190.83	2.24
4809	S	192.9	190.62	2.28
4811	S	192.45	189.81	2.64
4813	S	191.54	188.94	2.6
4851	S	193.78	192.17	1.61
4905	S	192.71	0	0
5651	S	193.42	191.88	1.54
5653	S	192.97	191.13	1.84
5655	S	190.79	189.59	1.2
5656	S	191.9	190.11	1.79
5657	S	190.61	189.13	1.48
5659	S	189.48	187.67	1.81
5752	S	194.87	193.44	1.43
5753	S	195.3	193.9	1.4
5755	S	192.92	190.98	1.94
5804	S	193.42	191.79	1.63
5805	S	193.3	191.62	1.68
5806	S	193.12	191.41	1.71
5809	S	194.85	193.37	1.47
5852	S	194.98	193.36	1.62
5853	S	195.52	193.86	1.66
5903	S	193.14	190.95	2.19
5905	S	194.35	192.01	2.34
5907	S	195.47	193.05	2.42
6851	S	197.14	195.79	1.35

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert
6901	S	197.01	195.38	1.63

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert



Date: 05/10/21

Scale: 1:1250

Map Centre: 402051,309905

Data updated: 14/09/21

Our Ref: 666366 - 1

Wastewater Plan A0

nisha.mistry@bwbconsulting.com

bmw3009

SEVERN TRENT

SEVERN TRENT

GENERAL CONDITIONS AND PRECAUTIONS TO BE TAKEN WHEN CARRYING OUT WORK ADJACENT TO SEVERN TRENT WATER'S APPARATUS

Please ensure that a copy of these conditions is passed to your representative and/or your contractor on site. If any damage is caused to Severn Trent Water Limited (STW) apparatus (defined below), the person, contractor or subcontractor responsible must inform STW immediately on:
0800 783 4444 (24 hours)

a) These general conditions and precautions apply to the public sewerage, water distribution and cables in ducts including (but not limited to) sewers which are the subject of an Agreement under Section 104 of the Water Industry Act 1991(a legal agreement between a developer and STW, where a developer agrees to build sewers to an agreed standard, which STW will then adopt); mains installed in accordance with an agreement for the self-construction of water mains entered into with STW and the assets described at condition b) of these general conditions and precautions. Such apparatus is referred to as "STW Apparatus" in these general conditions and precautions.

b) Please be aware that due to The Private Sewers Transfer Regulations June 2011, the number of public sewers has increased, but many of these are not shown on the public sewer record. However, some idea of their positions may be obtained from the position of inspection covers and their existence must be anticipated.

c) On request, STW will issue a copy of the plan showing the approximate locations of STW Apparatus although in certain instances a charge will be made. The position of private drains, private sewers and water service pipes to properties are not normally shown but their presence must be anticipated. This plan and the information supplied with it is furnished as a general guide only and STW does not guarantee its accuracy.

d) STW does not update these plans on a regular basis. Therefore the position and depth of STW Apparatus may change and this plan is issued subject to any such change. Before any works are carried out, you should confirm whether any changes to the plan have been made since it was issued.

e) The plan must not be relied upon in the event of excavations or other works in the vicinity of STW Apparatus. It is your responsibility to ascertain the precise location of any STW Apparatus prior to undertaking any development or other works (including but not limited to excavations).

f) No person or company shall be relieved from liability for loss and/or damage caused to STW Apparatus by reason of the actual position and/or depths of STW Apparatus being different from those shown on the plan.

In order to achieve safe working conditions adjacent to any STW Apparatus the following should be observed:

1. All STW Apparatus should be located by hand digging prior to the use of mechanical excavators.
2. All information set out in any plans received from us, or given by our staff at the site of the works, about the position and depth of the mains, is approximate. Every possible precaution should be taken to avoid damage to STW Apparatus. You or your contractor must ensure the safety of STW Apparatus and will be responsible for the cost of repairing any loss and/or damage caused (including without limitation replacement parts).
3. Water mains are normally laid at a depth of 900mm. No records are kept of customer service pipes which are normally laid at a depth of 750mm; but some idea of their positions may be obtained from the position of stop tap covers and their existence must be anticipated.
4. During construction work, where heavy plant will cross the line of STW Apparatus, specific crossing points must be agreed with STW and suitably reinforced where required. These crossing points should be clearly marked and crossing of the line of STW Apparatus at other locations must be prevented.
5. Where it is proposed to carry out piling or boring within 20 metres of any STW Apparatus, STW should be consulted to enable any affected STW Apparatus to be surveyed prior to the works commencing.
6. Where excavation of trenches adjacent to any STW Apparatus affects its support, the STW Apparatus must be supported to the satisfaction of STW. Water mains and some sewers are pressurised and can fail if excavation removes support to thrust blocks to bends and other fittings.
7. Where a trench is excavated crossing or parallel to the line of any STW Apparatus, the backfill should be adequately compacted to prevent any settlement which could subsequently cause damage to the STW Apparatus. In special cases, it may be necessary to provide permanent support to STW Apparatus which has been exposed over a length of the excavation before backfilling and reinstatement is carried out. There should be no concrete backfill in contact with the STW Apparatus.
8. No other apparatus should be laid along the line of STW Apparatus irrespective of clearance. Above ground apparatus must not be located within a minimum of 3 metres either side of the centre line of STW Apparatus for smaller sized pipes and 6 metres either side for larger sized pipes without prior approval. No manhole or chamber shall be built over or around any STW Apparatus.
9. A minimum radial clearance of 300 millimetres should be allowed between any plant or equipment being installed and existing STW Apparatus. We reserve the right to increase this distance where strategic assets are affected.
10. Where any STW Apparatus coated with a special wrapping is damaged, even to a minor extent, STW must be notified and the trench left open until the damage has been inspected and the necessary repairs have been carried out. In the case of any material damage to any STW Apparatus causing leakage, weakening of the mechanical strength of the pipe or corrosion-protection damage, the necessary remedial work will be recharged to you.
11. It may be necessary to adjust the finished level of any surface boxes which may fall within your proposed construction. Please ensure that these are not damaged, buried or otherwise rendered inaccessible as a result of the works and that all stop taps, valves, hydrants, etc. remain accessible and operable. Minor reduction in existing levels may result in conflict with STW Apparatus such as valve spindles or tops of hydrants housed under the surface boxes. Checks should be made during site investigations to ascertain the level of such STW Apparatus in order to determine any necessary alterations in advance of the works.
12. With regard to any proposed resurfacing works, you are required to contact STW on the number given above to arrange a site inspection to establish the condition of any STW Apparatus in the nature of surface boxes or manhole covers and frames affected by the works. STW will then advise on any measures to be taken, in the event of this a proportionate charge will be made.
13. You are advised that STW will not agree to either the erection of posts, directly over or within 1.0 metre of valves and hydrants,
14. No explosives are to be used in the vicinity of any STW Apparatus without prior consultation with STW.

TREE PLANTING RESTRICTIONS

There are many problems with the location of trees adjacent to sewers, water mains and other STW Apparatus and these can lead to the loss of trees and hence amenity to the area which many people may have become used to. It is best if the problem is not created in the first place. Set out below are the recommendations for tree planting in close proximity to public sewers, water mains and other STW Apparatus.

15. Please ensure that, in relation to STW Apparatus, the mature root systems and canopies of any tree planted do not and will not encroach within the recommended distances specified in the notes below.
16. Both Poplar and Willow trees have extensive root systems and should not be planted within 12 metres of a sewer, water main or other STW Apparatus.
17. The following trees and those of similar size, be they deciduous or evergreen, should not be planted within 6 metres of a sewer, water main or other STW Apparatus. E.g. Ash, Beech, Birch, most Conifers, Elm, Horse Chestnut, Lime, Oak, Sycamore, Apple and Pear. Asset Protection Statements Updated May 2014
18. STW personnel require a clear path to conduct surveys etc. No shrubs or bushes should be planted within 2 metre of the centre line of a sewer, water main or other STW Apparatus.
19. In certain circumstances, both STW and landowners may wish to plant shrubs/bushes in close proximity to a sewer, water main of other STW Apparatus for screening purposes. The following are shallow rooting and are suitable for this purpose: Blackthorn, Broom, Cotoneaster, Elder, Hazel, Laurel, Privet, Quickthorn, Snowberry, and most ornamental flowering shrubs.

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert
	C		0	0
	C		0	0
	C		0	0
	C		0	0
	C		0	0
3101	C	178.14	174.39	3.75
3103	C	178.71	174.43	4.28
3155	C	0	0	0
3202	C	179.05	177.7	1.35
3302	C	178.33	176.18	2.15
3303	C	177.55	175.36	2.19
3901	C	179.92	175.88	4.04
4002	C	182.09	177.37	4.72
4003	C	182.67	180.45	2.22
4101	C	180.47	175.36	5.11
4102	C	181.03	175.92	5.11
4201	C	179.11	177.5	1.61
4901	C	181.23	176.62	4.61
5901	C	181.4	177.55	3.85
5902	C	179.44	177.65	1.79
5903	C	179.93	177.91	2.02
6201	C		0	0
6701	C		0	0
6702	C	172.96	169.75	3.21
6703	C	172.25	168.86	3.39
6801	C	174.79	171.67	3.12
6904	C	176.87	175.08	1.79
7703	C	167.56	164.73	2.83
7704	C		0	0
7801	C	172	168	4
7802	C	168.36	166.48	1.88
8401	C	166.36	161.87	4.49
8501	C	165.26	162.52	2.74
8601	C	165.88	163.04	2.84
	F		0	0
	F		0	0
	F		0	0
	F		0	0
	F		0	0
	F		0	0
	F		0	0
	F		0	0
	F		0	0
	F		0	0
	F		0	0
	F		0	0
	F		0	0
	F		0	0
	F		0	0
	F		0	0
	F		0	0
	F		0	0
	F		0	0
	F		0	0
	F		0	0
3000	F		0	0
3801	F	175.69	174.09	1.6
4100	F		0	0
4902	F	181.49	178.79	2.7
4903	F	181.39	177.12	4.27
4910	F	181.2	179.37	1.83
	S		0	0
3152	S	178.12	176.15	1.97
3154	S	178.95	177.19	1.76
3255	S	178.77	177.13	1.64
3256	S	176.17	174.4	1.77
3952	S	178.28	176.24	2.04
3954	S	176.47	0	0
4051	S	181.44	179.8	1.64
4154	S	182.49	180.88	1.61
4155	S	181.33	179.65	1.68
4252	S	180.12	178.67	1.45
4253	S	179.56	178.15	1.41
4911	S	181.28	179.66	1.62
4951	S	180.87	178.93	1.94
4952	S	180.36	178.04	2.32
4953	S	181.55	179.24	2.31
5251	S	182.99	182.17	0.82
5252	S	183.16	182.38	0.78
5253	S	183.55	182.01	1.54
5254	S	183.11	181.61	1.5
5255	S	182.91	181.68	1.23
5351	S	184.26	183.49	0.77
5352	S	183.94	182.99	0.95
5353	S	184.66	183.29	1.37
5354	S	184.59	183.27	1.32
5355	S	184.59	183.25	1.34
5356	S	184.47	183.17	1.3
5357	S	184.17	182.41	1.76

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert

Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert

Appendix 3: Existing Runoff Rate

ICP SUDS Mean Annual Flood

Input

Return Period (years)	1	Soil	0.450
Area (ha)	1.000	Urban	0.000
SAAR (mm)	757	Region Number	Region 4

Results l/s

QBAR Rural	4.8
QBAR Urban	4.8
Q1 year	4.0
Q1 year	4.0
Q30 years	9.4
Q100 years	12.4

Appendix 4: Micro Drainage Calculations

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	198.596	0.396	11.9	549.7	O K
30 min Summer	198.707	0.507	11.9	715.4	O K
60 min Summer	198.815	0.615	11.9	884.0	O K
120 min Summer	198.917	0.717	11.9	1046.8	O K
180 min Summer	198.971	0.771	11.9	1135.1	O K
240 min Summer	199.003	0.803	11.9	1188.9	O K
360 min Summer	199.036	0.836	11.9	1243.1	O K
480 min Summer	199.048	0.848	11.9	1264.3	O K
600 min Summer	199.050	0.850	11.9	1266.9	O K
720 min Summer	199.044	0.844	11.9	1258.1	O K
960 min Summer	199.024	0.824	11.9	1223.0	O K
1440 min Summer	198.978	0.778	11.9	1146.5	O K
2160 min Summer	198.904	0.704	11.9	1025.5	O K
2880 min Summer	198.830	0.630	11.9	906.7	O K
4320 min Summer	198.713	0.513	11.9	724.8	O K
5760 min Summer	198.623	0.423	11.9	589.0	O K
7200 min Summer	198.558	0.358	11.9	493.1	O K
8640 min Summer	198.510	0.310	11.9	423.5	O K
10080 min Summer	198.475	0.275	11.9	373.9	O K
15 min Winter	198.642	0.442	11.9	616.9	O K
30 min Winter	198.764	0.564	11.9	803.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	156.800	0.0	521.8	26
30 min Summer	102.480	0.0	681.5	41
60 min Summer	63.980	0.0	895.6	70
120 min Summer	38.640	0.0	1081.9	130
180 min Summer	28.507	0.0	1196.2	188
240 min Summer	22.855	0.0	1277.4	248
360 min Summer	16.590	0.0	1387.6	366
480 min Summer	13.171	0.0	1464.7	484
600 min Summer	10.988	0.0	1522.5	602
720 min Summer	9.462	0.0	1567.3	722
960 min Summer	7.453	0.0	1629.7	878
1440 min Summer	5.285	0.0	1666.2	1114
2160 min Summer	3.708	0.0	1897.4	1504
2880 min Summer	2.885	0.0	1967.2	1880
4320 min Summer	2.043	0.0	2083.8	2644
5760 min Summer	1.616	0.0	2215.8	3400
7200 min Summer	1.368	0.0	2343.3	4112
8640 min Summer	1.207	0.0	2477.9	4840
10080 min Summer	1.096	0.0	2618.4	5544
15 min Winter	156.800	0.0	585.1	26
30 min Winter	102.480	0.0	759.6	41

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	198.884	0.684	11.9	994.1	O K
120 min Winter	198.997	0.797	11.9	1178.1	O K
180 min Winter	199.057	0.857	11.9	1279.0	O K
240 min Winter	199.094	0.894	11.9	1341.8	O K
360 min Winter	199.132	0.932	11.9	1407.8	O K
480 min Winter	199.149	0.949	11.9	1436.9	O K
600 min Winter	199.154	0.954	11.9	1445.4	O K
720 min Winter	199.151	0.951	11.9	1441.1	O K
960 min Winter	199.133	0.933	11.9	1409.9	O K
1440 min Winter	199.075	0.875	11.9	1310.7	O K
2160 min Winter	198.986	0.786	11.9	1160.3	O K
2880 min Winter	198.894	0.694	11.9	1009.1	O K
4320 min Winter	198.714	0.514	11.9	726.5	O K
5760 min Winter	198.579	0.379	11.9	524.2	O K
7200 min Winter	198.486	0.286	11.9	389.9	O K
8640 min Winter	198.425	0.225	11.7	304.0	O K
10080 min Winter	198.388	0.188	11.4	251.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	63.980	0.0	1003.5	70
120 min Winter	38.640	0.0	1210.9	128
180 min Winter	28.507	0.0	1337.8	186
240 min Winter	22.855	0.0	1427.5	244
360 min Winter	16.590	0.0	1547.7	360
480 min Winter	13.171	0.0	1629.8	474
600 min Winter	10.988	0.0	1688.8	588
720 min Winter	9.462	0.0	1731.1	700
960 min Winter	7.453	0.0	1774.3	916
1440 min Winter	5.285	0.0	1722.1	1162
2160 min Winter	3.708	0.0	2125.2	1620
2880 min Winter	2.885	0.0	2202.9	2080
4320 min Winter	2.043	0.0	2335.0	2856
5760 min Winter	1.616	0.0	2482.5	3576
7200 min Winter	1.368	0.0	2625.6	4248
8640 min Winter	1.207	0.0	2777.0	4848
10080 min Winter	1.096	0.0	2936.0	5456

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 401850 310150 SK 01850 10150
Data Type	Catchment
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 1.910

Time From: (mins)	To:	Area (ha)	Time From: (mins)	To:	Area (ha)	Time From: (mins)	To:	Area (ha)
0	4	0.637	4	8	0.637	8	12	0.637

Model Details

Storage is Online Cover Level (m) 199.600

Tank or Pond Structure

Invert Level (m) 198.200

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1299.5	1.000	1765.9	1.400	2020.3

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0158-1190-1000-1190
Design Head (m)	1.000
Design Flow (l/s)	11.9
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	158
Invert Level (m)	198.200
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	11.9
Flush-Flo™	0.311	11.9
Kick-Flo®	0.687	10.0
Mean Flow over Head Range	-	10.2

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.7	1.200	13.0	3.000	20.0	7.000	30.1
0.200	11.5	1.400	13.9	3.500	21.6	7.500	31.1
0.300	11.9	1.600	14.9	4.000	23.0	8.000	32.1
0.400	11.8	1.800	15.7	4.500	24.3	8.500	33.1
0.500	11.5	2.000	16.5	5.000	25.6	9.000	34.0
0.600	11.0	2.200	17.3	5.500	26.8	9.500	34.9
0.800	10.7	2.400	18.0	6.000	28.0		
1.000	11.9	2.600	18.7	6.500	29.1		

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	198.534	0.334	11.9	459.1	O K
30 min Summer	198.630	0.430	11.9	600.1	O K
60 min Summer	198.725	0.525	11.9	742.6	O K
120 min Summer	198.812	0.612	11.9	878.1	O K
180 min Summer	198.856	0.656	11.9	948.1	O K
240 min Summer	198.882	0.682	11.9	989.6	O K
360 min Summer	198.907	0.707	11.9	1031.3	O K
480 min Summer	198.919	0.719	11.9	1049.6	O K
600 min Summer	198.921	0.721	11.9	1053.0	O K
720 min Summer	198.917	0.717	11.9	1046.9	O K
960 min Summer	198.903	0.703	11.9	1024.4	O K
1440 min Summer	198.870	0.670	11.9	970.4	O K
2160 min Summer	198.816	0.616	11.9	884.6	O K
2880 min Summer	198.763	0.563	11.9	801.3	O K
4320 min Summer	198.664	0.464	11.9	650.1	O K
5760 min Summer	198.578	0.378	11.9	523.2	O K
7200 min Summer	198.509	0.309	11.9	421.9	O K
8640 min Summer	198.455	0.255	11.8	345.1	O K
10080 min Summer	198.415	0.215	11.6	289.0	O K
15 min Winter	198.573	0.373	11.9	515.3	O K
30 min Winter	198.680	0.480	11.9	674.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	131.351	0.0	435.0	26
30 min Summer	86.314	0.0	574.8	41
60 min Summer	54.074	0.0	755.8	70
120 min Summer	32.762	0.0	917.2	128
180 min Summer	24.128	0.0	1013.3	188
240 min Summer	19.312	0.0	1081.0	248
360 min Summer	14.018	0.0	1175.7	366
480 min Summer	11.175	0.0	1248.0	484
600 min Summer	9.366	0.0	1305.5	602
720 min Summer	8.105	0.0	1353.1	720
960 min Summer	6.446	0.0	1428.1	834
1440 min Summer	4.660	0.0	1527.1	1070
2160 min Summer	3.364	0.0	1721.6	1452
2880 min Summer	2.667	0.0	1818.7	1848
4320 min Summer	1.920	0.0	1957.6	2604
5760 min Summer	1.519	0.0	2082.3	3352
7200 min Summer	1.266	0.0	2167.7	4040
8640 min Summer	1.090	0.0	2237.7	4752
10080 min Summer	0.961	0.0	2293.3	5352
15 min Winter	131.351	0.0	488.9	26
30 min Winter	86.314	0.0	643.6	40

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	198.784	0.584	11.9	835.0	O K
120 min Winter	198.882	0.682	11.9	990.9	O K
180 min Winter	198.933	0.733	11.9	1072.5	O K
240 min Winter	198.962	0.762	11.9	1121.0	O K
360 min Winter	198.993	0.793	11.9	1171.1	O K
480 min Winter	199.007	0.807	11.9	1195.6	O K
600 min Winter	199.012	0.812	11.9	1203.9	O K
720 min Winter	199.011	0.811	11.9	1202.0	O K
960 min Winter	198.998	0.798	11.9	1180.1	O K
1440 min Winter	198.957	0.757	11.9	1113.1	O K
2160 min Winter	198.889	0.689	11.9	1001.0	O K
2880 min Winter	198.806	0.606	11.9	868.8	O K
4320 min Winter	198.654	0.454	11.9	635.7	O K
5760 min Winter	198.529	0.329	11.9	450.7	O K
7200 min Winter	198.438	0.238	11.7	321.7	O K
8640 min Winter	198.382	0.182	11.3	243.5	O K
10080 min Winter	198.359	0.159	10.5	211.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	54.074	0.0	847.5	70
120 min Winter	32.762	0.0	1027.5	128
180 min Winter	24.128	0.0	1134.5	184
240 min Winter	19.312	0.0	1209.8	242
360 min Winter	14.018	0.0	1314.9	358
480 min Winter	11.175	0.0	1394.5	474
600 min Winter	9.366	0.0	1457.3	586
720 min Winter	8.105	0.0	1508.5	696
960 min Winter	6.446	0.0	1586.4	910
1440 min Winter	4.660	0.0	1663.4	1142
2160 min Winter	3.364	0.0	1928.4	1604
2880 min Winter	2.667	0.0	2037.3	2020
4320 min Winter	1.920	0.0	2194.6	2812
5760 min Winter	1.519	0.0	2332.9	3512
7200 min Winter	1.266	0.0	2428.9	4120
8640 min Winter	1.090	0.0	2507.9	4680
10080 min Winter	0.961	0.0	2571.8	5344

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.100	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 1.910

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.637	4	8	0.637	8	12	0.637

Model Details

Storage is Online Cover Level (m) 199.600

Tank or Pond Structure

Invert Level (m) 198.200

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1299.5	1.000	1765.9	1.400	2020.3

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0158-1190-1000-1190
Design Head (m)	1.000
Design Flow (l/s)	11.9
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	158
Invert Level (m)	198.200
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	11.9
Flush-Flo™	0.311	11.9
Kick-Flo®	0.687	10.0
Mean Flow over Head Range	-	10.2

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.7	1.200	13.0	3.000	20.0	7.000	30.1
0.200	11.5	1.400	13.9	3.500	21.6	7.500	31.1
0.300	11.9	1.600	14.9	4.000	23.0	8.000	32.1
0.400	11.8	1.800	15.7	4.500	24.3	8.500	33.1
0.500	11.5	2.000	16.5	5.000	25.6	9.000	34.0
0.600	11.0	2.200	17.3	5.500	26.8	9.500	34.9
0.800	10.7	2.400	18.0	6.000	28.0		
1.000	11.9	2.600	18.7	6.500	29.1		

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	199.519	0.419	16.7	739.1	O K
30 min Summer	199.634	0.534	16.7	961.8	O K
60 min Summer	199.745	0.645	16.7	1188.0	O K
120 min Summer	199.848	0.748	16.7	1405.6	O K
180 min Summer	199.902	0.802	16.7	1522.8	O K
240 min Summer	199.934	0.834	16.7	1593.4	O K
360 min Summer	199.965	0.865	16.7	1663.0	O K
480 min Summer	199.977	0.877	16.7	1688.1	O K
600 min Summer	199.977	0.877	16.7	1688.5	O K
720 min Summer	199.970	0.870	16.7	1673.5	O K
960 min Summer	199.948	0.848	16.7	1625.2	O K
1440 min Summer	199.902	0.802	16.7	1521.8	O K
2160 min Summer	199.826	0.726	16.7	1357.2	O K
2880 min Summer	199.749	0.649	16.7	1195.7	O K
4320 min Summer	199.627	0.527	16.7	948.1	O K
5760 min Summer	199.532	0.432	16.7	764.0	O K
7200 min Summer	199.465	0.365	16.7	635.5	O K
8640 min Summer	199.416	0.316	16.7	544.9	O K
10080 min Summer	199.380	0.280	16.6	480.6	O K
15 min Winter	199.566	0.466	16.7	829.5	O K
30 min Winter	199.692	0.592	16.7	1080.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	156.800	0.0	700.3	26
30 min Summer	102.480	0.0	916.3	41
60 min Summer	63.980	0.0	1204.0	70
120 min Summer	38.640	0.0	1454.9	130
180 min Summer	28.507	0.0	1609.2	188
240 min Summer	22.855	0.0	1718.9	248
360 min Summer	16.590	0.0	1868.1	366
480 min Summer	13.171	0.0	1973.2	484
600 min Summer	10.988	0.0	2052.5	602
720 min Summer	9.462	0.0	2114.8	720
960 min Summer	7.453	0.0	2204.7	840
1440 min Summer	5.285	0.0	2284.3	1086
2160 min Summer	3.708	0.0	2552.6	1484
2880 min Summer	2.885	0.0	2646.5	1872
4320 min Summer	2.043	0.0	2802.7	2640
5760 min Summer	1.616	0.0	2981.0	3352
7200 min Summer	1.368	0.0	3152.4	4104
8640 min Summer	1.207	0.0	3333.2	4760
10080 min Summer	1.096	0.0	3521.7	5456
15 min Winter	156.800	0.0	785.8	26
30 min Winter	102.480	0.0	1022.8	40

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	199.816	0.716	16.7	1336.1	O K
120 min Winter	199.929	0.829	16.7	1581.8	O K
180 min Winter	199.989	0.889	16.7	1715.9	O K
240 min Winter	200.025	0.925	16.7	1798.7	O K
360 min Winter	200.062	0.962	16.7	1884.0	O K
480 min Winter	200.078	0.978	16.7	1919.6	O K
600 min Winter	200.081	0.981	16.7	1927.6	O K
720 min Winter	200.077	0.977	16.7	1918.7	O K
960 min Winter	200.057	0.957	16.7	1871.0	O K
1440 min Winter	199.998	0.898	16.7	1736.4	O K
2160 min Winter	199.905	0.805	16.7	1528.2	O K
2880 min Winter	199.806	0.706	16.7	1316.2	O K
4320 min Winter	199.620	0.520	16.7	934.5	O K
5760 min Winter	199.480	0.380	16.7	663.8	O K
7200 min Winter	199.386	0.286	16.6	489.9	O K
8640 min Winter	199.326	0.226	16.3	383.4	O K
10080 min Winter	199.293	0.193	15.9	325.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	63.980	0.0	1349.3	70
120 min Winter	38.640	0.0	1629.0	128
180 min Winter	28.507	0.0	1800.6	186
240 min Winter	22.855	0.0	1922.2	242
360 min Winter	16.590	0.0	2086.3	358
480 min Winter	13.171	0.0	2200.1	474
600 min Winter	10.988	0.0	2284.0	586
720 min Winter	9.462	0.0	2347.5	698
960 min Winter	7.453	0.0	2428.6	912
1440 min Winter	5.285	0.0	2424.3	1142
2160 min Winter	3.708	0.0	2859.3	1604
2880 min Winter	2.885	0.0	2964.1	2056
4320 min Winter	2.043	0.0	3141.6	2816
5760 min Winter	1.616	0.0	3339.8	3520
7200 min Winter	1.368	0.0	3532.2	4184
8640 min Winter	1.207	0.0	3735.6	4768
10080 min Winter	1.096	0.0	3949.1	5352

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 401850 310150 SK 01850 10150
Data Type	Catchment
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 2.570

Time From: (mins)	To:	Area (ha)	Time From: (mins)	To:	Area (ha)	Time From: (mins)	To:	Area (ha)
0	4	0.857	4	8	0.857	8	12	0.857

Model Details

Storage is Online Cover Level (m) 200.500

Tank or Pond Structure

Invert Level (m) 199.100

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1620.0	1.000	2345.6	1.400	2664.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0183-1670-1000-1670
Design Head (m)	1.000
Design Flow (l/s)	16.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	183
Invert Level (m)	199.100
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	16.7
Flush-Flo™	0.330	16.7
Kick-Flo®	0.711	14.2
Mean Flow over Head Range	-	14.1

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.4	1.200	18.2	3.000	28.2	7.000	42.4
0.200	16.0	1.400	19.6	3.500	30.3	7.500	43.9
0.300	16.6	1.600	20.9	4.000	32.4	8.000	45.2
0.400	16.6	1.800	22.1	4.500	34.3	8.500	46.6
0.500	16.3	2.000	23.2	5.000	36.0	9.000	47.9
0.600	15.7	2.200	24.3	5.500	37.7	9.500	49.2
0.800	15.0	2.400	25.3	6.000	39.4		
1.000	16.7	2.600	26.3	6.500	40.9		

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	199.455	0.355	16.7	617.3	O K
30 min Summer	199.555	0.455	16.7	806.7	O K
60 min Summer	199.652	0.552	16.7	997.9	O K
120 min Summer	199.741	0.641	16.7	1179.1	O K
180 min Summer	199.785	0.685	16.7	1272.0	O K
240 min Summer	199.811	0.711	16.7	1326.6	O K
360 min Summer	199.836	0.736	16.7	1379.7	O K
480 min Summer	199.846	0.746	16.7	1401.2	O K
600 min Summer	199.847	0.747	16.7	1402.7	O K
720 min Summer	199.842	0.742	16.7	1391.8	O K
960 min Summer	199.828	0.728	16.7	1362.0	O K
1440 min Summer	199.793	0.693	16.7	1289.2	O K
2160 min Summer	199.737	0.637	16.7	1171.4	O K
2880 min Summer	199.681	0.581	16.7	1056.9	O K
4320 min Summer	199.577	0.477	16.7	850.5	O K
5760 min Summer	199.488	0.388	16.7	678.8	O K
7200 min Summer	199.416	0.316	16.7	545.5	O K
8640 min Summer	199.362	0.262	16.5	447.1	O K
10080 min Summer	199.322	0.222	16.2	376.9	O K
15 min Winter	199.495	0.395	16.7	692.9	O K
30 min Winter	199.606	0.506	16.7	906.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	131.351	0.0	583.4	26
30 min Summer	86.314	0.0	771.9	41
60 min Summer	54.074	0.0	1015.8	70
120 min Summer	32.762	0.0	1233.0	128
180 min Summer	24.128	0.0	1362.5	188
240 min Summer	19.312	0.0	1453.7	246
360 min Summer	14.018	0.0	1581.5	364
480 min Summer	11.175	0.0	1679.2	484
600 min Summer	9.366	0.0	1757.0	602
720 min Summer	8.105	0.0	1821.5	706
960 min Summer	6.446	0.0	1924.0	812
1440 min Summer	4.660	0.0	2063.5	1048
2160 min Summer	3.364	0.0	2315.9	1436
2880 min Summer	2.667	0.0	2446.5	1828
4320 min Summer	1.920	0.0	2632.5	2600
5760 min Summer	1.519	0.0	2801.3	3344
7200 min Summer	1.266	0.0	2916.1	4032
8640 min Summer	1.090	0.0	3009.9	4672
10080 min Summer	0.961	0.0	3084.3	5352
15 min Winter	131.351	0.0	656.0	26
30 min Winter	86.314	0.0	864.9	40

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	199.713	0.613	16.7	1122.1	O K
120 min Winter	199.813	0.713	16.7	1330.6	O K
180 min Winter	199.864	0.764	16.7	1438.8	O K
240 min Winter	199.893	0.793	16.7	1502.4	O K
360 min Winter	199.922	0.822	16.7	1566.5	O K
480 min Winter	199.935	0.835	16.7	1596.3	O K
600 min Winter	199.939	0.839	16.7	1604.4	O K
720 min Winter	199.937	0.837	16.7	1599.0	O K
960 min Winter	199.921	0.821	16.7	1564.4	O K
1440 min Winter	199.880	0.780	16.7	1473.7	O K
2160 min Winter	199.806	0.706	16.7	1314.9	O K
2880 min Winter	199.719	0.619	16.7	1133.9	O K
4320 min Winter	199.560	0.460	16.7	816.6	O K
5760 min Winter	199.430	0.330	16.7	571.2	O K
7200 min Winter	199.340	0.240	16.4	407.4	O K
8640 min Winter	199.290	0.190	15.8	320.5	O K
10080 min Winter	199.271	0.171	14.1	286.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	54.074	0.0	1139.2	70
120 min Winter	32.762	0.0	1381.7	126
180 min Winter	24.128	0.0	1525.9	184
240 min Winter	19.312	0.0	1627.5	242
360 min Winter	14.018	0.0	1769.6	358
480 min Winter	11.175	0.0	1877.7	472
600 min Winter	9.366	0.0	1963.2	584
720 min Winter	8.105	0.0	2033.5	694
960 min Winter	6.446	0.0	2142.9	904
1440 min Winter	4.660	0.0	2271.2	1126
2160 min Winter	3.364	0.0	2594.3	1584
2880 min Winter	2.667	0.0	2740.8	1996
4320 min Winter	1.920	0.0	2951.9	2772
5760 min Winter	1.519	0.0	3138.6	3464
7200 min Winter	1.266	0.0	3267.6	4048
8640 min Winter	1.090	0.0	3373.5	4584
10080 min Winter	0.961	0.0	3459.1	5264

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.100	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 2.570

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.857	4	8	0.857	8	12	0.857

Model Details

Storage is Online Cover Level (m) 200.500

Tank or Pond Structure

Invert Level (m) 199.100

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1620.0	1.000	2345.6	1.400	2664.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0183-1670-1000-1670
Design Head (m)	1.000
Design Flow (l/s)	16.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	183
Invert Level (m)	199.100
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	16.7
Flush-Flo™	0.330	16.7
Kick-Flo®	0.711	14.2
Mean Flow over Head Range	-	14.1

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.4	1.200	18.2	3.000	28.2	7.000	42.4
0.200	16.0	1.400	19.6	3.500	30.3	7.500	43.9
0.300	16.6	1.600	20.9	4.000	32.4	8.000	45.2
0.400	16.6	1.800	22.1	4.500	34.3	8.500	46.6
0.500	16.3	2.000	23.2	5.000	36.0	9.000	47.9
0.600	15.7	2.200	24.3	5.500	37.7	9.500	49.2
0.800	15.0	2.400	25.3	6.000	39.4		
1.000	16.7	2.600	26.3	6.500	40.9		

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	191.038	0.438	13.1	577.6	O K
30 min Summer	191.154	0.554	13.1	751.7	O K
60 min Summer	191.265	0.665	13.1	928.5	O K
120 min Summer	191.366	0.766	13.1	1097.2	O K
180 min Summer	191.417	0.817	13.1	1187.1	O K
240 min Summer	191.448	0.848	13.1	1241.0	O K
360 min Summer	191.477	0.877	13.1	1292.9	O K
480 min Summer	191.487	0.887	13.1	1310.3	O K
600 min Summer	191.486	0.886	13.1	1308.4	O K
720 min Summer	191.478	0.878	13.1	1294.7	O K
960 min Summer	191.455	0.855	13.1	1254.2	O K
1440 min Summer	191.407	0.807	13.1	1169.5	O K
2160 min Summer	191.331	0.731	13.1	1039.3	O K
2880 min Summer	191.255	0.655	13.1	912.8	O K
4320 min Summer	191.129	0.529	13.1	714.2	O K
5760 min Summer	191.032	0.432	13.1	568.1	O K
7200 min Summer	190.961	0.361	13.1	466.0	O K
8640 min Summer	190.909	0.309	13.1	394.4	O K
10080 min Summer	190.872	0.272	13.1	343.6	O K
15 min Winter	191.086	0.486	13.1	648.4	O K
30 min Winter	191.212	0.612	13.1	844.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	156.800	0.0	558.2	26
30 min Summer	102.480	0.0	729.2	41
60 min Summer	63.980	0.0	947.7	70
120 min Summer	38.640	0.0	1144.9	130
180 min Summer	28.507	0.0	1266.4	188
240 min Summer	22.855	0.0	1353.0	248
360 min Summer	16.590	0.0	1471.0	366
480 min Summer	13.171	0.0	1554.4	484
600 min Summer	10.988	0.0	1617.6	602
720 min Summer	9.462	0.0	1667.7	720
960 min Summer	7.453	0.0	1740.9	836
1440 min Summer	5.285	0.0	1809.3	1082
2160 min Summer	3.708	0.0	2000.8	1480
2880 min Summer	2.885	0.0	2074.7	1876
4320 min Summer	2.043	0.0	2198.9	2640
5760 min Summer	1.616	0.0	2333.4	3352
7200 min Summer	1.368	0.0	2468.0	4104
8640 min Summer	1.207	0.0	2610.4	4760
10080 min Summer	1.096	0.0	2759.8	5448
15 min Winter	156.800	0.0	625.8	26
30 min Winter	102.480	0.0	813.6	41

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	191.334	0.734	13.1	1044.2	O K
120 min Winter	191.445	0.845	13.1	1234.9	O K
180 min Winter	191.502	0.902	13.1	1338.6	O K
240 min Winter	191.537	0.937	13.1	1402.2	O K
360 min Winter	191.572	0.972	13.1	1466.8	O K
480 min Winter	191.586	0.986	13.1	1492.7	O K
600 min Winter	191.588	0.988	13.1	1497.2	O K
720 min Winter	191.583	0.983	13.1	1488.4	O K
960 min Winter	191.562	0.962	13.1	1448.1	O K
1440 min Winter	191.503	0.903	13.1	1338.7	O K
2160 min Winter	191.409	0.809	13.1	1172.2	O K
2880 min Winter	191.313	0.713	13.1	1008.9	O K
4320 min Winter	191.121	0.521	13.1	701.5	O K
5760 min Winter	190.975	0.375	13.1	486.4	O K
7200 min Winter	190.876	0.276	13.1	349.2	O K
8640 min Winter	190.815	0.215	12.8	266.7	O K
10080 min Winter	190.780	0.180	12.4	221.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	63.980	0.0	1061.8	70
120 min Winter	38.640	0.0	1281.9	128
180 min Winter	28.507	0.0	1417.3	184
240 min Winter	22.855	0.0	1513.3	242
360 min Winter	16.590	0.0	1643.4	358
480 min Winter	13.171	0.0	1734.2	474
600 min Winter	10.988	0.0	1801.6	586
720 min Winter	9.462	0.0	1853.1	698
960 min Winter	7.453	0.0	1919.9	912
1440 min Winter	5.285	0.0	1915.5	1140
2160 min Winter	3.708	0.0	2241.1	1604
2880 min Winter	2.885	0.0	2323.6	2056
4320 min Winter	2.043	0.0	2464.4	2816
5760 min Winter	1.616	0.0	2614.1	3520
7200 min Winter	1.368	0.0	2765.0	4184
8640 min Winter	1.207	0.0	2925.0	4760
10080 min Winter	1.096	0.0	3093.8	5352

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 401850 310150 SK 01850 10150
Data Type	Catchment
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 2.010

Time From: (mins)	To:	Area (ha)	Time From: (mins)	To:	Area (ha)	Time From: (mins)	To:	Area (ha)
0	4	0.670	4	8	0.670	8	12	0.670

Model Details

Storage is Online Cover Level (m) 192.000

Tank or Pond Structure

Invert Level (m) 190.600

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1173.4	1.000	1894.5	1.400	2213.4

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0165-1310-1000-1310
Design Head (m)	1.000
Design Flow (l/s)	13.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	165
Invert Level (m)	190.600
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	13.1
Flush-Flo™	0.315	13.1
Kick-Flo®	0.694	11.0
Mean Flow over Head Range	-	11.2

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.9	1.200	14.3	3.000	22.1	7.000	33.2
0.200	12.7	1.400	15.4	3.500	23.8	7.500	34.3
0.300	13.1	1.600	16.4	4.000	25.4	8.000	35.4
0.400	13.0	1.800	17.3	4.500	26.8	8.500	36.5
0.500	12.7	2.000	18.2	5.000	28.2	9.000	37.5
0.600	12.2	2.200	19.0	5.500	29.6	9.500	38.5
0.800	11.8	2.400	19.9	6.000	30.8		
1.000	13.1	2.600	20.6	6.500	32.0		

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	190.972	0.372	13.1	482.2	O K
30 min Summer	191.074	0.474	13.1	630.3	O K
60 min Summer	191.171	0.571	13.1	779.5	O K
120 min Summer	191.260	0.660	13.1	920.6	O K
180 min Summer	191.304	0.704	13.1	993.1	O K
240 min Summer	191.329	0.729	13.1	1034.6	O K
360 min Summer	191.351	0.751	13.1	1073.0	O K
480 min Summer	191.360	0.760	13.1	1087.2	O K
600 min Summer	191.359	0.759	13.1	1086.2	O K
720 min Summer	191.353	0.753	13.1	1075.8	O K
960 min Summer	191.338	0.738	13.1	1050.5	O K
1440 min Summer	191.304	0.704	13.1	993.2	O K
2160 min Summer	191.244	0.644	13.1	895.0	O K
2880 min Summer	191.186	0.586	13.1	802.1	O K
4320 min Summer	191.079	0.479	13.1	637.6	O K
5760 min Summer	190.986	0.386	13.1	501.3	O K
7200 min Summer	190.910	0.310	13.1	395.6	O K
8640 min Summer	190.854	0.254	13.0	318.5	O K
10080 min Summer	190.812	0.212	12.8	263.7	O K
15 min Winter	191.013	0.413	13.1	541.4	O K
30 min Winter	191.125	0.525	13.1	708.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	131.351	0.0	465.9	26
30 min Summer	86.314	0.0	614.9	41
60 min Summer	54.074	0.0	800.1	70
120 min Summer	32.762	0.0	970.6	128
180 min Summer	24.128	0.0	1072.3	188
240 min Summer	19.312	0.0	1144.1	246
360 min Summer	14.018	0.0	1244.9	364
480 min Summer	11.175	0.0	1322.1	482
600 min Summer	9.366	0.0	1383.7	602
720 min Summer	8.105	0.0	1435.0	702
960 min Summer	6.446	0.0	1517.0	808
1440 min Summer	4.660	0.0	1628.7	1058
2160 min Summer	3.364	0.0	1815.3	1448
2880 min Summer	2.667	0.0	1918.0	1828
4320 min Summer	1.920	0.0	2065.5	2600
5760 min Summer	1.519	0.0	2192.8	3344
7200 min Summer	1.266	0.0	2283.2	4032
8640 min Summer	1.090	0.0	2357.5	4672
10080 min Summer	0.961	0.0	2417.5	5344
15 min Winter	131.351	0.0	523.2	26
30 min Winter	86.314	0.0	688.5	40

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	191.233	0.633	13.1	876.8	O K
120 min Winter	191.331	0.731	13.1	1039.3	O K
180 min Winter	191.380	0.780	13.1	1122.3	O K
240 min Winter	191.408	0.808	13.1	1170.8	O K
360 min Winter	191.436	0.836	13.1	1218.8	O K
480 min Winter	191.448	0.848	13.1	1240.0	O K
600 min Winter	191.450	0.850	13.1	1244.5	O K
720 min Winter	191.447	0.847	13.1	1238.6	O K
960 min Winter	191.430	0.830	13.1	1208.5	O K
1440 min Winter	191.387	0.787	13.1	1134.3	O K
2160 min Winter	191.314	0.714	13.1	1009.9	O K
2880 min Winter	191.224	0.624	13.1	863.0	O K
4320 min Winter	191.059	0.459	13.1	608.6	O K
5760 min Winter	190.923	0.323	13.1	413.8	O K
7200 min Winter	190.829	0.229	12.9	285.8	O K
8640 min Winter	190.777	0.177	12.4	217.3	O K
10080 min Winter	190.758	0.158	11.1	193.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	54.074	0.0	896.9	70
120 min Winter	32.762	0.0	1087.3	126
180 min Winter	24.128	0.0	1200.8	184
240 min Winter	19.312	0.0	1280.9	242
360 min Winter	14.018	0.0	1393.1	358
480 min Winter	11.175	0.0	1478.7	472
600 min Winter	9.366	0.0	1546.7	584
720 min Winter	8.105	0.0	1602.9	694
960 min Winter	6.446	0.0	1691.0	902
1440 min Winter	4.660	0.0	1797.3	1122
2160 min Winter	3.364	0.0	2033.3	1588
2880 min Winter	2.667	0.0	2148.5	2000
4320 min Winter	1.920	0.0	2315.6	2772
5760 min Winter	1.519	0.0	2456.6	3464
7200 min Winter	1.266	0.0	2558.1	4048
8640 min Winter	1.090	0.0	2641.8	4584
10080 min Winter	0.961	0.0	2710.5	5248

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.100	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 2.010

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.670	4	8	0.670	8	12	0.670

Model Details

Storage is Online Cover Level (m) 192.000

Tank or Pond Structure

Invert Level (m) 190.600

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1173.4	1.000	1894.5	1.400	2213.4

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0165-1310-1000-1310
Design Head (m)	1.000
Design Flow (l/s)	13.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	165
Invert Level (m)	190.600
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	13.1
Flush-Flo™	0.315	13.1
Kick-Flo®	0.694	11.0
Mean Flow over Head Range	-	11.2

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.9	1.200	14.3	3.000	22.1	7.000	33.2
0.200	12.7	1.400	15.4	3.500	23.8	7.500	34.3
0.300	13.1	1.600	16.4	4.000	25.4	8.000	35.4
0.400	13.0	1.800	17.3	4.500	26.8	8.500	36.5
0.500	12.7	2.000	18.2	5.000	28.2	9.000	37.5
0.600	12.2	2.200	19.0	5.500	29.6	9.500	38.5
0.800	11.8	2.400	19.9	6.000	30.8		
1.000	13.1	2.600	20.6	6.500	32.0		

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	190.029	0.429	5.0	224.0	O K
30 min Summer	190.137	0.537	5.0	291.5	O K
60 min Summer	190.241	0.641	5.0	360.1	O K
120 min Summer	190.333	0.733	5.0	424.9	O K
180 min Summer	190.380	0.780	5.0	459.4	O K
240 min Summer	190.407	0.807	5.0	479.9	O K
360 min Summer	190.433	0.833	5.0	499.5	O K
480 min Summer	190.441	0.841	5.0	505.8	O K
600 min Summer	190.440	0.840	5.0	504.7	O K
720 min Summer	190.432	0.832	5.0	499.1	O K
960 min Summer	190.409	0.809	5.0	481.7	O K
1440 min Summer	190.362	0.762	5.0	446.3	O K
2160 min Summer	190.291	0.691	5.0	394.8	O K
2880 min Summer	190.221	0.621	5.0	346.6	O K
4320 min Summer	190.100	0.500	5.0	267.5	O K
5760 min Summer	190.006	0.406	5.0	210.4	O K
7200 min Summer	189.938	0.338	5.0	170.7	O K
8640 min Summer	189.887	0.287	5.0	142.4	O K
10080 min Summer	189.850	0.250	5.0	122.5	O K
15 min Winter	190.074	0.474	5.0	251.5	O K
30 min Winter	190.192	0.592	5.0	327.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	156.800	0.0	222.4	26
30 min Summer	102.480	0.0	290.0	41
60 min Summer	63.980	0.0	371.0	70
120 min Summer	38.640	0.0	448.0	130
180 min Summer	28.507	0.0	495.6	188
240 min Summer	22.855	0.0	529.5	248
360 min Summer	16.590	0.0	575.9	366
480 min Summer	13.171	0.0	608.8	484
600 min Summer	10.988	0.0	633.9	602
720 min Summer	9.462	0.0	653.8	720
960 min Summer	7.453	0.0	683.0	862
1440 min Summer	5.285	0.0	706.7	1102
2160 min Summer	3.708	0.0	778.6	1496
2880 min Summer	2.885	0.0	807.6	1904
4320 min Summer	2.043	0.0	856.9	2644
5760 min Summer	1.616	0.0	906.5	3400
7200 min Summer	1.368	0.0	959.0	4104
8640 min Summer	1.207	0.0	1014.8	4768
10080 min Summer	1.096	0.0	1074.0	5456
15 min Winter	156.800	0.0	249.1	26
30 min Winter	102.480	0.0	323.3	41

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	190.305	0.705	5.0	405.0	O K
120 min Winter	190.405	0.805	5.0	478.6	O K
180 min Winter	190.458	0.858	5.0	518.6	O K
240 min Winter	190.489	0.889	5.0	543.1	O K
360 min Winter	190.520	0.920	5.0	567.9	O K
480 min Winter	190.532	0.932	5.0	577.7	O K
600 min Winter	190.534	0.934	5.0	579.3	O K
720 min Winter	190.530	0.930	5.0	575.7	O K
960 min Winter	190.510	0.910	5.0	559.6	O K
1440 min Winter	190.453	0.853	5.0	514.6	O K
2160 min Winter	190.366	0.766	5.0	449.1	O K
2880 min Winter	190.279	0.679	5.0	386.7	O K
4320 min Winter	190.096	0.496	5.0	265.1	O K
5760 min Winter	189.955	0.355	5.0	180.9	O K
7200 min Winter	189.859	0.259	5.0	127.3	O K
8640 min Winter	189.796	0.196	4.8	94.4	O K
10080 min Winter	189.757	0.157	4.7	74.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	63.980	0.0	415.5	70
120 min Winter	38.640	0.0	501.6	128
180 min Winter	28.507	0.0	554.6	186
240 min Winter	22.855	0.0	592.3	244
360 min Winter	16.590	0.0	643.5	358
480 min Winter	13.171	0.0	679.3	474
600 min Winter	10.988	0.0	705.8	588
720 min Winter	9.462	0.0	725.6	700
960 min Winter	7.453	0.0	747.7	916
1440 min Winter	5.285	0.0	728.6	1156
2160 min Winter	3.708	0.0	872.1	1608
2880 min Winter	2.885	0.0	904.4	2076
4320 min Winter	2.043	0.0	960.0	2852
5760 min Winter	1.616	0.0	1015.4	3536
7200 min Winter	1.368	0.0	1074.3	4184
8640 min Winter	1.207	0.0	1136.9	4848
10080 min Winter	1.096	0.0	1203.5	5456

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 401850 310150 SK 01850 10150
Data Type	Catchment
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.780

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.260	4	8	0.260	8	12	0.260

Model Details

Storage is Online Cover Level (m) 191.000

Tank or Pond Structure

Invert Level (m) 189.600

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	447.3	1.000	840.7	1.400	1026.6

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0105-5000-1000-5000
Design Head (m)	1.000
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	105
Invert Level (m)	189.600
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	5.0
Flush-Flo™	0.296	5.0
Kick-Flo®	0.637	4.1
Mean Flow over Head Range	-	4.3

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.6	1.200	5.4	3.000	8.4	7.000	12.5
0.200	4.8	1.400	5.8	3.500	9.0	7.500	12.9
0.300	5.0	1.600	6.2	4.000	9.6	8.000	13.3
0.400	4.9	1.800	6.6	4.500	10.1	8.500	13.7
0.500	4.7	2.000	6.9	5.000	10.6	9.000	14.1
0.600	4.3	2.200	7.2	5.500	11.1	9.500	14.5
0.800	4.5	2.400	7.5	6.000	11.6		
1.000	5.0	2.600	7.8	6.500	12.1		

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	189.966	0.366	5.0	186.9	O K
30 min Summer	190.062	0.462	5.0	244.4	O K
60 min Summer	190.154	0.554	5.0	302.0	O K
120 min Summer	190.236	0.636	5.0	356.7	O K
180 min Summer	190.276	0.676	5.0	384.3	O K
240 min Summer	190.298	0.698	5.0	399.8	O K
360 min Summer	190.317	0.717	5.0	413.9	O K
480 min Summer	190.324	0.724	5.0	418.7	O K
600 min Summer	190.323	0.723	5.0	417.8	O K
720 min Summer	190.317	0.717	5.0	413.3	O K
960 min Summer	190.300	0.700	5.0	401.7	O K
1440 min Summer	190.266	0.666	5.0	377.7	O K
2160 min Summer	190.209	0.609	5.0	338.7	O K
2880 min Summer	190.153	0.553	5.0	301.5	O K
4320 min Summer	190.050	0.450	5.0	237.0	O K
5760 min Summer	189.961	0.361	5.0	184.0	O K
7200 min Summer	189.887	0.287	5.0	142.7	O K
8640 min Summer	189.830	0.230	4.9	112.0	O K
10080 min Summer	189.788	0.188	4.8	90.0	O K
15 min Winter	190.005	0.405	5.0	209.9	O K
30 min Winter	190.111	0.511	5.0	274.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	131.351	0.0	186.1	26
30 min Summer	86.314	0.0	244.8	41
60 min Summer	54.074	0.0	313.4	70
120 min Summer	32.762	0.0	379.9	130
180 min Summer	24.128	0.0	419.6	188
240 min Summer	19.312	0.0	447.7	248
360 min Summer	14.018	0.0	487.3	366
480 min Summer	11.175	0.0	517.6	484
600 min Summer	9.366	0.0	542.0	602
720 min Summer	8.105	0.0	562.3	718
960 min Summer	6.446	0.0	595.0	822
1440 min Summer	4.660	0.0	640.0	1074
2160 min Summer	3.364	0.0	706.5	1460
2880 min Summer	2.667	0.0	746.6	1848
4320 min Summer	1.920	0.0	805.0	2604
5760 min Summer	1.519	0.0	852.0	3344
7200 min Summer	1.266	0.0	887.3	4040
8640 min Summer	1.090	0.0	916.7	4680
10080 min Summer	0.961	0.0	941.1	5352
15 min Winter	131.351	0.0	208.6	26
30 min Winter	86.314	0.0	273.9	40

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	190.211	0.611	5.0	340.1	O K
120 min Winter	190.302	0.702	5.0	402.7	O K
180 min Winter	190.346	0.746	5.0	434.5	O K
240 min Winter	190.371	0.771	5.0	453.0	O K
360 min Winter	190.396	0.796	5.0	471.2	O K
480 min Winter	190.406	0.806	5.0	479.0	O K
600 min Winter	190.408	0.808	5.0	480.4	O K
720 min Winter	190.404	0.804	5.0	477.8	O K
960 min Winter	190.388	0.788	5.0	465.6	O K
1440 min Winter	190.346	0.746	5.0	434.4	O K
2160 min Winter	190.278	0.678	5.0	386.0	O K
2880 min Winter	190.195	0.595	5.0	329.0	O K
4320 min Winter	190.035	0.435	5.0	227.9	O K
5760 min Winter	189.904	0.304	5.0	152.0	O K
7200 min Winter	189.810	0.210	4.9	101.5	O K
8640 min Winter	189.751	0.151	4.6	71.4	O K
10080 min Winter	189.722	0.122	4.3	56.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	54.074	0.0	351.1	70
120 min Winter	32.762	0.0	425.5	126
180 min Winter	24.128	0.0	469.9	184
240 min Winter	19.312	0.0	501.3	242
360 min Winter	14.018	0.0	545.3	358
480 min Winter	11.175	0.0	579.1	472
600 min Winter	9.366	0.0	605.9	586
720 min Winter	8.105	0.0	628.2	696
960 min Winter	6.446	0.0	663.3	906
1440 min Winter	4.660	0.0	703.4	1132
2160 min Winter	3.364	0.0	791.3	1604
2880 min Winter	2.667	0.0	836.2	2024
4320 min Winter	1.920	0.0	902.1	2776
5760 min Winter	1.519	0.0	954.3	3464
7200 min Winter	1.266	0.0	994.0	4112
8640 min Winter	1.090	0.0	1026.9	4680
10080 min Winter	0.961	0.0	1054.6	5248

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.100	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.780

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.260	4	8	0.260	8	12	0.260

Model Details

Storage is Online Cover Level (m) 191.000

Tank or Pond Structure

Invert Level (m) 189.600

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	447.3	1.000	840.7	1.400	1026.6

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0105-5000-1000-5000
Design Head (m)	1.000
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	105
Invert Level (m)	189.600
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	5.0
Flush-Flo™	0.296	5.0
Kick-Flo®	0.637	4.1
Mean Flow over Head Range	-	4.3

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.6	1.200	5.4	3.000	8.4	7.000	12.5
0.200	4.8	1.400	5.8	3.500	9.0	7.500	12.9
0.300	5.0	1.600	6.2	4.000	9.6	8.000	13.3
0.400	4.9	1.800	6.6	4.500	10.1	8.500	13.7
0.500	4.7	2.000	6.9	5.000	10.6	9.000	14.1
0.600	4.3	2.200	7.2	5.500	11.1	9.500	14.5
0.800	4.5	2.400	7.5	6.000	11.6		
1.000	5.0	2.600	7.8	6.500	12.1		

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	182.026	0.426	22.1	934.2	O K
30 min Summer	182.143	0.543	22.1	1215.3	O K
60 min Summer	182.258	0.658	22.1	1500.7	O K
120 min Summer	182.364	0.764	22.1	1774.4	O K
180 min Summer	182.420	0.820	22.1	1920.9	O K
240 min Summer	182.453	0.853	22.1	2008.5	O K
360 min Summer	182.484	0.884	22.1	2092.9	O K
480 min Summer	182.494	0.894	22.1	2121.1	O K
600 min Summer	182.493	0.893	22.1	2118.0	O K
720 min Summer	182.485	0.885	22.1	2095.6	O K
960 min Summer	182.463	0.863	22.1	2036.0	O K
1440 min Summer	182.414	0.814	22.1	1906.2	O K
2160 min Summer	182.334	0.734	22.1	1695.3	O K
2880 min Summer	182.253	0.653	22.1	1488.9	O K
4320 min Summer	182.126	0.526	22.1	1172.6	O K
5760 min Summer	182.029	0.429	22.1	940.7	O K
7200 min Summer	181.961	0.361	22.1	782.1	O K
8640 min Summer	181.912	0.312	22.0	671.3	O K
10080 min Summer	181.878	0.278	21.9	594.6	O K
15 min Winter	182.074	0.474	22.1	1048.5	O K
30 min Winter	182.204	0.604	22.1	1364.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	156.800	0.0	878.1	26
30 min Summer	102.480	0.0	1151.8	41
60 min Summer	63.980	0.0	1518.0	70
120 min Summer	38.640	0.0	1835.2	130
180 min Summer	28.507	0.0	2030.5	188
240 min Summer	22.855	0.0	2169.3	248
360 min Summer	16.590	0.0	2358.5	366
480 min Summer	13.171	0.0	2492.2	484
600 min Summer	10.988	0.0	2593.4	602
720 min Summer	9.462	0.0	2673.6	718
960 min Summer	7.453	0.0	2791.4	818
1440 min Summer	5.285	0.0	2912.6	1064
2160 min Summer	3.708	0.0	3225.0	1472
2880 min Summer	2.885	0.0	3343.5	1848
4320 min Summer	2.043	0.0	3538.7	2600
5760 min Summer	1.616	0.0	3767.8	3344
7200 min Summer	1.368	0.0	3984.1	4040
8640 min Summer	1.207	0.0	4212.0	4752
10080 min Summer	1.096	0.0	4448.5	5440
15 min Winter	156.800	0.0	986.3	26
30 min Winter	102.480	0.0	1287.5	40

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	182.331	0.731	22.1	1687.8	O K
120 min Winter	182.448	0.848	22.1	1996.7	O K
180 min Winter	182.510	0.910	22.1	2164.4	O K
240 min Winter	182.547	0.947	22.1	2267.0	O K
360 min Winter	182.585	0.985	22.1	2370.7	O K
480 min Winter	182.599	0.999	22.1	2411.7	O K
600 min Winter	182.601	1.001	22.1	2417.9	O K
720 min Winter	182.596	0.996	22.1	2403.0	O K
960 min Winter	182.572	0.972	22.1	2336.3	O K
1440 min Winter	182.511	0.911	22.1	2167.4	O K
2160 min Winter	182.411	0.811	22.1	1897.4	O K
2880 min Winter	182.303	0.703	22.1	1616.0	O K
4320 min Winter	182.110	0.510	22.1	1134.0	O K
5760 min Winter	181.968	0.368	22.1	798.8	O K
7200 min Winter	181.877	0.277	21.9	593.2	O K
8640 min Winter	181.825	0.225	21.4	475.7	O K
10080 min Winter	181.803	0.203	20.2	428.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	63.980	0.0	1701.7	70
120 min Winter	38.640	0.0	2055.6	128
180 min Winter	28.507	0.0	2273.0	184
240 min Winter	22.855	0.0	2427.3	242
360 min Winter	16.590	0.0	2636.3	358
480 min Winter	13.171	0.0	2782.6	472
600 min Winter	10.988	0.0	2891.9	586
720 min Winter	9.462	0.0	2976.6	696
960 min Winter	7.453	0.0	3094.3	906
1440 min Winter	5.285	0.0	3167.2	1126
2160 min Winter	3.708	0.0	3612.8	1584
2880 min Winter	2.885	0.0	3745.4	2024
4320 min Winter	2.043	0.0	3968.2	2776
5760 min Winter	1.616	0.0	4221.6	3464
7200 min Winter	1.368	0.0	4464.4	4112
8640 min Winter	1.207	0.0	4720.9	4680
10080 min Winter	1.096	0.0	4989.2	5344

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 401850 310150 SK 01850 10150
Data Type	Catchment
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 3.250

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	1.083	4	8	1.083	8	12	1.083

Model Details

Storage is Online Cover Level (m) 183.000

Tank or Pond Structure

Invert Level (m) 181.600

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	2037.6	1.000	2810.7	1.400	3148.2

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0208-2210-1000-2210
Design Head (m)	1.000
Design Flow (l/s)	22.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	208
Invert Level (m)	181.600
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	22.1
Flush-Flo™	0.350	22.1
Kick-Flo®	0.728	19.0
Mean Flow over Head Range	-	18.5

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	7.1	1.200	24.1	3.000	37.4	7.000	56.4
0.200	20.0	1.400	25.9	3.500	40.3	7.500	58.3
0.300	22.0	1.600	27.7	4.000	43.0	8.000	60.2
0.400	22.0	1.800	29.3	4.500	45.5	8.500	62.0
0.500	21.7	2.000	30.8	5.000	47.9	9.000	63.7
0.600	21.0	2.200	32.2	5.500	50.1	9.500	65.4
0.800	19.9	2.400	33.6	6.000	52.3		
1.000	22.1	2.600	34.9	6.500	54.4		

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	181.960	0.360	22.1	780.2	O K
30 min Summer	182.062	0.462	22.1	1019.1	O K
60 min Summer	182.162	0.562	22.1	1260.3	O K
120 min Summer	182.253	0.653	22.1	1488.1	O K
180 min Summer	182.299	0.699	22.1	1604.1	O K
240 min Summer	182.325	0.725	22.1	1671.6	O K
360 min Summer	182.350	0.750	22.1	1735.8	O K
480 min Summer	182.359	0.759	22.1	1760.0	O K
600 min Summer	182.358	0.758	22.1	1758.8	O K
720 min Summer	182.353	0.753	22.1	1743.4	O K
960 min Summer	182.339	0.739	22.1	1707.0	O K
1440 min Summer	182.303	0.703	22.1	1614.8	O K
2160 min Summer	182.244	0.644	22.1	1464.3	O K
2880 min Summer	182.185	0.585	22.1	1317.4	O K
4320 min Summer	182.076	0.476	22.1	1052.7	O K
5760 min Summer	181.985	0.385	22.1	838.1	O K
7200 min Summer	181.914	0.314	22.1	676.0	O K
8640 min Summer	181.862	0.262	21.8	559.0	O K
10080 min Summer	181.826	0.226	21.4	478.3	O K
15 min Winter	182.001	0.401	22.1	875.7	O K
30 min Winter	182.114	0.514	22.1	1145.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	131.351	0.0	730.3	26
30 min Summer	86.314	0.0	968.7	41
60 min Summer	54.074	0.0	1280.2	70
120 min Summer	32.762	0.0	1554.7	128
180 min Summer	24.128	0.0	1718.2	188
240 min Summer	19.312	0.0	1833.6	246
360 min Summer	14.018	0.0	1995.2	364
480 min Summer	11.175	0.0	2118.8	482
600 min Summer	9.366	0.0	2217.3	600
720 min Summer	8.105	0.0	2299.2	680
960 min Summer	6.446	0.0	2429.7	790
1440 min Summer	4.660	0.0	2610.7	1030
2160 min Summer	3.364	0.0	2925.6	1424
2880 min Summer	2.667	0.0	3090.5	1820
4320 min Summer	1.920	0.0	3323.4	2592
5760 min Summer	1.519	0.0	3540.6	3296
7200 min Summer	1.266	0.0	3685.3	3968
8640 min Summer	1.090	0.0	3803.2	4664
10080 min Summer	0.961	0.0	3895.6	5264
15 min Winter	131.351	0.0	822.0	26
30 min Winter	86.314	0.0	1086.5	40

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	182.225	0.625	22.1	1417.3	O K
120 min Winter	182.328	0.728	22.1	1679.5	O K
180 min Winter	182.380	0.780	22.1	1814.6	O K
240 min Winter	182.409	0.809	22.1	1893.2	O K
360 min Winter	182.439	0.839	22.1	1970.8	O K
480 min Winter	182.451	0.851	22.1	2004.9	O K
600 min Winter	182.454	0.854	22.1	2011.8	O K
720 min Winter	182.450	0.850	22.1	2001.8	O K
960 min Winter	182.432	0.832	22.1	1952.8	O K
1440 min Winter	182.389	0.789	22.1	1838.8	O K
2160 min Winter	182.307	0.707	22.1	1626.6	O K
2880 min Winter	182.216	0.616	22.1	1394.9	O K
4320 min Winter	182.050	0.450	22.1	991.8	O K
5760 min Winter	181.921	0.321	22.1	691.8	O K
7200 min Winter	181.837	0.237	21.5	503.3	O K
8640 min Winter	181.800	0.200	20.0	422.6	O K
10080 min Winter	181.781	0.181	17.8	380.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	54.074	0.0	1436.1	70
120 min Winter	32.762	0.0	1742.6	126
180 min Winter	24.128	0.0	1925.0	184
240 min Winter	19.312	0.0	2053.6	242
360 min Winter	14.018	0.0	2233.5	358
480 min Winter	11.175	0.0	2370.6	472
600 min Winter	9.366	0.0	2479.5	582
720 min Winter	8.105	0.0	2569.4	692
960 min Winter	6.446	0.0	2710.7	894
1440 min Winter	4.660	0.0	2890.1	1112
2160 min Winter	3.364	0.0	3277.8	1564
2880 min Winter	2.667	0.0	3462.8	1972
4320 min Winter	1.920	0.0	3727.6	2732
5760 min Winter	1.519	0.0	3967.1	3408
7200 min Winter	1.266	0.0	4129.8	3976
8640 min Winter	1.090	0.0	4263.0	4584
10080 min Winter	0.961	0.0	4369.7	5264

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.100	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 3.250

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	1.083	4	8	1.083	8	12	1.083

Model Details

Storage is Online Cover Level (m) 183.000

Tank or Pond Structure

Invert Level (m) 181.600

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	2037.6	1.000	2810.7	1.400	3148.2

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0208-2210-1000-2210
Design Head (m)	1.000
Design Flow (l/s)	22.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	208
Invert Level (m)	181.600
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	22.1
Flush-Flo™	0.350	22.1
Kick-Flo®	0.728	19.0
Mean Flow over Head Range	-	18.5

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	7.1	1.200	24.1	3.000	37.4	7.000	56.4
0.200	20.0	1.400	25.9	3.500	40.3	7.500	58.3
0.300	22.0	1.600	27.7	4.000	43.0	8.000	60.2
0.400	22.0	1.800	29.3	4.500	45.5	8.500	62.0
0.500	21.7	2.000	30.8	5.000	47.9	9.000	63.7
0.600	21.0	2.200	32.2	5.500	50.1	9.500	65.4
0.800	19.9	2.400	33.6	6.000	52.3		
1.000	22.1	2.600	34.9	6.500	54.4		

Cascade Summary of Results for Catchment A 100yr 40CC Storage FEH_P01.SRCX

	Upstream Structures	Outflow To	Overflow To
Catchment B 100yr 40CC Storage FEH_P01.SRCX		(None)	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	181.958	0.358	16.8	205.0	O K
30 min Summer	182.050	0.450	16.8	266.5	O K
60 min Summer	182.137	0.537	16.8	328.9	O K
120 min Summer	182.216	0.616	16.8	388.4	O K
180 min Summer	182.259	0.659	16.8	422.7	O K
240 min Summer	182.288	0.688	16.8	445.5	O K
360 min Summer	182.320	0.720	16.8	471.7	O K
480 min Summer	182.335	0.735	16.8	484.0	O K
600 min Summer	182.339	0.739	16.8	488.1	O K
720 min Summer	182.338	0.738	16.8	487.0	O K
960 min Summer	182.323	0.723	16.8	474.3	O K
1440 min Summer	182.259	0.659	16.8	422.3	O K
2160 min Summer	182.187	0.587	16.8	366.0	O K
2880 min Summer	182.139	0.539	16.8	330.1	O K
4320 min Summer	182.054	0.454	16.8	269.7	O K
5760 min Summer	181.985	0.385	16.8	222.5	O K
7200 min Summer	181.934	0.334	16.8	189.1	O K
8640 min Summer	181.896	0.296	16.8	165.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	156.800	0.0	715.3	26
30 min Summer	102.480	0.0	934.0	41
60 min Summer	63.980	0.0	1219.3	70
120 min Summer	38.640	0.0	1472.9	128
180 min Summer	28.507	0.0	1629.1	188
240 min Summer	22.855	0.0	1740.2	248
360 min Summer	16.590	0.0	1891.5	368
480 min Summer	13.171	0.0	1998.1	486
600 min Summer	10.988	0.0	2078.7	604
720 min Summer	9.462	0.0	2142.1	724
960 min Summer	7.453	0.0	2233.6	962
1440 min Summer	5.285	0.0	2311.2	1084
2160 min Summer	3.708	0.0	2576.9	1396
2880 min Summer	2.885	0.0	2671.9	1808
4320 min Summer	2.043	0.0	2831.3	2600
5760 min Summer	1.616	0.0	3006.2	3352
7200 min Summer	1.368	0.0	3179.4	4048
8640 min Summer	1.207	0.0	3362.6	4760

Cascade Summary of Results for Catchment A 100yr 40CC Storage FEH_P01.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
10080 min Summer	181.867	0.267	16.7	147.3	O K
15 min Winter	181.996	0.396	16.8	229.9	O K
30 min Winter	182.096	0.496	16.8	299.0	O K
60 min Winter	182.190	0.590	16.8	368.9	O K
120 min Winter	182.280	0.680	16.8	439.2	O K
180 min Winter	182.331	0.731	16.8	480.8	O K
240 min Winter	182.362	0.762	16.8	507.2	O K
360 min Winter	182.396	0.796	16.8	536.3	O K
480 min Winter	182.413	0.813	16.8	550.8	O K
600 min Winter	182.419	0.819	16.8	556.9	O K
720 min Winter	182.420	0.820	16.8	557.7	O K
960 min Winter	182.410	0.810	16.8	549.0	O K
1440 min Winter	182.364	0.764	16.8	509.0	O K
2160 min Winter	182.249	0.649	16.8	414.1	O K
2880 min Winter	182.163	0.563	16.8	347.8	O K
4320 min Winter	182.047	0.447	16.8	264.6	O K
5760 min Winter	181.945	0.345	16.8	196.5	O K
7200 min Winter	181.872	0.272	16.7	150.2	O K
8640 min Winter	181.820	0.220	16.3	119.1	O K
10080 min Winter	181.792	0.192	16.0	103.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	1.096	0.0	3554.3	5456
15 min Winter	156.800	0.0	801.9	26
30 min Winter	102.480	0.0	1041.3	40
60 min Winter	63.980	0.0	1366.0	70
120 min Winter	38.640	0.0	1649.0	128
180 min Winter	28.507	0.0	1822.7	186
240 min Winter	22.855	0.0	1945.8	244
360 min Winter	16.590	0.0	2112.1	362
480 min Winter	13.171	0.0	2227.5	478
600 min Winter	10.988	0.0	2312.2	594
720 min Winter	9.462	0.0	2375.7	708
960 min Winter	7.453	0.0	2452.5	932
1440 min Winter	5.285	0.0	2418.1	1358
2160 min Winter	3.708	0.0	2886.4	1592
2880 min Winter	2.885	0.0	2992.4	1912
4320 min Winter	2.043	0.0	3173.3	2772
5760 min Winter	1.616	0.0	3367.8	3520
7200 min Winter	1.368	0.0	3562.2	4184
8640 min Winter	1.207	0.0	3768.1	4832
10080 min Winter	1.096	0.0	3985.0	5248

Cascade Rainfall Details for Catchment A 100yr 40CC Storage FEH_P01.SRCX

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 401850 310150 SK 01850 10150
Data Type	Catchment
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.710

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.237	4	8	0.237	8	12	0.237

Cascade Model Details for Catchment A 100yr 40CC Storage FEH_P01.SRCX

Storage is Online Cover Level (m) 183.000

Tank or Pond Structure

Invert Level (m) 181.600

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	496.7	1.000	979.9	1.400	1209.4

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0184-1680-1000-1680
Design Head (m)	1.000
Design Flow (l/s)	16.8
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	184
Invert Level (m)	181.600
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	16.8
Flush-Flo™	0.325	16.8
Kick-Flo®	0.706	14.2
Mean Flow over Head Range	-	14.2

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.5	1.200	18.3	3.000	28.4	7.000	42.7
0.200	16.1	1.400	19.7	3.500	30.6	7.500	44.2
0.300	16.8	1.600	21.0	4.000	32.6	8.000	45.6
0.400	16.7	1.800	22.2	4.500	34.5	8.500	46.9
0.500	16.3	2.000	23.4	5.000	36.3	9.000	48.3
0.600	15.8	2.200	24.5	5.500	38.0	9.500	49.5
0.800	15.1	2.400	25.5	6.000	39.7		
1.000	16.8	2.600	26.5	6.500	41.2		

Cascade Summary of Results for Catchment A 100yr 40CC Storage FSR_P01.SRCX

	Upstream Structures	Outflow To	Overflow To
Catchment B 100yr 40CC Storage FSR_P01.SRCX		(None)	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	181.906	0.306	16.8	171.6	O K
30 min Summer	181.987	0.387	16.8	223.9	O K
60 min Summer	182.065	0.465	16.8	277.2	O K
120 min Summer	182.135	0.535	16.8	327.4	O K
180 min Summer	182.168	0.568	16.8	351.7	O K
240 min Summer	182.186	0.586	16.8	365.4	O K
360 min Summer	182.202	0.602	16.8	378.0	O K
480 min Summer	182.208	0.608	16.8	382.1	O K
600 min Summer	182.206	0.606	16.8	380.8	O K
720 min Summer	182.203	0.603	16.8	378.4	O K
960 min Summer	182.194	0.594	16.8	371.4	O K
1440 min Summer	182.171	0.571	16.8	354.1	O K
2160 min Summer	182.134	0.534	16.8	326.6	O K
2880 min Summer	182.095	0.495	16.8	298.1	O K
4320 min Summer	182.018	0.418	16.8	244.8	O K
5760 min Summer	181.951	0.351	16.8	200.3	O K
7200 min Summer	181.896	0.296	16.8	165.2	O K
8640 min Summer	181.851	0.251	16.6	137.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	131.351	0.0	596.9	26
30 min Summer	86.314	0.0	787.9	41
60 min Summer	54.074	0.0	1029.2	70
120 min Summer	32.762	0.0	1248.7	128
180 min Summer	24.128	0.0	1379.5	186
240 min Summer	19.312	0.0	1471.8	246
360 min Summer	14.018	0.0	1601.3	362
480 min Summer	11.175	0.0	1700.4	480
600 min Summer	9.366	0.0	1779.4	548
720 min Summer	8.105	0.0	1845.0	598
960 min Summer	6.446	0.0	1949.5	710
1440 min Summer	4.660	0.0	2089.9	968
2160 min Summer	3.364	0.0	2338.0	1388
2880 min Summer	2.667	0.0	2470.1	1796
4320 min Summer	1.920	0.0	2659.6	2592
5760 min Summer	1.519	0.0	2825.1	3304
7200 min Summer	1.266	0.0	2941.3	4032
8640 min Summer	1.090	0.0	3036.8	4680

Cascade Summary of Results for Catchment A 100yr 40CC Storage FSR_P01.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
10080 min Summer	181.817	0.217	16.3	117.6	O K
15 min Winter	181.939	0.339	16.8	192.3	O K
30 min Winter	182.028	0.428	16.8	251.3	O K
60 min Winter	182.113	0.513	16.8	311.1	O K
120 min Winter	182.189	0.589	16.8	367.5	O K
180 min Winter	182.228	0.628	16.8	397.6	O K
240 min Winter	182.251	0.651	16.8	416.3	O K
360 min Winter	182.277	0.677	16.8	437.0	O K
480 min Winter	182.291	0.691	16.8	448.3	O K
600 min Winter	182.297	0.697	16.8	452.9	O K
720 min Winter	182.296	0.696	16.8	452.4	O K
960 min Winter	182.281	0.681	16.8	439.7	O K
1440 min Winter	182.233	0.633	16.8	401.7	O K
2160 min Winter	182.168	0.568	16.8	352.2	O K
2880 min Winter	182.116	0.516	16.8	313.6	O K
4320 min Winter	182.004	0.404	16.8	235.4	O K
5760 min Winter	181.907	0.307	16.8	172.4	O K
7200 min Winter	181.832	0.232	16.5	126.4	O K
8640 min Winter	181.791	0.191	15.9	102.4	O K
10080 min Winter	181.772	0.172	14.3	91.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	0.961	0.0	3113.4	5352
15 min Winter	131.351	0.0	670.4	26
30 min Winter	86.314	0.0	882.0	40
60 min Winter	54.074	0.0	1153.8	68
120 min Winter	32.762	0.0	1398.8	126
180 min Winter	24.128	0.0	1544.7	184
240 min Winter	19.312	0.0	1647.6	242
360 min Winter	14.018	0.0	1791.6	358
480 min Winter	11.175	0.0	1901.3	476
600 min Winter	9.366	0.0	1988.1	590
720 min Winter	8.105	0.0	2059.7	704
960 min Winter	6.446	0.0	2170.9	918
1440 min Winter	4.660	0.0	2298.5	1096
2160 min Winter	3.364	0.0	2618.8	1492
2880 min Winter	2.667	0.0	2767.1	1936
4320 min Winter	1.920	0.0	2981.7	2732
5760 min Winter	1.519	0.0	3165.0	3464
7200 min Winter	1.266	0.0	3295.5	4104
8640 min Winter	1.090	0.0	3403.1	4536
10080 min Winter	0.961	0.0	3491.0	5304

Cascade Rainfall Details for Catchment A 100yr 40CC Storage FSR_P01.SRCX

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.100	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.710

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.237	4	8	0.237	8	12	0.237

Cascade Model Details for Catchment A 100yr 40CC Storage FSR_P01.SRCX

Storage is Online Cover Level (m) 183.000

Tank or Pond Structure

Invert Level (m) 181.600

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	496.7	1.000	979.9	1.400	1209.4

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0184-1680-1000-1680
Design Head (m)	1.000
Design Flow (l/s)	16.8
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	184
Invert Level (m)	181.600
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	16.8
Flush-Flo™	0.325	16.8
Kick-Flo®	0.706	14.2
Mean Flow over Head Range	-	14.2

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.5	1.200	18.3	3.000	28.4	7.000	42.7
0.200	16.1	1.400	19.7	3.500	30.6	7.500	44.2
0.300	16.8	1.600	21.0	4.000	32.6	8.000	45.6
0.400	16.7	1.800	22.2	4.500	34.5	8.500	46.9
0.500	16.3	2.000	23.4	5.000	36.3	9.000	48.3
0.600	15.8	2.200	24.5	5.500	38.0	9.500	49.5
0.800	15.1	2.400	25.5	6.000	39.7		
1.000	16.8	2.600	26.5	6.500	41.2		

Cascade Summary of Results for Catchment B 100yr 40CC Storage FEH_P01.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	Catchment A 100yr 40CC Storage FEH_P01.SRCX	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	187.033	0.433	12.2	540.3	O K
30 min Summer	187.146	0.546	12.2	703.2	O K
60 min Summer	187.255	0.655	12.2	868.5	O K
120 min Summer	187.354	0.754	12.2	1026.5	O K
180 min Summer	187.405	0.805	12.2	1110.9	O K
240 min Summer	187.435	0.835	12.2	1161.5	O K
360 min Summer	187.464	0.864	12.2	1210.5	O K
480 min Summer	187.473	0.873	12.2	1227.3	O K
600 min Summer	187.473	0.873	12.2	1226.0	O K
720 min Summer	187.465	0.865	12.2	1213.6	O K
960 min Summer	187.443	0.843	12.2	1175.5	O K
1440 min Summer	187.396	0.796	12.2	1095.9	O K
2160 min Summer	187.321	0.721	12.2	973.8	O K
2880 min Summer	187.246	0.646	12.2	855.1	O K
4320 min Summer	187.124	0.524	12.2	670.3	O K
5760 min Summer	187.028	0.428	12.2	533.9	O K
7200 min Summer	186.958	0.358	12.2	438.5	O K
8640 min Summer	186.908	0.308	12.2	371.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	156.800	0.0	522.8	26
30 min Summer	102.480	0.0	682.7	41
60 min Summer	63.980	0.0	886.8	70
120 min Summer	38.640	0.0	1071.3	130
180 min Summer	28.507	0.0	1185.0	188
240 min Summer	22.855	0.0	1265.9	248
360 min Summer	16.590	0.0	1376.2	366
480 min Summer	13.171	0.0	1454.1	484
600 min Summer	10.988	0.0	1513.2	602
720 min Summer	9.462	0.0	1559.9	720
960 min Summer	7.453	0.0	1627.9	842
1440 min Summer	5.285	0.0	1689.0	1086
2160 min Summer	3.708	0.0	1871.7	1488
2880 min Summer	2.885	0.0	1940.8	1876
4320 min Summer	2.043	0.0	2057.1	2640
5760 min Summer	1.616	0.0	2182.6	3360
7200 min Summer	1.368	0.0	2308.5	4104
8640 min Summer	1.207	0.0	2441.8	4760

Cascade Summary of Results for Catchment B 100yr 40CC Storage FEH_P01.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
10080 min Summer	186.871	0.271	12.1	323.3	O K
15 min Winter	187.079	0.479	12.2	606.5	O K
30 min Winter	187.204	0.604	12.2	789.7	O K
60 min Winter	187.323	0.723	12.2	976.8	O K
120 min Winter	187.431	0.831	12.2	1155.4	O K
180 min Winter	187.488	0.888	12.2	1252.7	O K
240 min Winter	187.522	0.922	12.2	1312.4	O K
360 min Winter	187.556	0.956	12.2	1373.4	O K
480 min Winter	187.570	0.970	12.2	1398.1	O K
600 min Winter	187.573	0.973	12.2	1402.7	O K
720 min Winter	187.568	0.968	12.2	1395.0	O K
960 min Winter	187.548	0.948	12.2	1358.1	O K
1440 min Winter	187.490	0.890	12.2	1255.4	O K
2160 min Winter	187.398	0.798	12.2	1099.9	O K
2880 min Winter	187.305	0.705	12.2	947.0	O K
4320 min Winter	187.117	0.517	12.2	660.3	O K
5760 min Winter	186.974	0.374	12.2	459.2	O K
7200 min Winter	186.876	0.276	12.1	330.2	O K
8640 min Winter	186.814	0.214	11.9	251.6	O K
10080 min Winter	186.778	0.178	11.5	207.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	1.096	0.0	2581.7	5456
15 min Winter	156.800	0.0	586.0	26
30 min Winter	102.480	0.0	761.6	41
60 min Winter	63.980	0.0	993.5	70
120 min Winter	38.640	0.0	1199.4	128
180 min Winter	28.507	0.0	1326.0	186
240 min Winter	22.855	0.0	1415.7	242
360 min Winter	16.590	0.0	1537.3	358
480 min Winter	13.171	0.0	1621.9	474
600 min Winter	10.988	0.0	1684.6	586
720 min Winter	9.462	0.0	1732.0	698
960 min Winter	7.453	0.0	1792.2	912
1440 min Winter	5.285	0.0	1777.5	1144
2160 min Winter	3.708	0.0	2096.4	1604
2880 min Winter	2.885	0.0	2173.6	2060
4320 min Winter	2.043	0.0	2305.4	2816
5760 min Winter	1.616	0.0	2445.1	3520
7200 min Winter	1.368	0.0	2586.4	4184
8640 min Winter	1.207	0.0	2736.1	4768
10080 min Winter	1.096	0.0	2894.2	5352

Cascade Rainfall Details for Catchment B 100yr 40CC Storage FEH_P01.SRCX

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 401850 310150 SK 01850 10150
Data Type	Catchment
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 1.880

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.627	4	8	0.627	8	12	0.627

Cascade Model Details for Catchment B 100yr 40CC Storage FEH_P01.SRCX

Storage is Online Cover Level (m) 188.000

Tank or Pond Structure

Invert Level (m) 186.600

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1106.6	1.000	1828.5	1.400	2145.7

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0159-1220-1000-1220
Design Head (m)	1.000
Design Flow (l/s)	12.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	159
Invert Level (m)	186.600
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	12.2
Flush-Flo™	0.313	12.2
Kick-Flo®	0.689	10.2
Mean Flow over Head Range	-	10.4

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.7	1.200	13.3	3.000	20.5	7.000	30.8
0.200	11.8	1.400	14.3	3.500	22.1	7.500	31.9
0.300	12.2	1.600	15.2	4.000	23.6	8.000	32.9
0.400	12.1	1.800	16.1	4.500	24.9	8.500	33.9
0.500	11.8	2.000	16.9	5.000	26.2	9.000	34.8
0.600	11.3	2.200	17.7	5.500	27.5	9.500	35.8
0.800	11.0	2.400	18.5	6.000	28.6		
1.000	12.2	2.600	19.2	6.500	29.8		

Cascade Summary of Results for Catchment B 100yr 40CC Storage FSR_P01.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	Catchment A 100yr 40CC Storage FSR_P01.SRCX	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	186.968	0.368	12.2	451.1	O K
30 min Summer	187.068	0.468	12.2	589.6	O K
60 min Summer	187.163	0.563	12.2	729.1	O K
120 min Summer	187.250	0.650	12.2	861.2	O K
180 min Summer	187.293	0.693	12.2	929.0	O K
240 min Summer	187.318	0.718	12.2	968.0	O K
360 min Summer	187.340	0.740	12.2	1004.4	O K
480 min Summer	187.349	0.749	12.2	1018.1	O K
600 min Summer	187.348	0.748	12.2	1017.5	O K
720 min Summer	187.343	0.743	12.2	1008.1	O K
960 min Summer	187.328	0.728	12.2	984.0	O K
1440 min Summer	187.294	0.694	12.2	929.7	O K
2160 min Summer	187.235	0.635	12.2	838.0	O K
2880 min Summer	187.178	0.578	12.2	751.6	O K
4320 min Summer	187.074	0.474	12.2	598.4	O K
5760 min Summer	186.982	0.382	12.2	471.1	O K
7200 min Summer	186.908	0.308	12.2	372.0	O K
8640 min Summer	186.852	0.252	12.1	299.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	131.351	0.0	436.4	26
30 min Summer	86.314	0.0	575.8	41
60 min Summer	54.074	0.0	748.7	70
120 min Summer	32.762	0.0	908.2	128
180 min Summer	24.128	0.0	1003.3	188
240 min Summer	19.312	0.0	1070.5	246
360 min Summer	14.018	0.0	1164.8	364
480 min Summer	11.175	0.0	1237.0	484
600 min Summer	9.366	0.0	1294.7	602
720 min Summer	8.105	0.0	1342.7	706
960 min Summer	6.446	0.0	1419.3	812
1440 min Summer	4.660	0.0	1523.5	1062
2160 min Summer	3.364	0.0	1698.1	1448
2880 min Summer	2.667	0.0	1794.2	1844
4320 min Summer	1.920	0.0	1932.4	2600
5760 min Summer	1.519	0.0	2051.2	3344
7200 min Summer	1.266	0.0	2135.7	4032
8640 min Summer	1.090	0.0	2205.3	4672

Cascade Summary of Results for Catchment B 100yr 40CC Storage FSR_P01.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
10080 min Summer	186.811	0.211	11.8	247.3	O K
15 min Winter	187.008	0.408	12.2	506.4	O K
30 min Winter	187.118	0.518	12.2	662.4	O K
60 min Winter	187.224	0.624	12.2	820.2	O K
120 min Winter	187.320	0.720	12.2	972.3	O K
180 min Winter	187.368	0.768	12.2	1050.2	O K
240 min Winter	187.396	0.796	12.2	1095.7	O K
360 min Winter	187.423	0.823	12.2	1141.1	O K
480 min Winter	187.435	0.835	12.2	1161.4	O K
600 min Winter	187.437	0.837	12.2	1166.0	O K
720 min Winter	187.434	0.834	12.2	1160.8	O K
960 min Winter	187.418	0.818	12.2	1133.3	O K
1440 min Winter	187.376	0.776	12.2	1063.3	O K
2160 min Winter	187.305	0.705	12.2	947.1	O K
2880 min Winter	187.217	0.617	12.2	810.0	O K
4320 min Winter	187.056	0.456	12.2	573.1	O K
5760 min Winter	186.922	0.322	12.2	390.7	O K
7200 min Winter	186.828	0.228	12.0	269.6	O K
8640 min Winter	186.774	0.174	11.5	202.8	O K
10080 min Winter	186.755	0.155	10.4	179.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	0.961	0.0	2261.6	5352
15 min Winter	131.351	0.0	490.0	26
30 min Winter	86.314	0.0	644.6	40
60 min Winter	54.074	0.0	839.2	70
120 min Winter	32.762	0.0	1017.4	126
180 min Winter	24.128	0.0	1123.6	184
240 min Winter	19.312	0.0	1198.5	242
360 min Winter	14.018	0.0	1303.4	358
480 min Winter	11.175	0.0	1383.4	472
600 min Winter	9.366	0.0	1447.0	584
720 min Winter	8.105	0.0	1499.4	694
960 min Winter	6.446	0.0	1581.5	904
1440 min Winter	4.660	0.0	1678.8	1126
2160 min Winter	3.364	0.0	1902.1	1588
2880 min Winter	2.667	0.0	2009.9	2000
4320 min Winter	1.920	0.0	2166.2	2772
5760 min Winter	1.519	0.0	2297.9	3464
7200 min Winter	1.266	0.0	2392.8	4104
8640 min Winter	1.090	0.0	2471.2	4592
10080 min Winter	0.961	0.0	2535.6	5256

Cascade Rainfall Details for Catchment B 100yr 40CC Storage FSR_P01.SRCX

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.100	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 1.880

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.627	4	8	0.627	8	12	0.627

Cascade Model Details for Catchment B 100yr 40CC Storage FSR_P01.SRCX

Storage is Online Cover Level (m) 188.000

Tank or Pond Structure

Invert Level (m) 186.600

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1106.6	1.000	1828.5	1.400	2145.7

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0159-1220-1000-1220
Design Head (m)	1.000
Design Flow (l/s)	12.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	159
Invert Level (m)	186.600
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	12.2
Flush-Flo™	0.313	12.2
Kick-Flo®	0.689	10.2
Mean Flow over Head Range	-	10.4

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.7	1.200	13.3	3.000	20.5	7.000	30.8
0.200	11.8	1.400	14.3	3.500	22.1	7.500	31.9
0.300	12.2	1.600	15.2	4.000	23.6	8.000	32.9
0.400	12.1	1.800	16.1	4.500	24.9	8.500	33.9
0.500	11.8	2.000	16.9	5.000	26.2	9.000	34.8
0.600	11.3	2.200	17.7	5.500	27.5	9.500	35.8
0.800	11.0	2.400	18.5	6.000	28.6		
1.000	12.2	2.600	19.2	6.500	29.8		

Cascade Summary of Results for Catchment C 100yr 40CC Storage FEH_P01.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	Catchment D 100yr 40CC Storage FEH_P01.SRCX	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	183.043	0.443	13.9	615.1	O K
30 min Summer	183.159	0.559	13.9	800.5	O K
60 min Summer	183.271	0.671	13.9	988.8	O K
120 min Summer	183.373	0.773	13.9	1168.5	O K
180 min Summer	183.426	0.826	13.9	1264.3	O K
240 min Summer	183.457	0.857	13.9	1321.8	O K
360 min Summer	183.486	0.886	13.9	1377.2	O K
480 min Summer	183.496	0.896	13.9	1395.9	O K
600 min Summer	183.495	0.895	13.9	1394.1	O K
720 min Summer	183.488	0.888	13.9	1379.6	O K
960 min Summer	183.465	0.865	13.9	1336.9	O K
1440 min Summer	183.417	0.817	13.9	1247.4	O K
2160 min Summer	183.341	0.741	13.9	1109.9	O K
2880 min Summer	183.264	0.664	13.9	976.8	O K
4320 min Summer	183.138	0.538	13.9	765.3	O K
5760 min Summer	183.039	0.439	13.9	609.7	O K
7200 min Summer	182.968	0.368	13.9	500.9	O K
8640 min Summer	182.916	0.316	13.9	424.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	156.800	0.0	593.4	26
30 min Summer	102.480	0.0	775.2	41
60 min Summer	63.980	0.0	1008.5	70
120 min Summer	38.640	0.0	1218.4	130
180 min Summer	28.507	0.0	1347.7	188
240 min Summer	22.855	0.0	1439.7	248
360 min Summer	16.590	0.0	1565.2	366
480 min Summer	13.171	0.0	1653.9	484
600 min Summer	10.988	0.0	1721.1	602
720 min Summer	9.462	0.0	1774.2	720
960 min Summer	7.453	0.0	1851.7	836
1440 min Summer	5.285	0.0	1923.1	1082
2160 min Summer	3.708	0.0	2129.8	1480
2880 min Summer	2.885	0.0	2208.4	1876
4320 min Summer	2.043	0.0	2340.5	2640
5760 min Summer	1.616	0.0	2484.2	3360
7200 min Summer	1.368	0.0	2627.4	4104
8640 min Summer	1.207	0.0	2779.0	4760

Cascade Summary of Results for Catchment C 100yr 40CC Storage FEH_P01.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
10080 min Summer	182.878	0.278	13.8	370.0	O K
15 min Winter	183.091	0.491	13.9	690.4	O K
30 min Winter	183.219	0.619	13.9	899.0	O K
60 min Winter	183.342	0.742	13.9	1112.0	O K
120 min Winter	183.453	0.853	13.9	1315.0	O K
180 min Winter	183.512	0.912	13.9	1425.5	O K
240 min Winter	183.547	0.947	13.9	1493.3	O K
360 min Winter	183.582	0.982	13.9	1562.3	O K
480 min Winter	183.596	0.996	13.9	1590.1	O K
600 min Winter	183.599	0.999	13.9	1594.9	O K
720 min Winter	183.594	0.994	13.9	1585.8	O K
960 min Winter	183.572	0.972	13.9	1543.2	O K
1440 min Winter	183.513	0.913	13.9	1427.6	O K
2160 min Winter	183.419	0.819	13.9	1251.3	O K
2880 min Winter	183.323	0.723	13.9	1079.4	O K
4320 min Winter	183.130	0.530	13.9	753.0	O K
5760 min Winter	182.983	0.383	13.9	523.6	O K
7200 min Winter	182.883	0.283	13.9	376.8	O K
8640 min Winter	182.820	0.220	13.6	287.9	O K
10080 min Winter	182.784	0.184	13.2	239.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	1.096	0.0	2937.8	5456
15 min Winter	156.800	0.0	665.3	26
30 min Winter	102.480	0.0	864.8	41
60 min Winter	63.980	0.0	1129.9	70
120 min Winter	38.640	0.0	1364.2	128
180 min Winter	28.507	0.0	1508.1	184
240 min Winter	22.855	0.0	1610.3	242
360 min Winter	16.590	0.0	1748.6	358
480 min Winter	13.171	0.0	1845.0	474
600 min Winter	10.988	0.0	1916.6	586
720 min Winter	9.462	0.0	1971.0	698
960 min Winter	7.453	0.0	2041.5	912
1440 min Winter	5.285	0.0	2034.5	1140
2160 min Winter	3.708	0.0	2385.7	1600
2880 min Winter	2.885	0.0	2473.3	2056
4320 min Winter	2.043	0.0	2623.1	2816
5760 min Winter	1.616	0.0	2783.0	3520
7200 min Winter	1.368	0.0	2943.7	4184
8640 min Winter	1.207	0.0	3114.0	4768
10080 min Winter	1.096	0.0	3293.5	5352

Cascade Rainfall Details for Catchment C 100yr 40CC Storage FEH_P01.SRCX

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 401850 310150 SK 01850 10150
Data Type	Catchment
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 2.140

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.713	4	8	0.713	8	12	0.713

Cascade Model Details for Catchment C 100yr 40CC Storage FEH_P01.SRCX

Storage is Online Cover Level (m) 184.000

Tank or Pond Structure

Invert Level (m) 182.600

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1236.5	1.000	1989.0	1.400	2319.5

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0169-1390-1000-1390
Design Head (m)	1.000
Design Flow (l/s)	13.9
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	169
Invert Level (m)	182.600
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	13.9
Flush-Flo™	0.318	13.9
Kick-Flo®	0.698	11.7
Mean Flow over Head Range	-	11.8

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.0	1.200	15.2	3.000	23.5	7.000	35.3
0.200	13.4	1.400	16.3	3.500	25.3	7.500	36.5
0.300	13.9	1.600	17.4	4.000	26.9	8.000	37.6
0.400	13.8	1.800	18.4	4.500	28.5	8.500	38.7
0.500	13.5	2.000	19.3	5.000	30.0	9.000	39.8
0.600	13.0	2.200	20.2	5.500	31.4	9.500	40.9
0.800	12.5	2.400	21.1	6.000	32.7		
1.000	13.9	2.600	21.9	6.500	34.0		

Cascade Summary of Results for Catchment C 100yr 40CC Storage FSR_P01.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	Catchment D 100yr 40CC Storage FSR_P01.SRCX	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	182.976	0.376	13.9	513.5	O K
30 min Summer	183.079	0.479	13.9	671.2	O K
60 min Summer	183.177	0.577	13.9	830.1	O K
120 min Summer	183.267	0.667	13.9	980.6	O K
180 min Summer	183.311	0.711	13.9	1058.0	O K
240 min Summer	183.336	0.736	13.9	1102.2	O K
360 min Summer	183.359	0.759	13.9	1143.3	O K
480 min Summer	183.368	0.768	13.9	1158.6	O K
600 min Summer	183.367	0.767	13.9	1157.7	O K
720 min Summer	183.361	0.761	13.9	1146.9	O K
960 min Summer	183.347	0.747	13.9	1120.4	O K
1440 min Summer	183.313	0.713	13.9	1060.5	O K
2160 min Summer	183.253	0.653	13.9	957.1	O K
2880 min Summer	183.194	0.594	13.9	858.3	O K
4320 min Summer	183.086	0.486	13.9	683.4	O K
5760 min Summer	182.993	0.393	13.9	538.3	O K
7200 min Summer	182.916	0.316	13.9	425.5	O K
8640 min Summer	182.859	0.259	13.8	342.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	131.351	0.0	495.3	26
30 min Summer	86.314	0.0	653.7	41
60 min Summer	54.074	0.0	851.4	70
120 min Summer	32.762	0.0	1032.8	128
180 min Summer	24.128	0.0	1141.0	188
240 min Summer	19.312	0.0	1217.4	246
360 min Summer	14.018	0.0	1324.7	364
480 min Summer	11.175	0.0	1406.8	482
600 min Summer	9.366	0.0	1472.3	602
720 min Summer	8.105	0.0	1526.8	700
960 min Summer	6.446	0.0	1613.9	806
1440 min Summer	4.660	0.0	1731.8	1058
2160 min Summer	3.364	0.0	1932.3	1448
2880 min Summer	2.667	0.0	2041.6	1844
4320 min Summer	1.920	0.0	2198.6	2600
5760 min Summer	1.519	0.0	2334.5	3344
7200 min Summer	1.266	0.0	2430.7	4032
8640 min Summer	1.090	0.0	2509.7	4672

Cascade Summary of Results for Catchment C 100yr 40CC Storage FSR_P01.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
10080 min Summer	182.817	0.217	13.5	284.2	O K
15 min Winter	183.018	0.418	13.9	576.5	O K
30 min Winter	183.131	0.531	13.9	754.1	O K
60 min Winter	183.239	0.639	13.9	933.8	O K
120 min Winter	183.339	0.739	13.9	1106.9	O K
180 min Winter	183.388	0.788	13.9	1195.3	O K
240 min Winter	183.417	0.817	13.9	1247.1	O K
360 min Winter	183.444	0.844	13.9	1298.3	O K
480 min Winter	183.457	0.857	13.9	1321.2	O K
600 min Winter	183.459	0.859	13.9	1326.1	O K
720 min Winter	183.456	0.856	13.9	1320.0	O K
960 min Winter	183.439	0.839	13.9	1288.4	O K
1440 min Winter	183.396	0.796	13.9	1210.3	O K
2160 min Winter	183.324	0.724	13.9	1079.6	O K
2880 min Winter	183.234	0.634	13.9	924.5	O K
4320 min Winter	183.068	0.468	13.9	653.7	O K
5760 min Winter	182.930	0.330	13.9	445.8	O K
7200 min Winter	182.834	0.234	13.7	308.3	O K
8640 min Winter	182.781	0.181	13.2	234.4	O K
10080 min Winter	182.761	0.161	11.8	208.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	0.961	0.0	2573.5	5344
15 min Winter	131.351	0.0	556.2	26
30 min Winter	86.314	0.0	731.9	40
60 min Winter	54.074	0.0	954.4	70
120 min Winter	32.762	0.0	1157.0	126
180 min Winter	24.128	0.0	1277.8	184
240 min Winter	19.312	0.0	1363.0	242
360 min Winter	14.018	0.0	1482.4	358
480 min Winter	11.175	0.0	1573.4	472
600 min Winter	9.366	0.0	1645.6	584
720 min Winter	8.105	0.0	1705.3	694
960 min Winter	6.446	0.0	1798.7	902
1440 min Winter	4.660	0.0	1910.5	1122
2160 min Winter	3.364	0.0	2164.5	1588
2880 min Winter	2.667	0.0	2287.0	2016
4320 min Winter	1.920	0.0	2464.7	2772
5760 min Winter	1.519	0.0	2615.4	3464
7200 min Winter	1.266	0.0	2723.3	4048
8640 min Winter	1.090	0.0	2812.4	4584
10080 min Winter	0.961	0.0	2885.4	5248

Cascade Rainfall Details for Catchment C 100yr 40CC Storage FSR_P01.SRCX

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.100	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 2.140

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.713	4	8	0.713	8	12	0.713

Cascade Model Details for Catchment C 100yr 40CC Storage FSR_P01.SRCX

Storage is Online Cover Level (m) 184.000

Tank or Pond Structure

Invert Level (m) 182.600

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1236.5	1.000	1989.0	1.400	2319.5

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0169-1390-1000-1390
Design Head (m)	1.000
Design Flow (l/s)	13.9
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	169
Invert Level (m)	182.600
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	13.9
Flush-Flo™	0.318	13.9
Kick-Flo®	0.698	11.7
Mean Flow over Head Range	-	11.8

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.0	1.200	15.2	3.000	23.5	7.000	35.3
0.200	13.4	1.400	16.3	3.500	25.3	7.500	36.5
0.300	13.9	1.600	17.4	4.000	26.9	8.000	37.6
0.400	13.8	1.800	18.4	4.500	28.5	8.500	38.7
0.500	13.5	2.000	19.3	5.000	30.0	9.000	39.8
0.600	13.0	2.200	20.2	5.500	31.4	9.500	40.9
0.800	12.5	2.400	21.1	6.000	32.7		
1.000	13.9	2.600	21.9	6.500	34.0		

Cascade Summary of Results for Catchment D 100yr 40CC Storage FEH_P01.SRCX

	Upstream Structures	Outflow To	Overflow To
Catchment C 100yr 40CC Storage FEH_P01.SRCX		(None)	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	178.523	0.423	23.6	438.0	O K
30 min Summer	178.631	0.531	23.6	569.8	O K
60 min Summer	178.734	0.634	23.6	703.8	O K
120 min Summer	178.828	0.728	23.6	834.0	O K
180 min Summer	178.879	0.779	23.6	907.0	O K
240 min Summer	178.910	0.810	23.6	951.7	O K
360 min Summer	178.940	0.840	23.6	997.2	O K
480 min Summer	178.952	0.852	23.6	1015.6	O K
600 min Summer	178.954	0.854	23.6	1018.6	O K
720 min Summer	178.950	0.850	23.6	1011.9	O K
960 min Summer	178.931	0.831	23.6	983.9	O K
1440 min Summer	178.888	0.788	23.6	920.5	O K
2160 min Summer	178.811	0.711	23.6	810.2	O K
2880 min Summer	178.745	0.645	23.6	718.6	O K
4320 min Summer	178.639	0.539	23.6	580.1	O K
5760 min Summer	178.553	0.453	23.6	473.9	O K
7200 min Summer	178.490	0.390	23.6	399.2	O K
8640 min Summer	178.443	0.343	23.6	345.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	156.800	0.0	1005.9	26
30 min Summer	102.480	0.0	1313.9	41
60 min Summer	63.980	0.0	1720.3	70
120 min Summer	38.640	0.0	2078.3	130
180 min Summer	28.507	0.0	2298.7	188
240 min Summer	22.855	0.0	2455.4	248
360 min Summer	16.590	0.0	2668.8	366
480 min Summer	13.171	0.0	2819.1	484
600 min Summer	10.988	0.0	2932.8	602
720 min Summer	9.462	0.0	3022.0	722
960 min Summer	7.453	0.0	3150.9	874
1440 min Summer	5.285	0.0	3261.2	1108
2160 min Summer	3.708	0.0	3639.6	1476
2880 min Summer	2.885	0.0	3773.7	1848
4320 min Summer	2.043	0.0	3998.0	2636
5760 min Summer	1.616	0.0	4247.3	3360
7200 min Summer	1.368	0.0	4491.9	4104
8640 min Summer	1.207	0.0	4750.3	4768

Cascade Summary of Results for Catchment D 100yr 40CC Storage FEH_P01.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
10080 min Summer	178.408	0.308	23.5	306.3	O K
15 min Winter	178.568	0.468	23.6	491.4	O K
30 min Winter	178.685	0.585	23.6	639.6	O K
60 min Winter	178.798	0.698	23.6	790.9	O K
120 min Winter	178.902	0.802	23.6	939.9	O K
180 min Winter	178.956	0.856	23.6	1021.8	O K
240 min Winter	178.990	0.890	23.6	1073.0	O K
360 min Winter	179.025	0.925	23.6	1127.6	O K
480 min Winter	179.040	0.940	23.6	1152.3	O K
600 min Winter	179.045	0.945	23.6	1160.0	O K
720 min Winter	179.043	0.943	23.6	1157.1	O K
960 min Winter	179.027	0.927	23.6	1132.3	O K
1440 min Winter	178.975	0.875	23.6	1050.8	O K
2160 min Winter	178.890	0.790	23.6	923.3	O K
2880 min Winter	178.790	0.690	23.6	780.1	O K
4320 min Winter	178.635	0.535	23.6	574.7	O K
5760 min Winter	178.506	0.406	23.6	418.1	O K
7200 min Winter	178.415	0.315	23.5	313.7	O K
8640 min Winter	178.353	0.253	23.1	246.6	O K
10080 min Winter	178.318	0.218	22.7	210.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	1.096	0.0	5020.2	5456
15 min Winter	156.800	0.0	1127.9	26
30 min Winter	102.480	0.0	1464.9	40
60 min Winter	63.980	0.0	1927.5	70
120 min Winter	38.640	0.0	2326.9	128
180 min Winter	28.507	0.0	2572.0	186
240 min Winter	22.855	0.0	2745.7	244
360 min Winter	16.590	0.0	2980.3	360
480 min Winter	13.171	0.0	3143.0	474
600 min Winter	10.988	0.0	3262.8	588
720 min Winter	9.462	0.0	3352.8	700
960 min Winter	7.453	0.0	3465.0	918
1440 min Winter	5.285	0.0	3439.1	1160
2160 min Winter	3.708	0.0	4076.8	1612
2880 min Winter	2.885	0.0	4226.3	2024
4320 min Winter	2.043	0.0	4481.2	2816
5760 min Winter	1.616	0.0	4758.3	3528
7200 min Winter	1.368	0.0	5032.8	4184
8640 min Winter	1.207	0.0	5323.3	4840
10080 min Winter	1.096	0.0	5628.9	5344

Cascade Rainfall Details for Catchment D 100yr 40CC Storage FEH_P01.SRCX

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 401850 310150 SK 01850 10150
Data Type	Catchment
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 1.520

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.507	4	8	0.507	8	12	0.507

Cascade Model Details for Catchment D 100yr 40CC Storage FEH_P01.SRCX

Storage is Online Cover Level (m) 179.500

Tank or Pond Structure

Invert Level (m) 178.100

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	893.2	1.000	1643.0	1.400	1972.2

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0214-2370-1000-2370
Design Head (m)	1.000
Design Flow (l/s)	23.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	214
Invert Level (m)	178.100
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	23.7
Flush-Flo™	0.355	23.6
Kick-Flo®	0.729	20.4
Mean Flow over Head Range	-	19.7

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	7.2	1.200	25.8	3.000	40.1	7.000	60.5
0.200	20.8	1.400	27.8	3.500	43.2	7.500	62.6
0.300	23.5	1.600	29.7	4.000	46.1	8.000	64.6
0.400	23.5	1.800	31.4	4.500	48.8	8.500	66.5
0.500	23.2	2.000	33.0	5.000	51.4	9.000	68.4
0.600	22.5	2.200	34.6	5.500	53.8	9.500	70.2
0.800	21.3	2.400	36.0	6.000	56.1		
1.000	23.7	2.600	37.5	6.500	58.4		

Cascade Summary of Results for Catchment D 100yr 40CC Storage FSR_P01.SRCX

Upstream Structures	Outflow To	Overflow To
Catchment C 100yr 40CC Storage FSR_P01.SRCX	(None)	(None)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	178.461	0.361	23.6	366.1	O K
30 min Summer	178.557	0.457	23.6	478.2	O K
60 min Summer	178.649	0.549	23.6	592.0	O K
120 min Summer	178.731	0.631	23.6	699.9	O K
180 min Summer	178.771	0.671	23.6	754.4	O K
240 min Summer	178.795	0.695	23.6	786.9	O K
360 min Summer	178.819	0.719	23.6	820.8	O K
480 min Summer	178.831	0.731	23.6	837.2	O K
600 min Summer	178.833	0.733	23.6	840.7	O K
720 min Summer	178.829	0.729	23.6	835.2	O K
960 min Summer	178.814	0.714	23.6	814.1	O K
1440 min Summer	178.782	0.682	23.6	769.6	O K
2160 min Summer	178.735	0.635	23.6	705.8	O K
2880 min Summer	178.687	0.587	23.6	641.9	O K
4320 min Summer	178.594	0.494	23.6	523.4	O K
5760 min Summer	178.511	0.411	23.6	424.0	O K
7200 min Summer	178.443	0.343	23.6	345.4	O K
8640 min Summer	178.389	0.289	23.4	285.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	131.351	0.0	839.1	26
30 min Summer	86.314	0.0	1108.1	41
60 min Summer	54.074	0.0	1452.0	70
120 min Summer	32.762	0.0	1761.8	128
180 min Summer	24.128	0.0	1946.3	188
240 min Summer	19.312	0.0	2076.6	246
360 min Summer	14.018	0.0	2259.3	364
480 min Summer	11.175	0.0	2399.0	484
600 min Summer	9.366	0.0	2510.3	602
720 min Summer	8.105	0.0	2602.8	720
960 min Summer	6.446	0.0	2749.8	802
1440 min Summer	4.660	0.0	2946.2	1016
2160 min Summer	3.364	0.0	3302.1	1424
2880 min Summer	2.667	0.0	3488.6	1824
4320 min Summer	1.920	0.0	3755.4	2600
5760 min Summer	1.519	0.0	3991.3	3344
7200 min Summer	1.266	0.0	4155.4	4040
8640 min Summer	1.090	0.0	4289.8	4680

Cascade Summary of Results for Catchment D 100yr 40CC Storage FSR_P01.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
10080 min Summer	178.348	0.248	23.1	241.9	O K
15 min Winter	178.500	0.400	23.6	410.8	O K
30 min Winter	178.605	0.505	23.6	537.0	O K
60 min Winter	178.705	0.605	23.6	665.1	O K
120 min Winter	178.796	0.696	23.6	788.4	O K
180 min Winter	178.843	0.743	23.6	855.2	O K
240 min Winter	178.871	0.771	23.6	895.5	O K
360 min Winter	178.900	0.800	23.6	937.3	O K
480 min Winter	178.914	0.814	23.6	958.0	O K
600 min Winter	178.919	0.819	23.6	965.2	O K
720 min Winter	178.918	0.818	23.6	964.0	O K
960 min Winter	178.906	0.806	23.6	945.9	O K
1440 min Winter	178.867	0.767	23.6	889.2	O K
2160 min Winter	178.791	0.691	23.6	782.1	O K
2880 min Winter	178.720	0.620	23.6	685.7	O K
4320 min Winter	178.580	0.480	23.6	506.4	O K
5760 min Winter	178.458	0.358	23.6	362.7	O K
7200 min Winter	178.367	0.267	23.3	262.0	O K
8640 min Winter	178.316	0.216	22.6	207.8	O K
10080 min Winter	178.294	0.194	20.2	185.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	0.961	0.0	4397.2	5352
15 min Winter	131.351	0.0	942.7	26
30 min Winter	86.314	0.0	1240.7	40
60 min Winter	54.074	0.0	1627.9	68
120 min Winter	32.762	0.0	1973.7	126
180 min Winter	24.128	0.0	2179.6	184
240 min Winter	19.312	0.0	2324.8	242
360 min Winter	14.018	0.0	2527.9	358
480 min Winter	11.175	0.0	2682.5	474
600 min Winter	9.366	0.0	2804.9	586
720 min Winter	8.105	0.0	2905.7	696
960 min Winter	6.446	0.0	3062.2	910
1440 min Winter	4.660	0.0	3242.7	1138
2160 min Winter	3.364	0.0	3698.8	1560
2880 min Winter	2.667	0.0	3908.1	1988
4320 min Winter	1.920	0.0	4210.6	2772
5760 min Winter	1.519	0.0	4471.7	3464
7200 min Winter	1.266	0.0	4655.9	4104
8640 min Winter	1.090	0.0	4807.6	4584
10080 min Winter	0.961	0.0	4930.9	5256

Cascade Rainfall Details for Catchment D 100yr 40CC Storage FSR_P01.SRCX

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.100	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 1.520

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.507	4	8	0.507	8	12	0.507

Cascade Model Details for Catchment D 100yr 40CC Storage FSR_P01.SRCX

Storage is Online Cover Level (m) 179.500

Tank or Pond Structure

Invert Level (m) 178.100

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	893.2	1.000	1643.0	1.400	1972.2

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0214-2370-1000-2370
Design Head (m)	1.000
Design Flow (l/s)	23.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	214
Invert Level (m)	178.100
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	23.7
Flush-Flo™	0.355	23.6
Kick-Flo®	0.729	20.4
Mean Flow over Head Range	-	19.7

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	7.2	1.200	25.8	3.000	40.1	7.000	60.5
0.200	20.8	1.400	27.8	3.500	43.2	7.500	62.6
0.300	23.5	1.600	29.7	4.000	46.1	8.000	64.6
0.400	23.5	1.800	31.4	4.500	48.8	8.500	66.5
0.500	23.2	2.000	33.0	5.000	51.4	9.000	68.4
0.600	22.5	2.200	34.6	5.500	53.8	9.500	70.2
0.800	21.3	2.400	36.0	6.000	56.1		
1.000	23.7	2.600	37.5	6.500	58.4		

Appendix 5: Conceptual Surface Water Drainage Strategy and Flood Risk Constraints

Catchment 1
Attenuation sized to accommodate the 1 in 100-year + 40% climate change storm.

Residential developable area: 1.61ha
Spine Road: 0.67ha
Basin area: 0.20ha
Total developable area: 2.48ha

Residential impermeable area (65% + 10% urban creep): 1.15ha
Spine road (embankment (20%) + road (100%)): 0.56ha
Basin area (100%): 0.20ha
Total impermeable area: 1.91ha

QBAR runoff rate: 11.9l/s
Approximate volume at maximum water level: 1445m³
Depth: 1.4m
Bank: 1:4

Outfall to ditch based on equivalent greenfield QBAR rate.

Manholes located within the site and proposed basin location. Basin location subject to further investigation of manholes.

STW surface water manhole reference: 6851

Invert level: 195.79m AOD

Proposed connection to existing surface water sewer via new headwall and pipe, subject to agreement with STW.

Future development to incorporate green corridor into areas shown to be at surface water flood risk

Proposed road crossing the ditch. It is recommended that crossings are clear span or a suitably sized culvert with sufficient freeboard.

Due to unknown onward connectivity of ditch, it is recommended that a direct direction is made to the STW surface water sewer at manhole reference: 6581 or to the collector drain adjacent to Catchment 3 via a swale

Topographical high point located within the centre of the channel and therefore the channel falls towards both the north west and south east. Existing ditch to be maintained to allow outfalls for future development. Abandonment of western portion of ditch to be explored as design progressed, subject to assessment of onward connectivity to the west.

Catchment 2
Attenuation sized to accommodate the 1 in 100-year + 40% climate change storm.

Residential developable area: 3.21ha
Basin area: 0.27ha
Total developable area: 3.48ha

Residential impermeable area (65% + 10% urban creep): 2.30ha
Basin area (100%): 0.27ha
Total impermeable area: 2.57ha

QBAR runoff rate: 16.7l/s
Approximate volume at maximum water level: 1928m³
Depth: 1.4m
Bank: 1:4

Outfall to ditch based on equivalent greenfield QBAR rate.

Catchment 3
Attenuation sized to accommodate the 1 in 100-year + 40% climate change storm.

Residential developable area: 2.50ha
Basin area: 0.22ha
Total developable area: 2.72ha

Residential impermeable area (65% + 10% urban creep): 1.79ha
Basin area (100%): 0.22ha
Total impermeable area: 2.01ha

QBAR runoff rate: 13.1l/s

Approximate volume at maximum water level: 1497m³
Depth: 1.4m
Bank: 1:4

Outfall to drain based on equivalent greenfield QBAR rate.

Approx. ditch invert level: 197.79m AOD

Basin location subject to confirmation of flow path and connectivity of culverts shown to outfall to ditch.

Existing collector drain.

Proposed road crossing the drain. It is recommended that crossings are clear span or a suitably sized culvert with sufficient freeboard.

STW combined manhole reference: 6502

Invert level: 188.79m AOD

Catchment 4
Attenuation sized to accommodate the 1 in 100-year + 40% climate change storm.

Residential developable area: 0.95ha
Basin area: 0.10ha
Total developable area: 1.05ha

Residential impermeable area (65% + 10% urban creep): 0.68ha
Basin area (100%): 0.10ha
Total impermeable area: 0.78ha

QBAR runoff rate: 5.0l/s
Approximate volume at maximum water level: 579m³
Depth: 1.4m
Bank: 1:4

Outfall to collector drain based on equivalent greenfield QBAR rate.

Approx. drain invert level: 189.05m AOD

Approx. drain invert level: 188.30m AOD

Catchment 5
Attenuation sized to accommodate the 1 in 100-year + 40% climate change storm.

Residential developable area: 2.52ha
Spine road: 1.77ha
Basin area: 0.31ha
Total developable area: 4.60ha

Residential impermeable area (65% + 10% urban creep): 1.80ha
Spine road (embankment (20%) + road (100%)): 1.14ha
Basin area (100%): 0.31ha
Total impermeable area: 3.25ha

QBAR runoff rate: 22.1l/s
Approximate volume at maximum water level: 2418m³
Depth: 1.4m
Bank: 1:4

Outfall to watercourse based on equivalent greenfield QBAR rate. Outfall subject to land ownership and consent.

Spine road crossing the watercourse to link to future development. It is recommended that crossings are clear span or a suitably sized culvert with sufficient freeboard. The crossing will also need to take into consideration the modelled surface water extents.

A two-stage treatment may be requested for the spine road and therefore swales and additional treatment should be considered at the detailed design stage.

Proposed road crossing the drain. It is recommended that crossings are clear span or a suitably sized culvert with sufficient freeboard.

Proposed foul connection via new manhole to STW combined sewer, subject to agreement with STW.

Proposed foul water pumping station to serve Catchment 4, 5 and a portion of Catchment 3. Catchment 1, 2 and a portion of Catchment 3 should be able to drain via gravity, subject to detailed design.

Approx. watercourse invert level: 180.65m AOD

Outfall understood to be located within land within Taylor Wimpey control.

Catchment A
Attenuation sized to accommodate the 1 in 100-year + 40% climate change storm.

Residential developable area: 0.83ha
Basin area: 0.12ha
Total developable area: 0.95ha

Residential impermeable area (65% + 10% urban creep): 0.59ha
Basin area (100%): 0.12ha
Total impermeable area: 0.71ha

QBAR runoff rate: 4.6l/s
Proposed discharge rate (Catchment A + Catchment B): 16.8l/s
Approximate volume at maximum water level: 558m³
Depth: 1.4m
Bank: 1:4

Catchment B will cascade into Catchment A and the overall runoff rate from Catchment A will not exceed the greenfield QBAR runoff rate. Outfall to watercourse based on equivalent greenfield QBAR rate.

Catchment B
Attenuation sized to accommodate the 1 in 100-year + 40% climate change storm.

Residential developable area: 2.34ha
Basin area: 0.21ha
Total developable area: 2.55ha

Residential impermeable area (65% + 10% urban creep): 1.67ha
Basin area (100%): 0.21ha
Total impermeable area: 1.88ha

QBAR runoff rate: 12.2l/s
Approximate volume at maximum water level: 1403m³
Depth: 1.4m
Bank: 1:4

Outfall to Catchment A based on equivalent greenfield QBAR rate.

Approx. ditch invert level: 179.54m AOD

Outfall understood to be located within land within Taylor Wimpey control.

Catchment D
Attenuation sized to accommodate the 1 in 100-year + 40% climate change storm.

Residential developable area: 0.70ha
Spine road: 1.14ha
Basin area: 0.2ha
Total developable area: 2.04ha

Residential impermeable area (65% + 10% urban creep): 0.50ha
Spine road (embankment (20%) + road (100%)): 0.82ha
Basin area (100%): 0.2ha
Total impermeable area: 1.52ha

QBAR runoff rate: 9.8l/s
Proposed discharge rate (Catchment C + Catchment D): 23.7l/s
Approximate volume at maximum water level: 1160m³
Depth: 1.4m
Bank: 1:4

Catchment C will cascade into Catchment D and the overall runoff rate from Catchment D will not exceed the greenfield QBAR runoff rate. Outfall to watercourse based on equivalent greenfield QBAR rate.

Catchment C
Attenuation sized to accommodate the 1 in 100-year + 40% climate change storm.

Residential developable area: 2.67ha
Basin area: 0.23ha
Total developable area: 2.90ha

Residential impermeable area (65% + 10% urban creep): 1.91ha
Basin area (100%): 0.23ha
Total impermeable area: 2.14ha

QBAR runoff rate: 13.9l/s
Approximate volume at maximum water level: 1595m³
Depth: 1.4m
Bank: 1:4

Outfall to Catchment D based on equivalent greenfield QBAR rate.

Approx. ditch invert level: 176.41m AOD

Outfall understood to be located within land within Taylor Wimpey control.

Assumed route of ditch between two ponds. Subject to confirmation of connectivity.

Proposed foul water pumping station to serve Catchments A, B, C and D.

Proposed foul connection via new manhole to STW combined sewer, subject to agreement with STW.

Notes

1. Do not scale this drawing. All dimensions must be checked/ verified on site. If in doubt ask.
2. This drawing is to be read in conjunction with all relevant architects, engineers and specialists drawings and specifications.
3. All dimensions in millimetres unless noted otherwise. All levels in metres unless noted otherwise.
4. Any discrepancies noted on site are to be reported to the engineer immediately.
5. Do not construct based on this drawing.
6. The surface water extents are based on a rainfall runoff model undertaken by BWB in July 2022. Flood mapping has been filtered to remove shallow and slow moving water.
7. 65% of the developable area is assumed to be impermeable with a 10% allowance to account for urban creep (subject to confirmation following receipt of development density). The greenfield QBAR runoff rate has been calculated at 4.8l/s/ha.
8. Outfall to watercourses and ditches are subject to land ownership and consent.
9. All SuDS features are indicative and subject to further development of the masterplan and detailed design. It is recommended that the basins are enhanced with low flow channels, permanent water and forebays.
10. Drawing intended to support masterplan development only. Subject to detailed design and masterplan production.
11. It is recommended that an earthworks exercise is undertaken to determine the land take associated with the proposed SuDs features.
12. Sewer locations are approximate and taken from Severn Trent Sewer Records.
13. To be read in conjunction with Flood Risk and Drainage Technical Note (reference: WRC-BWB-ZZ-XX-RP-YE-0005).
14. Spine road areas based on Highway Catchment Plan (reference: WRC-BWB-INF-XX-G-C-0500).

Legend

- Land with Taylor Wimpey Control
- Land East of Wimblebury Road, Heath Hayes (SH2)
- Safeguarded Land (S1)
- Existing Watercourses/Ditches
- Existing Collector Drain
- 8m Watercourse Easement (From Top of Banks)
- 2m Maintenance Bugger (From Top of Banks)
- Existing Surface Water Sewer
- Existing Foul Water Sewer
- Existing Combined Sewer
- **Rainfall Runoff Modelled Flood Extents**
  1 in 100-Year + 40CC
  1 in 1000-Year
- Detention Basin
- 3m SuDS Easement
- Illustrative Swales
- Proposed Outfall
- Proposed Flow Control
- Proposed Foul Pumping Station
- Proposed Rising Main
- Proposed Foul Water Sewer

Rev	Date	Details of issue / revision	Drw	Rev
P01	27.02.24	Preliminary Issue	LR	KA

Issues & Revisions

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Client
Taylor Wimpey Strategic Land

Project Title
Wimblebury Road, Cannock

Drawing Title
Conceptual Surface Water Drainage Strategy and Flood Risk Constraints

Drawn:	L. Reeves	Reviewed:	K. Alger
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WRC-BWB-ZZ-XX-DR-CD-0016	**S2**	**P01**

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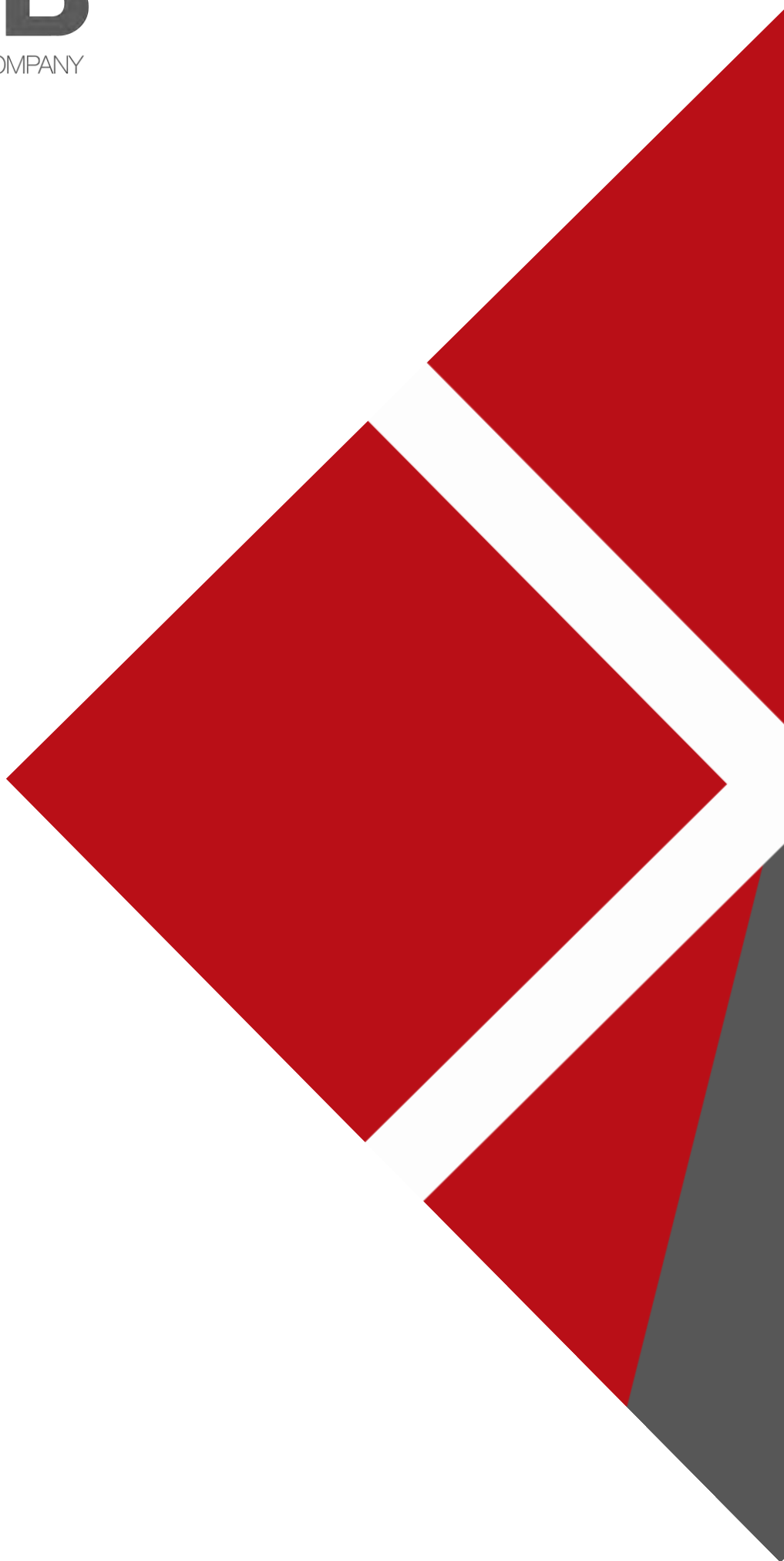

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