Taylor Wimpey (UK) Ltd

Land off Barkby Road, Syston

Flood Risk Assessment

Project No: 18014

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1.0 INTRODUCTION

1.1 Commission

1.1.1 Travis Baker East Midlands Limited have been commissioned by Taylor Wimpey (UK) Ltd, to prepare a Flood Risk Assessment (FRA) to support an Outline planning application for the proposed Barkby Road development.

1.1.2 The report assesses the existing external flood risk to the development to ascertain whether additional mitigation measures are required. Flood risk information has been sourced from the Environment Agency flood mapping database. The area in which the site is located is referred to as PSH441 in the Level 2 Strategic Flood Risk Assessment (SFRA) for Charnwood, Leicestershire, dated January 2021

1.2 Background

1.2.1 The proposal is for an Outline planning application for up to 195 dwellings, together with associated affordable housing, open space, landscaping, drainage and play space facilities. All matters reserved bar access which is proposed from Barkby Road.

1.2.2 The FRA includes a site wide drainage strategy providing flood storage and a controlled discharge into the downstream drainage system. The strategy makes necessary assumptions about the development that might come forward and the possible extent of positively drained hard surfacing that it may entail.

1.2.3 The Environment Agency's flood mapping database regularly updates as detailed hydraulic modelling evolves on a nationwide scale over time. The study assesses the current data against the proposals to understand the current impacts.

1.3 Flood Risk Assessment Methodology

1.3.1 The aim of an FRA is to assess the risks of all forms of flooding to and from a development. The Environment Agency emphasises the need for a risk based approach to be adopted by Local Planning Authorities through the application of the Source-Pathway-Receptor model. Travis Baker's approach to a flood risk assessment is based on the Source-Pathway-Receptor model.

1.3.2 The Source-Pathway-Receptor model firstly identifies the causes or 'sources' of flooding to and from a development. The identification is based on a review of local conditions and consideration of the effects of climate change. The nature and likely extent of flooding arising from any one source is considered, e.g. whether such flooding is likely to be localised or widespread.

1.3.3 The presence of a flood source does not always imply a risk. The exposure pathway or 'flooding mechanism' determines the risk to the receptor and the effective consequence of exposure. For example, the presence of a sewer does not necessarily increase the risk of flooding unless the sewer is local to the site and ground levels encourage surcharged water to accumulate.

1.3.4 The varying effect of flooding on the 'receptors' depends largely on the sensitivity of the target. Receptors include any people or buildings within the range of the flood source, which are connected to the source by a pathway.

1.3.5 In order for there to be a flood risk all the elements of the model must be present. Furthermore, effective mitigation can be provided by removing one element of the model, for example by removing the pathway or receptor.

1.3.6 A desk based review of available information has been undertaken to establish the likely flooding sources and mechanisms for the site. Once the flood risk has been established, mitigation measures are proposed (where necessary) and residual risks explained.

1.4 Aims and Objectives

1.4.1 The aims and objectives of this FRA are as follows:

- Collect and review existing flood risk data including topographical data, surface water drainage strategy, public sewerage records, ground investigation report, scheme proposals and any relevant Strategic Flood Risk Assessments;
- Assess and interpret available information to identify potential sources of flood risk including groundwater, sewers, surface water and infrastructure failure;
- Summarise the proposed surface water drainage strategy to demonstrate that surface water from the site can be managed in a sustainable manner, including appropriate allowances for climate change;
- Provide recommendations for appropriate flood risk mitigation measures (where applicable);
- Produce and FRA to accompany the planning application for the proposed development.

1.5 Sources of Information

1.5.1 The following information has been used to inform the flood study:

- P20-3155 003F-01 Concept Masterplan
- Topographical Survey by Survey Solutions
- Environment Agency (EA) Flood mapping data
- Charnwood Strategic Flood Risk Assessment, Level 1 dated December 2018, and Level 2 dated January 2021.
- British Geological Survey local borehole data
- RSK Phase II Geo-Environmental Site Investigation Report 302001 R01

1.6 Consultees

1.6.1 Organisations consulted during the preparation of this report have included:

- Asset Protection – Severn Trent Water (STW.)
- LLFA – Leicestershire County Council

2.0 SITE SETTING

2.1 Site Description

2.1.1 The site lies to the north of Barkby Road, in the north eastern outer reaches of the town of Syston. The site is bound to the east by Queniborough Road with a residential estate on the western boundary. Agricultural land abuts the northern boundary. The site is currently greenfield with a gross site area of 8.34Ha. A site location plan can be referred to in Appendix I.

2.2 Topography

2.2.1 A site specific topographic survey has been undertaken and is included within Appendix II of the report. The site falls mainly toward the centre of the site with an average site gradient of approximately 1 in 54 from the south and 1 in 48 from the north.

2.3 Local Drainage Features

2.3.1 A watercourse runs across the centre of the site, with a confirmed direction of flow from east to west. An additional watercourse flows along the western boundary and connects into the aforementioned watercourse. A further watercourse abuts the north eastern boundary serving overland flows from the north. Some photographs below demonstrate some of the existing drainage features on site.

Figure 2-1: Watercourse that abuts the north eastern boundary

Figure 2-2: Piped culvert to allow continuation of flows for the central watercourse flowing across the site.

Figure 2-3: Development outfall looking from outside the site on the western boundary

2.3.2 The development outfall is located on the western boundary of the site. A larger watercourse is located on the other side of the boundary offsite, with the two watercourses connected via a piped culvert. The watercourse flows to an eventual outfall into the Barkby Brook, approximately 400m south west of the development site.

2.4 Proposed Development

2.4.1 The proposal is for the construction of 195 new residential dwellings. The scheme includes new access roads, which will be positively drained via road gullies. The planning layout can be found as Appendix III of the report.

3.0 FLOOD RISK PLANNING POLICY

3.1 National Planning Policy Framework (NPPF)

3.1.1 The NPPF sets out the government's national planning policy for consideration of aspects of flood risk for new developments. To support the NPPF, a technical guidance document has also been published to ensure the NPPF is effectively implemented.

3.1.2 The technical guidance document classifies different forms of development into higher or lower levels of vulnerability depending on the perceived consequences of being flooded. Policy outlines the types of development that may be permitted in areas of differing levels of flood risk. Details of the vulnerability classification for different types of development are listed below.

Vulnerability Classification	Development Type
Essential Infrastructure	Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. • Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood. • Wind turbines.
Highly Vulnerable	Police stations, ambulance stations and fire stations and command centres and telecommunications installations required to be operational during flooding. • Emergency dispersal points. • Basement dwellings. • Caravans, mobile homes and park homes intended for permanent residential use. • Installations requiring hazardous substances consent. (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as "essential infrastructure")
More Vulnerable	Hospitals. • Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. • Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels. • Non–residential uses for health services, nurseries and educational establishments. • Landfill and sites used for waste management facilities for hazardous waste. • Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.
Less Vulnerable	Police, ambulance and fire stations which are not required to be operational during flooding. • Buildings used for shops, financial, professional and other services, restaurants and cafes, hot food takeaways, offices, general industry, storage and distribution, non–residential institutions not included in "more vulnerable", and assembly and leisure. • Land and buildings used for agriculture and forestry. • Waste treatment (except landfill and hazardous waste facilities). • Minerals working and processing (except for sand and gravel working). • Water treatment works which do not need to remain operational during times of flood. • Sewage treatment works (if adequate measures to control pollution and manage sewage during flooding events are in place).
Water Compatible	Flood control infrastructure. • Water transmission infrastructure and pumping stations. • Sewage transmission infrastructure and pumping stations. • Sand and gravel working. • Docks, marinas and wharves. • Navigation facilities. • Ministry of Defence installations. • Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. • Water-based recreation (excluding sleeping accommodation). • Lifeguard and coastguard stations. • Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. • Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

3.2 Sequential Test and Exception Test

3.2.1 The Sequential Test is designed to steer new development to areas with the lowest probability of flooding. The exercise compares the Flood Zone of the development area (as discussed in Section 1) against the vulnerability classification of the type of development.

3.2.2 The vulnerability classifications previously outlined indicates that the development type can be classified as 'More Vulnerable'.

3.2.3 The following table summarises the types of development that can be considered appropriate for any given Flood Zone.

	Vulnerability Classification	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	Zone 1	√	√	√	√	√
	Zone 2	√	√	Exception Test required	√	√
	Zone 3a	Exception Test required	√	x	Exception Test required	√
	Zone 3b	Exception Test required	√	x	x	x

√ Appropriate development
x Development should not be permitted

3.2.4 As the site is classed as More Vulnerable and located within Flood Zone 1 it can be considered as appropriate for development. Therefore, the requirement to undertake the Sequential Test and Exception Test need not apply.

3.2.5 This view is supported by the Charnwood Level 2 SFRA Detailed Site Summary Tables for site PSH441.

4.0 EXTERNAL FLOOD RISK

4.1 Fluvial Flood Risk

4.1.1 Current guidance requires that all potential sources of flooding that could affect the proposed development are considered. The current Environment Agency's Flood Zone Map for the site, provided as Figure 4-1 within the report, indicates that the site lies entirely within Flood Zone 1. The definitions of each zone are outlined in table 4-1.

4.1.2 **Table 4-1:** Flood Zone Definitions

Flood Zone Definitions		
Flood Zone 1	Low Probability – less than 1 in 1000 annual probability of river or coastal flooding	Appropriate for all land uses
Flood Zone 2	Medium Probability – between 1in 100 and 1 in 1000 annual probability or river flooding or 1 in 200 and 1 in 1000 annual probability of coastal flooding	Essential infrastructure and the water-compatible, less vulnerable and more vulnerable uses are appropriate in this zone. The highly vulnerable uses are only appropriate in this zone if the Exception Test is passed.
Flood Zone 3a	High Probability – having a greater than 1 in 100 year annual probability of river flooding or 1 in 200 year probability of coastal flooding.	The water-compatible and less vulnerable uses of land are appropriate in this zone. The highly vulnerable uses should not be permitted in this zone. The more vulnerable uses and essential infrastructure should only be permitted in this zone if the Exception Test is passed. Essential infrastructure permitted in this zone should be designed and constructed to remain operational and safe for users in times of flood.
Flood Zone 3b	Functional Floodplain - having a greater than 1 in 20 year annual probability of river flooding or 1 in 200 year probability of coastal flooding	Only the water-compatible uses and essential infrastructure that has to be there should be permitted in this zone. It should be designed and constructed to: • remain operational and safe for users in times of flood; • result in no net loss of floodplain storage; • not impede water flows; and • not increase flood risk elsewhere. Essential infrastructure in this zone should pass the Exception Test.

4.1.3 As the site has a probability of annual flooding from fluvial sources of less than 1 in 1000 or 0.1%. The site can be considered to be at a very low risk.

Figure 4-1: Flood Zone Map

4.2 Tidal Flood Risk

4.2.1 As the site is not coastal or in a low lying area, the risks of tidal flooding have been discounted for the purposes of this assessment.

4.3 Pluvial Flood Risk

4.3.1 In assessing the flood risk to the development site, consideration shall be given to the risk of flooding from overland run-off in the event that the local drainage networks capacity is exceeded.

4.3.2 Figure 4.2 below indicates the potential risk to the site based on pluvial flood map data obtained from the Environment Agency. The extract from the flood maps indicate that there is high risk of flooding from offsite sources, particularly toward the central area of the site. Following a walkover survey on-site, poor crop growth and saturated ground was noted in the approximate areas highlighted on the surface water flood maps. Details of the watercourses across the site are shown on the topographic survey included in Appendix II of this report. From this, the pluvial flows pose a high flood risk without mitigation.

4.3.3 The local SFRA does not show any history of flooding from pluvial sources in the Syston town area.

Figure 4-2: Surface Water Map

4.4 Groundwater Flood Risk

4.4.1 Site susceptible to flooding from groundwater after prolonged or intensive bouts of rain are likely to be in low lying areas, overly aquifers or on steeply sloped sites prone to groundwater seepage. The Charnwood Strategic Flood Risk Assessment states that the catchment of which the development site is within is not located within a groundwater source protection zone.

4.4.2 Given that the site is neither steeply sloped in a low lying area, the risk of groundwater flooding is considered to be low.

4.5 Flood Risk from Artificial Sources

4.5.1 Artificial flood sources include raised channels such as canals or storage features such as ponds and reservoirs. There are no such features in the immediate vicinity of the site.

4.5.2 Flood data for reservoirs breaches is prepared by the EA and indicates the worst case flood extent in the case of catastrophic failure although reservoirs are well maintained and breaches are extremely rare. The site is not located within an area at risk therefore the risk of flooding from reservoirs is considered to be low.

4.6 Flood Risk from Sewers

4.6.1 Modern drainage systems are designed to accommodate the 1 in 30 year annual probability storm event, therefore in any storms greater than this, sewers can be expected to surcharge. However, older sewer systems were not subject to these design standards (introduced by Sewers for Adoption) and the risk of flooding from such systems is difficult to quantify.

4.6.2 The local Strategic Flood Risk Assessment notes that the nearest road that suffered with sewer flooding was High Street, Syston in the extreme rainfall of 2006/07. The road is however some 0.8 miles west of the proposed development boundary. On this basis, the flood risk is considered to be low.

4.7 Summary

4.7.1 The table below summarises the potential risk to the development from sources outside of the site prior to any mitigation measures.

	Flood Risk				
Potential Sources of Flooding	Low	Moderate	High	None	Description
Fluvial	x				Located in FZ 1
Tidal				x	Inland site
Pluvial			x		Poses a high flood risk without mitigation
Groundwater	x				Not recorded at shallow depths
Artificial Sources				x	None within influence of the site
Sewers	x				No flood route into the site from nearby assets

5.0 FLOOD RISK – FROM DEVELOPMENT

5.1 Current Policy

5.1.1 Current Policy outlined in the NPPF states that as well as assessing risk to a development, a suitable flood risk assessment should consider the risk of flooding arising from a development.

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

5.2 Climate Change

5.2.1 The design of the storm water system will need to take into account the anticipated increase in rainfall intensity as well as the piped drainage system. In accordance with the table below, design flows have been increased by 40% to accommodate the anticipated effects of climate change. Provision is therefore made to manage the risk of climate change in accordance with current government guidance.

Table 5-1: Recommended national precautionary sensitivity ranges for peak rainfall intensities, peak river flows, offshore wind speeds and wave heights.

Applies across all of England	2015-2039	2040 - 2069	2070-2115
Upper End	10%	20%	40%
Central	5%	10%	20%

5.3 Existing Surface Water Runoff

5.3.1 As described previously, the site generally falls in a westerly direction with a low point towards the centre of the site. It is assumed that rainwater run-off is conveyed by the watercourse running through the centre of the site east to west and north to south along the western boundary. Rainwater is then conveyed to a larger drainage channel west of the site via a piped culvert. The watercourse serves overland flow from land to the east of the site, beyond Queniborough Road. An existing culvert has been constructed crossing underneath the road to allow the run-off to continue downstream.

5.3.2 As previously mentioned, a short drainage isolated drainage ditch exists along the north eastern boundary collecting overland flows from land to the north. As no outfall for this watercourse is apparent, it appears to periodically spill, over contributing to surface water ponding to its west.

5.4 Proposed Surface Water Management Principles

5.4.1 New surface water drainage provision will need to be made for all new dwellings and the associated highway infrastructure and under the requirements of the Building Regulations, disposal of surface water run-off by means of ground infiltration shall be investigated as a primary means of disposal before any outfall to a watercourse or sewer shall be considered.

5.4.2 Existing British Geological Survey (BGS) data within the site describes the existing ground conditions to be mainly sandy and stiff clay. Due to the clayey sub-strata, it is considered that drainage by infiltration is not suitable for the proposed development. In addition, preliminary infiltration tests were carried out by RSK which have indicated that the sub-soils have poor infiltration characteristics with extrapolated permeability rates ranging between 3.15x10-7 and 8.23x10-9m/s and are therefore not suitable for the use of soakaway systems.

5.4.3 As infiltration is considered not suitable at this site, disposal of the surface water via a watercourse is to be considered. As an existing watercourse is present across the centre of the site, flowing in east to west. An additional watercourse is located along the north-eastern boundary. It is advised that the watercourse is utilised.

5.4.4 Hydraulic modelling has been carried out by Jeremy Benn Associates (JBA) to determine the extent of existing surface water flooding and its influence on the site and the provision for compensatory works required. The study has been subject to an independent third party review by BWB and considered fit for purpose. The report makes the following recommendations;

- Raise ground levels so that all new plots are not at fluvial flood risk
- Provide a flood compensation area to offset the loss of potential flood volume removed by the raising of ground levels
- Introduce a 450mm flow control to the existing watercourse traversing the site.

A copy of the Hydraulic Modelling Report including the peer review is shown within Appendix VIII.

5.4.5 Approximately 133m³ of the flood compensation is required to mitigate overland flows from the upper catchment north east of the site. The vast majority of the flood compensation provision will be provided within the POS area near the western boundary.

5.4.6 To maintain the existing run-off leaving the site and thus removing additional flood risk to properties off site, a flow control in the form of an orifice plate or similar non-mechanical control will restrict flows in the existing watercourse whilst ensuring that all upstream attenuation remains in channel.

5.4.7 The overall catchment within the site will be contained by a series of four surface water sewer networks, each network leading to an online attenuation basin and then discharged at a restricted flow to greenfield run-off rates. Based on the gross site area, an overall QBAR rate of 36.6l/s has been calculated for the site. The QBAR calculations are included within the appendices.

5.4.8 The storage requirements for each basin have been assessed based on a 50% impervious area with a 10% allowance for urban creep. Each sewer network will have a separate outfall into the existing watercourse or new watercourse as part of the improvement works to existing surface water drainage. The restricted flow and attenuation storage will be distributed equally based on share of the catchment area each network is serving.

5.4.9 The attenuation basins are to include a permanent wetland area immediately upstream of the flow control chamber to allow for de-sedimentation of any collected run-off. This will ensure that the basin, in conjunction with the filtration of the grassed edge and base, will provide the two stages of treatment required by C753 SUDS manual.

5.4.10 Sewers serving multiple properties are to be offered for adoption by Severn Trent Water subject to their design and construction to water company standards. Changes to water company policy allow attenuation to be adopted by Severn Trent Water Ltd, therefore it is intended for these to be offered for adoption under Section 104 of the Water Industry Act by the developer. A maintenance plan will be put in place in line with C753 SUDS Manual.

Activity	Indicative frequency	Typical tasks
Routine/regular maintenance	Monthly (for normal care of SuDS)	litter picking grass cutting inspection of inlets, outlets and control structures.
Occasional maintenance	Annually (dependent on the design)	silt control around components vegetation management around components suction sweeping of permeable paving silt removal from catch pits, soakaways and cellular storage.
Remedial maintenance	As required (tasks to repair problems due to damage or vandalism)	inlet/outlet repair erosion repairs reinstatement of edgings reinstatement following pollution removal of silt builds up

Table 5-2: Typical inspection and maintenance requirements.

5.4.11 Surface levels shall be designed to ensure that run-off is not directed toward properties or off site in the event that the sewer system fails or its design capacity is exceeded. Low points or depressions shall ensure that the flood volumes generated by critical storm events for the 1 in 100-year return period, plus 40% climate change allowance shall be retained on site and not impose a flood risk to any property.

5.4.12 A copy of the WinDes QBAR and storage calculations, as well as indicative drainage strategy plans is included within Appendices VI and VII.

5.6 Proposed Foul Drainage

5.6.1 An existing foul water sewer is located in Empingham Drive. A pre-development enquiry has been made to Severn Trent Water to identify the ideal point of connection for the foul water strategy. Severn Trent Water have stated that connecting into the existing sewers to the west of the site will not have a detrimental impact on the existing system and therefore will accept the flows from the new development.

5.6.2 The foul drainage strategy therefore will fall southerly and westerly to connect into FWMH 6000.

5.6.3 The final connection points will be confirmed at detailed design stage. A copy of the pre-development enquiry is included within Appendix V.

5.6.4 All new connections are subject to the approval of Severn Trent Water under Section 106 of the Water Industry Act.

6.0 RESIDUAL RISK

The need to manage residual risks is identified within current guidance. Residual risks are the risks to the proposed development should the existing and/or proposed flood mitigation measures fail to perform as intended. Examples of residual flood risk include:

- The failure of flood management infrastructure such as a breach of a raised flood defence, blockage of a surface water conveyance system, failure of a flap-valve, overtopping of an upstream storage area, or failure of a pumped drainage system;
- A severe flood event that exceeds a flood management design standard.

6.1 Assessing of Flooding Consequences

6.1.1 It is considered that the measures described in Section 5.4 provide adequate protection against flooding. In the unlikely event that an extreme rainfall event exceeds the capacity of the rainwater collection systems, ground modelling will ensure that overland flows are directed away from the buildings. Wherever applicable, external levels shall generally be 150mm lower than finish floor levels at ground floor.

6.1.2 Although risk of groundwater flooding is considered to be low, some consideration of groundwater should be made in the development drainage strategy wherever retaining structures are proposed.

6.1.3 It is therefore considered that consequences of flooding and the possibility of flooding are minimal and acceptable within the standards set.

6.2 Access and Egress

6.2.1 Current guidance required that, where required, safe access and escape is available to/from new developments in flood risk areas.

6.2.2 As the development affected area is situated within Flood Zone 1 and is of a type compatible with this flood zone, and therefore not at risk of flooding from any watercourse, dry access has not been considered in further detail.

7.0 CONCLUSIONS

Following the completion of this flood risk assessment, in line with the recommendations of current guidance, the following conclusions can be made:

7.1 Flood Risk – To Development

7.1.1 The flood risk assessment concluded that the proposed development is at low risk of flooding from tidal, fluvial, overland flow, drainage flooding, groundwater flooding and flooding from artificial sources. Under normal circumstances the site is at low risk of flooding as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).

7.2 Flood Risk – From the Development

7.2.1 The proposed development represents an increase in impermeable, positively drained areas over the pre-development condition. Flood risk to the site and the surrounding area would increase without the mitigation measures proposed in Section 7.3 being put in place.

7.3 Flood Mitigation Measures

7.3.1 The surface water drainage system shall be designed to ensure that flood storage volumes are retained onsite for critical storm events up to the 1 in 100-year return period plus an allowance for climate change.

7.3.2 To further mitigate the flood risk to properties in the event of a failure within the drainage system, surface levels will be designed to ensure that flood flows are not directed toward dwellings. The design shall make due consideration of the existing surface water flow paths from off site that traverse to study site. External levels surrounding dwellings shall generally 150mm below ground floor levels.

7.3.3 The Hydraulic Modelling Report prepared by JBA has recommended a provision made on site for a flood compensation scheme to be incorporated within the development drainage scheme. The overall catchment within the site will be contained by a series of four surface water sewer networks, each network leading to an online attenuation basin and then discharged at a restricted flow to greenfield run-off rates.

7.3.4 The existing watercourse is to be cleared of debris and intrusive vegetation. To maintain the existing run-off leaving the site and thus removing additional flood risk to properties off site, a flow control in the form of an orifice plate or similar non-mechanical control will restrict flows in the existing watercourse whilst ensuring that all upstream attenuation remains in channel.

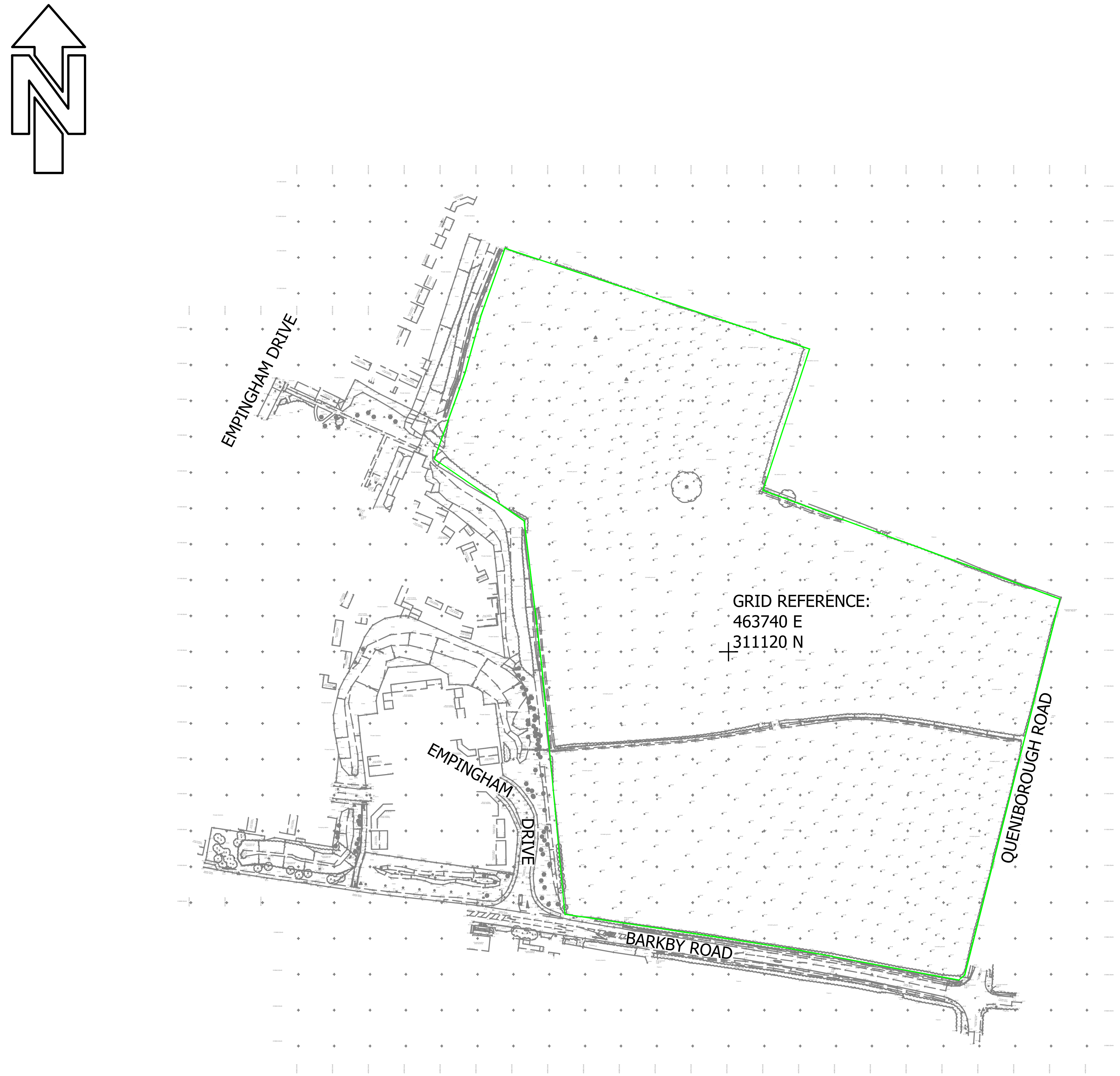
7.4 Residual Risk – Flood Consequences

7.4.1 It is considered that the proposed development will not result in any detrimental impact onto the existing surrounding properties.

7.4.2 It is considered that the proposed drainage scheme will neither result in nor cause an increase of flood risk to surrounding properties or the development site.

7.4.3 It is therefore considered that Planning Consent should not be withheld on flood risk grounds.

Appendix I – Site Location Plan



KEY

SITE BOUNDARY

REV	DESCRIPTION	DATE	BY	AUTH

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Transport Planning
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CLIENT
TAYLOR WIMPEY
STRATEGIC LAND

PROJECT
BARKBY ROAD, SYSTON

TITLE
SITE LOCATION PLAN

DRAWN	AUTHORISED	SCALE	DATE
JG	TW	1:2500@A3	27.04.18

PROJECT NO.	DRAWING NO.	REV
18014	003	-

STATUS.
PRELIMINARY

Appendix II – Topographical Survey

TOPOGRAPHICAL & MEASURED BUILDING SURVEYS

ABBREVIATIONS & SYMBOLS

AH	Arch Head Height	FH	Fire Hydrant	RSJ	Rolled Steel Joist
AR	Assumed Route	FBD	Floor Board Direction	SI	Sign Post
AV	Air Valve	FH	Fire Hydrant	SP	Arch Spring Point Height
BB	Belisha Beacon	FL	Floor Level	SV	Stop Valve
BH	Bore Hole	FP	Flag Pole	SW	Surface Water
BL	Bed Level	FW	Foul Water	SY	Stay
BO	Bollard	GG	Gully Grate	Tac	Tactile Paving
BrP	Brace Post	GV	Gas Valve	TC	Telecom Cover
BS	Bus Stop	HH	Head Height	TH	Trial Pit
BU	Bush	IC	Inspection Cover	THL	Threshold Level
B/W	Barbed Wire Fence	IL	Invert Level	TL	Traffic Light
BX	Box (Utilities)	I/R	Iron Railings	ToW	Top of Wall
C/B	Close Board Fence	KO	Kerb Outlet	TP	Telegraph Pole
CH	Cill Height	LP	Lamp Post	TV	Cable TV Cover
CL	Cover Level	MH	Manhole	UB	Universal Beam
C/L	Chain Link Fence	MP	Marker Post	UC	Unknown Cover
C-Lev	Ceiling Level	NB	Name Board	UK	Unknown Tree
Col	Column	OHL	Overhead Line (approx)	USB	Under Side Beam
C/P	Chestnut Paling Fence	Pan	Panel Fence	UTL	Unable To Lift
CR	Cable Riser	PB	Post Box	VP	Vent Pipe
DC	Drainage Channel	PM	Parking Meter	WB	Waste Bin
DH	Door Head Height	PO	Post	WH	Weep Hole
DP	Down Pipe	P/R	Post & Rail Fence	WL	Water Level
DR	Drain	P/W	Post & Wire Fence	WM	Water Meter
EL	Eaves Level	P/Wall	Partition Wall	WO	Wash Out
EP	Electric Pole	RE	Rodding Eye	x.xx	Floor to Ceiling Height
ER	Earth Rod	RL	Ridge Level		
ET	EP+Transformer	RP	Reflector Post	x.xx F/C	Floor to False Ceiling Ht
FB	Flower Bed	RS	Road Sign		
FBD	Floor Board Direction	RSD	Roller Shutter Door	▲	Survey Control Station

DRAWING NOTE
Topographical Surveys

Trees are drawn to scale showing the average canopy spread. Descriptions and heights should be used as a guide only.

All building names, descriptions, number of storeys, construction type including roof line details are indicative only and taken externally from ground level.

All below ground details including drainage, voids and services have been identified from above ground and therefore all details relating to these features including; sizes, depth, description etc will be approximate only. All critical dimensions and connections should be checked and verified prior to starting work.

Detail, services and features may not have been surveyed if obstructed or not reasonably visible at the time of the survey.

Measured Building Surveys

Measurements to internal walls are taken to the wall finishes at approx 1m above the floor level and the wall assumed to be vertical.

Cill heights are measured as floor to the cill and head heights are measured from cill to the top of window.

General

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Do not scale from this drawing.

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The level datum established for this survey is related to Ordnance Survey (OS) using GPS Smartnet.

To avoid discrepancies any coordinated data used in conjunction with this survey must be derived directly from this control data.

CONTROL CO-ORDINATES

STATIONS	EASTINGS	NORTHINGS	LEVEL	DESCRIPTION
MA01	311271.97	463683.04	62.32	Peg & Pk nail
MA02	311295.17	463665.83	62.64	Peg & Pk nail
ST01	310979.09	463624.00	60.56	Pk nail
ST02	311006.47	463630.77	60.65	Pk nail
ST03	310962.16	463672.77	61.02	Pk nail
ST04	310934.62	463862.08	64.08	Peg & Pk nail
ST10	311110.37	463621.32	61.09	Peg & Pk nail
ST11	311199.18	463601.44	61.78	Peg & Pk nail
ST12	311114.02	463532.01	59.07	Peg & Pk nail
ST13	311252.88	463570.69	61.84	Peg & Pk nail
ST20	311034.23	463531.25	58.83	Peg & Pk nail
ST21	310990.64	463534.80	60.15	Peg & Pk nail
ST22	310996.24	463466.70	59.44	Peg & Pk nail

REV	DESCRIPTION	DRAWN	APPR	DATE
	Drainage ditch and survey extended	IA	PDS	
C	Pipe invert added	PDS	MM	16/3/18
B	Survey extended	MA	PDS	5/3/18
A	Survey extended	MA	PDS	19/2/18

SURVEY SOLUTIONS

Ipswich Coventry Yeovil Norwich Perth Nottingham Brentwood

Tel No: 0845 0405 969 Fax No: 0845 0405 970
www.survey-solutions.co.uk enquiries@survey-solutions.co.uk

LAND SURVEYING BUILDING SURVEYING UNDERGROUND SURVEYING

PROJECT TITLE BARKBY LANE SYSTON, LE7 2AF				
DRAWING DETAIL TOPOGRAPHICAL SURVEY Sheet 1 of 2				
CLIENT TAYLOR WIMPEY STRATEGIC LAND				SCALE 1:500
SURVEYOR MA	SURVEY DATE 10/1/2018	CHECKED BY PDS	APPROVED BY PDS	DWG STATUS FINAL
DRAWING NUMBER 21105cv-01-REVD			REVISION D	ISSUE DATE 11/1/2018

Original Sheet Size A0H

Original Sheet Size A0H

NORTH Indicative

TOPOGRAPHICAL & MEASURED BUILDING SURVEYS

ABBREVIATIONS & SYMBOLS

AH	Arch Head Height	FH	Fire Hydrant	RSJ	Rolled Steel Joist
AR	Assumed Route	FBD	Floor Board Direction	SI	Sign Post
AV	Air Valve	FH	Fire Hydrant	SP	Arch Spring Point Height
BB	Belisha Beacon	FL	Floor Level	SV	Stop Valve
BH	Bore Hole	FP	Flag Pole	SW	Surface Water
BL	Bed Level	FW	Foul Water	SY	Stay
BO	Bollard	GG	Gully Grate	Tac	Tactile Paving
BrP	Brace Post	GV	Gas Valve	TC	Telecom Cover
BS	Bus Stop	HH	Head Height	TH	Trial Pit
BU	Bush	IC	Inspection Cover	THL	Threshold Level
B/W	Barbed Wire Fence	IL	Invert Level	TL	Traffic Light
BX	Box (Utilities)	I/R	Iron Railings	ToW	Top of Wall
C/B	Close Board Fence	KO	Kerb Outlet	TP	Telegraph Pole
CH	Cill Height	LP	Lamp Post	TV	Cable TV Cover
CL	Cover Level	MH	Manhole	UB	Universal Beam
C/L	Chain Link Fence	MP	Marker Post	UC	Unknown Cover
C-Lev	Ceiling Level	NB	Name Board	UK	Unknown Tree
Col	Column	OHL	Overhead Line (approx)	USB	Under Side Beam
C/P	Chestnut Paling Fence	Pan	Panel Fence	UTL	Unable To Lift
CR	Cable Riser	PB	Post Box	VP	Vent Pipe
DC	Drainage Channel	PM	Parking Meter	WB	Waste Bin
DH	Door Head Height	PO	Post	WH	Weep Hole
DP	Down Pipe	P/R	Post & Rail Fence	WL	Water Level
DR	Drain	P/W	Post & Wire Fence	WM	Water Meter
EL	Eaves Level	P/Wall	Partition Wall	WO	Wash Out
EP	Electric Pole	RE	Rodding Eye	(x.xx)	Floor to Ceiling Height
ER	Earth Rod	RL	Ridge Level		
ET	EP+Transformer	RP	Reflector Post	(x.xx) F/C	Floor to False Ceiling Ht
FB	Flower Bed	RS	Road Sign		
FBD	Floor Board Direction	RSD	Roller Shutter Door	△	Survey Control Station

DRAWING NOTE
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REV	DESCRIPTION	DRAWN	APPR	DATE
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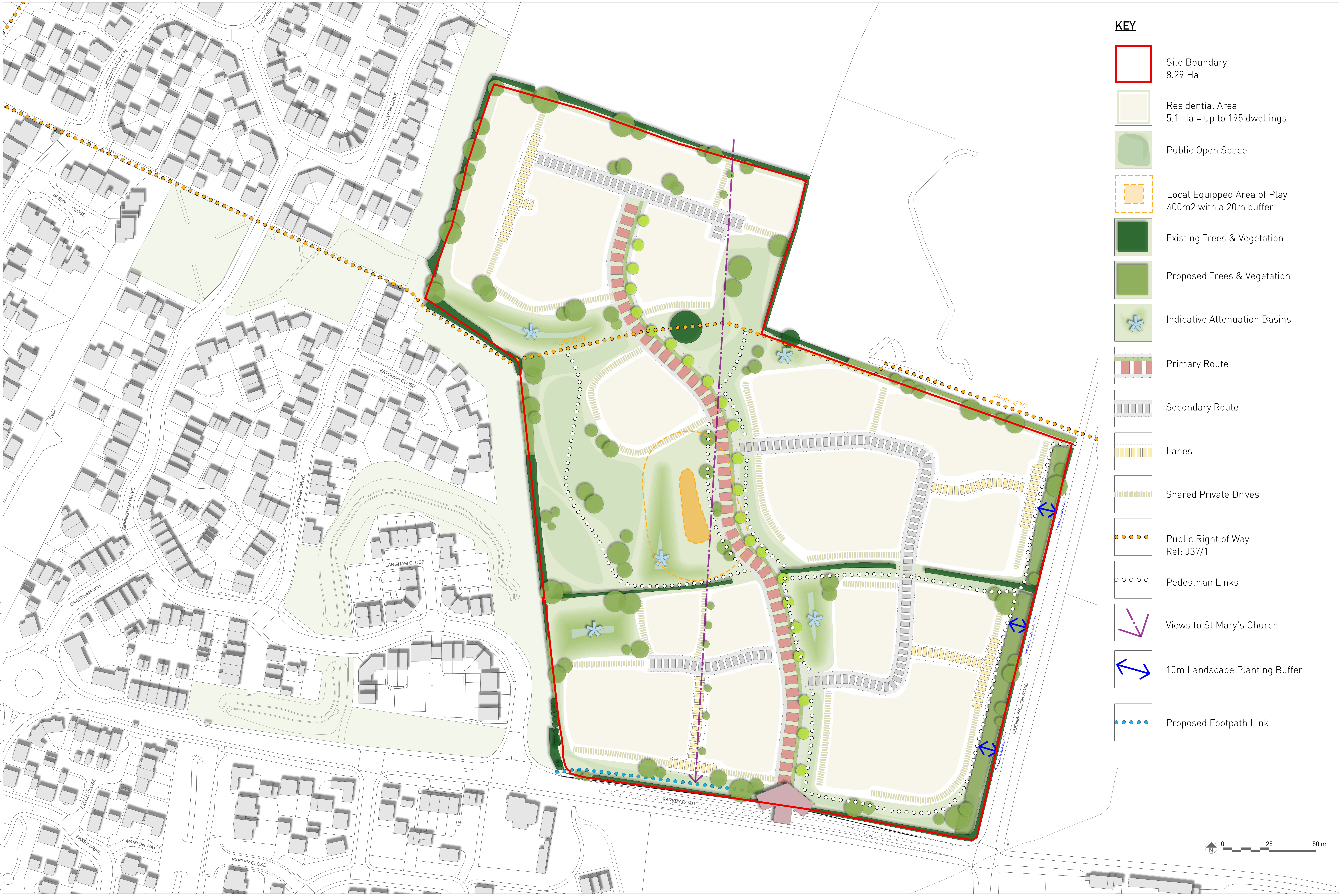
LAND SURVEYING BUILDING SURVEYING UNDERGROUND SURVEYING

PROJECT TITLE BARKBY LANE SYSTON, LE7 2AF				
DRAWING DETAIL TOPOGRAPHICAL SURVEY Sheet 2 of 2				
CLIENT TAYLOR WIMPEY STRATEGIC LAND				SCALE 1:500
SURVEYOR MA	SURVEY DATE 09/2/2018	CHECKED BY PDS	APPROVED BY PDS	DWG STATUS FINAL
DRAWING NUMBER 21105cv-02-REV D			REVISION D	ISSUE DATE 19/2/2018

Appendix III – Planning Layout



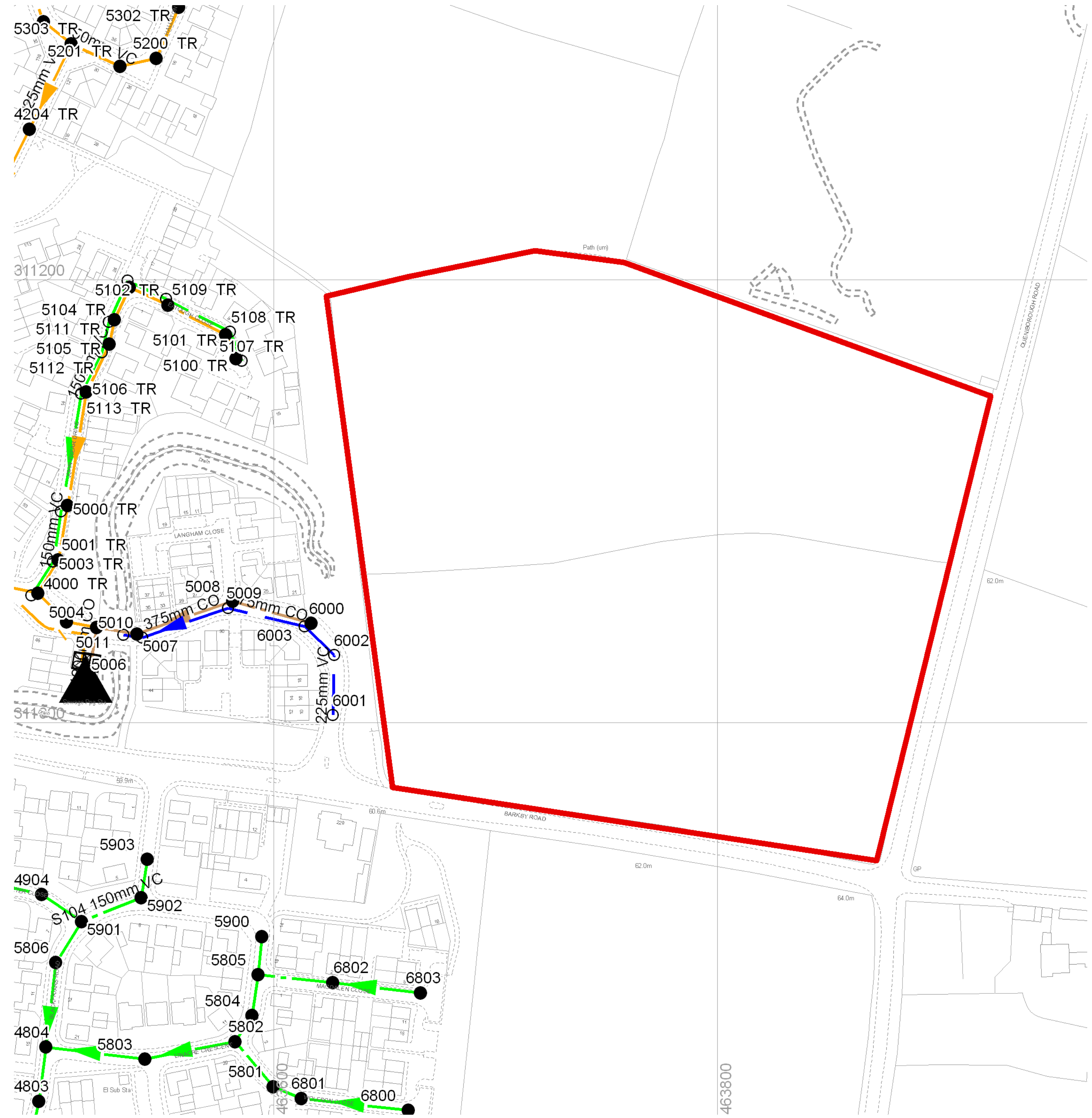
Planning | Design | Environment | Economics
East Midlands

Land North of Barkby Road, Syston, Leicestershire - **Concept Masterplan**

| Drawn by: LJE | Approved by: PS | Date: 28/06/21 | Scale: 1:1250 @ A2 | DRG: P20-3155 003 Sheet No: 1 Rev: F | Client: Taylor Wimpey |

Pegasus Design

Appendix IV – Severn Trent Water Sewer Records



Sewer Node / Sewer Pipe Data

REFERENCE	COVER LEVEL	INV LEVEL UPSTR	INV LEVEL DOWNSTR	PURP	MATL	SHAPE	MAX SIZE	MIN SIZE	GRADIENT	YEAR LAID
SK63104803	nil	57.04	56.89	F	VC	C	150	nil	150.14	nill
SK63104804	nil	57.20	57.04	F	VC	C	150	nil	152.17	nill
SK63104904	nil	57.95	57.60	F	VC	C	150	nil	62.92	nill
SK63105801	nil	59.86	58.58	F	VC	C	150	nil	20.77	nill
SK63105802	nil	58.58	58.30	F	VC	C	150	nil	148.44	nill
SK63105803	nil	58.30	57.20	F	VC	C	150	nil	41.13	nill
SK63105804	nil	58.70	58.58	F	VC	C	150	nil	111.13	nill
SK63105805	nil	58.83	58.70	F	VC	C	150	nil	148.89	nill
SK63105806	nil	57.46	57.20	F	VC	C	150	nil	149.25	nill
SK63105900	nil	58.95	58.83	F	VC	C	150	nil	148.51	nill
SK63105901	nil	57.60	57.46	F	VC	C	150	nil	152.15	nill
SK63105902	nil	58.30	57.60	F	VC	C	150	nil	41.64	nill
SK63105903	nil	58.62	58.30	F	VC	C	150	nil	55.42	nill
SK63106800	nil	60.27	59.95	F	VC	C	150	nil	151.75	nill
SK63106801	nil	59.95	59.86	F	VC	C	150	nil	149.35	nill
SK63106802	nil	59.54	58.83	F	VC	C	150	nil	47.32	nill
SK63106803	nil	59.81	59.54	F	VC	C	150	nil	151.32	nill
SK63114000	nil	nil	nil	F	VC	C	225	nil	0.00	nill
SK63114204	nil	nil	nil	F	VC	C	225	nil	0.00	nill
SK63114300	nil	nil	nil	F	VC	C	150	nil	0.00	nill
SK63115000	nil	56.11	55.95	F	VC	C	150	nil	149.65	nill
SK63115001	nil	55.95	55.25	F	VC	C	150	nil	18.23	nill
SK63115002	nil	56.65	56.59	S	CO	C	450	nil	376.87	nill
SK63115003	nil	56.59	56.55	S	CO	C	450	nil	294.48	nill
SK63115004	58.57	53.20	nil	F	CO	C	1200	nil	0.00	2012
SK63115005	nil	nil	nil	F	VC	C	1200	nil	0.00	nill
SK63115007	58.73	53.27	53.20	F	CO	C	1200	nil	0.00	2012
SK63115008	58.91	56.60	55.85	F	VC	C	150	nil	0.00	2012
SK63115009	59.04	57.14	56.51	S	CO	C	375	nil	0.00	2012
SK63115010	58.74	56.51	56.41	S	CO	C	375	nil	0.00	2012
SK63115100	nil	57.41	57.33	F	VC	C	150	nil	146.49	nill
SK63115101	nil	57.33	57.14	F	VC	C	150	nil	153.93	nill
SK63115102	nil	57.14	56.90	F	VC	C	150	nil	78.13	nill
SK63115103	nil	56.90	56.70	F	VC	C	150	nil	78.26	nill
SK63115104	nil	56.70	56.61	F	VC	C	150	nil	139.80	nill
SK63115105	nil	56.61	56.45	F	VC	C	150	nil	146.74	nill
SK63115106	nil	56.45	56.11	F	VC	C	150	nil	152.19	nill
SK63115107	nil	57.89	57.81	S	VC	C	300	nil	175.95	nill
SK63115108	nil	57.81	57.57	S	VC	C	300	nil	134.98	nill
SK63115109	nil	57.57	57.26	S	VC	C	300	nil	60.98	nill
SK63115110	nil	57.26	57.18	S	VC	C	300	nil	256.40	nill
SK63115111	nil	57.18	57.12	S	VC	C	300	nil	243.24	nill
SK63115112	nil	57.04	56.95	S	CO	C	375	nil	227.78	nill
SK63115113	nil	56.95	56.72	S	CO	C	375	nil	236.60	nill

Abandoned Gravity Sewer
Private Combined Gravity Sewer
Private Foul Gravity Sewer
Private Surface Water Gravity Sewer
Public Combined Gravity Sewer
Public Foul Gravity Sewer
Public Surface Water Gravity Sewer
Trunk Combined Gravity Sewer
Trunk Foul Use Gravity Sewer
Trunk Surface Water Gravity Sewer
Combined Use Pressurised Sewer
Foul Use Pressurised Sewer
Surface Water Pressurised Sewer
Highway Drain
Combined Lateral Drain (SS)
Foul Lateral Drain (SS)
Surface Water Lateral Drain (SS)

All Private Sewers are shown in magenta
All section 104 sewers are shown in green
All Sewers that have been transferred to Severn Trent Water after the 1st October 2011, but have not been surveyed and confirmed by Severn Trent Water are shown in orange

Culverted Watercourse
Cable, Earthing
Cable Junction
Cable, Optical Fibre/Instrumentation
Cable, Low Voltage
Cable, High Voltage
Cable, Other
Housing, Building
Housing, Kiosk
Disposal Site
Sewage Treatment Works
Housing, Other
Pipe Support Structure
Sewage Pumping Facility
Sewer Facility Connection Inlet / Outlet

Blind Shaft
Combined Use Manhole
Flushing Chamber
Foul Use Manhole
Grease Trap
Head Node
Hydrobrake
Lamphole
Outfall
Overflow
Penstock
Petrol Interceptor

Sewer Chemical Injection Point
Sewer Junction
Sewerage Air Valve
Sewerage Hatch Box Point
Sewerage Isolation Valve
Soakaway
Surface Water Manhole
Vent Column
Waste Water Storage
Pre-1937 Properties

TABULAR KEY

A. **Sewer pipe data refers to downstream sewer pipe.**

B. **Where the node bifurcates (splits) X and Y indicates downstream sewer pipe.**

C. **Gradient is stated a 1 in...**

MATERIALS

- \- - NONE
- AC - ASBESTOS CEMENT
- BR - BRICK
- CC - CONCRETE BOX CULVERT
- CI - CAST IRON
- CO - CONCRETE
- CSB - CONCRETE SEGMENTS (BOLTED)
- CSU - CONCRETE SEGMENTS (UNBOLTED)
- DI - DUCTILE IRON
- GRC - GLASS REINFORCED CONCRETE
- GRP - GLASS REINFORCED PLASTIC
- MAC - MASONRY IN REGULAR COURSES
- MAR - MASONRY RANDOMLY COURSED
- PE - POLYETHLENE
- PF - PITCH
- PP - POLYPROPYLENE
- PSC - PLASTIC STEEL COMPOSITE
- PVC - POLYVINYL CHLORIDE
- RPM - REINFORCED PLASTIC MATRIX
- SI - SPUN (GREY) IRON
- ST - STEEL
- U - UNKNOWN
- VC - VITRIFIED CLAY
- XXX - OTHER

SHAPE

- C - CIRCULAR
- E - EGG SHAPED
- O - OTHER
- R - RECTANGLE
- S - SQUARE
- T - TRAPEZOIDAL
- U - UNKNOWN

PURPOSE

- C - COMBINED
- E - FINAL EFFLUENT
- F - FOUL
- L - SLUDGE
- S - SURFACE WATER

CATEGORIES

N
W E
S

- W - WEIR
- C - CASCADE
- DB - DAMBOARD
- SE - SIDE ENTRY
- FV - FLAP VALVE
- BD - BACK DROP
- S - SIPHON
- HD - HIGHWAY DRAIN
- S104 - SECTION 104

SEVERN TRENT WATER

Severn Trent Water Limited
Asset Data Management
PO Box 5344
Coventry
CV3 9FT
Telephone: 0845 601 6616

SEWER RECORD (Tabular)

O/S Map scale: 1:2500
Date of issue: 06.02.18
Sheet No. 1 of 2

This map is centred upon:
O / S Grid reference:
x : 463724
y : 311073

Disclaimer Statement:

1. Do not scale off this Map.

2. This map and any information supplied with it is furnished as a general guide, is only valid at the date of issue and no warranty as to its correctness is given or implied. In particular this Map and any information shown on it must not be relied upon in the event of any development or works (including but not limited to excavations) in the vicinity of Severn Trent Water's assets or for the purposes of determining the suitability of a point of connection to the sewerage or distribution systems.

3. On **1 October 2011** most private sewers and private lateral drains in Severn Trent Water's sewerage area, which were connected to a public sewer as at 1 July 2011, transferred to the ownership of Severn Trent Water and became public sewers and public lateral drains. A further transfer takes place on 1 October 2012 (date to be confirmed).
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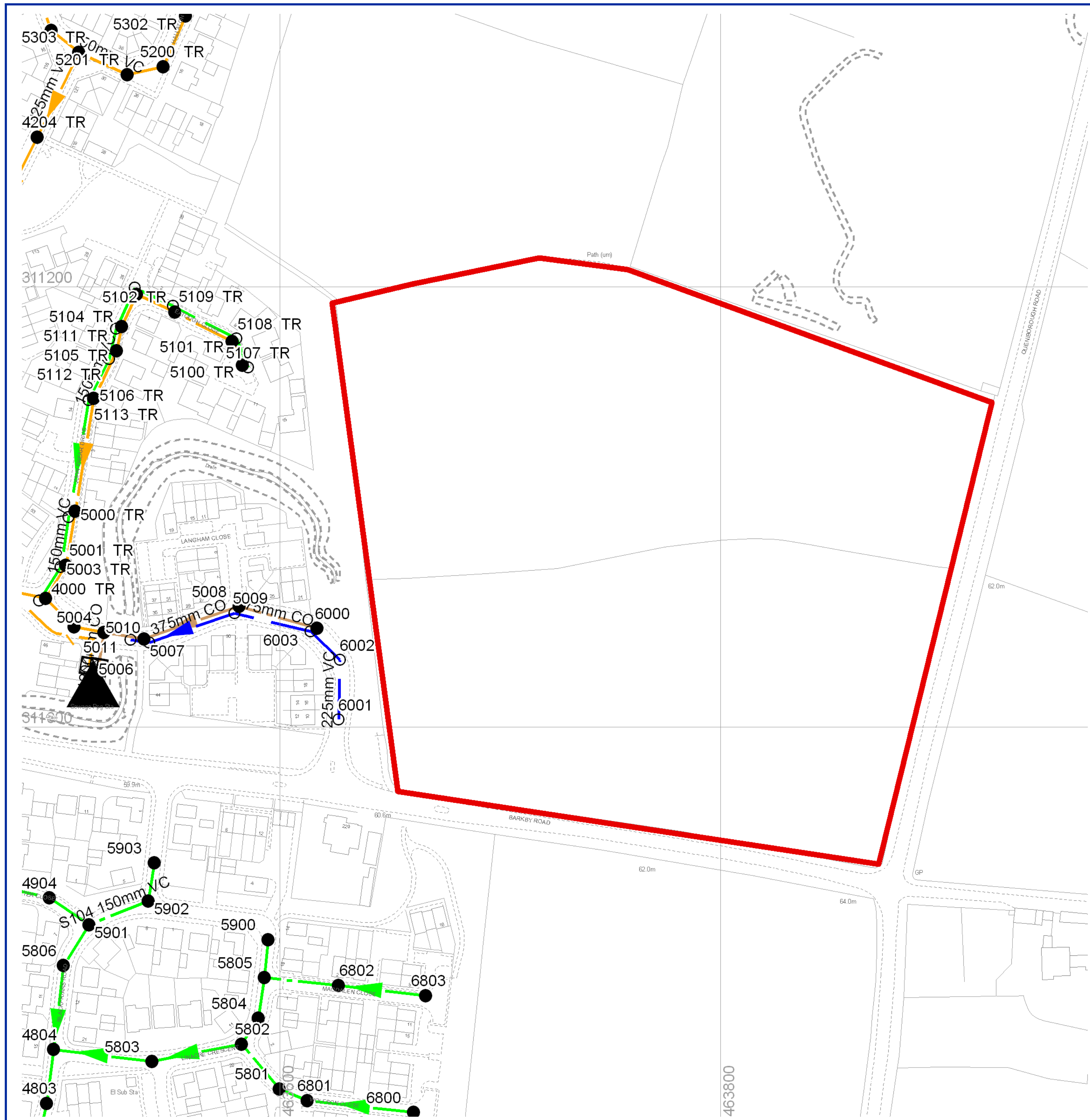
These assets may not be displayed on this Map.



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SK63115200	nil	nil	nil	F	VC	C	150	nil	0.00	nill
SK63115201	nil	nil	nil	F	VC	C	150	nil	0.00	nill
SK63115302	nil	nil	nil	F	VC	C	150	nil	0.00	nill
SK63115303	nil	nil	nil	F	VC	C	225	nil	0.00	nill
SK63116000	59.50	56.92	56.61	F	VC	C	150	nil	0.00	2012
SK63116001	60.59	58.58	58.01	S	VC	C	225	nil	0.00	2012
SK63116002	60.03	58.00	57.47	S	VC	C	225	nil	0.00	2012
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SEWER RECORD (Tabular)

O/S Map scale: 1:2500
Date of issue: 06.02.18
Sheet No. 2 of 2

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Appendix V – Severn Trent Water Pre-Development Enquiry

Travis Baker
11 Malin Hill,
The Lace Market,
Nottingham,
NG1 1JQ.

FAO: Ted Wake

Severn Trent Water
Severn Trent Water Ltd
Leicester Water Centre
Gorse Hill
Anstey
Leicester
LE7 7GU

Tel: 02477716843
www.stwater.co.uk

Contact:
Emma Nowak

Email:
Net.Dev.East@SevernTrent.co.uk

Our ref: 8296260

6th February 2018

Dear Mr Wake

Proposed Residential Development (150 Dwellings) at: Land off Barkby Lane, Syston, LE7 2AJ.

X: 463668 / Y: 311084

I refer to your Development Enquiry Request submitted in respect of the above site. Please find enclosed the sewer records that are included in the fee together with the Supplementary Guidance Notes (SGN) referred to below.

Public Sewers in Site – Required Protection

Sewer Records show there are no public sewers crossing the site.

Please note: *On 1st October 2011 many private sewers were transferred into the ownership of Severn Trent Water as public sewers, where two or more properties in separate ownership are served by those sewers. Most of these former private sewers will not be shown on the public sewer records, therefore a full site survey should be carried out prior to any layout design or construction works to identify where these sewers may be and to avoid later delays and possible added costs.*

Foul Water Drainage

There are some existing public foul sewers to the west of the site, please see attached public sewer records.

An unrestricted, domestic, ‘foul water only’ discharge from the proposed 150 Residential Dwellings, can be accommodated by the existing public foul sewerage network, subject to receipt of satisfactory foul water details and calculations.

Please submit foul water drainage proposals based on these comments for review when available.

Severn Trent Water

Surface Water Drainage

Under the terms of Section H of the Building Regulations 2000, the disposal of surface water by means of soakaways should be considered as the primary method. If this is not practical and no watercourse is available as an alternative, the use of sewerage should be considered. In addition, other sustainable drainage methods should also be explored before a discharge to the public sewerage system is considered.

If these are found to be unsuitable, satisfactory evidence will need to be submitted. The evidence should be either percolation test results or a statement from the SI consultant (extract or a supplementary letter).

Subject to the above, the 225mm diameter public surface water sewer west of the site on Empingham Drive (MH6001) will be able to accept green-field runoff rate flows of 5 l/sec/ha. However this should be considered as a last resort as capacity is unlikely to be currently available in the existing public surface water sewerage system. It will be preferable for the surface water run-off from the new development to discharge into the land drainage system, i.e. soakaways, subject to levels, capacities, and obtaining any necessary approvals to connect and discharge. Please investigate this further with the appropriate Land Drainage Authority and/or the Environment Agency.

Any flows exceeding this would need to be appropriately attenuated on site and discharged at a controlled rate. Please submit surface water drainage proposals based on these comments for review when available.

New Connections

For any new connections (including the re-use of existing connections) to the public sewerage system, you will need to submit a Section 106 application form. Our New Connections department are responsible for handling all such enquiries and applications. To contact them for an application form and associated guidance notes please call 0800 7076600 or download from www.stwater.co.uk.

Please quote 8296260 in any future correspondence (including e-mails) with STW Limited. Please note that 'Development Enquiry' responses are only valid for 6 months from the date of this letter.

Yours sincerely,

Emma Nowak.
Asset Protection East.
Asset Management.
Wholesale Operations.

Severn Trent Water

Severn Trent Water

Appendix VI – WinDes QBAR and storage calculations for each basin

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.450
Area (ha)	8.340	Urban	0.000
SAAR (mm)	700	Region Number	Region 5

Results	**l/s**
QBAR Rural	36.6
QBAR Urban	36.6
Q100 years	130.4
Q1 year	31.9
Q30 years	88.0
Q100 years	130.4

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
1	0.099	5.00	62.453	1200	463878.768	311009.414	1.425
2	0.077	5.00	61.620	1200	463885.126	311042.110	1.425
3	0.021	5.00	61.950	1200	463882.226	311028.886	1.910
4	0.021	5.00	61.480	1500	463854.944	311034.265	1.654
5	0.104	5.00	61.583	1200	463833.859	311071.066	1.425
6	0.033	5.00	61.368	1200	463832.877	311049.517	1.425
7	0.021	5.00	61.241	1500	463831.890	311036.848	1.575
8	0.026	5.00	61.407	1500	463828.110	311021.857	1.789
9	0.080	5.00	61.387	1500	463823.163	311019.705	1.861
10	0.034	5.00	61.160	1500	463801.588	311024.273	1.702
11	0.053	5.00	61.143	1500	463789.379	311023.843	1.798
12			60.500	1500	463788.334	311031.722	1.190
13			60.500	1500	463788.463	311072.065	1.200
14			60.500	3000	463789.766	311076.436	1.379
15			60.000	1200	463787.492	311079.992	0.900

Simulation Settings

Rainfall Methodology	FSR	Skip Steady State	x
FSR Region	England and Wales	Drain Down Time (mins)	240
M5-60 (mm)	20.000	Additional Storage (m^3/ha)	20.0
Ratio-R	0.400	Check Discharge Rate(s)	✓
Summer CV	0.750	Check Discharge Volume	✓
Winter CV	0.840	100 year 360 minute (m^3)	
Analysis Speed	Normal		

Storm Durations

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

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
2	0	0	0
30	0	0	0
100	40	0	0

Pre-development Discharge Rate

Site Makeup	Greenfield	Growth Factor 30 year	1.95
Greenfield Method	IH124	Growth Factor 100 year	2.48
Positively Drained Area (ha)		Betterment (%)	0
SAAR (mm)		QBar	
Soil Index	1	Q 1 year (l/s)	
SPR	0.10	Q 30 year (l/s)	
Region	1	Q 100 year (l/s)	
Growth Factor 1 year	0.85		

Pre-development Discharge Volume

Site Makeup	Greenfield	Return Period (years)	100
Greenfield Method	FSR/FEH	Climate Change (%)	0
Positively Drained Area (ha)		Storm Duration (mins)	360
Soil Index	1	Betterment (%)	0
SPR	0.10	PR	
CWI		Runoff Volume (m³)	

Node 15 Surcharged Outfall

Overrides Design Area	x	Depression Storage Area (m²)	0	Evapo-transpiration (mm/day)	0
Overrides Design Additional Inflow	x	Depression Storage Depth (mm)	0		

Applies to All storms

Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)
0	-0.130	150	-0.380	300	-0.307	450	-0.041	600	-0.194	750	-0.296
15	-0.472	165	-0.377	315	-0.288	465	-0.061	615	-0.206	765	-0.310
30	-0.469	180	-0.373	330	-0.263	480	-0.077	630	-0.215	780	-0.327
45	-0.417	195	-0.361	345	-0.229	495	-0.094	645	-0.226	795	-0.336
60	-0.414	210	-0.361	360	-0.174	510	-0.113	660	-0.236	810	-0.348
75	-0.422	225	-0.358	375	-0.079	525	-0.130	675	-0.243	825	-0.360
90	-0.401	240	-0.349	390	0.007	540	-0.145	690	-0.251	840	-0.370
105	-0.400	255	-0.343	405	0.021	555	-0.159	705	-0.260		
120	-0.386	270	-0.331	420	0.007	570	-0.166	720	-0.268		
135	-0.385	285	-0.322	435	-0.017	585	-0.184	735	-0.284		

Node 14 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	59.121	Product Number	CTL-SHE-0101-5000-1300-5000
Design Depth (m)	1.300	Min Outlet Diameter (m)	0.150
Design Flow (l/s)	5.0	Min Node Diameter (mm)	1200

Node 14 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	59.300
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	150.0	0.0	1.300	533.0	0.0

Results for 2 year Critical Storm Duration. Lowest mass balance: 96.11%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	1	10	61.089	0.061	18.0	0.1535	0.0000	OK
15 minute winter	2	10	60.291	0.096	14.0	0.2131	0.0000	OK
15 minute winter	3	11	60.186	0.146	35.4	0.1972	0.0000	OK
15 minute winter	4	11	59.948	0.122	38.6	0.2457	0.0000	OK
15 minute winter	5	10	60.255	0.097	19.0	0.2504	0.0000	OK
15 minute winter	6	10	60.060	0.117	24.7	0.1865	0.0000	OK
15 minute winter	7	11	59.904	0.238	66.7	0.4833	0.0000	OK
15 minute winter	8	11	59.848	0.230	71.3	0.4729	0.0000	OK
15 minute winter	9	11	59.768	0.242	84.8	0.6348	0.0000	OK
15 minute winter	10	11	59.697	0.239	90.2	0.5178	0.0000	OK
15 minute winter	11	12	59.608	0.263	98.1	0.6199	0.0000	OK
15 minute winter	12	12	59.580	0.270	97.3	0.4771	0.0000	OK
120 minute winter	13	96	59.576	0.276	60.6	0.4869	0.0000	OK
120 minute winter	14	114	59.570	0.449	89.8	54.4903	0.0000	SURCHARGED
720 minute winter	15	405	59.121	0.021	5.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	1	1.000	3	17.9	1.946	0.160	0.1916	
15 minute winter	2	2.000	3	13.7	0.883	0.345	0.2104	
15 minute winter	3	1.001	4	35.0	1.064	0.447	0.9156	
15 minute winter	4	1.002	7	38.8	0.749	0.234	1.2122	
15 minute winter	5	3.000	6	18.7	1.008	0.360	0.4005	
15 minute winter	6	3.001	7	24.3	1.233	0.468	0.2505	
15 minute winter	7	1.003	8	66.8	0.926	0.603	1.1160	
15 minute winter	8	1.004	9	71.1	1.106	0.639	0.3466	
15 minute winter	9	1.005	10	84.4	0.980	0.473	1.8987	
15 minute winter	10	1.006	11	89.0	1.140	0.499	0.9566	
15 minute winter	11	1.007	12	97.3	0.904	0.303	0.8744	
15 minute winter	12	1.008	13	96.7	1.084	0.915	3.8076	
120 minute winter	13	1.009	14	89.8	1.025	0.140	0.5924	
120 minute winter	14	Hydro-Brake®	15	5.0				94.3

Results for 30 year Critical Storm Duration. Lowest mass balance: 96.11%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	1	10	61.113	0.085	34.2	0.2130	0.0000	OK
15 minute winter	2	10	60.343	0.148	26.6	0.3277	0.0000	OK
15 minute winter	3	10	60.265	0.225	67.4	0.3043	0.0000	OK
15 minute winter	4	11	60.085	0.259	73.1	0.5234	0.0000	OK
15 minute winter	5	10	60.303	0.145	36.0	0.3749	0.0000	OK
15 minute winter	6	11	60.192	0.249	47.2	0.3968	0.0000	SURCHARGED
15 minute winter	7	11	60.064	0.398	122.4	0.8097	0.0000	SURCHARGED
15 minute winter	8	11	59.977	0.359	129.8	0.7387	0.0000	OK
15 minute winter	9	11	59.901	0.375	155.1	0.9839	0.0000	OK
180 minute winter	10	180	59.828	0.370	41.1	0.8022	0.0000	OK
180 minute winter	11	180	59.828	0.483	45.7	1.1390	0.0000	OK
180 minute winter	12	180	59.828	0.518	43.7	0.9157	0.0000	OK
180 minute winter	13	180	59.828	0.528	50.6	0.9336	0.0000	SURCHARGED
180 minute winter	14	180	59.828	0.707	83.3	125.4430	0.0000	SURCHARGED
600 minute summer	15	405	59.121	0.021	5.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	1	1.000	3	34.0	1.986	0.303	0.4131	
15 minute winter	2	2.000	3	26.1	0.964	0.658	0.3783	
15 minute winter	3	1.001	4	66.3	1.241	0.847	1.4851	
15 minute winter	4	1.002	7	71.5	0.800	0.431	2.2210	
15 minute winter	5	3.000	6	35.8	1.113	0.689	0.6931	
15 minute winter	6	3.001	7	45.3	1.292	0.872	0.5054	
15 minute winter	7	1.003	8	121.3	1.100	1.094	1.6922	
15 minute winter	8	1.004	9	129.0	1.258	1.160	0.5476	
15 minute winter	9	1.005	10	153.8	1.109	0.862	3.0578	
180 minute winter	10	1.006	11	41.5	0.881	0.233	1.7753	
180 minute winter	11	1.007	12	43.7	0.549	0.136	1.6827	
180 minute winter	12	1.008	13	39.5	0.671	0.374	10.5203	
180 minute winter	13	1.009	14	83.3	0.911	0.130	0.7227	
180 minute winter	14	Hydro-Brake®	15	5.0				114.5

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 96.11%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	1	12	61.343	0.315	62.2	0.7938	0.0000	SURCHARGED
15 minute winter	2	12	61.204	1.009	48.4	2.2330	0.0000	SURCHARGED
15 minute winter	3	12	61.095	1.055	108.8	1.4250	0.0000	SURCHARGED
15 minute winter	4	12	60.789	0.963	115.5	1.9459	0.0000	SURCHARGED
15 minute winter	5	12	61.317	1.159	65.4	3.0034	0.0000	FLOOD RISK
15 minute winter	6	12	61.022	1.079	74.4	1.7202	0.0000	SURCHARGED
15 minute winter	7	12	60.683	1.017	197.6	2.0677	0.0000	SURCHARGED
15 minute winter	8	12	60.444	0.826	211.5	1.6997	0.0000	SURCHARGED
15 minute winter	9	12	60.287	0.761	253.3	1.9997	0.0000	SURCHARGED
360 minute winter	10	368	60.252	0.793	41.5	1.7195	0.0000	SURCHARGED
360 minute winter	11	384	60.303	0.958	45.3	2.2581	0.0000	SURCHARGED
240 minute winter	12	320	60.260	0.950	61.5	1.6791	0.0000	FLOOD RISK
360 minute winter	13	392	60.268	0.968	82.2	1.7099	0.0000	FLOOD RISK
360 minute winter	14	352	60.249	1.128	75.8	283.0077	0.0000	FLOOD RISK
600 minute summer	15	405	59.121	0.021	5.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	1	1.000	3	58.5	1.942	0.521	0.7866	
15 minute winter	2	2.000	3	42.4	1.065	1.066	0.5384	
15 minute winter	3	1.001	4	103.7	1.472	1.324	1.9581	
15 minute winter	4	1.002	7	115.2	1.044	0.694	2.5587	
15 minute winter	5	3.000	6	54.9	1.381	1.059	0.8579	
15 minute winter	6	3.001	7	72.2	1.815	1.389	0.5054	
15 minute winter	7	1.003	8	198.7	1.802	1.792	1.7052	
15 minute winter	8	1.004	9	212.5	1.927	1.910	0.5951	
15 minute winter	9	1.005	10	252.8	1.596	1.417	3.4942	
360 minute winter	10	1.006	11	40.7	0.771	0.228	1.9357	
360 minute winter	11	1.007	12	44.8	0.441	0.140	1.7170	
240 minute winter	12	1.008	13	60.5	0.616	0.573	11.3637	
360 minute winter	13	1.009	14	75.8	0.792	0.118	0.7227	
360 minute winter	14	Hydro-Brake®	15	5.0				159.7

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
20	0.163	5.00	61.841	1200	463769.930	310971.973	1.500
21	0.060	5.00	61.365	1200	463776.196	311019.590	1.500
22	0.064	5.00	61.285	1200	463774.020	311051.316	1.425
23	0.043	5.00	61.162	1500	463774.364	311038.279	1.575
24	0.021	5.00	60.882	1500	463750.175	311036.283	1.575
25	0.166	5.00	61.187	1200	463721.852	310977.324	1.500
26	0.047	5.00	60.602	1500	463725.782	311021.833	1.575
27	0.050	5.00	60.650	1500	463726.288	311030.051	1.746
28	0.062	5.00	60.357	1500	463698.760	311032.596	1.650
29	0.104	5.00	60.290	1500	463672.011	311032.048	1.740
30			59.750	1500	463669.482	311037.532	1.275
31			59.750	1500	463653.598	311058.136	1.300
32			59.500	3000	463648.326	311061.263	1.275
33			58.850	1200	463646.935	311064.423	0.710

Simulation Settings

Rainfall Methodology	FSR	Skip Steady State	x
FSR Region	England and Wales	Drain Down Time (mins)	240
M5-60 (mm)	20.000	Additional Storage (m³/ha)	20.0
Ratio-R	0.400	Check Discharge Rate(s)	✓
Summer CV	0.750	Check Discharge Volume	✓
Winter CV	0.840	100 year 360 minute (m³)	
Analysis Speed	Normal		

Storm Durations

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

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
2	0	0	0
30	0	0	0
100	40	0	0

Pre-development Discharge Rate

Site Makeup	Greenfield	Growth Factor 30 year	1.95
Greenfield Method	IH124	Growth Factor 100 year	2.48
Positively Drained Area (ha)		Betterment (%)	0
SAAR (mm)		QBar	
Soil Index	1	Q 1 year (l/s)	
SPR	0.10	Q 30 year (l/s)	
Region	1	Q 100 year (l/s)	
Growth Factor 1 year	0.85		

Pre-development Discharge Volume

Site Makeup	Greenfield	CWI	
Greenfield Method	FSR/FEH	Return Period (years)	100
Positively Drained Area (ha)		Climate Change (%)	0
Soil Index	1	Storm Duration (mins)	360
SPR	0.10	Betterment (%)	0

Pre-development Discharge Volume

PR	Runoff Volume (m³)

Node 33 Surcharged Outfall

Overrides Design Area	x	Depression Storage Area (m²)	0	Evapo-transpiration (mm/day)	0
Overrides Design Additional Inflow	x	Depression Storage Depth (mm)	0		

Applies to All storms

Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)
0	-0.060	150	0.291	300	0.353	450	0.385	600	0.511	750	0.494
15	0.237	165	0.295	315	0.359	465	0.405	615	0.513	765	0.488
30	0.227	180	0.298	330	0.364	480	0.432	630	0.514	780	0.482
45	0.231	195	0.304	345	0.369	495	0.452	645	0.514	795	0.473
60	0.258	210	0.311	360	0.375	510	0.467	660	0.513	810	0.466
75	0.257	225	0.312	375	0.384	525	0.480	675	0.511	825	0.458
90	0.257	240	0.319	390	0.387	540	0.489	690	0.509	840	0.451
105	0.267	255	0.325	405	0.388	555	0.497	705	0.506		
120	0.272	270	0.334	420	0.388	570	0.503	720	0.502		
135	0.286	285	0.346	435	0.388	585	0.508	735	0.498		

Node 32 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	58.225	Product Number	CTL-SHE-0127-8000-1300-8000
Design Depth (m)	1.300	Min Outlet Diameter (m)	0.150
Design Flow (l/s)	8.0	Min Node Diameter (mm)	1200

Node 32 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	58.450
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	521.0	0.0	1.300	907.0	0.0

Results for 2 year Critical Storm Duration. Lowest mass balance: 99.52%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	20	10	60.446	0.105	29.7	0.3456	0.0000	OK
15 minute winter	21	11	59.994	0.129	40.1	0.2488	0.0000	OK
15 minute winter	22	10	59.937	0.077	11.7	0.1563	0.0000	OK
15 minute winter	23	11	59.728	0.141	58.2	0.3251	0.0000	OK
15 minute winter	24	11	59.447	0.140	62.2	0.2848	0.0000	OK
15 minute winter	25	10	59.787	0.100	30.3	0.3354	0.0000	OK
15 minute winter	26	11	59.173	0.146	37.9	0.3443	0.0000	OK
15 minute winter	27	11	59.122	0.218	108.8	0.5106	0.0000	OK
15 minute winter	28	11	58.954	0.247	120.0	0.6218	0.0000	OK
15 minute winter	29	11	58.826	0.276	137.3	0.8180	0.0000	OK
15 minute winter	30	12	58.766	0.291	135.9	0.5142	0.0000	OK
960 minute winter	31	720	58.726	0.276	30.5	0.4878	0.0000	OK
960 minute winter	32	705	58.724	0.499	28.5	157.6324	0.0000	SURCHARGED
480 minute summer	33	632	58.654	0.514	5.7	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	20	1.000	21	29.2	1.158	0.264	1.2142	
15 minute winter	21	1.001	23	39.6	1.436	0.343	0.5179	
15 minute winter	22	2.000	23	11.5	0.998	0.228	0.1503	
15 minute winter	23	1.002	24	58.6	1.559	0.273	0.9121	
15 minute winter	24	1.003	27	62.6	1.660	0.271	0.9397	
15 minute winter	25	3.000	26	29.3	1.461	0.230	0.9009	
15 minute winter	26	3.001	27	37.6	1.039	0.247	0.3219	
15 minute winter	27	1.004	28	109.4	1.324	0.401	2.2834	
15 minute winter	28	1.005	29	119.5	1.252	0.484	2.5548	
15 minute winter	29	1.006	30	135.9	1.292	0.377	0.6351	
15 minute winter	30	1.007	31	134.3	1.338	0.905	2.6428	
960 minute winter	31	1.008	32	28.5	0.494	0.074	0.6046	
960 minute winter	32	Hydro-Brake®	33	5.0				117.9

Results for 30 year Critical Storm Duration. Lowest mass balance: 99.52%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	20	10	60.493	0.152	56.4	0.5031	0.0000	OK
15 minute winter	21	11	60.058	0.193	76.3	0.3735	0.0000	OK
15 minute winter	22	10	59.971	0.111	22.1	0.2259	0.0000	OK
15 minute winter	23	11	59.795	0.208	110.7	0.4806	0.0000	OK
15 minute winter	24	11	59.519	0.212	118.1	0.4320	0.0000	OK
15 minute winter	25	10	59.829	0.142	57.4	0.4761	0.0000	OK
15 minute winter	26	12	59.296	0.269	73.3	0.6368	0.0000	OK
15 minute winter	27	12	59.278	0.374	202.4	0.8763	0.0000	OK
15 minute winter	28	11	59.177	0.470	216.2	1.1827	0.0000	SURCHARGED
15 minute winter	29	11	59.019	0.469	247.8	1.3905	0.0000	SURCHARGED
15 minute winter	30	12	58.924	0.449	247.4	0.7934	0.0000	OK
1440 minute winter	31	930	58.815	0.365	24.8	0.6454	0.0000	OK
1440 minute winter	32	930	58.815	0.590	23.2	214.4118	0.0000	SURCHARGED
480 minute summer	33	632	58.654	0.514	7.7	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	20	1.000	21	55.5	1.325	0.502	2.0110	
15 minute winter	21	1.001	23	75.4	1.665	0.652	0.8496	
15 minute winter	22	2.000	23	21.8	1.172	0.431	0.2423	
15 minute winter	23	1.002	24	111.3	1.756	0.518	1.5413	
15 minute winter	24	1.003	27	118.2	1.681	0.512	1.9516	
15 minute winter	25	3.000	26	57.0	1.644	0.448	1.7226	
15 minute winter	26	3.001	27	70.8	1.049	0.465	0.7374	
15 minute winter	27	1.004	28	195.0	1.415	0.715	4.1388	
15 minute winter	28	1.005	29	213.9	1.350	0.865	4.2392	
15 minute winter	29	1.006	30	247.4	1.562	0.686	0.9564	
15 minute winter	30	1.007	31	244.7	1.461	1.649	4.3795	
1440 minute winter	31	1.008	32	23.2	0.343	0.060	0.6736	
1440 minute winter	32	Hydro-Brake®	33	7.6				324.6

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 99.52%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	20	12	61.288	0.947	102.5	3.1291	0.0000	SURCHARGED
15 minute winter	21	12	61.001	1.136	128.8	2.1935	0.0000	SURCHARGED
15 minute winter	22	12	60.816	0.956	40.2	1.9401	0.0000	SURCHARGED
15 minute winter	23	12	60.755	1.168	174.7	2.7024	0.0000	SURCHARGED
15 minute winter	24	12	60.547	1.240	168.3	2.5224	0.0000	SURCHARGED
15 minute winter	25	12	60.649	0.962	104.3	3.2156	0.0000	SURCHARGED
15 minute winter	26	12	60.356	1.329	114.6	3.1420	0.0000	FLOOD RISK
15 minute winter	27	12	60.310	1.406	297.8	3.2890	0.0000	SURCHARGED
15 minute winter	28	12	59.982	1.275	327.4	3.2119	0.0000	SURCHARGED
15 minute winter	29	12	59.596	1.046	377.6	3.0997	0.0000	SURCHARGED
15 minute winter	30	12	59.369	0.894	376.4	1.5806	0.0000	SURCHARGED
15 minute winter	31	13	59.145	0.695	375.5	1.2274	0.0000	SURCHARGED
360 minute winter	32	352	59.108	0.883	91.1	413.8974	0.0000	SURCHARGED
480 minute summer	33	632	58.654	0.514	8.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	20	1.000	21	93.3	1.447	0.843	3.3821	
15 minute winter	21	1.001	23	113.4	1.695	0.981	1.3224	
15 minute winter	22	2.000	23	36.0	1.245	0.713	0.5187	
15 minute winter	23	1.002	24	158.0	1.792	0.735	2.6770	
15 minute winter	24	1.003	27	169.5	1.591	0.734	2.7229	
15 minute winter	25	3.000	26	86.8	1.656	0.682	3.1465	
15 minute winter	26	3.001	27	106.8	1.032	0.700	0.9082	
15 minute winter	27	1.004	28	297.0	1.875	1.090	4.3802	
15 minute winter	28	1.005	29	326.5	2.061	1.321	4.2392	
15 minute winter	29	1.006	30	376.4	2.376	1.044	0.9568	
15 minute winter	30	1.007	31	375.5	1.738	2.529	5.6203	
15 minute winter	31	1.008	32	374.3	3.394	0.973	0.6761	
360 minute winter	32	Hydro-Brake®	33	8.0				252.4

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
60	0.127	5.00	60.961	1200	463750.696	311088.185	1.425
61	0.021	5.00	60.855	1200	463743.255	311096.314	1.500
62	0.084	5.00	60.739	1500	463738.874	311107.337	1.575
63	0.067	5.00	60.468	1500	463736.933	311134.610	1.389
64	0.021	5.00	60.282	1500	463735.672	311153.068	1.375
65	0.050	5.00	60.525	1200	463698.406	311202.793	1.300
66	0.021	5.00	60.318	1500	463713.815	311189.047	1.375
67	0.041	5.00	60.132	1500	463727.187	311175.702	1.375
68	0.625	5.00	60.131	1500	463731.708	311163.044	1.491
69	0.099	5.00	60.270	1500	463715.799	311155.210	1.844
70	0.116	5.00	59.930	1500	463680.036	311134.713	1.650
71	0.141	5.00	59.900	1500	463654.128	311119.734	1.700
72			59.900	1500	463648.221	311113.226	1.735
73			59.900	1500	463648.416	311082.915	1.750
74			59.900	3000	463646.461	311079.933	1.786
75			58.800	1500	463641.759	311078.310	0.735

Simulation Settings

Rainfall Methodology	FSR	Skip Steady State	x
FSR Region	England and Wales	Drain Down Time (mins)	240
M5-60 (mm)	20.000	Additional Storage (m^3/ha)	20.0
Ratio-R	0.400	Check Discharge Rate(s)	✓
Summer CV	0.750	Check Discharge Volume	✓
Winter CV	0.840	100 year 360 minute (m^3)	
Analysis Speed	Normal		

Storm Durations

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

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	0	0	0
30	0	0	0
100	40	0	0

Pre-development Discharge Rate

Site Makeup	Greenfield	Growth Factor 30 year	1.95
Greenfield Method	IH124	Growth Factor 100 year	2.48
Positively Drained Area (ha)		Betterment (%)	0
SAAR (mm)		QBar	
Soil Index	1	Q 1 year (l/s)	
SPR	0.10	Q 30 year (l/s)	
Region	1	Q 100 year (l/s)	
Growth Factor 1 year	0.85		

Pre-development Discharge Volume

Site Makeup	Greenfield	Return Period (years)	100
Greenfield Method	FSR/FEH	Climate Change (%)	0
Positively Drained Area (ha)		Storm Duration (mins)	360
Soil Index	1	Betterment (%)	0
SPR	0.10	PR	
CWI		Runoff Volume (m³)	

Node 75 Surcharged Outfall

Overrides Design Area	x	Depression Storage Area (m²)	0	Evapo-transpiration (mm/day)	0
Overrides Design Additional Inflow	x	Depression Storage Depth (mm)	0		

Applies to All storms

Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)
0	-0.030	150	0.321	300	0.383	450	0.415	600	0.541	750	0.523
15	0.267	165	0.325	315	0.389	465	0.435	615	0.543	765	0.518
30	0.257	180	0.328	330	0.394	480	0.462	630	0.544	780	0.512
45	0.261	195	0.334	345	0.399	495	0.482	645	0.544	795	0.503
60	0.288	210	0.341	360	0.405	510	0.497	660	0.543	810	0.496
75	0.287	225	0.342	375	0.414	525	0.510	675	0.541	825	0.488
90	0.287	240	0.349	390	0.417	540	0.519	690	0.539	840	0.481
105	0.297	255	0.355	405	0.418	555	0.527	705	0.536		
120	0.302	270	0.364	420	0.418	570	0.533	720	0.532		
135	0.316	285	0.376	435	0.418	585	0.538	735	0.528		

Node 74 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	58.114	Product Number	CTL-SHE-0184-1860-1600-1860
Design Depth (m)	1.600	Min Outlet Diameter (m)	0.225
Design Flow (l/s)	18.6	Min Node Diameter (mm)	1500

Node 74 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	58.400
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	100

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	661.0	0.0	1.500	1466.0	0.0

Results for 1 year Critical Storm Duration. Lowest mass balance: 99.59%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	60	10	59.634	0.098	17.9	0.2867	0.0000	OK
15 minute winter	61	10	59.449	0.094	20.6	0.1324	0.0000	OK
15 minute winter	62	10	59.305	0.141	32.2	0.4008	0.0000	OK
15 minute winter	63	11	59.204	0.125	41.0	0.3411	0.0000	OK
15 minute winter	64	11	59.021	0.114	44.1	0.2365	0.0000	OK
15 minute winter	65	10	59.277	0.052	7.1	0.0983	0.0000	OK
15 minute winter	66	11	58.999	0.056	9.9	0.1157	0.0000	OK
15 minute winter	67	11	58.883	0.126	15.5	0.2969	0.0000	OK
15 minute winter	68	11	58.874	0.234	144.0	2.3783	0.0000	OK
15 minute winter	69	12	58.816	0.390	157.6	1.1074	0.0000	OK
15 minute winter	70	12	58.732	0.452	165.4	1.4355	0.0000	SURCHARGED
960 minute winter	71	705	58.690	0.490	14.1	1.6777	0.0000	SURCHARGED
960 minute winter	72	690	58.690	0.525	13.9	0.9269	0.0000	OK
960 minute winter	73	690	58.690	0.540	13.7	0.9533	0.0000	SURCHARGED
960 minute winter	74	690	58.689	0.575	13.5	218.1752	0.0000	SURCHARGED
480 minute summer	75	632	58.609	0.544	9.7	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	60	1.000	61	17.6	1.114	0.346	0.1742	
15 minute winter	61	1.001	62	20.4	1.146	0.185	0.2114	
15 minute winter	62	1.002	63	31.9	0.916	0.287	0.9541	
15 minute winter	63	1.003	64	41.3	1.368	0.214	0.5582	
15 minute winter	64	1.004	68	44.2	1.493	0.165	0.3910	
15 minute winter	65	2.000	66	6.9	0.870	0.062	0.1633	
15 minute winter	66	2.001	67	9.7	0.557	0.049	0.4017	
15 minute winter	67	2.002	68	15.8	0.593	0.142	0.5166	
15 minute winter	68	1.005	69	144.5	1.330	0.407	1.9954	
15 minute winter	69	1.006	70	150.0	1.067	0.783	6.2708	
15 minute winter	70	1.007	71	161.0	1.021	0.969	4.7306	
960 minute winter	71	1.008	72	13.9	0.251	0.068	1.3926	
960 minute winter	72	1.009	73	13.7	0.204	0.067	9.1461	
960 minute winter	73	1.010	74	13.5	0.220	0.068	0.3933	
960 minute winter	74	Hydro-Brake®	75	7.8				179.2

Results for 30 year Critical Storm Duration. Lowest mass balance: 99.59%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	60	13	60.175	0.639	43.9	1.8615	0.0000	SURCHARGED
15 minute winter	61	13	60.127	0.772	55.5	1.0896	0.0000	SURCHARGED
15 minute winter	62	13	60.109	0.945	72.6	2.6773	0.0000	SURCHARGED
15 minute winter	63	12	60.080	1.001	90.6	2.7358	0.0000	SURCHARGED
15 minute winter	64	12	60.045	1.138	77.4	2.3595	0.0000	FLOOD RISK
15 minute winter	65	12	60.037	0.812	17.3	1.5433	0.0000	SURCHARGED
15 minute winter	66	12	60.029	1.086	40.4	2.2523	0.0000	FLOOD RISK
15 minute winter	67	12	60.023	1.266	55.5	2.9932	0.0000	FLOOD RISK
15 minute winter	68	12	60.018	1.378	273.1	13.9833	0.0000	FLOOD RISK
15 minute winter	69	12	59.849	1.423	274.4	4.0423	0.0000	SURCHARGED
15 minute winter	70	12	59.474	1.194	304.0	3.7901	0.0000	SURCHARGED
15 minute winter	71	12	59.115	0.915	340.1	3.1353	0.0000	SURCHARGED
15 minute winter	72	13	58.912	0.747	338.0	1.3192	0.0000	SURCHARGED
15 minute winter	73	13	58.857	0.707	336.8	1.2489	0.0000	SURCHARGED
1440 minute summer	74	840	58.805	0.691	29.3	317.1975	0.0000	SURCHARGED
480 minute summer	75	632	58.609	0.544	18.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	60	1.000	61	43.6	1.330	0.856	0.4383	
15 minute winter	61	1.001	62	45.2	1.289	0.412	0.8353	
15 minute winter	62	1.002	63	68.8	1.021	0.619	3.0157	
15 minute winter	63	1.003	64	74.5	1.551	0.386	2.0406	
15 minute winter	64	1.004	68	84.8	1.187	0.316	1.1840	
15 minute winter	65	2.000	66	16.9	1.015	0.152	1.4541	
15 minute winter	66	2.001	67	28.8	0.573	0.145	2.0837	
15 minute winter	67	2.002	68	49.1	0.742	0.441	1.4825	
15 minute winter	68	1.005	69	250.5	1.581	0.705	2.8097	
15 minute winter	69	1.006	70	274.3	1.731	1.431	6.5310	
15 minute winter	70	1.007	71	302.1	1.907	1.818	4.7416	
15 minute winter	71	1.008	72	338.0	2.133	1.663	1.3926	
15 minute winter	72	1.009	73	336.8	0.943	1.641	10.8207	
15 minute winter	73	1.010	74	335.7	3.044	1.678	0.3933	
1440 minute summer	74	Hydro-Brake®	75	17.5				533.8

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 99.59%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	60	10	60.961	1.425	79.7	4.1510	1.4085	FLOOD
15 minute winter	61	10	60.715	1.360	78.7	1.9183	0.0000	FLOOD RISK
15 minute winter	62	10	60.624	1.460	129.9	4.1362	0.0000	FLOOD RISK
15 minute winter	63	11	60.468	1.389	167.4	3.7947	0.4246	FLOOD
15 minute winter	64	11	60.282	1.375	177.5	2.8504	0.1373	FLOOD
15 minute winter	65	9	60.334	1.109	31.4	2.1076	0.0000	FLOOD RISK
15 minute winter	66	9	60.206	1.263	60.4	2.6180	0.0000	FLOOD RISK
15 minute summer	67	10	60.132	1.375	77.7	3.2505	16.9766	FLOOD
15 minute winter	68	9	60.131	1.491	566.9	15.1351	90.4232	FLOOD
15 minute winter	69	10	60.042	1.616	268.9	4.5923	0.0000	FLOOD RISK
15 minute winter	70	10	59.748	1.468	329.2	4.6593	0.0000	FLOOD RISK
15 minute winter	71	11	59.367	1.167	405.0	3.9993	0.0000	SURCHARGED
240 minute winter	72	228	59.190	1.025	158.0	1.8112	0.0000	SURCHARGED
240 minute winter	73	232	59.189	1.039	157.7	1.8356	0.0000	SURCHARGED
240 minute winter	74	236	59.187	1.073	157.5	694.8141	0.0000	SURCHARGED
480 minute summer	75	632	58.609	0.544	18.6	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	60	1.000	61	67.6	1.699	1.326	0.4383	
15 minute winter	61	1.001	62	79.8	1.269	0.726	0.8353	
15 minute winter	62	1.002	63	127.9	1.159	1.149	3.0157	
15 minute winter	63	1.003	64	165.1	1.497	0.856	2.0406	
15 minute winter	64	1.004	68	176.7	1.602	0.659	1.1840	
15 minute winter	65	2.000	66	38.7	0.984	0.348	1.4541	
15 minute winter	66	2.001	67	38.3	0.564	0.193	2.0837	
15 minute summer	67	2.002	68	37.3	0.642	0.335	1.4825	
15 minute winter	68	1.005	69	249.4	1.575	0.702	2.8097	
15 minute winter	69	1.006	70	271.9	1.716	1.419	6.5310	
15 minute winter	70	1.007	71	321.7	2.030	1.935	4.7416	
15 minute winter	71	1.008	72	401.0	2.531	1.973	1.3926	
240 minute winter	72	1.009	73	157.7	0.442	0.768	10.8207	
240 minute winter	73	1.010	74	157.5	1.428	0.787	0.3933	
240 minute winter	74	Hydro-Brake®	75	18.6				468.0

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
80	0.055	5.00	61.982	1200	463744.212	311268.990	1.500
81	0.128	5.00	62.273	1500	463724.845	311275.252	1.876
82	0.068	5.00	62.789	1200	463690.385	311286.395	2.543
83	0.021	5.00	61.899	1200	463682.264	311261.254	1.763
84	0.100	5.00	61.445	1500	463679.246	311248.719	1.500
85	0.030	5.00	60.872	1200	463679.983	311232.395	1.300
86	0.054	5.00	60.474	1500	463684.618	311219.579	1.375
87	0.112	5.00	59.700	1500	463666.646	311210.958	1.280
88	0.037	5.00	62.190	1200	463648.907	311299.941	1.425
89	0.043	5.00	62.180	1200	463634.048	311313.842	1.350
90	0.079	5.00	62.046	1200	463631.497	311306.027	1.425
91	0.041	5.00	61.631	1200	463623.835	311282.326	1.500
92	0.074	5.00	61.400	1500	463614.341	311254.744	1.500
93			61.150	1500	463609.800	311232.383	1.500
94			59.700	1500	463609.093	311223.495	1.250
95			59.700	1500	463630.854	311201.134	1.300
96			59.700	3000	463630.508	311196.736	1.480
97			59.000	1500	463630.751	311193.303	0.800

Simulation Settings

Rainfall Methodology	FSR	Skip Steady State	x
FSR Region	England and Wales	Drain Down Time (mins)	240
M5-60 (mm)	20.000	Additional Storage (m³/ha)	20.0
Ratio-R	0.400	Check Discharge Rate(s)	✓
Summer CV	0.750	Check Discharge Volume	✓
Winter CV	0.840	100 year 360 minute (m³)	
Analysis Speed	Normal		

Storm Durations

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

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
2	0	0	0
30	0	0	0
100	40	0	0

Pre-development Discharge Rate

Site Makeup	Greenfield	Growth Factor 30 year	1.95
Greenfield Method	IH124	Growth Factor 100 year	2.48
Positively Drained Area (ha)		Betterment (%)	0
SAAR (mm)		QBar	
Soil Index	1	Q 1 year (l/s)	
SPR	0.10	Q 30 year (l/s)	
Region	1	Q 100 year (l/s)	
Growth Factor 1 year	0.85		

Pre-development Discharge Volume

Site Makeup	Greenfield	Return Period (years)	100
Greenfield Method	FSR/FEH	Climate Change (%)	0
Positively Drained Area (ha)		Storm Duration (mins)	360
Soil Index	1	Betterment (%)	0
SPR	0.10	PR	
CWI		Runoff Volume (m³)	

Node 97 Surcharged Outfall

Overrides Design Area	x	Depression Storage Area (m²)	0	Evapo-transpiration (mm/day)	0
Overrides Design Additional Inflow	x	Depression Storage Depth (mm)	0		

Applies to All storms

Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)
0	-0.100	150	0.251	300	0.313	450	0.345	600	0.471	750	0.453
15	0.197	165	0.255	315	0.319	465	0.365	615	0.473	765	0.448
30	0.187	180	0.258	330	0.324	480	0.392	630	0.474	780	0.442
45	0.191	195	0.264	345	0.329	495	0.412	645	0.474	795	0.433
60	0.218	210	0.271	360	0.335	510	0.427	660	0.473	810	0.426
75	0.217	225	0.272	375	0.344	525	0.440	675	0.471	825	0.418
90	0.217	240	0.279	390	0.347	540	0.449	690	0.469	840	0.411
105	0.227	255	0.285	405	0.348	555	0.457	705	0.466		
120	0.232	270	0.294	420	0.348	570	0.463	720	0.462		
135	0.246	285	0.306	435	0.348	585	0.468	735	0.458		

Node 96 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	58.220	Product Number	CTL-SHE-0101-5000-1300-5000
Design Depth (m)	1.300	Min Outlet Diameter (m)	0.150
Design Flow (l/s)	5.0	Min Node Diameter (mm)	1200

Node 96 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	58.400
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	220.0	0.0	1.300	788.0	0.0

Results for 2 year Critical Storm Duration. Lowest mass balance: 99.64%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	80	10	60.556	0.074	10.0	0.1385	0.0000	OK
15 minute winter	81	10	60.541	0.144	33.1	0.4498	0.0000	OK
15 minute winter	82	11	60.420	0.174	44.4	0.2904	0.0000	OK
15 minute winter	83	11	60.273	0.136	48.2	0.1869	0.0000	OK
15 minute winter	84	11	60.086	0.141	65.4	0.4372	0.0000	OK
15 minute winter	85	11	59.713	0.141	70.6	0.2243	0.0000	OK
15 minute winter	86	11	59.216	0.117	79.8	0.2981	0.0000	OK
1440 minute winter	87	930	58.810	0.390	5.2	1.3715	0.0000	OK
15 minute winter	88	10	60.822	0.057	6.7	0.0945	0.0000	OK
15 minute winter	89	10	60.895	0.065	7.8	0.1144	0.0000	OK
15 minute winter	90	10	60.727	0.106	28.7	0.2380	0.0000	OK
15 minute winter	91	10	60.260	0.129	35.5	0.2162	0.0000	OK
15 minute winter	92	11	60.052	0.152	48.5	0.4196	0.0000	OK
15 minute winter	93	11	59.719	0.069	48.7	0.1224	0.0000	OK
1440 minute winter	94	930	58.810	0.360	2.5	0.6360	0.0000	OK
1440 minute winter	95	930	58.810	0.410	14.9	0.7244	0.0000	SURCHARGED
1440 minute winter	96	930	58.810	0.590	12.7	131.1547	0.0000	SURCHARGED
480 minute summer	97	632	58.674	0.474	4.7	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	80	1.000	81	9.8	0.425	0.137	0.4769	
15 minute winter	81	1.001	82	32.4	0.857	0.454	1.3691	
15 minute winter	82	1.002	83	44.6	1.210	0.624	0.9727	
15 minute winter	83	1.003	84	48.2	1.520	0.356	0.4107	
15 minute winter	84	1.004	85	65.5	2.015	0.389	0.5310	
15 minute winter	85	1.005	86	70.5	2.340	0.370	0.4108	
15 minute winter	86	1.006	87	79.8	1.378	0.215	1.1492	
1440 minute winter	87	1.007	95	5.0	0.187	0.023	8.1715	
15 minute winter	88	2.000	90	6.6	0.507	0.144	0.2432	
15 minute winter	89	3.000	90	7.7	1.112	0.339	0.0570	
15 minute winter	90	2.001	91	28.0	1.582	0.417	0.4434	
15 minute winter	91	2.002	92	35.4	1.096	0.359	0.9435	
15 minute winter	92	2.003	93	48.7	2.060	0.418	0.5499	
15 minute winter	93	2.004	94	48.7	1.795	0.119	0.2661	
1440 minute winter	94	2.005	95	3.1	0.193	0.008	6.5563	
1440 minute winter	95	1.008	96	12.7	0.461	0.031	0.4866	
1440 minute winter	96	Hydro-Brake®	97	4.7				189.6

Results for 30 year Critical Storm Duration. Lowest mass balance: 99.64%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	80	11	60.638	0.156	19.0	0.2910	0.0000	OK
15 minute winter	81	11	60.633	0.236	61.6	0.7377	0.0000	OK
15 minute winter	82	11	60.537	0.291	81.7	0.4850	0.0000	OK
15 minute winter	83	11	60.343	0.207	87.7	0.2837	0.0000	OK
15 minute winter	84	11	60.160	0.215	120.2	0.6670	0.0000	OK
15 minute winter	85	11	59.786	0.214	130.2	0.3414	0.0000	OK
15 minute winter	86	11	59.272	0.173	147.8	0.4415	0.0000	OK
1440 minute winter	87	1020	59.041	0.621	9.1	2.1854	0.0000	OK
15 minute winter	88	10	60.845	0.080	12.8	0.1322	0.0000	OK
15 minute winter	89	10	60.928	0.098	14.9	0.1729	0.0000	OK
15 minute winter	90	10	60.785	0.164	54.6	0.3663	0.0000	OK
15 minute winter	91	10	60.326	0.195	67.5	0.3279	0.0000	OK
15 minute winter	92	11	60.130	0.230	92.2	0.6338	0.0000	OK
15 minute winter	93	11	59.746	0.096	92.4	0.1697	0.0000	OK
1440 minute winter	94	1020	59.041	0.591	4.5	1.0449	0.0000	OK
1440 minute winter	95	1020	59.041	0.641	14.0	1.1333	0.0000	SURCHARGED
1440 minute winter	96	1020	59.041	0.821	15.0	236.8420	0.0000	SURCHARGED
480 minute summer	97	632	58.674	0.474	5.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	80	1.000	81	17.6	0.436	0.247	0.9809	
15 minute winter	81	1.001	82	59.0	0.933	0.826	2.3392	
15 minute winter	82	1.002	83	80.9	1.339	1.133	1.6083	
15 minute winter	83	1.003	84	87.7	1.699	0.647	0.6833	
15 minute winter	84	1.004	85	120.4	2.231	0.715	0.8818	
15 minute winter	85	1.005	86	130.2	2.652	0.683	0.6676	
15 minute winter	86	1.006	87	148.6	1.654	0.401	1.5939	
1440 minute winter	87	1.007	95	8.8	0.222	0.041	12.8813	
15 minute winter	88	2.000	90	12.6	0.576	0.275	0.4018	
15 minute winter	89	3.000	90	14.7	1.280	0.647	0.0944	
15 minute winter	90	2.001	91	53.3	1.815	0.792	0.7343	
15 minute winter	91	2.002	92	67.4	1.263	0.682	1.5519	
15 minute winter	92	2.003	93	92.4	2.363	0.794	0.8833	
15 minute winter	93	2.004	94	92.5	2.013	0.226	0.4005	
1440 minute winter	94	2.005	95	4.3	0.215	0.011	10.6382	
1440 minute winter	95	1.008	96	15.0	0.336	0.037	0.4866	
1440 minute winter	96	Hydro-Brake®	97	5.0				323.0

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 99.64%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	80	12	61.864	1.382	34.6	2.5767	0.0000	FLOOD RISK
15 minute winter	81	12	61.848	1.451	102.0	4.5447	0.0000	SURCHARGED
15 minute winter	82	12	61.565	1.319	127.9	2.1971	0.0000	SURCHARGED
15 minute winter	83	12	61.156	1.020	134.6	1.3958	0.0000	SURCHARGED
15 minute winter	84	12	60.877	0.932	190.0	2.8899	0.0000	SURCHARGED
15 minute winter	85	12	60.272	0.700	201.0	1.1158	0.0000	SURCHARGED
15 minute winter	86	12	59.660	0.561	231.5	1.4311	0.0000	SURCHARGED
720 minute winter	87	705	59.505	1.085	28.0	3.8161	0.0000	FLOOD RISK
15 minute winter	88	12	61.544	0.779	23.3	1.2855	0.0000	SURCHARGED
15 minute winter	89	12	61.688	0.858	27.0	1.5177	0.0000	SURCHARGED
15 minute winter	90	12	61.509	0.888	84.9	1.9902	0.0000	SURCHARGED
15 minute winter	91	11	60.750	0.619	104.0	1.0383	0.0000	SURCHARGED
15 minute winter	92	11	60.434	0.534	146.1	1.4697	0.0000	SURCHARGED
15 minute winter	93	12	59.816	0.166	144.3	0.2925	0.0000	OK
720 minute winter	94	705	59.504	1.054	13.4	1.8632	0.0000	FLOOD RISK
720 minute winter	95	690	59.506	1.106	40.8	1.9541	0.0000	FLOOD RISK
720 minute winter	96	705	59.506	1.286	40.6	519.4455	0.0000	FLOOD RISK
480 minute summer	97	632	58.674	0.474	5.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	80	1.000	81	27.7	0.455	0.387	1.4333	
15 minute winter	81	1.001	82	89.5	1.270	1.252	2.5504	
15 minute winter	82	1.002	83	122.4	1.738	1.713	1.8605	
15 minute winter	83	1.003	84	131.7	1.871	0.973	0.9079	
15 minute winter	84	1.004	85	183.2	2.602	1.088	1.1507	
15 minute winter	85	1.005	86	199.5	2.833	1.047	0.9597	
15 minute winter	86	1.006	87	215.7	2.041	0.582	2.1986	
720 minute winter	87	1.007	95	27.6	0.352	0.129	13.2496	
15 minute winter	88	2.000	90	20.2	0.603	0.440	0.7335	
15 minute winter	89	3.000	90	22.8	1.298	1.005	0.1447	
15 minute winter	90	2.001	91	82.6	2.078	1.229	0.9907	
15 minute winter	91	2.002	92	104.5	1.484	1.058	2.0541	
15 minute winter	92	2.003	93	144.3	2.392	1.240	1.2581	
15 minute winter	93	2.004	94	144.3	2.318	0.352	0.4916	
720 minute winter	94	2.005	95	13.1	0.296	0.035	11.1384	
720 minute winter	95	1.008	96	40.6	0.659	0.100	0.4866	
720 minute winter	96	Hydro-Brake®	97	5.0				215.3

Appendix VII – Indicative Drainage Strategy Plans

1. DO NOT SCALE FROM THIS DRAWING. IF IN DOUBT CONTACT TRAVIS BAKER LIMITED.
2. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
3. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DRAWINGS RELATING TO THIS PROJECT.
4. ALL DIMENSIONS SHOULD BE CHECKED ON SITE PRIOR TO CONSTRUCTION. ANY DISCREPANCIES SHOULD BE IMMEDIATELY NOTIFIED IN WRITING TO TRAVIS BAKER LIMITED.
5. THE CONTRACTOR SHALL PRIOR TO CONSTRUCTION CHECK AND VERIFY THAT THE DETAILS SHOWN ON THIS DRAWING ARE FULLY COMPATIBLE WITH ANY AS CONSTRUCTED DIMENSIONS OR LEVELS. ANY DISCREPANCIES TO BE REPORTED IMMEDIATELY IN WRITING TO TRAVIS BAKER LIMITED.
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KEY

- SITE BOUNDARY
- ADOPTABLE SURFACE WATER SEWER
- ADOPTABLE SURFACE WATER SEWER BYPASS PIPE
- ADOPTABLE FOUL WATER SEWER
- ATTENUATION BASIN
  TOB - Top of bank
  BED - Bed level
- EXISTING WATERCOURSE
- PROPOSED WATERCOURSE
- +59.05 INDICATIVE FINISHED GROUND LEVELS
- EXCEEDANCE ROUTE DIRECTION OF FLOW
- GROUND REPROFILING TO EXISTING BOUNDARY LEVELS OR FLOOD COMPENSATION LVL

NETWORK 1
BASIN 1
TOB - 60.45m
BED - 59.15m
RESTRICTED DISCHARGE - 5l/s
STORAGE - 290m³

NETWORK 2
BASIN 2
TOB - 59.60m
BED - 58.30m
RESTRICTED DISCHARGE - 8l/s
STORAGE - 585m³

NETWORK 4
BASIN 4
TOB - 59.55m
BED - 58.25m
RESTRICTED DISCHARGE - 18.6l/s
STORAGE - 1276m³

NETWORK 5
BASIN 5
TOB - 59.60m
BED - 58.30m
RESTRICTED DISCHARGE - 5l/s
STORAGE - 375m³

Total restricted discharge for site
36.6l/s
Total storage requirement for site
2782m³ based on 50% impermeable area with 10% urban creep

GREENFIELD RUN-OFF CALCULATIONS DETAILED WITHIN TRAVIS BAKER FRA 18014

SUBJECT TO DETAILED DESIGN

REV	DESCRIPTION	DATE	BY	AUTH
H	450mm culvert annotated	05.07.22	TW	TW
G	Updated to suit JBA Hydraulic Modelling outcomes	30.09.21	TW	TW
F	Additional run-off from north eastern added and flow control maintains existing flows leaving the site.	30.10.18	JG	JG
E	Exceedance routes added	21.08.18	JG	JG
D	Minor amendments to support final FRA report.	27.06.18	JG	JG
C	FW strategy revised to outfall into STW MH 6000	21.05.18	JG	JG
B	Updated to new layout	14.05.18	JG	JG
A	Minor revisions	27.04.18	JG	JG

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Flood Risk and Drainage
Geo-Environmental
Civil and Structural Engineering

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www.travisbaker.co.uk

CLIENT
TAYLOR WIMPEY (UK) LTD

PROJECT
BARKBY ROAD, SYSTON

TITLE
INDICATIVE LEVELS AND DRAINAGE STRATEGY SH 1 OF 2

DRAWN	AUTHORISED	SCALE	DATE
JG	TW	1:500@A1	28.03.18

PROJECT NO.	DRAWING NO.	REV
18014	001	H

STATUS.
PRELIMINARY

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- ATTENUATION BASIN – **TOB** - Top of bank; **BED** - Bed level
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RESTRICTED DISCHARGE - 5l/s
STORAGE - 290m³

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BASIN 2
TOB - 59.60m
BED - 58.30m
RESTRICTED DISCHARGE - 8l/s
STORAGE - 585m³

NETWORK 4
BASIN 4
TOB - 59.55m
BED - 58.25m
RESTRICTED DISCHARGE - 18.6l/s
STORAGE - 1276m³

NETWORK 5
BASIN 5
TOB - 59.60m
BED - 58.30m
RESTRICTED DISCHARGE - 5l/s
STORAGE - 375m³

Total restricted discharge for site **36.6l/s**
Total storage requirement for site **2782m³** based on 50% impermeable area with 10% urban creep

GREENFIELD RUN-OFF CALCULATIONS DETAILED WITHIN TRAVIS BAKER FRA 18014

SUBJECT TO DETAILED DESIGN

REV	DESCRIPTION	DATE	BY	AUTH
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CLIENT
TAYLOR WIMPEY (UK) LTD

PROJECT
BARKBY ROAD, SYSTON

TITLE
INDICATIVE LEVELS AND DRAINAGE STRATEGY SH 2 OF 2

DRAWN	AUTHORISED	SCALE	DATE
JG	TW	1:500@A1	28.03.18

PROJECT NO.	DRAWING NO.	REV
18014	002	J

STATUS:
PRELIMINARY

Appendix VIII – JBA Hydraulic Modelling Report

JBA consulting

Land off Barkby Road, Syston
Surface Water Modelling Study

DRAFT Report

June 2022

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Revision History

Revision Ref / Date Issued	Amendments	Issued to
Rev 1.0 / February 2019	Draft for comments	Jason Gates (Travis Baker)
Rev 2.0/ September 2021	Draft for comments	Ted Wake (Travis Baker)
Rev 3.0/ June 2021	Final (post 1st model review)	Ted Wake (Travis Baker)
Rev 4.0/ July 2021	Final (post model validation)	Ted Wake (Travis Baker)

Contract

This report describes work commissioned by Ted Wake of Travis Baker Ltd, by an email dated 11th June 2021. Dularee Goonetilleke and Olivier Saillofest of JBA Consulting carried out this work.

Prepared by .... Dularee Goonetilleke BSc MSc
Assistant Analyst

and

Olivier Saillofest BEng MSc CEng MCIWEM C.WEM
Technical Director

Reviewed by .... Alice Blanchard BSc PGCert
Analyst

Purpose

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Executive Summary

Introduction

JBA Consulting was commissioned by Travis Baker to undertake a rainfall-runoff modelling study in relation to their private development site at Barkby Road, Syston. The objective of the study was also to confirm the size of the flow control structure required to achieve a status-quo on off-site discharge rates (when compared to existing/pre-development discharge rates). To achieve this, a 1D-2D ESTRY-TUFLOW hydraulic model was produced to represent flood levels, flows and extents within the site boundary and the interactions between surface water over-land flows and the unnamed watercourses and ditches crossing the site.

Approach

A 1D-2D ESTRY-TUFLOW model of the watercourse network was developed to confirm the flood risk within the site. The hydraulic model was run for the 30-year, 100-year, 100-year with (+40%) climate change and 1,000-year storm events.

The hydraulic model was tested for its sensitivity to key model parameters by running the following scenarios during the 100-year flood event:

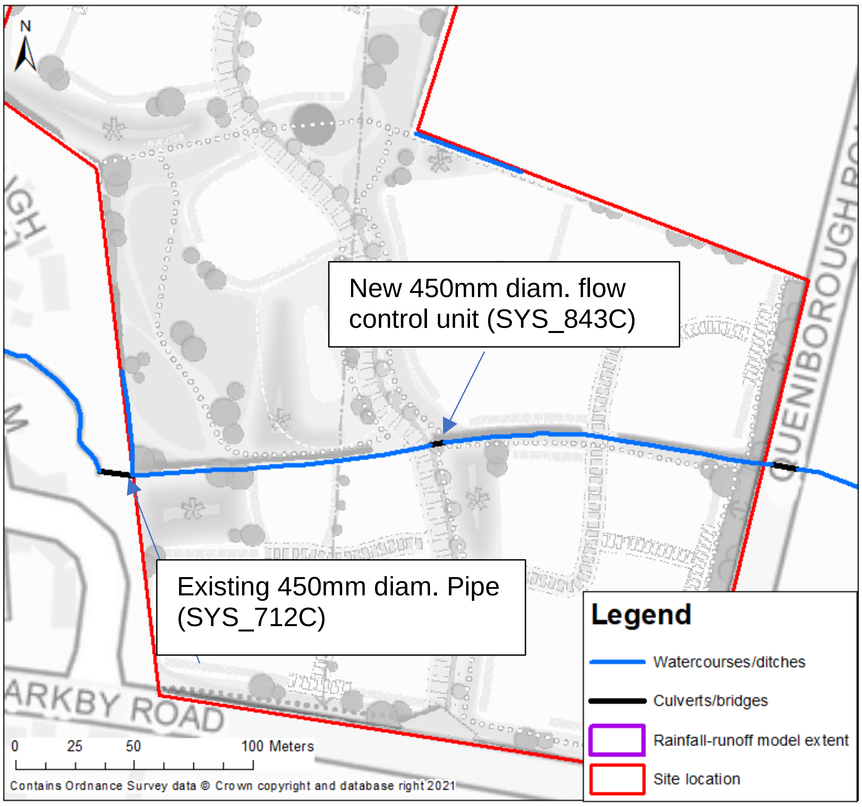
- Increasing the Manning's 'n' values by 20% in both the 1D and 2D domains
- Increasing the downstream boundary condition by 250mm
- Increasing rainfall intensity by 20%

To represent the proposed development, the following features were represented in the model:

- Landscape developable areas and raise ground levels by up to 1.9m (approximately) within the areas the most at risk of flooding.
- Introduce a new 450mm diameter orifice unit across the main watercourse crossing the site in order to attenuate the flows leaving the site.

The impact of the proposal (see Figure 0-1) was modelled for the 100-year with (+40%) climate change storm event and the effect of various flow control structures at the downstream end of the western ditch was tested.

Figure 0-1: The proposal



Results

The model results from the baseline/pre-development simulations show that:

- Model results correlate relatively well with the Environment Agency's updated Flood Maps for Surface Water and show the central part of the site being flooded.
- Model results at the site are relatively insensitive to changes in roughness values, rainfall intensity and changes in downstream boundary conditions in the channel.
- Flooding to the centre of the site occurs primarily as a result of the lack of capacity of the channel next to the 450mm diameter culvert crossing the embankment running alongside the western site boundary.

The model results from the post-development simulations show that:

- The proposal will not exacerbate flood risk across third-party land;
- A new 450mm flow control unit will be needed within the central part of the site to ensure the peak discharge leaving the site does not increase above its pre-development value;
- The 100-year with (+40%) climate change peak water level at the upstream end of the flow control unit is 60.02m AOD;
- Flood water backs up within the main watercourse channel, up to the central site flow control unit (SYS_843C) crossing approximately 131m upstream;
- To mitigate the impact of a blockage at the flow control unit, an emergency spillway will be required. It is recommended to set the crest level of the emergency spillway is set to 60.02m AOD.

Model validation

The model was reviewed by BWB in June 2022 and subsequently considered as 'fit for purpose' in July 2022.

Recommendations

As a way forward, it is recommended to:

- Consider the impact of a blockage at the new/proposed flow control structure. It is recommended that the flow control unit is not integrated as part of the proposed highway culverts in order to facilitate access for maintenance and allow the integration of an in-line emergency spillway in its design;
- Validate the proposed strategy (including results of this modelling study) with the Lead local Flood Authority before submitting a planning application;
- Refine the design of the proposal (including the location of the flow control unit) and consider the pond's drawdown regimes following the grant of outline planning permission.

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Abbreviations

1D .... One Dimensional

2D .... Two Dimensional

CC .... Climate Change

DTM .... Digital Terrain Model

EA .... Environment Agency

FEH .... Flood Estimation Handbook

FFL .... Finished Floor Levels

Ha .... Hectares

HQ .... Head-Flow

JBA .... Jeremy Benn Associates

LIDAR .... Light Detection and Ranging

M AOD .... Metres Above Ordnance Datum

QT .... Flow-Time

ReFH .... Revitalised Flood Hydrograph

TUFLOW......................... 2D Hydraulic Modelling Software

uFMfSW.......................... updated Flood Maps for Surface Water

1 Introduction

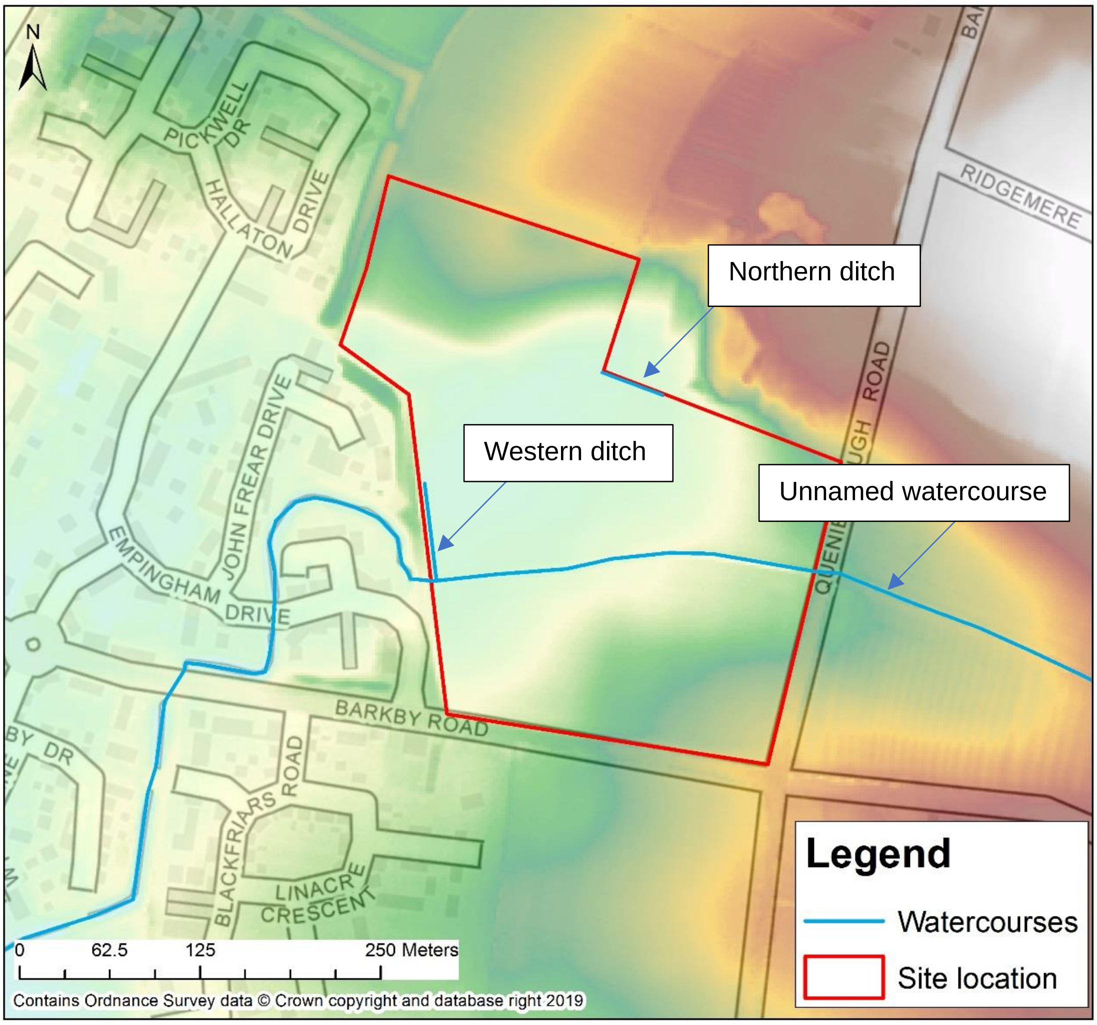
1.1 Terms of reference

JBA Consulting was commissioned by Travis Baker to undertake a rainfall-runoff modelling study in relation to their private development site at Barkby Road, Syston.

1.2 Site details

Table 1-1: Site details

Site name	Land off Barkby Road, Syston
Site area	8.3ha
Existing land-use	Greenfield site
OS NGR	463750/311150
County	Leicestershire
Country	England



1.3 Site description

The proposed development site is located at the junction between Barkby Road and Queniborough Road in Syston, Leicestershire (see Table 1-1). The site is crossed by an unnamed (ordinary) watercourse which collects water from a land drain (labelled 'western ditch' in Table 1-1) running alongside the western site boundary before flowing in a westerly direction and discharging into the

Barkby Brook, approximately 580m downstream of the site. A second land drain (labelled 'northern ditch' in Table 1-1) running alongside the northern site boundary appears to be collecting surface water runoff from adjacent land but does not seem to be connected to the rest of the site's drainage network.

The proposal for the site involves connecting the ditch running alongside the north-eastern site boundary to the one running alongside the western site boundary in order to mitigate flood risk on site. In order to prevent any additional flows leaving the site as a result of connecting these two ditches/watercourses, a flow control in the form of an orifice plate will be installed across the western ditch, immediately upstream of its junction with the unnamed watercourse.

1.4 Planning context

Outline Planning Permission has been granted for a residential scheme, subject to a number of conditions associated with the drainage scheme. Condition No. 5 requests that further hydraulic modelling of the existing watercourse is undertaken to identify the capacity within the watercourse channel.

1.5 Existing flood data

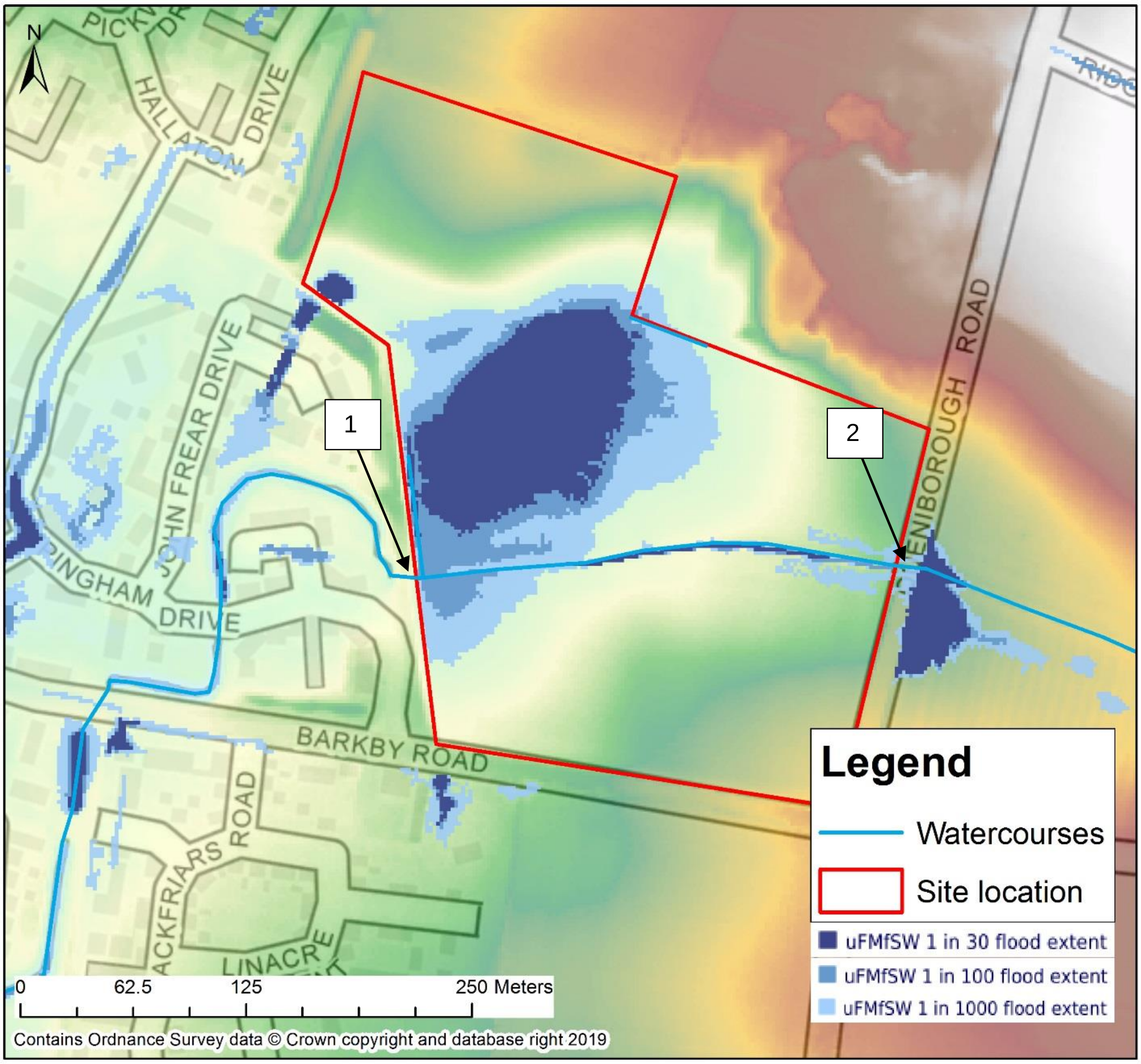
Given the catchment size, no fluvial flood data in relation to the ditch is available on the Environment Agency (EA)'s Flood Maps for Planning[1].

Flood risk from the ditch appears to be represented on the EA's Updated Flood Maps for Surface Water (uFMfSW) (See Figure 1-1) however these originate from broad-scale modelling techniques and thus approximate the representation of key hydraulic structures such as:

- the culvert crossing the embankment located alongside the site boundary (labelled 1 in Figure 1-1 below) which appears to generate a build-up of surface water on-site, and;
- the culvert crossing Queniborough Road (labelled 2 in Figure 1-1 below) which appears to be restricting the flow converging towards the site.

[1] https://flood-map-for-planning.service.gov.uk/

Figure 1-1: Updated Flood Maps for Surface Water



As a result, a detailed surface water model (also called rainfall-runoff model) is required to accurately represent the effect of these hydraulic structures on surface water flows and ultimately refine surface water flood risk to the site.

1.6 General approach

To achieve this a 1D-2D rainfall-runoff model was produced using ESTRY-TUFLOW modelling software. This study includes a hydrological analysis to derive the rainfall hyetographs corresponding to the 30-year, 100-year and 1,000-year rainfall/storm events.

The model was also run to simulate the impact of a proposed connection between the northern on-site ditch with the rest of the site's drainage network.

2 Approach

2.1 Model geometry

2.1.1 Data availability

A new 1D-2D ESTRY-TUFLOW model was developed to allow an accurate representation of flood depths and levels within the development site and across neighbouring third-party land.

A channel survey was carried out by Grantham Coates Survey Limited (GCS) in January 2019 and is provided in Appendix A. The survey consisted of cross sections along the ditch and at key hydraulic features. A total of 18 cross sections were surveyed along the ditch and the land drains running within the site boundary.

LiDAR data last flown in 2014 was obtained from the Open Data website to represent ground levels within the floodplain. The LiDAR had a grid resolution of 1m. To provide a greater level of detail within the site, topographic survey data was converted into a DTM and read into the model. The site topographic survey was carried out by the client and is provided in Appendix B.1.

The consistency of both data sets was reviewed (see Appendix B.2) and a good correlation was found between both datasets.

2.1.2 Model extent and build

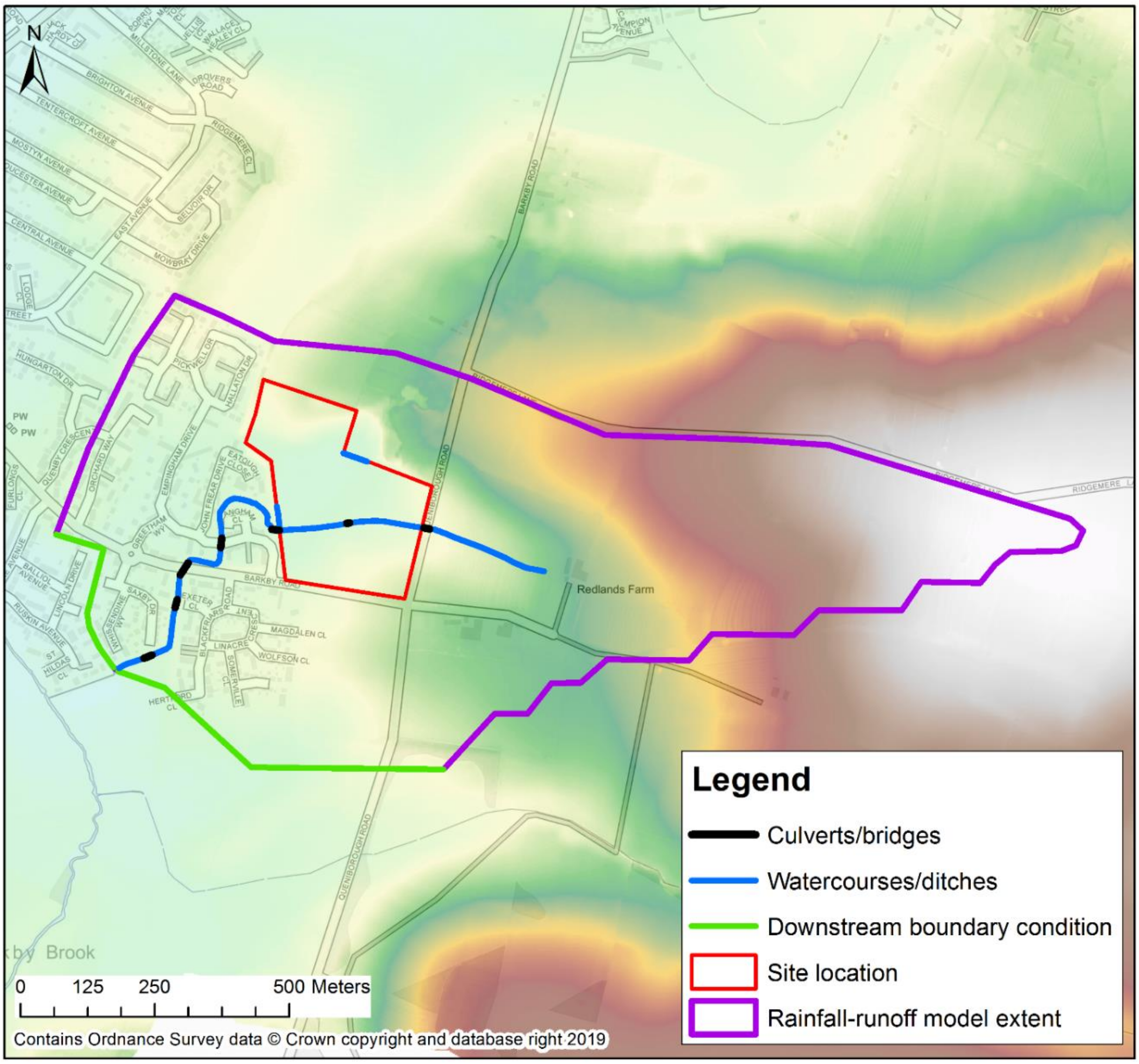
A 1D-2D ESTRY-TUFLOW model of the ditch was developed to determine the flood levels, flows and extents within the vicinity of the site. The extent of the hydraulic model for the proposed site is shown in Figure 2-1 and represents the watercourse running through the proposed development site.

The model is approximately 1km in length and includes the channels of the unnamed watercourse and ditches crossing the site. The model was run using TUFLOW version 2018-03-AA.

The channel was represented in 1D using ESTRY, constructed from channel topographic survey data collected in January 2019 by Grantham Coates Survey Limited. The cross sections were trimmed to top of bank with the 2D TUFLOW domain to represent the floodplain. Details of how the structures have been modelled are shown in Appendix D.

A 2D TUFLOW model was used to represent the floodplain. The TUFLOW 2D domain has an area of 0.39km^2 with a 2m grid resolution. The orientation of the grid is west to east, representing the main direction of the floodplain flow. The 1D and 2D models were linked along the top of banks using elevation data from the channel survey and LiDAR in between cross sections.

Figure 2-1: Hydraulic Model Extent



2.1.3 Model roughness parameters

Manning's 'n' was used to represent roughness values in the channel and floodplain. The values for the channel roughness were based on photographs gathered by Grantham Coates Survey during the site visit. The Manning's 'n' values in the 1D channel vary between 0.04 and 0.06. Much of the site was highly vegetated and therefore Manning's n values were increased to account for this. The roughness of the culverts within the 1D varied from 0.012 to 0.02. The range of Manning's 'n' values used in the 2D domain are shown in Table 2-1.

Table 2-1: Manning's values in the 2D domain

Features	Manning's 'n'
Buildings	0.300
Road and Tracks	0.015
Rail	0.025
Woodland	0.100
Inland water	0.025
General Surface	0.045

2.1.4 Building and road levels

Notwithstanding the outline nature of the planning application (i.e. building locations to be confirmed as part of reserved matters application(s)), the floor level of the existing buildings within the modelled catchment was raised by 150mm above the underlying LiDAR DTM. Existing roads within the modelled catchment were set 100mm below the underlying DTM.

Whilst such measures are commonly used to enhance the representation of surface water overland flows in urban environments, model results at the site are not affected by such measures for the following reasons:

1. The site is located immediately downstream of a rural catchment
2. The site is separated from the urban catchment by an embankment running alongside its western site boundary.

2.2 Model boundary conditions

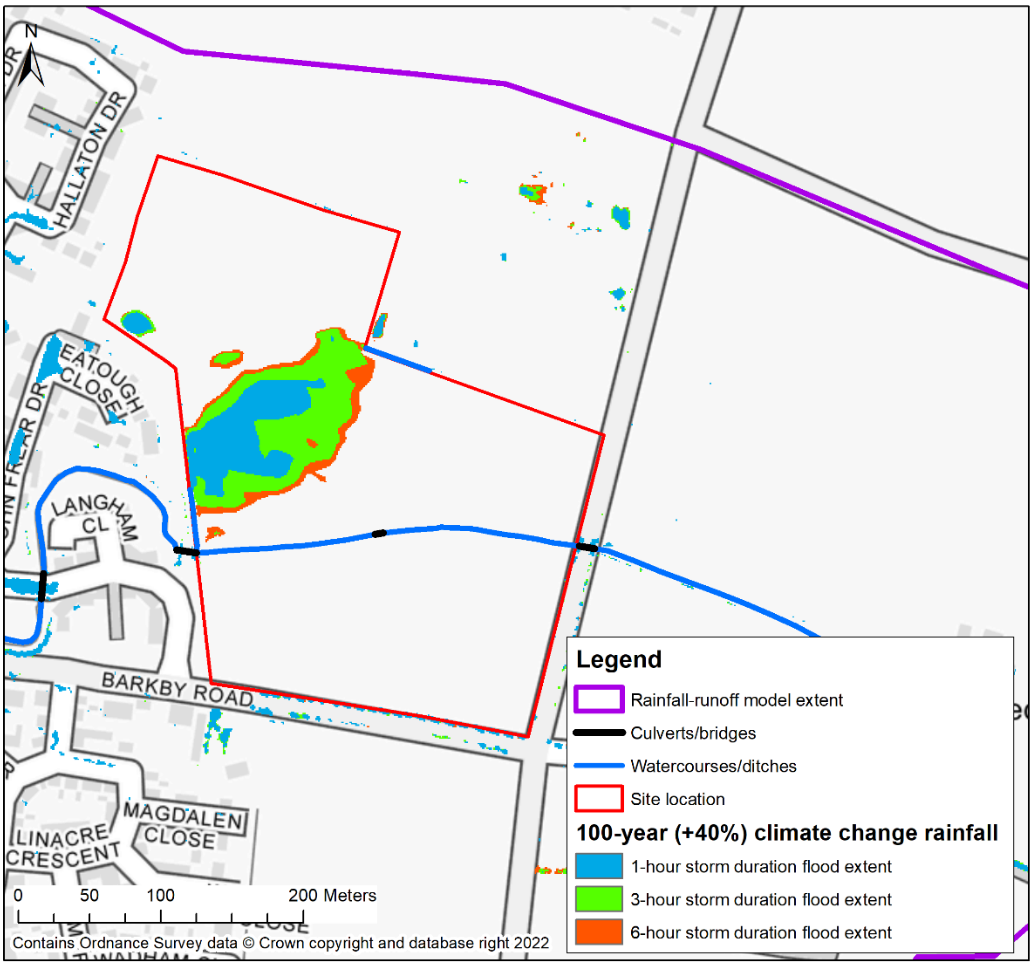
2.2.1 Model inflows

A hydrological assessment was carried out to derive hyetographs for the 30-year (3.33% AEP), 100-year (1% AEP), 100-year with climate change and 1,000-year (0.1% AEP) storm events. In line with the new Guidance on Climate Change issued by the Environment Agency in February 2016, the effect of climate change was assessed by increasing peak flows by 40%.

Rainfall was estimated for a 1 hour, 3 hour and 6-hour summer profile storm durations for each event.

A review of the initial model results indicated that the 6-hour storm duration generated the highest flood extents and depths on site.

Figure 2-2: Critical storm duration



The hydrological assessment is documented in Appendix C.

On-site surface water attenuation associated with the proposed residential scheme was conservatively not accounted for in this analysis.

2.2.2 Downstream boundary conditions

The downstream boundaries for both the 1D and 2D were calculated. 1D boundaries were derived by calculation of a stage-flow relationship using Flood Modeller (using the last two channel sections of the unnamed watercourse and a dummy flow-time hydrograph). The 2D downstream boundary was derived at the downstream end of the model extent by calculation of slope. A sensitivity run was undertaken to assess the impact of uncertainties associated with the downstream boundary condition (see Section 2.4).

2.2.3 1D-2D link

In line with recommendations from the TUFLOW Manual, the 'a' attribute of the HX link bounding parts of the floodplain with inconsistent ground levels (immediately upstream of Barkby Road, potentially due to ploughing when LiDAR data was collected) was set to 0.5 in order to improve model stabilities. Everywhere else, standard values were used.

2.3 Calibration

As no historical data is available for the unnamed watercourse, the hydraulic model is uncalibrated.

2.4 Sensitivity analysis

Model sensitivity was tested for increases in Manning's roughness, changes to the downstream boundary and rainfall intensity. The analysis of the model sensitivity runs is included in Appendix E.

Overall, Appendix E indicates that the model results at the site are relatively insensitive to changes in roughness values, rainfall intensity and changes in downstream boundary conditions in the channel.

2.5 Model runs

The baseline scenario was run using existing conditions for a series of modelled events:

- (Baseline scenario) - 30-year (3.33% AEP)
- (Baseline scenario) - 100-year (1% AEP)
- (Baseline scenario) - 100-year (1% AEP) with (+40%) climate change
- (Baseline scenario) – 1,000-year (0.1% AEP)
- (Sensitivity analysis) - 100-year (1% AEP) plus 20% increase in rainfall intensity
- (Sensitivity analysis) - 100-year (1% AEP) plus 20% increase in roughness values
- (Sensitivity analysis) - 100-year (1% AEP) plus 250mm increase in downstream boundary conditions
- (Sensitivity analysis) - 100-year (1% AEP) with water level at downstream model boundary set to 57.86m AOD.

2.6 Mass balance

The cumulative mass-balance of the model reaches +10.5% during the 100-year with (+40%). Such high mass balance values are expected within step catchments (note: ground levels within the modelled catchment drop by up to 36m over a distance of 1.8km) and where significant flood water ponding occurs (e.g. one site and upstream of Queniborough Road). A review of the TUFLOW log file confirms the mass balance issue predominantly affects the 2D domain.

Attempts to reduce the cumulative mass-balance by reducing the model timestep or by applying depth varying roughness over agricultural land were made but without success.

As both baseline and post-development simulations are similarly affected, it is considered that such issue does not affect the outcome of the flood risk impact analysis and that outstanding concerns can be addressed via the use of freeboard allowances in the design of the proposed dwellings.

2.7 Model validation

Following planning submission, the Lead Local Flood Authority that a peer-review of the hydraulic model is carried out with a third-party flood risk consultant. This review took place in June 2022. As part of his review, the consultant raised a number of comments leading to further alterations to the model. These are summarised in Appendix G.

A follow up review was carried out by BWB (see Appendix H) and the model was subsequently considered as 'fit for purpose' in July 2022.

3 Hydraulic modelling results

3.1 Baseline scenario

3.1.1 Flood Extents

Figure 3-1 shows the baseline flood extents for the 30-year, 100-year, 100-year with (+40%) climate change and the 1,000-year storm events. For graphical reasons, areas with flood depths lower than 25mm were filtered out.

Figure 3-1: Baseline Flood Extents

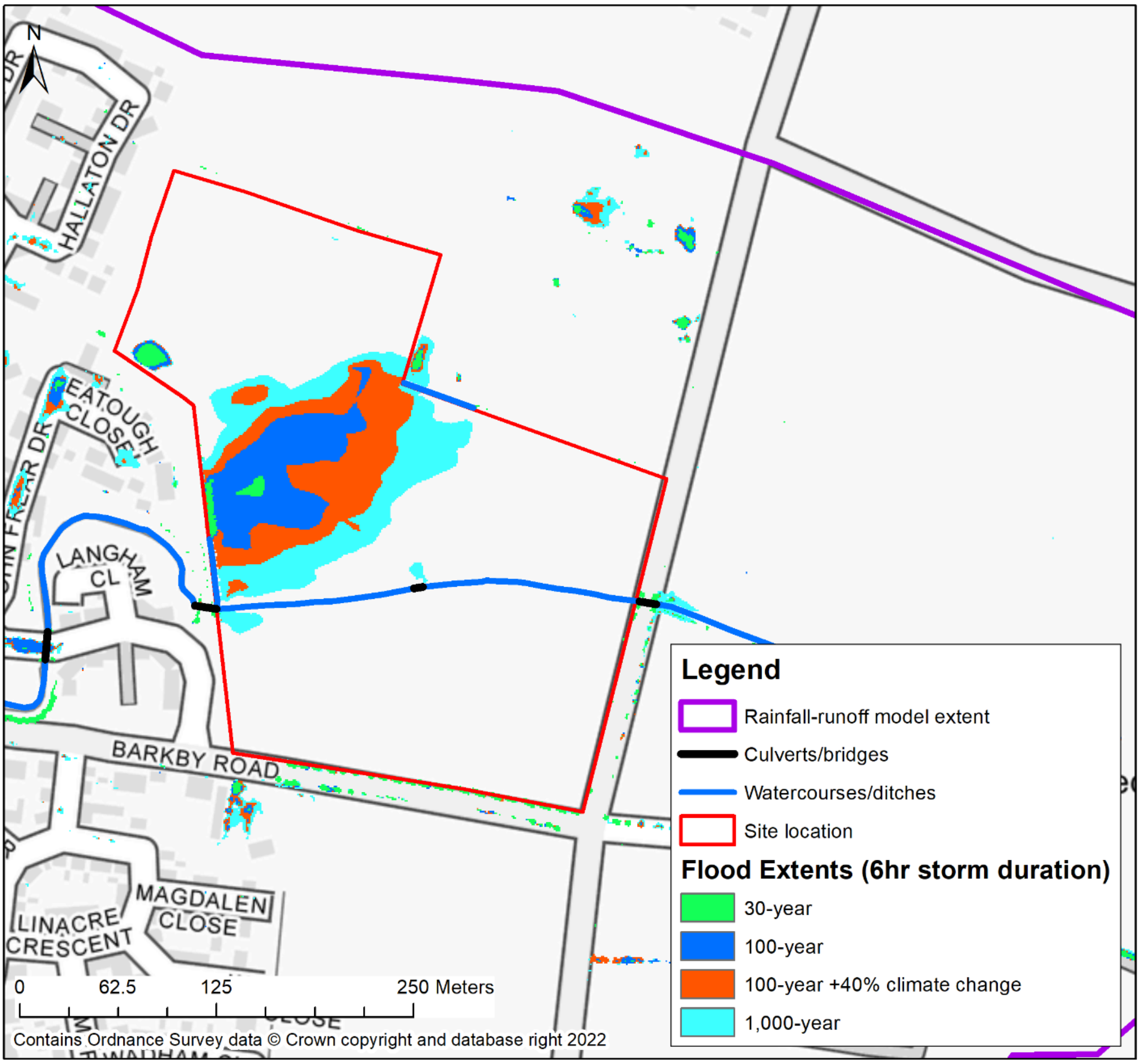


Figure 3-1 shows that:

- Model results correlate relatively well with the EA's uFMfSWF (see Figure 1-1) and show the central part of the site to be at high risk of surface water flooding;
- Flood water appears to be ponding immediately upstream of the 450mm culvert crossing the embankment running alongside the western site boundary;

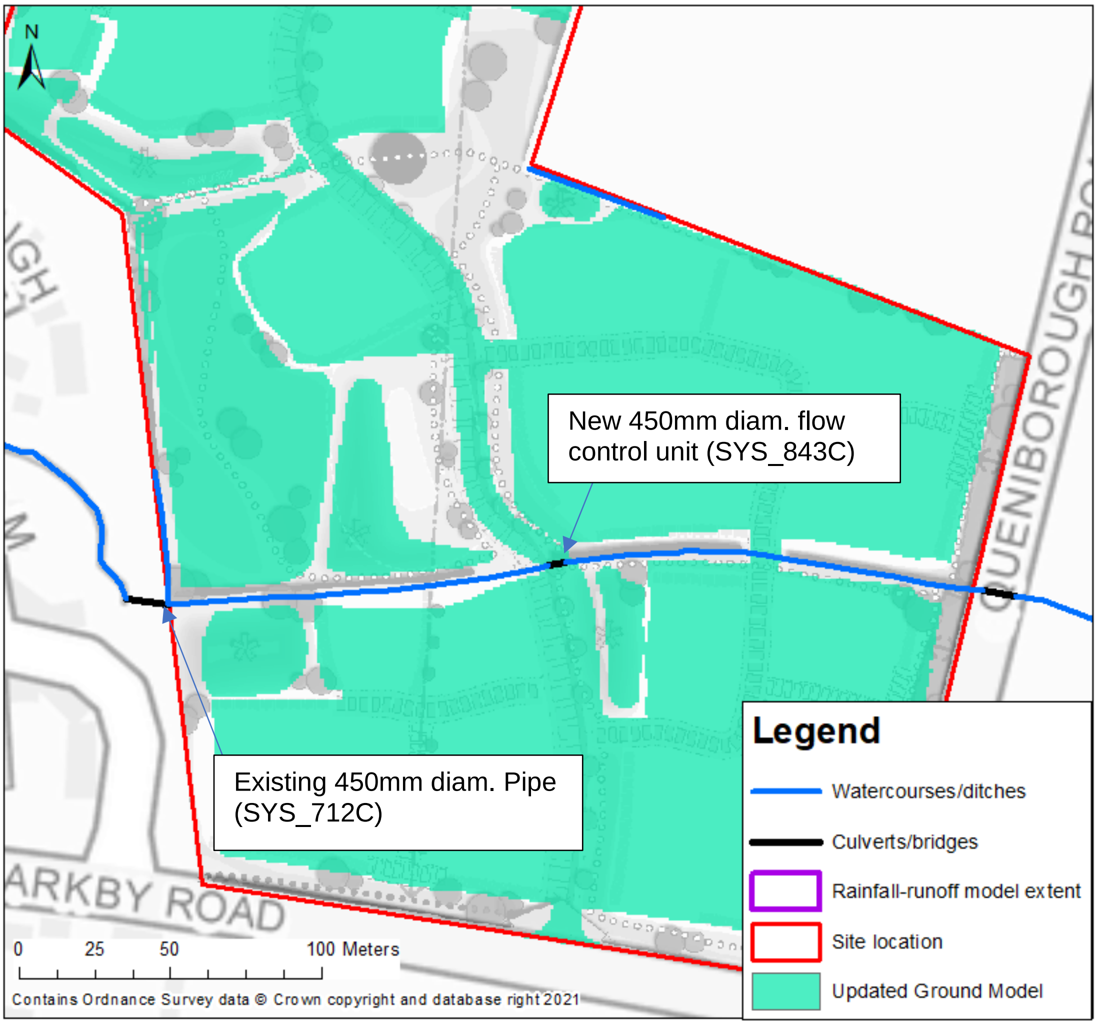
3.2 Post development scenario

3.2.1 The proposal – characteristics

As part of the proposed commercial scheme, it is considered to:

- Landscape developable areas and raise ground levels by up to 1.9m (approximately) within the areas the most at risk of flooding. This will be done by addition of an updated ground model across the site.
- Replace the central culvert (SYS_843C) across the main watercourse by a new 450mm diameter flow control unit. Given the outline nature of the planning application, a simplified representation of this flow control unit was made in the model by 'merging' it with the highway culvert crossing the spine road. Following the grant of outline planning permission, it is recommended to 'sperate' the flow control unit from the highway culvert and reallocate it a short distance upstream. This will ensure a) that the highway culvert is designed with sufficient clearance / freeboard and b) that flood water is allowed to overtop / bypass the flow control unit and return in the channel in the event of a blockage. Final details of the flow control unit will be confirmed as part of the detailed design stage / reserved matter application.

Figure 3-2: The proposal



3.2.2 Flood extent

The 100-year with (+40%) climate change post-development flood extent is shown in Figure 3-33.

Figure 3-3: 100-year with (+40%) climate change post-development flood extent

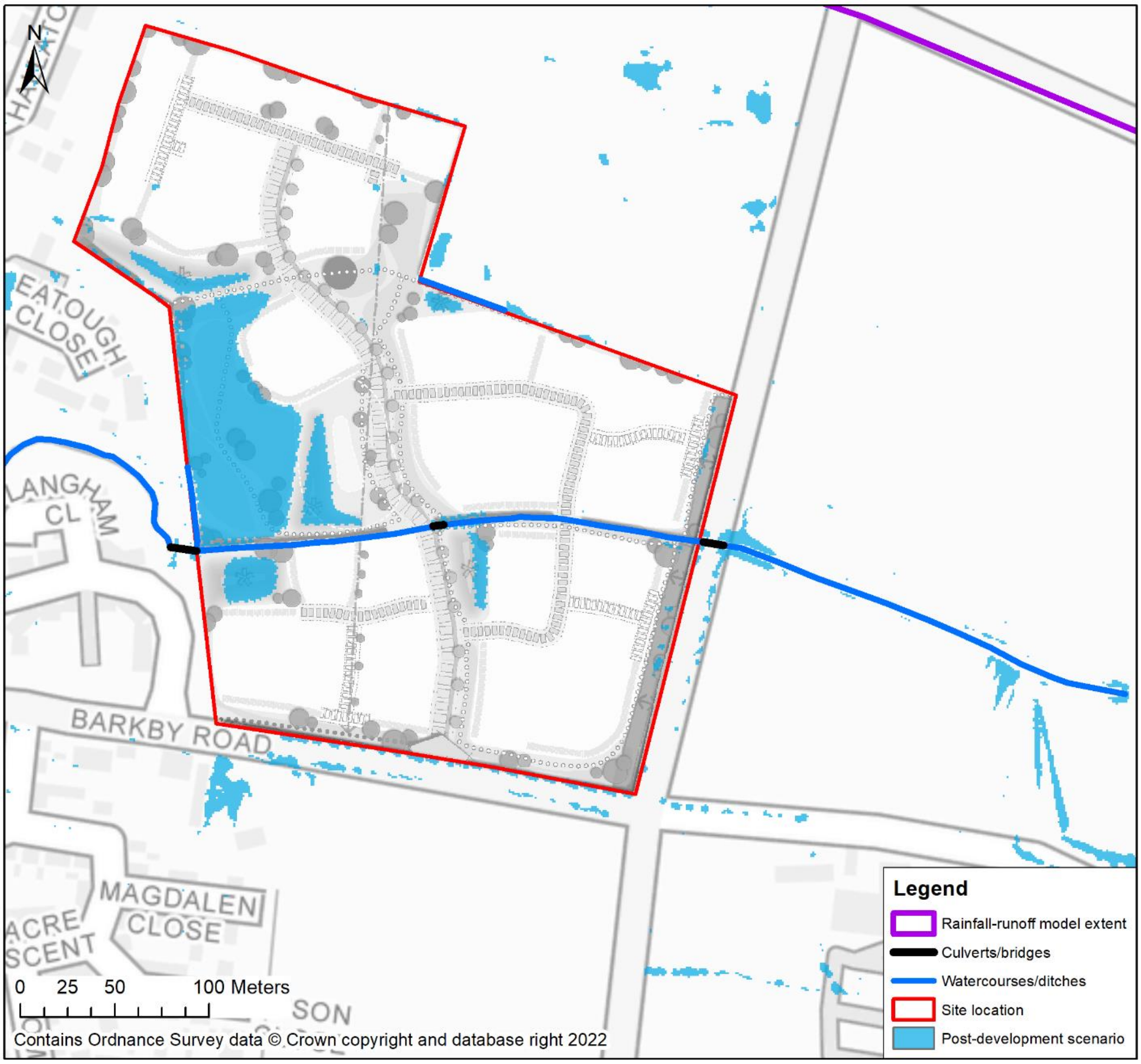


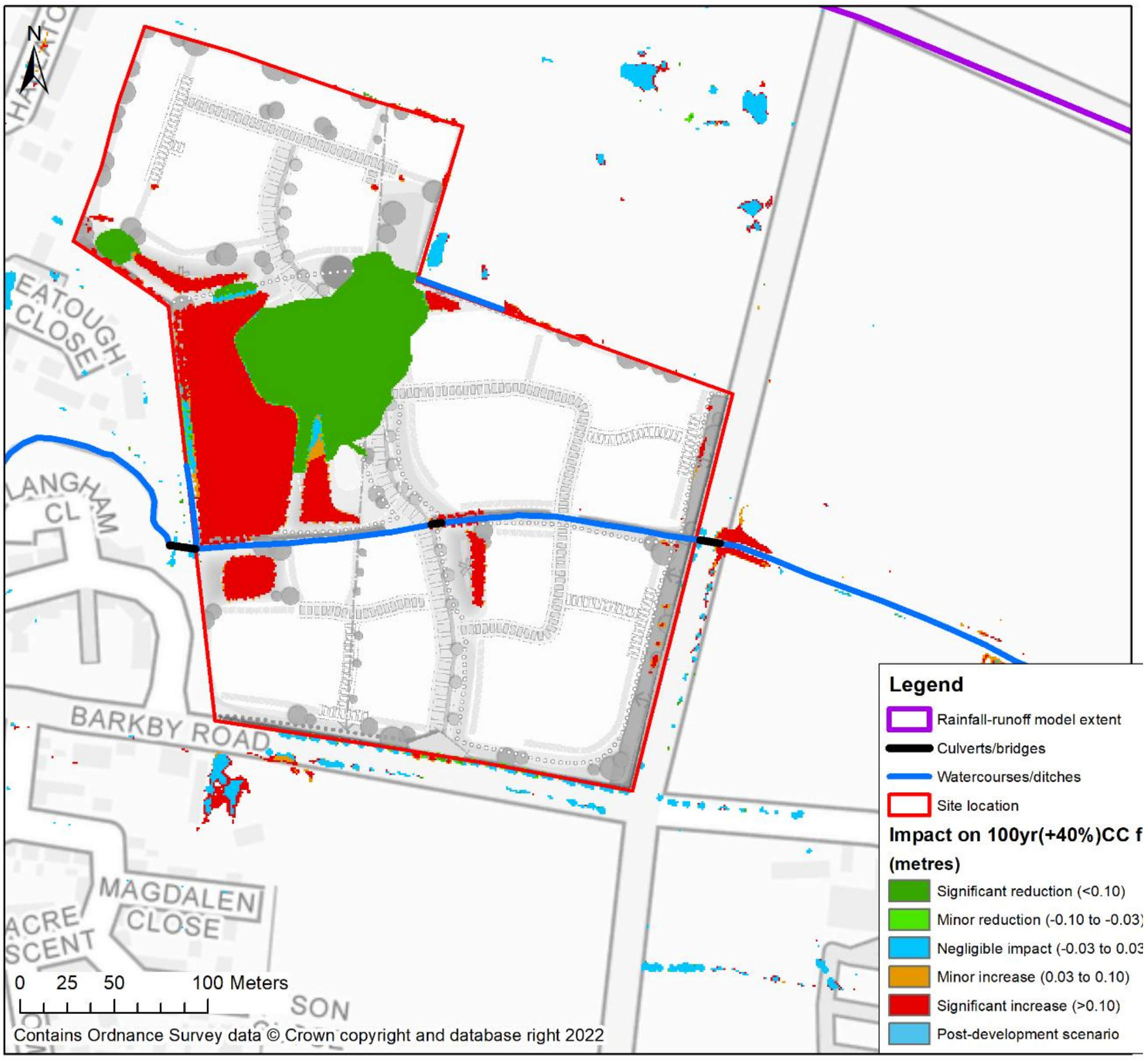
Figure 3-33 shows:

- The proposal will reduce surface water flood risk both within and outside the development site boundary.
- Greatest surface water extents are within the western portion of the site, along the western ditch.

3.2.3 Flood risk impact

The impact of the proposal on flood depths was assessed by subtracting the flood depth grids generated from the post-development scenario from the pre-development scenario for the 100-year plus climate change (40%) storm event (see Figure 3-44).

Figure 3-4: Impact on 100-year with (+40%) climate change flood depths



Notwithstanding the area between Magdalen Close and Barkby Road where residual instabilities in the model can be observed (i.e. this area is outside of the surface water conveyance routes crossing the site and thus cannot be affected by changes in the site topography), Figure 3-4 shows that the proposal will not increase flood depths across third-party land. Therefore, effective flood level compensation has been achieved with minimal floodwater displacement outside of the site.

3.2.4 Impact on flows

The peak discharge leaving the site (i.e. at node SYS_712C) for the 100-year with (+40%) climate change pre- and post-development scenarios is shown in Figure 3-5.

Figure 3-5: Discharge at node SYS_712C

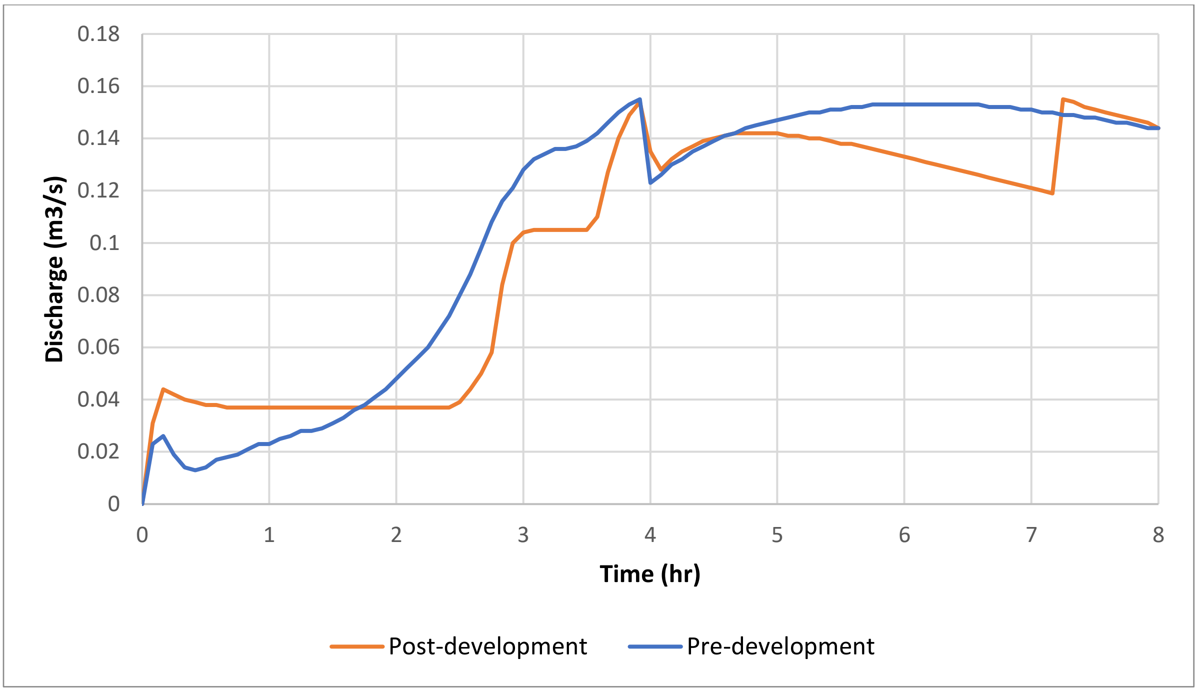


Figure 3-5 indicates that:

- The proposal does not increase the peak flows leaving the site
- Post-development volumes are lower than pre-development volumes for the duration of the simulation (i.e. 8hr).

3.2.5 Peak flood depths

The modelled peak flood depths for the 100-year with (40%) post-development scenario are represented in Figure 3-6.

Figure 3-6: Modelled flood depths for the 100-year with (+40%) climate change scenario

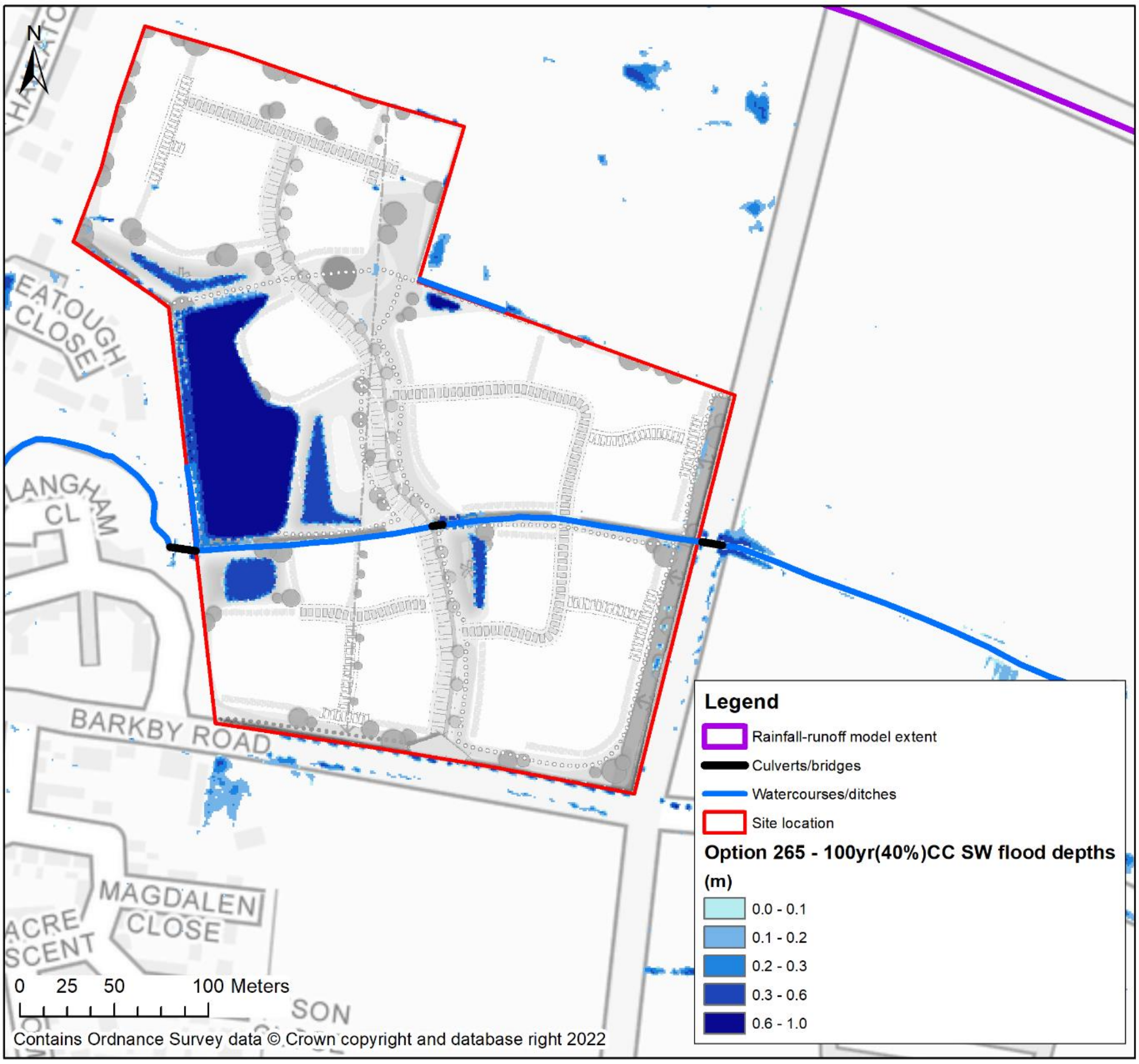
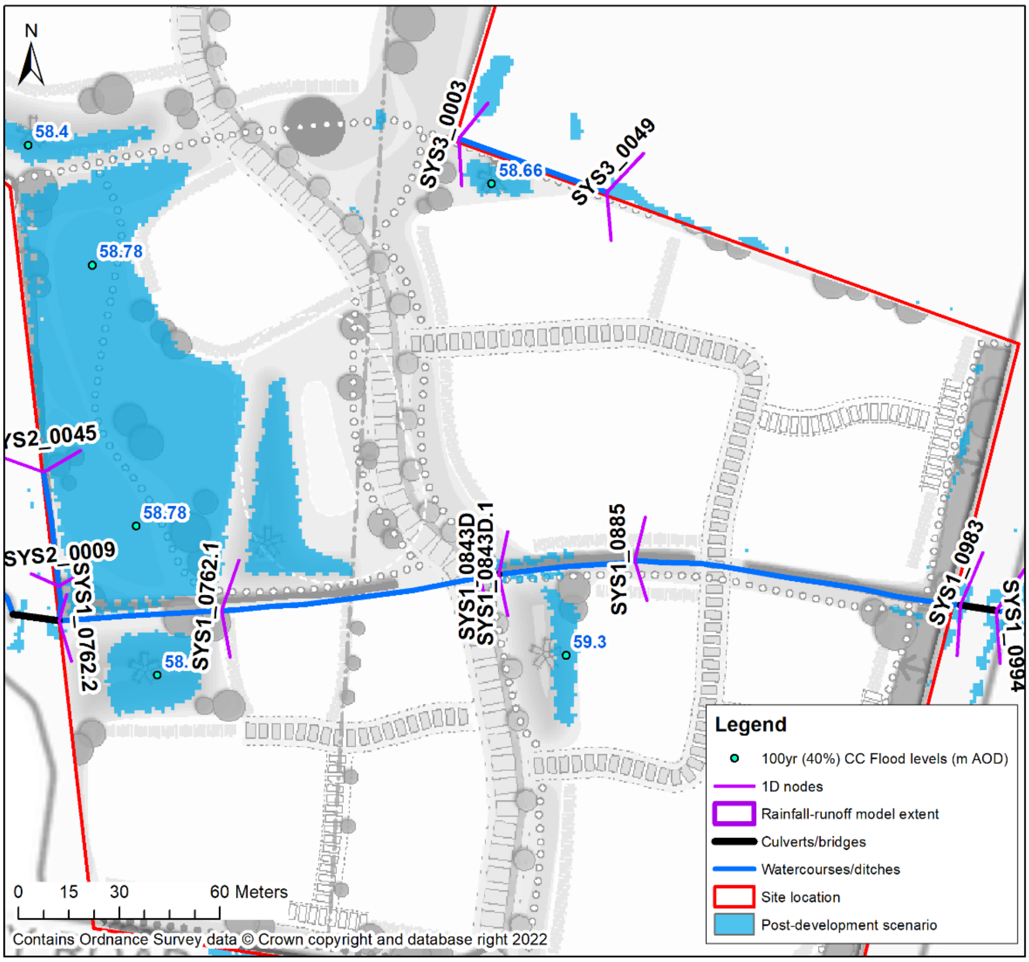


Figure 3-6 shows that the most significant flood depths are observed along the western pond within the site, which interacts with the unnamed watercourse during the 100-year with (+40%) climate change simulation. These are within the range 0.3-0.6m. There are minimal flood depths outside of the site boundary across third-party land.

3.2.6 Peak water levels

Table 3-1 shows the modelled water levels within the site boundary during the 100-year with (+40%) climate change post-development scenario.

Table 3-1: Modelled flood levels for the 100-year with (+40%) climate change post-development scenario



Node location (north-eastern watercourse)	Peak water level (m AOD)	Node location (unnamed watercourse)	Peak water level (m AOD)
SYS3_0003	58.77	SYS1_0994 (Quenilborough Road culvert, upstream face)	61.82
SYS3_0049	58.77	SYS1_0983 (Quenilborough Road culvert, downstream face)	61.25
		SYS1_0885	60.04
		SYS1_0843 (central site flow control unit, upstream face)	60.02
		SYS1_0843D (central site flow control unit, downstream face)	59.36
		SYS1_0762	58.97
		SYS1_0712 (upstream face of culvert crossing embankment alongside western site boundary)	58.78
		SYS1_0712D (downstream face of culvert crossing embankment alongside western site boundary)	58.34

Table 3-1 shows that, during the 100-year with (+40%) climate change storm event

- Flood water backs up in the main watercourse channel, up to the central site flow control unit crossing approximately 131m upstream;
- Flood water will build up to a level of 60.02m AOD at the upstream face of the flow control unit. It is recommended to set emergency spillway with a crest level set at this elevation in order to minimise flood risk in the event of a blockage of the flow control unit.

4 Conclusion and Recommendations

4.1 Conclusion

- JBA Consulting was commissioned by Travis Baker to undertake a rainfall-runoff modelling study in relation to their private development site at Barkby Road, Syston.
- A 1D-2D ESTRY-TUFLOW hydraulic model was produced to allow accurate representation of flood depths, extents and flows within the site boundary and the interactions between surface water over-land flows and the unnamed watercourses and ditches crossing the site. The watercourse flows along the north-eastern and north-western boundaries of the site.
- A channel survey was completed, consisting of cross sections at regular intervals along the watercourse and at key hydraulic structures. Ground levels within the floodplain of the hydraulic model were represented using LiDAR and site-specific topographic survey data.
- The hydraulic model was run for the 30-year, 100-year, 100-year plus 40% climate change and 1,000-year storm events.
- The hydraulic model was also tested for its sensitivity to changes in Manning's roughness, downstream boundary and increase in rainfall intensity. The model results at the site are relatively insensitive to changes in roughness values, rainfall intensity and downstream boundary conditions in the channel.
- The model results from the baseline/pre-development simulations show that:
  - Model results correlate relatively well with the Environment Agency's updated Flood Maps for Surface Water and show the central part of the site being flooded.
  - Flooding to the centre of the site occurs primarily as a result of the lack of capacity of the 450mm diameter culvert crossing the embankment running alongside the western site boundary.
- The model results from the post-development simulations show that:
  - The proposal, which involves the raising of ground levels by up to 1.9m, will not exacerbate flood risk across third-party land;
  - A 450mm flow control unit in the central part of the site will be needed to ensure the peak discharge leaving the site does not increase above its pre-development value;
  - The 100-year with (+40%) climate change peak water level at the upstream end of the flow control unit is 60.02m AOD;
  - To mitigate the impact of a blockage at the flow control unit, an emergency spillway will be required. It is recommended to set the crest level of the emergency spillway is set to 60.02m AOD.

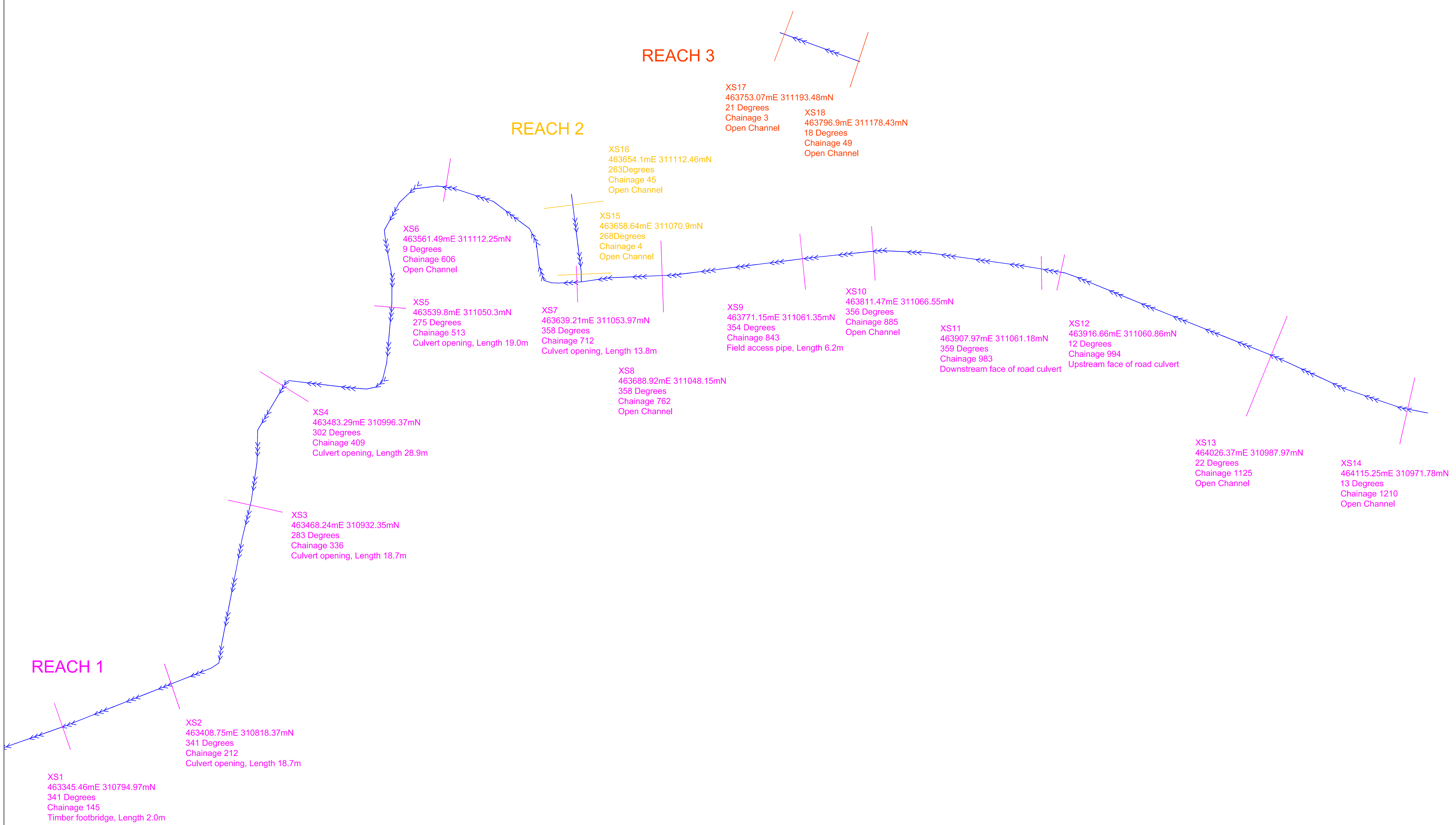
4.2 Recommendations

As a way forward, it is recommended to:

- Consider the impact of a blockage at the new/proposed flow control structure. It is recommended that the flow control unit is not integrated as part of the proposed highway culverts in order to facilitate access for maintenance and allow the integration of an in-line emergency spillway in its design;
- Validate the proposed strategy (including results of this modelling study) with the Lead local Flood Authority before submitting a planning application;
- Refine the design of the proposal (including the location of the flow control unit) and consider the pond's drawdown regimes following the grant of outline planning permission.

Appendices

A Appendix A - Channel Survey



Notes

This survey should only be relied upon for its original purpose. Grantham Coates Surveys Limited accepts no responsibility for use of this plan outside of the original remit, or by use of any party other than the original client.

Whilst every effort has been made to identify all above ground details, it should be noted that some items may have been obscured at time of survey.

Below ground drainage information as been visually inspected from the surface and should therefore be treated as approximate only.

Where this survey has been carried out for the purpose of enabling trackside drainage design. The position of any running rail has been surveyed in line with a general topographic survey and should not be used for the purpose of track design.

All dimensions to be checked on site prior to design and construction.

Legend

AIR VALVE	AV	WATER TAP	TAP
BOLLARD	BD	TEMPORARY BENCH MARK	TBM
BORE HOLE	BHL	TELEPHONE CALL BOX	TCB
BUS STOP	BS	TELEPHONE POST	TEL
BT INSPECTION COVER	BT	THRESHOLD LEVEL	THL
BT BOX	BTB	TRAFFIC LIGHT	TL
CABLE TV INSPECTION COVER	CTV	TOP OF WALL	TOW
COVER LEVEL	CL	TELEGRAPH POLE	TP
DOWN PIPE	DP	UNABLE TO LIFT	UTL
DROPPED KERB	DK	VENT PIPE	VP
ELECTRICITY CONTROL BOX	ECB	RAIL WELD	WE
EAVES HEIGHT	EH	WATER METER	WM
ELECTRICITY MANHOLE	EM	WASHOUT	WO
ELECTRICITY POLE	EP		
EARTH ROD	ER		
FINISHED FLOOR LEVEL	FFL		
FIRE HYDRANT	FH	SURVEY STATION	GCS1
FOUL WATER	FW		
GULLY	GY		
GATE POST	GP	BUSHES	BH
GAS VALVE	GV		
INSULATED BLOCK JOINT	IBJ		
INSPECTION COVER	IC	HEDGES	
INVERT LEVEL	IL		
KERB OUTLET	KO		
LAMPPOST	LP	TREES	Height Species (Spread to scale)
LITTER BIN	LB		
MARKER POST	MK		
MILE POST	MP		
POST	PO		
RODDING EYE	RE	GATE	
RIDGE HEIGHT	RH		
ROAD NAMEPLATE	RN		
ROAD SIGN	RS	SECURITY FENCE	—×—×—
STUMP	SP	FENCE	—/—/—
SOFFIT LEVEL	SF	OVERHEAD CABLES	—OH—OH—
SIGNAL POST	SIG	FOUL WATER	—FW—FW—
RAIL SLEEPER LEVEL	SLP	GAS MAIN	—GM—GM—
SIGNALS AND TELECOMS BOX	STB	U/G POWER LINE	—PL—PL—
SIGNALS AND TELECOMS CABLE	STC	STORM WATER	—SW—SW—
SIGNALS AND TELECOMS POST	STP	U/G TELEPHONE	—TEL—TEL—
SIGN POST	SN	WATER MAIN	—WM—WM—
STOP TAP	ST		
STOP VALVE	SV		
STAY	SY		
STORM WATER	SW		

Control Table

Station	Description	Eastings	Northings	Height

Grid and Datum

Grid: ***OS National Grid*** **Datum:** ***Ordnance Datum Newlyn***

Survey related to Ordnance Survey National Grid (OSGB36) via GPS and the OS Active Network.
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No scale factor has been applied to the survey

Title:

WATERCOURSE SURVEY AT BARKBY ROAD, SYSTON, LEICESTERSHIRE (Key Plan)

Client:

JBA CONSULTING
The Library
St. Philip's Courtyard
Coleshill
Warwickshire B46 3AD

Grantham Coates Surveys Ltd

Land - Engineering - Building Surveyors

2 Arden Court, Arden Road, Alcester
Warwickshire, B49 6HN

Tel: 01789 764420

E-Mail: info@gcsurveys.co.uk
Web Site: www.gcsurveys.co.uk

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Drawing No:	Rev:
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Date:	Notes:	Name:	Rev:

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SC	CC	1:1250	07/01/18

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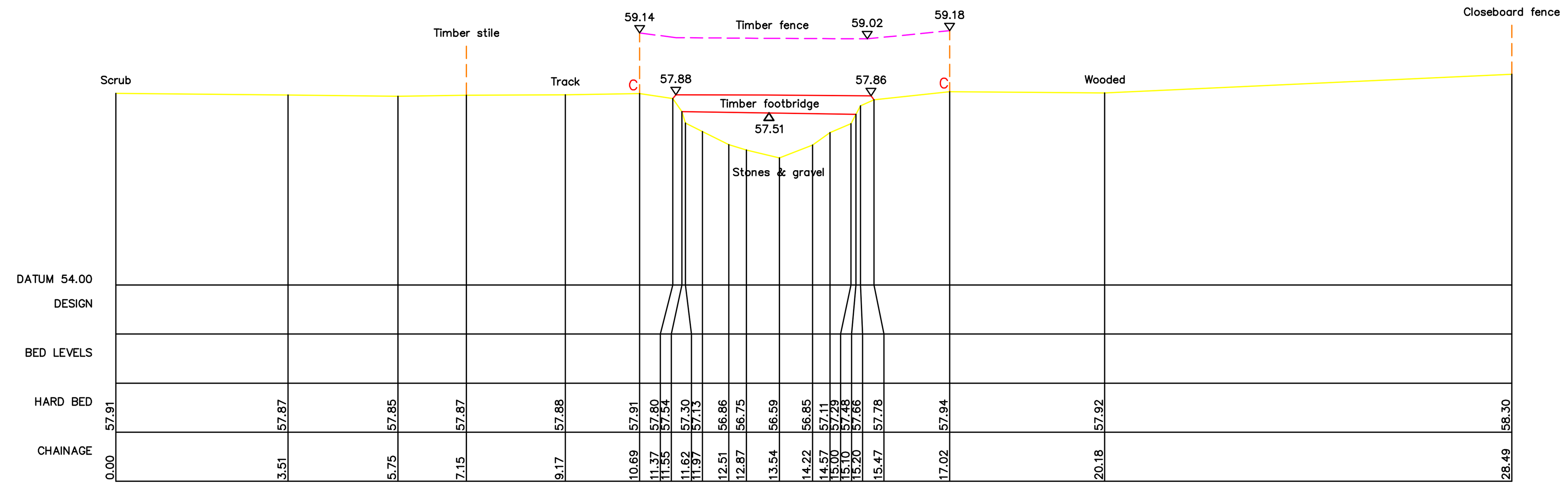
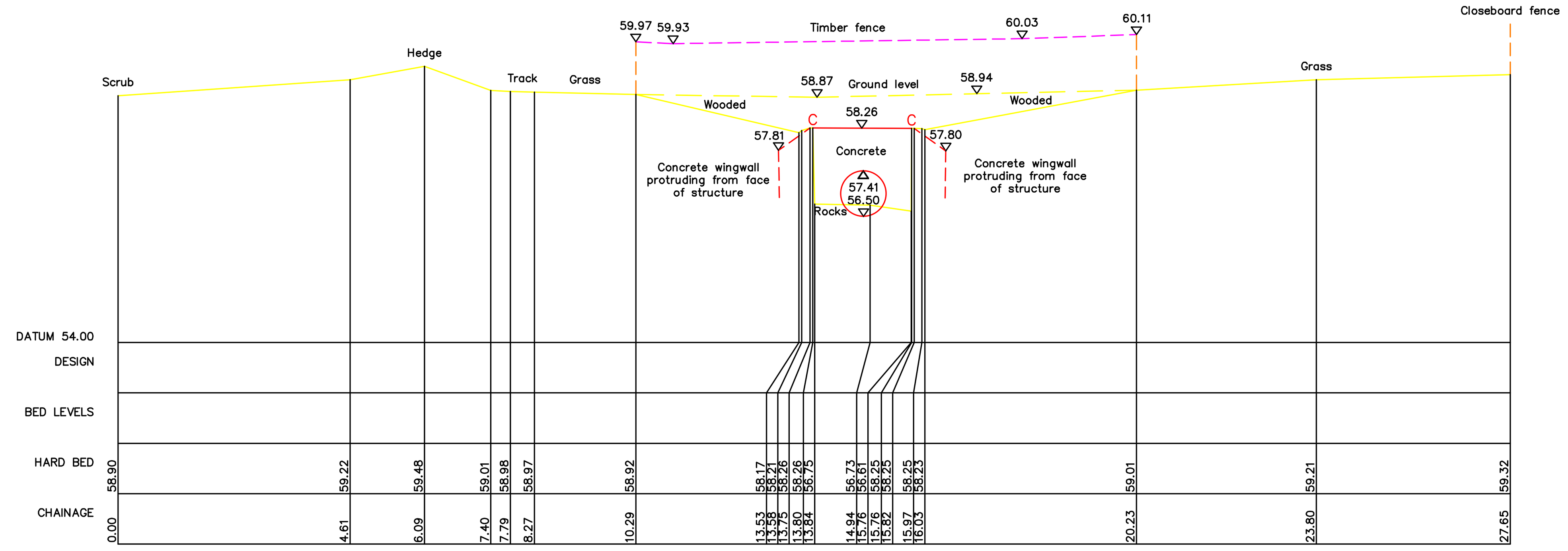
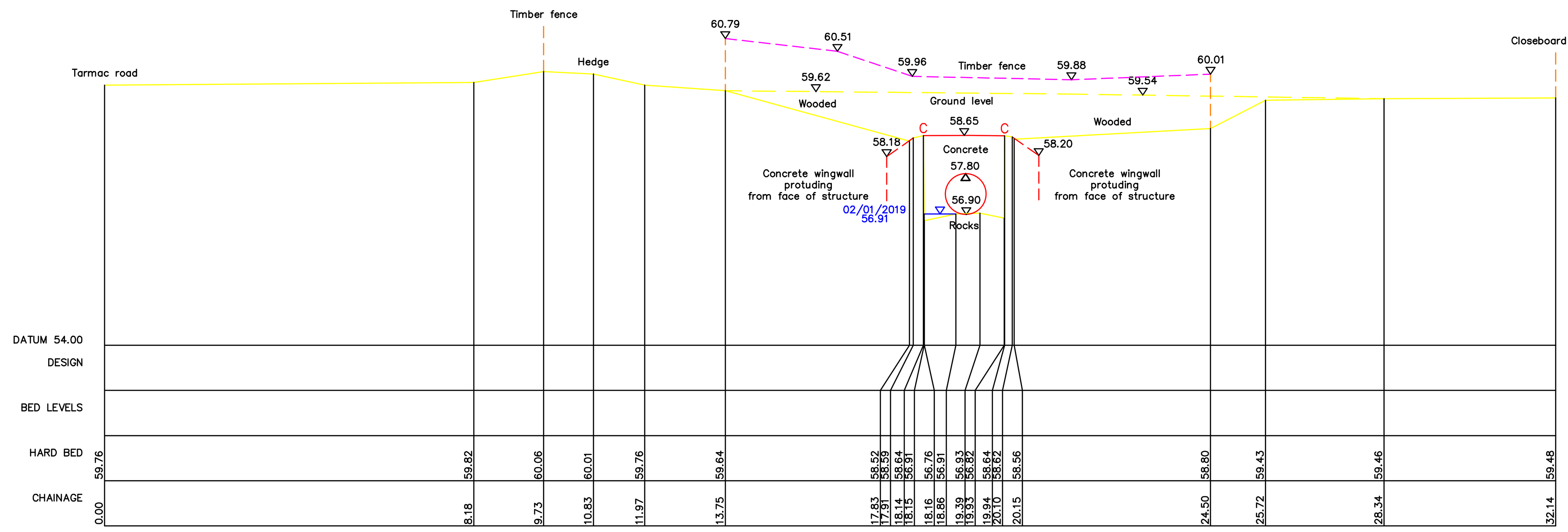


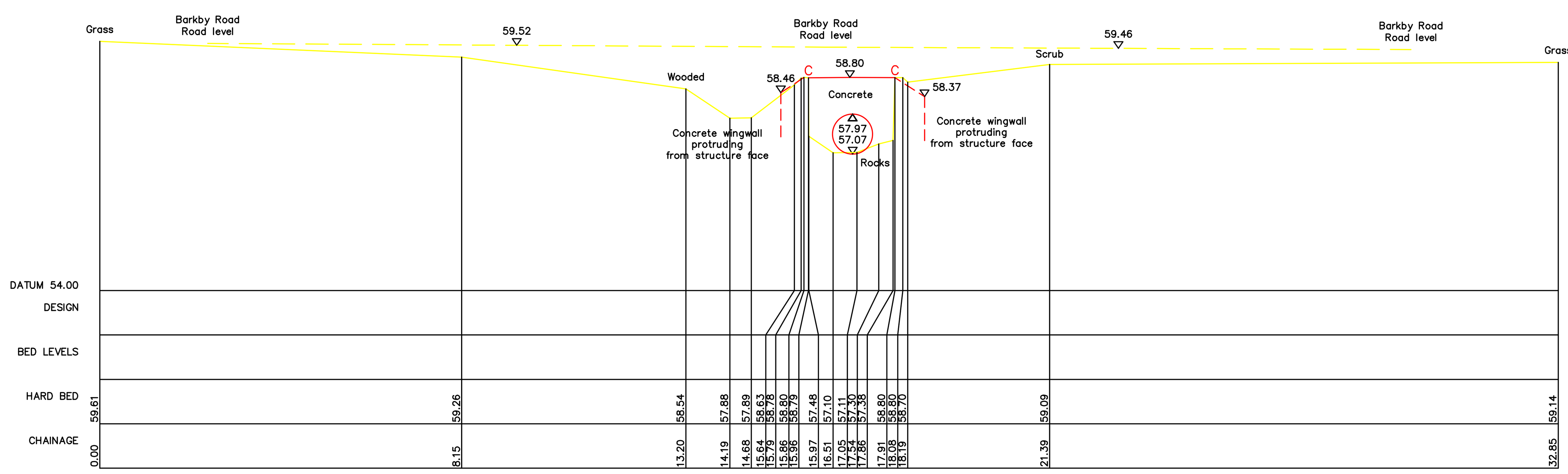
XS1
463345.46mE 310794.97mN Brg 341
Chainage 144.7
Timber footbridge, Length 2.0m



XS2
463408.75mE 310818.37mN Brg 341
Chainage 212.3
Culvert opening, Length 18.7m



XS3
463468.24mE 310932.35mN Brg 283
Chainage 335.9
Culvert opening, Length 18.7m



XS4
463483.29mE 310996.37mN Brg 302
Chainage 409.1
Culvert opening, Length 28.9m

Notes

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Legend

AIR VALVE	AV	WATER TAP	TAP
BOLLARD	BD	TEMPORARY BENCH MARK	TBM
BORE HOLE	BHL	TELEPHONE CALL BOX	TCB
BUS STOP	BS	TELEPHONE POST	TEL
BT INSPECTION COVER	BT	THRESHOLD LEVEL	THL
BT BOX	BTB	TRAFFIC LIGHT	TL
CABLE TV INSPECTION COVER	CTV	TOP OF WALL	TOW
COVER LEVEL	CL	TELEGRAPH POLE	TP
DOWN PIPE	DP	UNABLE TO LIFT	UTL
DROPPED KERB	DK	VENT PIPE	VP
ELECTRICITY CONTROL BOX	ECB	RAIL WELD	WE
EAVES HEIGHT	EH	WATER METER	WM
ELECTRICITY MANHOLE	EM	WASHOUT	WO
ELECTRICITY POLE	EP		
EARTH ROD	ER		
FINISHED FLOOR LEVEL	FFL	SURVEY STATION	GCS1
FIRE HYDRANT	FH		
FOUL WATER	FW		
GULLY	GY	BUSHES	BH
GATE POST	GP		
GAS VALVE	GV		
INSULATED BLOCK JOINT	IBJ	HEDGES	
INSPECTION COVER	IC		
INVERT LEVEL	IL		
KERB OUTLET	KO	TREES	Height Species (Spread to scale)
LAMPPOST	LP		
LITTER BIN	LB		
MARKER POST	MK		
MILE POST	MP		
POST	PO		
RODDING EYE	RE	GATE	
RIDGE HEIGHT	RH		
ROAD NAMEPLATE	RN		
ROAD SIGN	RS	SECURITY FENCE	X
STUMP	SP	FENCE	/
SOFFIT LEVEL	SF	OVERHEAD CABLES	OH
SIGNAL POST	SIG	FOUL WATER	FW
RAIL SLEEPER LEVEL	SLP	GAS MAIN	GM
SIGNALS AND TELECOMS BOX	STB	U/G POWER LINE	PL
SIGNALS AND TELECOMS CABLE	STC	STORM WATER	SW
SIGNALS AND TELECOMS POST	STP	U/G TELEPHONE	TEL
SIGN POST	SN	WATER MAIN	WM
STOP TAP	ST		
STOP VALVE	SV		
STAY	SY		
STORM WATER	SW		

Control Table

Station	Description	Eastings	Northings	Height

Grid and Datum

Grid: *OS National Grid* **Datum:** *Ordnance Datum Newlyn*

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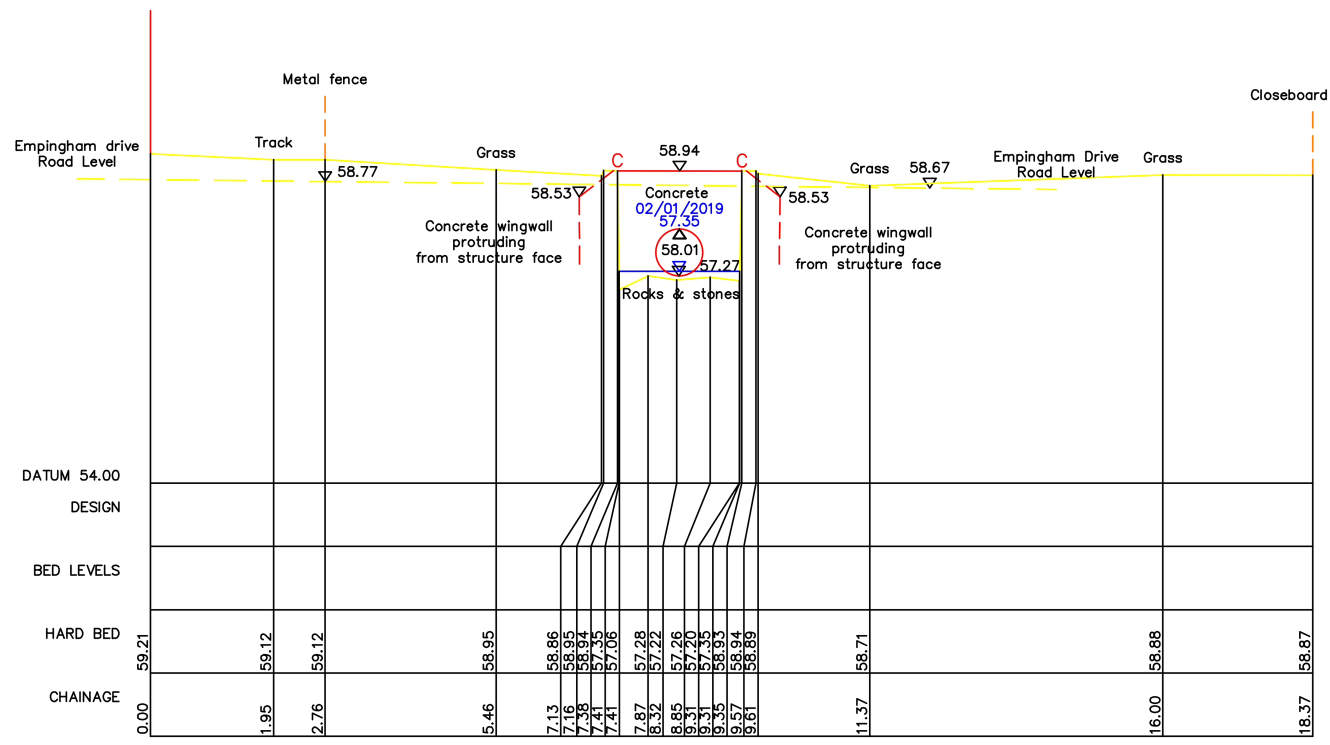

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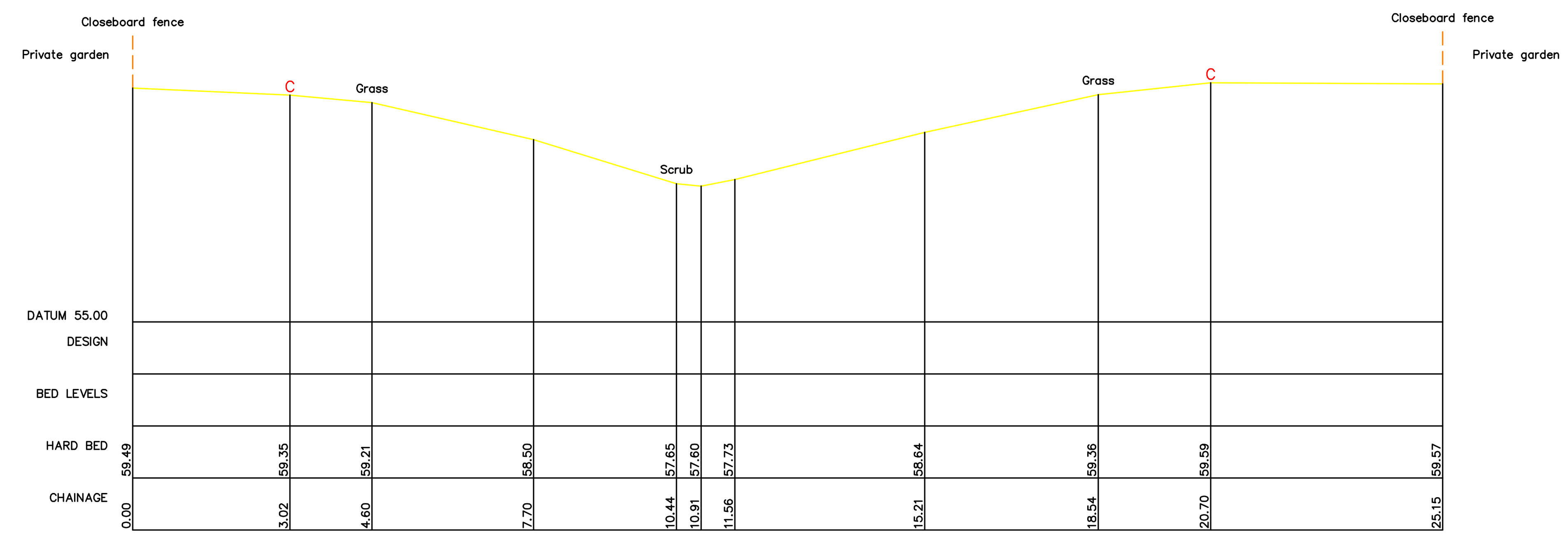
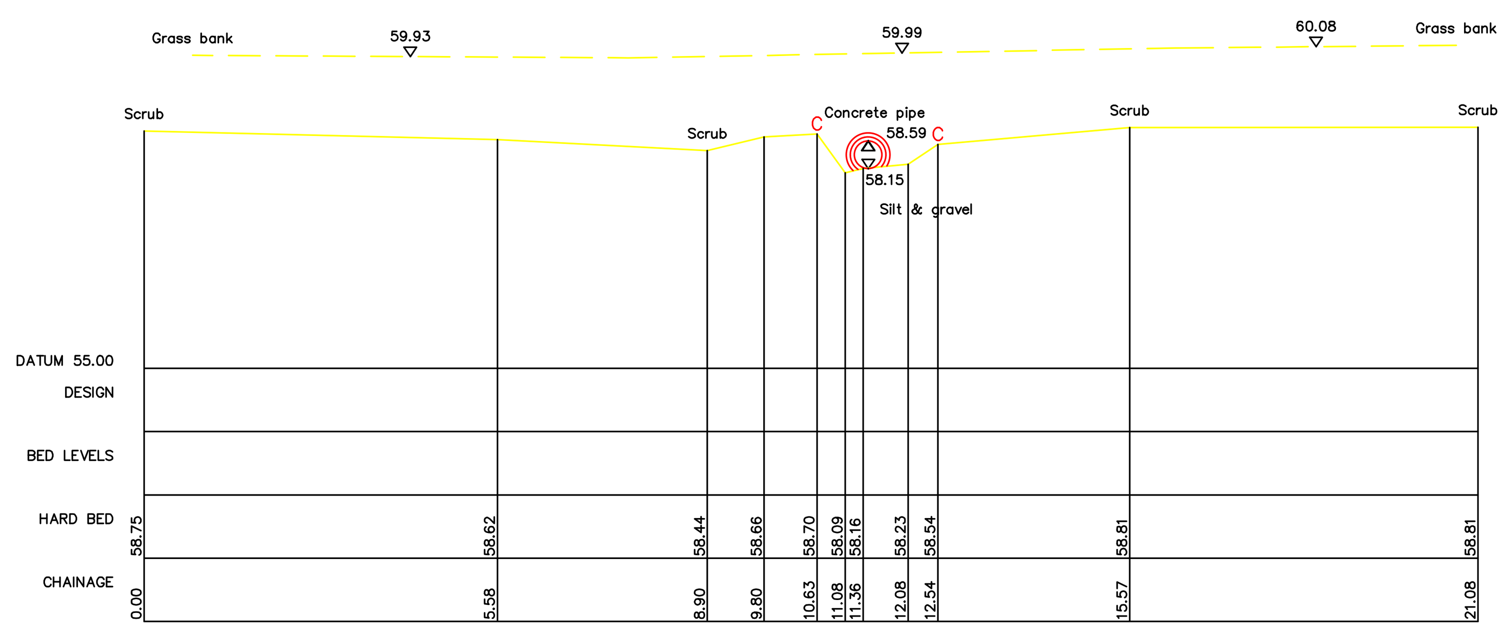
Chainage 512.8
Culvert opening, Length 19.0m



XS6
463561.49mE 311112.25mN Brg 9
Chainage 606.2
Open Channel



XS7
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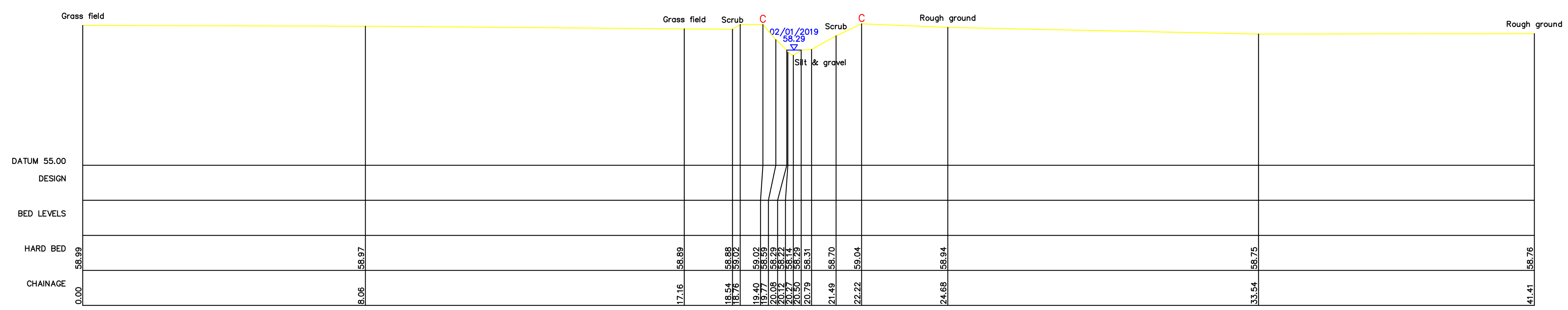
Chainage 712
Culvert opening, Length 13.8m



XS8
463688.92mE 311048.15mN Brg 358
Chainage 761.6
Open Channel

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Legend

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BOLLARD	BD	TEMPORARY BENCH MARK	TBM
BORE HOLE	BHL	TELEPHONE CALL BOX	TCB
BUS STOP	BS	TELEPHONE POST	TEL
BT INSPECTION COVER	BT	THRESHOLD LEVEL	THL
BT BOX	BTB	TRAFFIC LIGHT	TL
CABLE TV INSPECTION COVER	CTV	TOP OF WALL	TOW
COVER LEVEL	CL	TELEGRAPH POLE	TP
DOWN PIPE	DP	UNABLE TO LIFT	UTL
DROPPED KERB	DK	VENT PIPE	VP
ELECTRICITY CONTROL BOX	ECB	RAIL WELD	WE
EAVES HEIGHT	EH	WATER METER	WM
ELECTRICITY MANHOLE	EM	WASHOUT	WO
ELECTRICITY POLE	EP		
EARTH ROD	ER		
FINISHED FLOOR LEVEL	FFL		
FIRE HYDRANT	FH	SURVEY STATION	GCS1
FOUL WATER	FW		
GULLY	GY		
GATE POST	GP	BUSHES	BH
GAS VALVE	GV		
INSULATED BLOCK JOINT	IBJ		
INSPECTION COVER	IC	HEDGES	
INVERT LEVEL	IL		
KERB OUTLET	KO		
LAMPPOST	LP	TREES	Height Species (Spread to scale)
LITTER BIN	LB		
MARKER POST	MK		
MILE POST	MP		
POST	PO		
RODDING EYE	RE	GATE	
RIDGE HEIGHT	RH		
ROAD NAMEPLATE	RN		
ROAD SIGN	RS	SECURITY FENCE	
STUMP	SP	FENCE	
SOFFIT LEVEL	SF	OVERHEAD CABLES	OH
SIGNAL POST	SIG	FOUL WATER	FW
RAIL SLEEPER LEVEL	SLP	GAS MAIN	GM
SIGNALS AND TELECOMS BOX	STB	U/G POWER LINE	PL
SIGNALS AND TELECOMS CABLE	STC	STORM WATER	SW
SIGNALS AND TELECOMS POST	STP	U/G TELEPHONE	TEL
SIGN POST	SN	WATER MAIN	WM
STOP TAP	ST		
STOP VALVE	SV		
STAY	SY		
STORM WATER	SW		

Control Table

Station	Description	Eastings	Northings	Height

Grid and Datum

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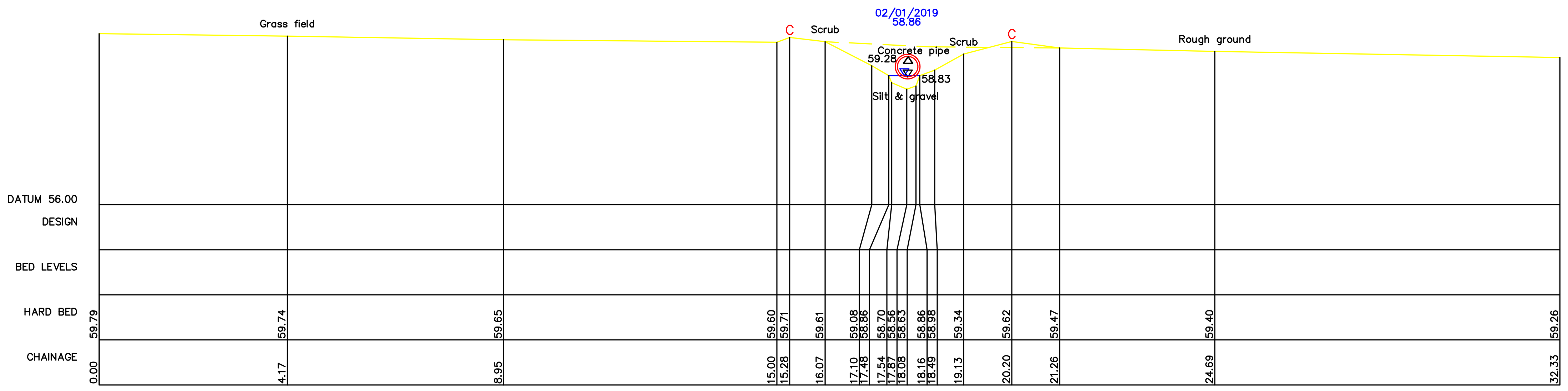

XS9
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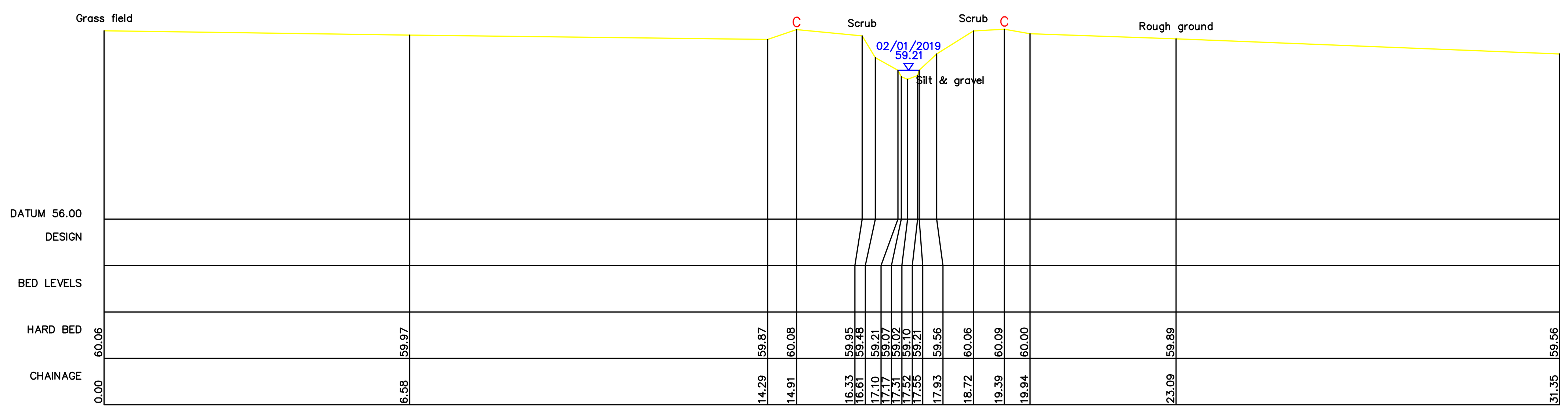
Chainage 843.4
Field access pipe, Length 6.2m



XS10
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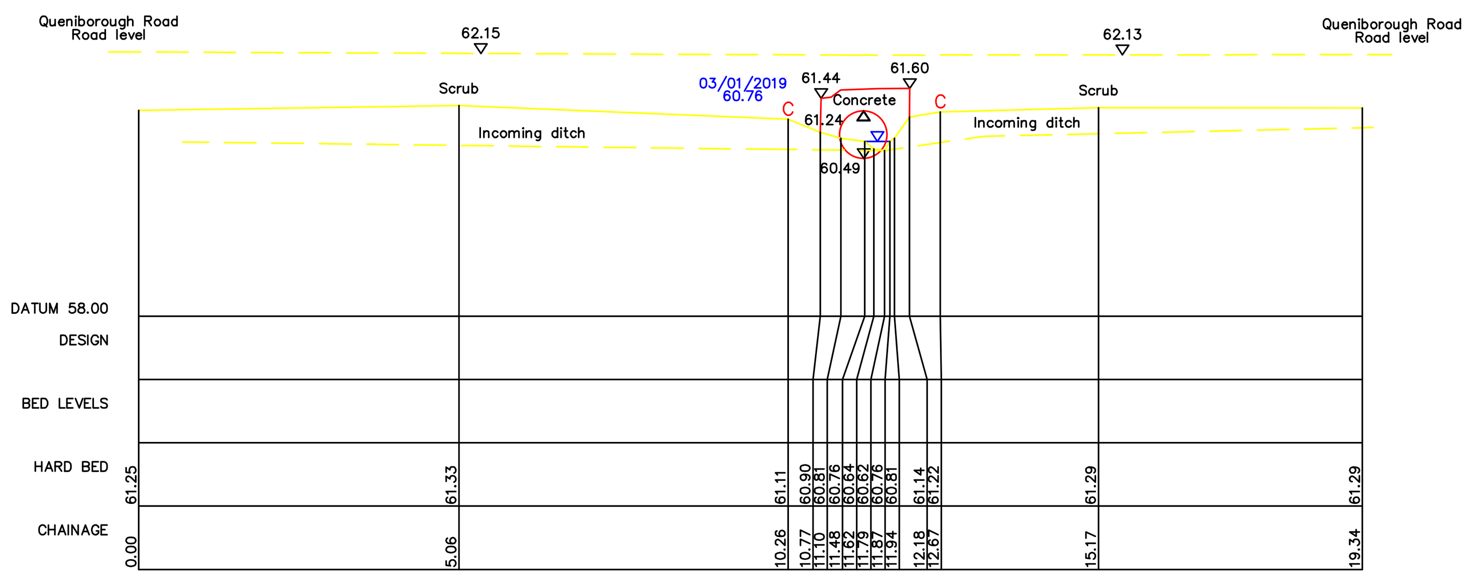
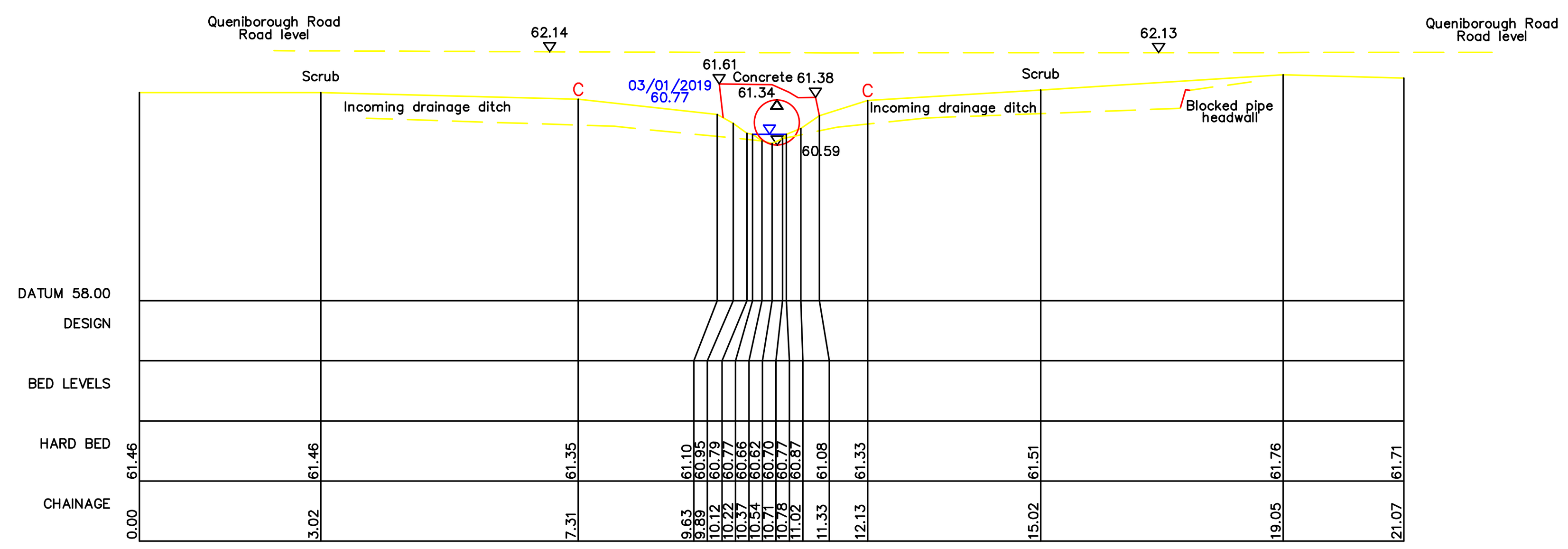
Chainage 884.6
Open Channel



XS11
463907.97mE 311061.18mN Brg 359
Chainage 982.8
Downstream face of road culvert



XS12
463916.66mE 311060.86mN Brg 12
Chainage 994.1
Upstream face of road culvert

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BT INSPECTION COVER	BT	THRESHOLD LEVEL	THL
BT BOX	BTB	TRAFFIC LIGHT	TL
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DOWN PIPE	DP	UNABLE TO LIFT	UTL
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EAVES HEIGHT	EH	WATER METER	WM
ELECTRICITY MANHOLE	EM	WASHOUT	WO
ELECTRICITY POLE	EP		
EARTH ROD	ER		
FINISHED FLOOR LEVEL	FFL		
FIRE HYDRANT	FH	SURVEY STATION	GCS1
FOUL WATER	FW		
GULLY	GY		
GATE POST	GP	BUSHES	BH
GAS VALVE	GV		
INSULATED BLOCK JOINT	IBJ		
INSPECTION COVER	IC	HEDGES	
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STOP TAP	ST		
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Control Table

Station	Description	Eastings	Northings	Height

Grid and Datum

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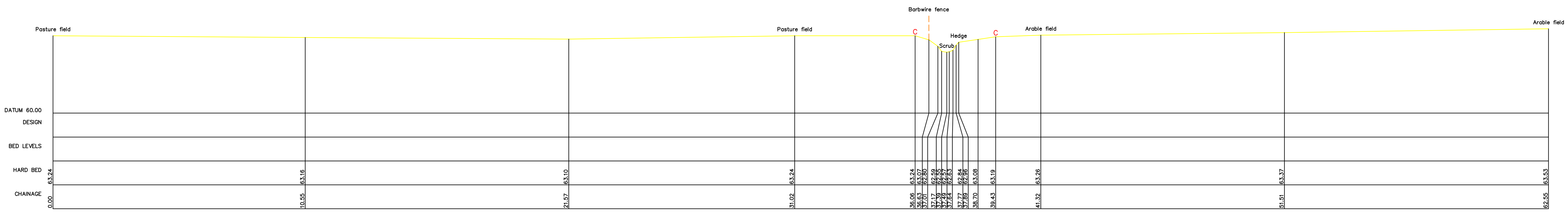

XS13
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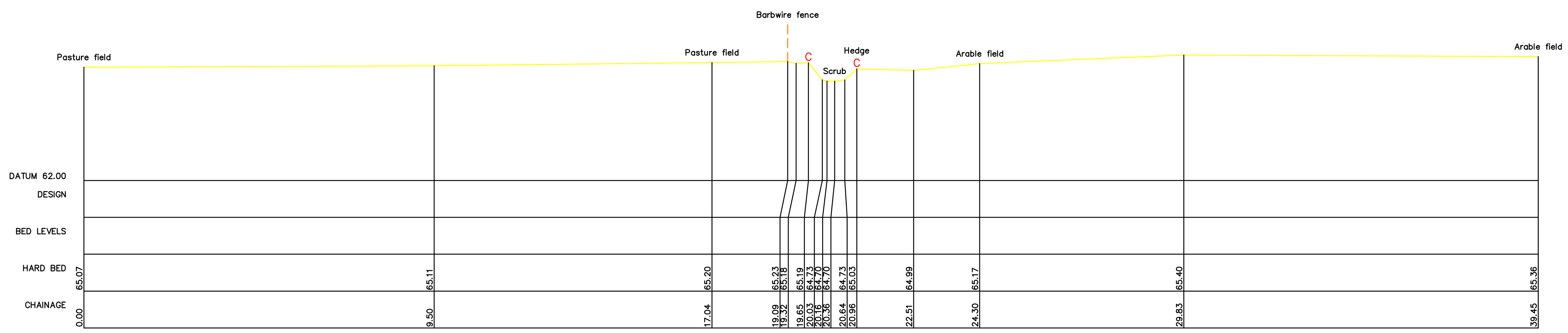
Chainage 1125.2
Open Channel



XS14
464115.25mE 310971.78mN Brg 13
Chainage 1210.3
Open Channel

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BT BOX	BTB	TRAFFIC LIGHT	TL
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DOWN PIPE	DP	UNABLE TO LIFT	UTL
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EAVES HEIGHT	EH	WATER METER	WM
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INSPECTION COVER	IC	HEDGES	
INVERT LEVEL	IL		
KERB OUTLET	KO		
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STOP TAP	ST		
STOP VALVE	SV		
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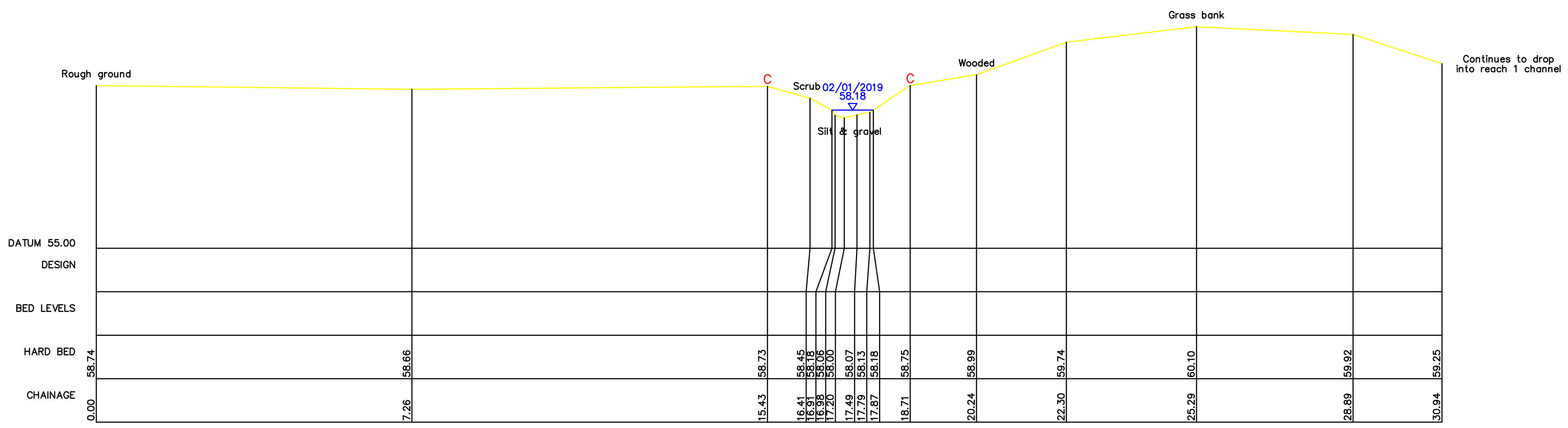

XS15
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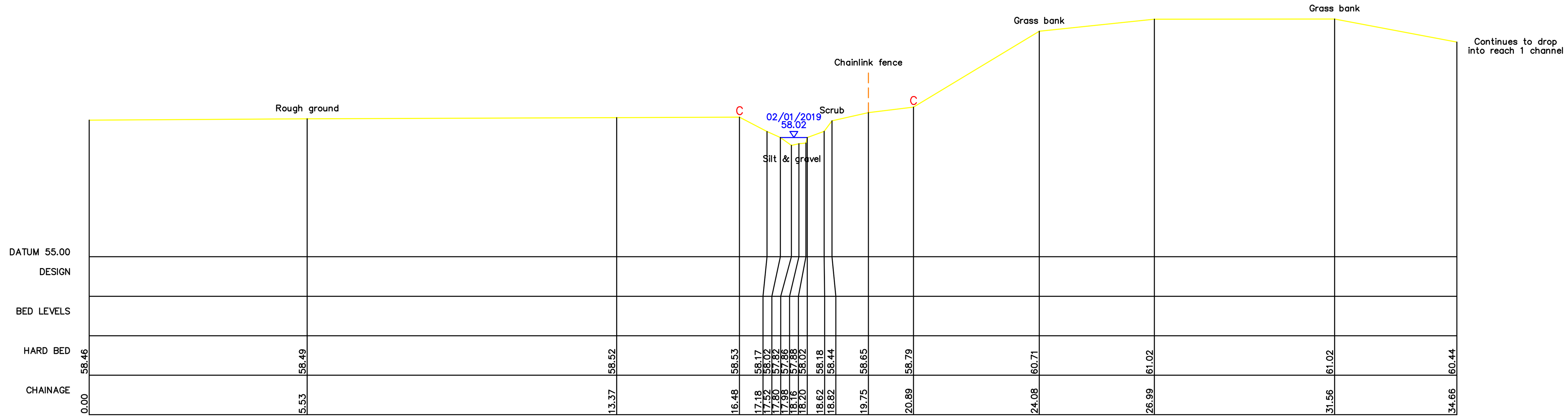
Chainage 4.5
Open Channel



XS16
463654.1mE 311112.46mN Brg 263
Chainage 44.9
Open Channel

N

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KERB OUTLET	KO		
LAMPPOST	LP		
LITTER BIN	LB	TREES	Height Species (Spread to scale)
MARKER POST	MK		
MILE POST	MP		
POST	PO		
RODDING EYE	RE	GATE	
RIDGE HEIGHT	RH		
ROAD NAMEPLATE	RN		
ROAD SIGN	RS	SECURITY FENCE	X
STUMP	SP	FENCE	/
SOFFIT LEVEL	SF	OVERHEAD CABLES	OH
SIGNAL POST	SIG	FOUL WATER	FW
RAIL SLEEPER LEVEL	SLP	GAS MAIN	GM
SIGNALS AND TELECOMS BOX	STB	U/G POWER LINE	PL
SIGNALS AND TELECOMS CABLE	STC	STORM WATER	SW
SIGNALS AND TELECOMS POST	STP	U/G TELEPHONE	TEL
SIGN POST	SN	WATER MAIN	WM
STOP TAP	ST		
STOP VALVE	SV		
STAY	SY		
STORM WATER	SW		

Control Table

Station	Description	Eastings	Northings	Height

Grid and Datum

Grid: ***OS National Grid*** **Datum:** ***Ordnance Datum Newlyn***

Survey related to Ordnance Survey National Grid (OSGB36) via GPS and the OS Active Network.
A National Grid (OSGB36) coordinate has been established on site via Transformation OSTN15 and Geoid Model OSGM15, a further OS coordinate was used to orientate the survey to Ordnance Grid.
No scale factor has been applied to the survey

Title:

WATERCOURSE SURVEY AT BARKBY ROAD, SYSTON, LEICESTERSHIRE
(Cross Sections)

Client:

JBA CONSULTING
The Library
St. Philip's Courtyard
Coleshill
Warwickshire B46 3AD

Grantham Coates Surveys Ltd

Land - Engineering - Building Surveyors

2 Arden Court, Arden Road, Alcester
Warwickshire, B49 6HN

THE SURVEY ASSOCIATION FULL MEMBER

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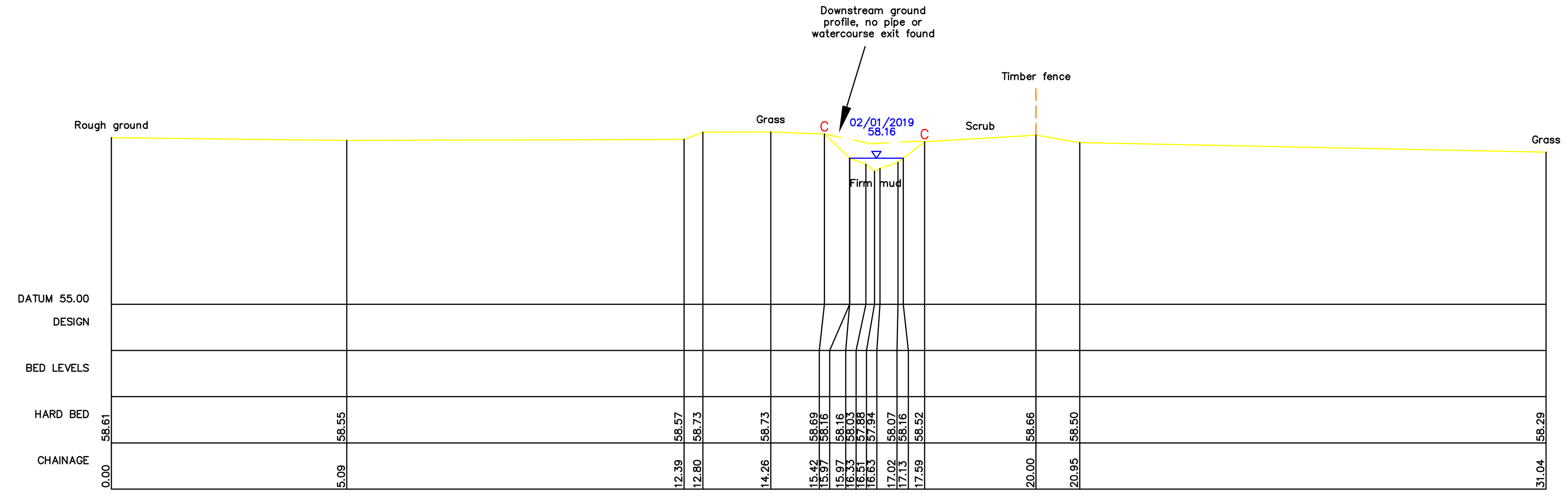
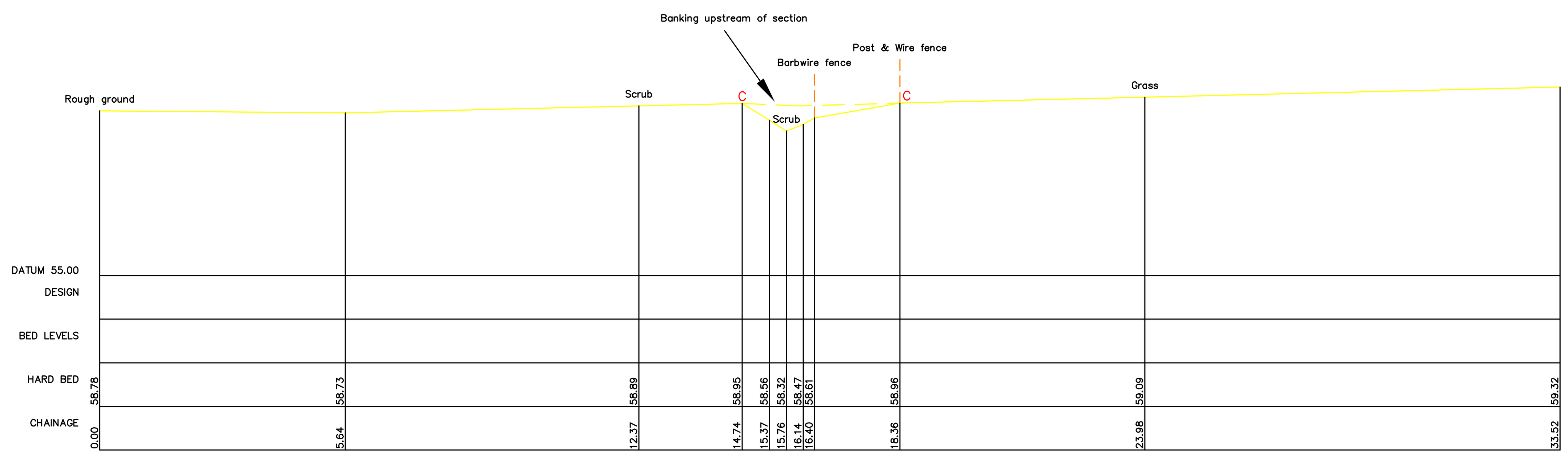
Drawing No:	Rev:
GCS/JBA/BARKBY ROAD/1	-

Date:	Notes:	Name:	Rev:

Drawn:	Checked:	Scale:	Date:
SC	CC	1:100	07/01/18
File Name: GCS-JBA-BARKBY ROAD-1		Sheet size: A1	Sheet: 6 of 7



XS17
463753.07mE 311193.48mN Brg 21
Chainage 2.8
Open Channel



XS18
463796.9mE 311178.43mN Brg 18
Chainage 48.5
Open Channel

N

Notes

This survey should only be relied upon for its original purpose. Grantham Coates Surveys Limited accepts no responsibility for use of this plan outside of the original remit, or by use of any party other than the original client.

Whilst every effort has been made to identify all above ground details, it should be noted that some items may have been obscured at time of survey.

Below ground drainage information has been visually inspected from the surface and should therefore be treated as approximate only.

Where this survey has been carried out for the purpose of enabling trackside drainage design. The position of any running rail has been surveyed in line with a general topographic survey and should not be used for the purpose of track design.

All dimensions to be checked on site prior to design and construction.

Legend

AIR VALVE	AV	WATER TAP	TAP
BOLLARD	BD	TEMPORARY BENCH MARK	TBM
BORE HOLE	BHL	TELEPHONE CALL BOX	TCB
BUS STOP	BS	TELEPHONE POST	TEL
BT INSPECTION COVER	BT	THRESHOLD LEVEL	THL
BT BOX	BTB	TRAFFIC LIGHT	TL
CABLE TV INSPECTION COVER	CTV	TOP OF WALL	TOW
COVER LEVEL	CL	TELEGRAPH POLE	TP
DOWN PIPE	DP	UNABLE TO LIFT	UTL
DROPPED KERB	DK	VENT PIPE	VP
ELECTRICITY CONTROL BOX	ECB	RAIL WELD	WE
EAVES HEIGHT	EH	WATER METER	WM
ELECTRICITY MANHOLE	EM	WASHOUT	WO
ELECTRICITY POLE	EP		
EARTH ROD	ER		
FINISHED FLOOR LEVEL	FFL		
FIRE HYDRANT	FH	SURVEY STATION	GCS1
FOUL WATER	FW		
GULLY	GY		
GATE POST	GP	BUSHES	BH
GAS VALVE	GV		
INSULATED BLOCK JOINT	IBJ		
INSPECTION COVER	IC	HEDGES	
INVERT LEVEL	IL		
KERB OUTLET	KO		
LAMPPOST	LP	TREES	Height Species (Spread to scale)
LITTER BIN	LB		
MARKER POST	MK		
MILE POST	MP		
POST	PO		
RODDING EYE	RE	GATE	
RIDGE HEIGHT	RH		
ROAD NAMEPLATE	RN		
ROAD SIGN	RS	SECURITY FENCE	—×—×—
STUMP	SP	FENCE	—/—/—
SOFFIT LEVEL	SF	OVERHEAD CABLES	—OH—OH—
SIGNAL POST	SIG	FOUL WATER	—FW—FW—
RAIL SLEEPER LEVEL	SLP	GAS MAIN	—GM—GM—
SIGNALS AND TELECOMS BOX	STB	U/G POWER LINE	—PL—PL—
SIGNALS AND TELECOMS CABLE	STC	STORM WATER	—SW—SW—
SIGNALS AND TELECOMS POST	STP	U/G TELEPHONE	—TEL—TEL—
SIGN POST	SN	WATER MAIN	—WM—WM—
STOP TAP	ST		
STOP VALVE	SV		
STAY	SY		
STORM WATER	SW		

Control Table

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THE SURVEY ASSOCIATION FULL MEMBER

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Drawing No:	Rev:
GCS/JBA/BARKBY ROAD/1	-

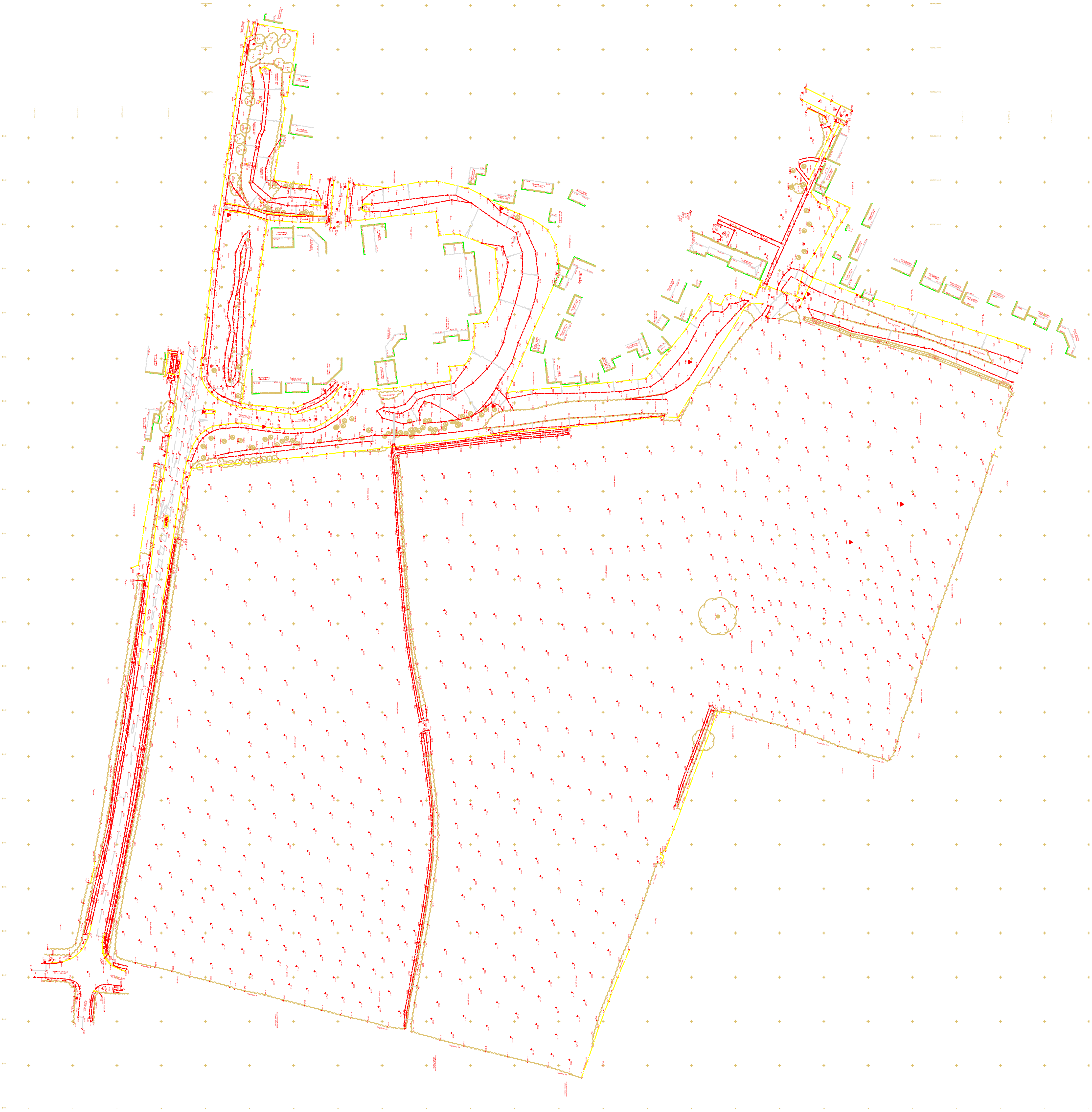
Date:	Notes:	Name:	Rev:

Drawn:	Checked:	Scale:	Date:
SC	CC	1:100	07/01/18

File Name:	Sheet size:	Sheet:
GCS-JBA-BARKBY ROAD-1	A1	7 of 7

B Appendix B - Topographic Survey

B.1 Topographic survey drawing



B.2 Topographic survey quality assessment

Figure B-1: Quality assessment – topographic survey grid minus LiDAR grid

C Appendix C - Hydrological Assessment

Surface Water rainfall-runoff estimation Update

Introduction

This report template is based on a supporting document to the Environment Agency's flood estimation guidelines (Version 5, 2015). It provides a record of the hydrological context, the method statement, the calculations and decisions made during flood estimation and the results.

Contents

Approval

	Name and qualifications	Date
Calculations prepared by:	Sam Cogan BSC MSc	14/06/2022
Calculations reviewed by:	Eva Kordomenidi BSC MSc MCIWEM CWEM CSci	15/06/2022

1 Updated Rainfall hyetographs

Updated rainfall hyetographs are required as an input into a surface water hydraulic model. Flows for the model, which was developed for a site located off of Barkby Road in Syston, Leicestershire were originally derived within 2018.

As part of the 2018 study, the surface water catchment area was assessed and updated based on EA 1m LiDAR data to account for the local topography. The catchment descriptors obtained from the FEHwebservice were updated based on modifications made to the catchment extent. The catchment extent and descriptors derived within the 2018 study were adopted for this study[1].

Following an external review of the 2018 study, the rainfall hyetographs were re-assessed. The Updated Flood Map for Surface Water (uFMfSW) methodology[2] has been followed as closely as possible to generate the hyetographs for this study. A comparison between the cumulative rainfall totals generated within this study were compared to the cumulative rainfall totals generated within the 2018 study, which utilised FEH99 rainfall statistics. The comparison found that the cumulative rainfall totals for the 2018 study and this study for both rural and urban, without losses applied, for the 1, 3 and 6hr durations were relatively similar. As this study utilised FEH13 rainfall statistics, ReFH2 software and accounts for sewer losses in line with uFMfSW methodology, rainfall hyetographs generated within this study were taken forward.

Cumulative rainfall - Final assessment							
Return Period	30yr				100yr		
Storm Duration	1	3	6		1	3	6
2018 - ReFH1	3.84	5.42	6.81		5.37	7.50	9.35
2022 - ReFH2 - Summer - Rural Net Rainfall	3.62	5.19	6.54		5.29	7.88	10.07
2022 - ReFH2 - Winter - Rural Net Rainfall	3.20	4.62	5.86		4.73	7.09	9.11

In the uFMfSW, the hyetographs were derived for 'rural' and 'urban' areas; a different approach to applying losses was used for the two areas. The 'rural' hyetographs use the ReFH losses model to calculate effective (net) rainfall. The losses for the 'urban' hyetographs were applied by reducing rainfall to 95% to represent infiltration and then reducing this by a further 12mm/hr to represent the effects of the drainage system – referred to within this report as the "uFMfSW urban method".

It is believed that the uFMfSW used the FEH99 (Flood Estimation Handbook) rainfall statistics and ReFH1 to apply the losses for the 'rural' areas. Since the uFMfSW was developed the FEH13 rainfall statistics and ReFH2 have been released; due to the availability of updated rainfall statistics, it was decided to use the FEH13 rainfall statistics to derive the gross rainfall (depth-duration-frequency (DDF) rainfall), for the rural-net rainfall outputs. The uFMfSW urban method rainfall is considered to be more conservative than the rural net rainfall outputs, and therefore it was decided that the uFMfSW urban method rainfall would be applied for some of the model extent.

The uFMfSW states that an areal reduction factor (ARF) was not applied to the FEH DDF parameters. An areal reduction factor (ARF) of 1 was therefore applied to the rainfall, and seasonal correction factor remained as default for the catchment, chosen by ReFH2. This was because unlike for fluvial studies, there is no defined catchment into which the rainfall is falling. The direct rainfall approach to surface water mapping can be viewed as merging together many separate point rainfall events during a single model run.

Hyetographs for a 1.1hr, 3.1hr and 6.25hr storm duration were generated. The uFMfSW used 1hr, 3hr and 6hr storm durations. ReFH2 requires the use of a data interval which gives an odd integer when the storm duration is divided by the timestep. This is the reason for the slight discrepancy in storm durations between this study and the uFMfSW for the 1hr and 6hr storm durations. A data interval of 0.1 hours was used for the 1.1-hour and 3.1-hour storms and a timestep of 0.25 hours was used for the 6.25-hour storm.

1 JBA Counsulting (2018) 2018s1664 - Note to file - Rainfall Hydrology Method v2.0
[2] Environment Agency (2019) What is the Risk of Flooding from Surface Water map? Report version 2.0 - April 2019. Souce: What is the Risk of Flooding from Surface Water Map? (publishing.service.gov.uk)

Hyetographs for both summer and winter seasons were exported and will be tested in the Rainfall-Runoff model, along with the range of storm durations, to determine which is critical to take forward to the chosen modelling profile.

The coefficient for the urban runoff was chosen as 70% in the uFMfSW study. The site of interest is located in an residential area, set outside of the outskirts of Silby. The uFMfSW study quotes standard hydrology guidelines that city centre runoff coefficients are in the range 70-95% and suburban runoff coefficients are in the range 50-70%. Following these guidelines, the runoff coefficient of 70% was verified as appropriate for this site as the drainage catchment is not located within a city centre. The runoff coefficient of 70% was also verified as appropriate for this study as the drainage catchment is not fully urbanised and the areas which are located in an urban setting are considered to be suburban.

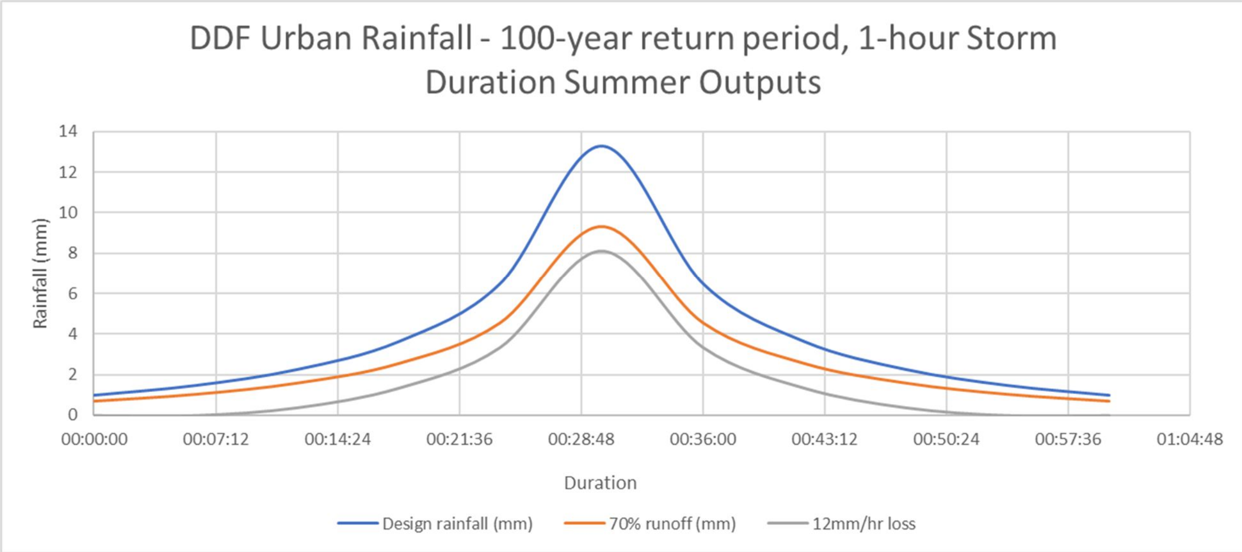
1.1 Rainfall hyetograph used in the model extent

An assessment of the catchment indicated that east of the site the run-off would be predominately rural in nature, with run-off west of the catchment being urban. The uFMfSW urban method rainfall was applied to the western model extent, while rural rainfall was applied to the eastern model extent so as the model was representative of the study catchment.

For the urban hyetograph losses, the design rainfall hyetograph was multiplied by 0.7 to give the losses due to infiltration. The loss of 12mm/hr to represent the drainage system was applied to the resulting hyetograph (i.e. 0.1hr (6 minute) data interval has a loss of 1.2mm/6 minutes). The loss was applied to each hyetograph ordinate:

- Where the DDF * 0.7 depth is less than the loss value, the depth is set to zero, i.e. all rainfall is removed by the drainage system.
- Where the DDF * 0.7 depth is greater than the loss value the depth is reduced by the loss value, for example, an ordinate depth of 3.00mm with a loss of 1.2mm/6 minutes becomes 1.80mm.

Rural net rainfall and calculated urban net rainfall winter outputs - 100-year return period, 1-hour Storm Duration					
Time (hr)	**Design rainfall (mm)**	**RURAL NET rural rainfall (mm)**	**70% runoff (mm)**	**Drainage capacity (mm)**	**Urban net rainfall (mm)**
00:00:00	0.50	0.07	0.35	1.20	0.00
00:06:00	0.84	0.12	0.59	1.20	0.00
00:12:00	1.41	0.21	0.98	1.20	0.00
00:18:00	2.32	0.35	1.63	1.20	0.43
00:24:00	3.78	0.59	2.65	1.20	1.45
00:30:00	5.21	0.85	3.65	1.20	2.45
00:36:00	3.78	0.65	2.65	1.20	1.45
00:42:00	2.32	0.41	1.63	1.20	0.43
00:48:00	1.41	0.25	0.98	1.20	0.00
00:54:00	0.84	0.15	0.59	1.20	0.00
01:00:00	0.50	0.09	0.35	1.20	0.00



Effective Cumulative Rainfall estimates from the ReFH2 method – 1 hour storm duration		
Return period	Design Scenario	
	Winter – With losses (urban)	Summer – With losses (rural)
30 year	3.02	11.38
100 year	6.20	18.27
1000 year	18.48	43.97

Effective Cumulative Rainfall estimates from the ReFH2 method – 1 hour storm duration		
Return period	Design Scenario	
	Winter – Without losses (urban)	Summer – Without losses (rural)
30 year	2.63	3.52
100 year	3.75	5.29
1000 year	7.85	12.62

2 Discussion and summary of results

2.1 Final choice of method

Choice of method and reasons Include reference to type of study, nature of catchment and type of data available.	The Updated Flood Map for Surface Water (uFMfSW) methodology has been followed as closely as possible to generate the hyetographs for this study. The rainfall runoff method (RefH2) was used to calculate catchment wide rainfall over the study area by following Updated Flood Map for Surface Water (uFMfSW) methodology. It is believed that the uFMfSW used the FEH99 (Flood Estimation Handbook) rainfall statistics and ReFH1 to apply the losses for the 'rural' areas. Since the uFMfSW was developed the FEH13 rainfall statistics and ReFH2 have been released. Due to the availability of updated rainfall statistics, the preferred method is the use of FEH13 rainfall statistics and ReFH2 to derive the gross rainfall (depth-duration-frequency (DDF) rainfall), for the rural-net rainfall outputs. For design scenario, the summer events give more conservative peak flows than the winter outputs and so it's recommended that the summer outputs are taken forward for modelling purposes. A comparison between the cumulative rainfall totals generated within this study were compared to the cumulative rainfall totals generated within the 2018 study, which utilised FEH99 rainfall statistics. The comparison found that the cumulative rainfall totals for the 2018 study and this study for both rural and urban, without losses applied, for the 1, 3 and 6hr durations were relatively similar. The cumulative rainfall was higher in the 2018 study for the 30-year event (1, 3 and 6 hr durations) and for the 100-year, 1 hour duration. For the 100-year 3- and 6-hour duration, the Summer - Rural Net Rainfall cumulative rainfall totals were higher than the totals for the 2018 study. In order to provide an accurate representation of the study catchment, which is predominately rural to the upper and central reaches but is slightly urbanised to the lower reaches, the rainfall model was divided into a rural spilt and an urban split. The rural net rainfall hyetograph was applied to the rural section of the model and the urban net hyetograph, with sewer losses applied, was distributed to the urban split. A 40% climate change has been accounted for within the model for the 1 in 100-year event. Based on EA climate change allowance guidance[3], the applicable climate change allowances for the Central and Upper End ranges are 25% and 35% respectively for the '2070' scenario for the 3.3% annual exceedance rainfall event and 25% and 40% for the 1% annual exceedance rainfall event for the Soar Management Catchment peak rainfall allowances. Rainfall peaks are available for the 30-year event with a 25% and 35% climate change allowance and for the 100-year event with a 25% and 40% climate change allowance.

2.2 Assumptions, limitations and uncertainty

List the main assumptions made (specific to this study)	It is assumed that the rainfall statistics give an accurate representation of rainfall over the study area.
Discuss any particular limitations, e.g. applying methods outside the range of catchment types or return periods for which they were developed.	There is no available catchment flow data to verify the peak flow estimates generated by this assessment which can affect the calibration of the rainfall-runoff method. There are no raingauges located within the study catchment.

[3] Environment Agency (2021). Climate change allowances map. Accessed: 23/06/2022. [Source: Climate change allowances for peak river flow in England (data.gov.uk)].

Comment on the suitability of the results for future studies, e.g. at nearby locations or for different purposes.	It is emphasised that the results of the analysis should be considered in the context of the needs of this study. The results of this assessment should be revisited for use on future studies. Once the baseline model has been undertaken, using the hyetographs provided within this study, consultation with the client will be undertaken to ensure that the baseline model results match on-site knowledge of flood mechanisms on site.
Give any other comments on the study, e.g. suggestions for additional work.	N/A

2.3 Final results

Return period	Effective Rainfall (mm) for the following storm durations (hours) Summer Scenario - Urban		
	1	3	6
30 year	11.38	18.27	43.97
100 year	7.93	15.25	41.33
1000 year	4.23	10.03	32.23

Return period	Effective Rainfall (mm) for the following storm durations (hours) Summer Scenario - Rural		
	1	3	6
30 year	3.62	5.29	12.62
100 year	5.19	7.88	18.21
1000 year	6.54	10.07	22.40

If flood hydrographs are needed for the next stage of the study, where are they provided? (e.g. give filename of spreadsheet, hydraulic model, or reference to table below)	**<u>Design Hyetographs:</u>** \\col-rdc01\Live Data\2018\Projects\2018s1664 - Travis Baker East Midlands Ltd - Barkby Rd Syston Model\Calculations\Rainfall Hydrology\Surface Water 2022 update\HLU_JBAU_XX_00_CA_HO_0001_S0_P0_Surface_Water_Rainfall_Runoff_Summary.xlsx

3 Annex A: ReFH2 export

UK Design Flood Estimation

Generated on Monday, June 13, 2022 11:22:51 AM by jflownw
Printed from the ReFH2 Flood Modelling software package, version 3.1.7439.12207

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH2)

Site details Checksum: 41CB-7D57

Site name: SW_01 - Point Data - 2018

Easting: 462950

Northing: 311450

Country: England, Wales or Northern Ireland

Catchment Area (km^2): 0.9

Using plot scale calculations: No

Model: ReFH2.2

Site description: None

Model run: 100 year

Summary of results

Rainfall - FEH 2013 model (mm):	43.44	Total runoff (ML):	6.25
Total Rainfall (mm):	43.03	Total flow (ML):	12.09
Peak Rainfall (mm):	13.31	Peak flow (m^3/s):	0.43

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.
** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH 2013 model)

Name	Value	User-defined?
Duration (hh:mm:ss)	01:06:00 [04:30:00]	Yes
Timestep (hh:mm:ss)	00:06:00 [00:30:00]	Yes
SCF (Seasonal correction factor)	0.99	No
ARF (Areal reduction factor)	1 [0.96]	Yes
Seasonality	Summer [Winter]	Yes

Loss model parameters

Name	Value	User-defined?
Cini (mm)	53.84	No
Cmax (mm)	612.81	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No
Use seasonal CIni for equations	Yes	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	2.89	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	0.01	No
BL (hr)	40.69	No
BR	1.58	No

Urbanisation parameters

Name	Value	User-defined?
Urban area (km^2)	0.2	No
Urbext 2000	0.14	No
Impervious runoff factor	0.7	No
Imperviousness factor	0.3	No
Tp scaling factor	0.5	No
Exporting drained area (km^2)	0.00	Yes
Sewer capacity (m^3/s)	0.00	Yes

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m³/s)	Baseflow (m³/s)	Total Flow (m³/s)
00:00:00	0.993	0.000	0.129	0.000	0.008	0.008
00:06:00	1.477	0.000	0.194	0.000	0.008	0.008
00:12:00	2.262	0.000	0.304	0.001	0.008	0.009
00:18:00	3.635	0.000	0.504	0.004	0.008	0.011
00:24:00	6.496	0.000	0.951	0.008	0.008	0.015
00:30:00	13.308	0.000	2.149	0.015	0.008	0.022
00:36:00	6.496	0.000	1.147	0.029	0.008	0.037
00:42:00	3.635	0.000	0.670	0.050	0.008	0.058
00:48:00	2.262	0.000	0.427	0.075	0.008	0.083
00:54:00	1.477	0.000	0.283	0.103	0.008	0.110
01:00:00	0.993	0.000	0.192	0.131	0.008	0.139
01:06:00	0.000	0.000	0.000	0.161	0.008	0.169
01:12:00	0.000	0.000	0.000	0.191	0.008	0.199
01:18:00	0.000	0.000	0.000	0.221	0.008	0.229
01:24:00	0.000	0.000	0.000	0.251	0.008	0.260
01:30:00	0.000	0.000	0.000	0.281	0.009	0.290
01:36:00	0.000	0.000	0.000	0.311	0.009	0.320
01:42:00	0.000	0.000	0.000	0.339	0.009	0.348
01:48:00	0.000	0.000	0.000	0.365	0.010	0.375
01:54:00	0.000	0.000	0.000	0.388	0.010	0.398
02:00:00	0.000	0.000	0.000	0.406	0.010	0.416
02:06:00	0.000	0.000	0.000	0.414	0.011	0.425
02:12:00	0.000	0.000	0.000	0.416	0.011	0.427
02:18:00	0.000	0.000	0.000	0.415	0.012	0.427
02:24:00	0.000	0.000	0.000	0.413	0.012	0.425
02:30:00	0.000	0.000	0.000	0.409	0.013	0.421
02:36:00	0.000	0.000	0.000	0.404	0.013	0.417
02:42:00	0.000	0.000	0.000	0.399	0.014	0.413
02:48:00	0.000	0.000	0.000	0.394	0.015	0.409
02:54:00	0.000	0.000	0.000	0.389	0.015	0.404
03:00:00	0.000	0.000	0.000	0.384	0.016	0.400
03:06:00	0.000	0.000	0.000	0.379	0.017	0.396
03:12:00	0.000	0.000	0.000	0.374	0.018	0.391
03:18:00	0.000	0.000	0.000	0.368	0.018	0.387
03:24:00	0.000	0.000	0.000	0.362	0.019	0.382

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m³/s)	Baseflow (m³/s)	Total Flow (m³/s)
03:30:00	0.000	0.000	0.000	0.355	0.020	0.375
03:36:00	0.000	0.000	0.000	0.347	0.021	0.367
03:42:00	0.000	0.000	0.000	0.337	0.022	0.359
03:48:00	0.000	0.000	0.000	0.328	0.022	0.350
03:54:00	0.000	0.000	0.000	0.318	0.023	0.341
04:00:00	0.000	0.000	0.000	0.307	0.024	0.331
04:06:00	0.000	0.000	0.000	0.297	0.025	0.321
04:12:00	0.000	0.000	0.000	0.286	0.025	0.312
04:18:00	0.000	0.000	0.000	0.276	0.026	0.302
04:24:00	0.000	0.000	0.000	0.265	0.027	0.292
04:30:00	0.000	0.000	0.000	0.255	0.027	0.282
04:36:00	0.000	0.000	0.000	0.245	0.028	0.273
04:42:00	0.000	0.000	0.000	0.234	0.029	0.263
04:48:00	0.000	0.000	0.000	0.224	0.029	0.253
04:54:00	0.000	0.000	0.000	0.213	0.030	0.243
05:00:00	0.000	0.000	0.000	0.203	0.030	0.233
05:06:00	0.000	0.000	0.000	0.192	0.031	0.223
05:12:00	0.000	0.000	0.000	0.182	0.031	0.213
05:18:00	0.000	0.000	0.000	0.172	0.032	0.203
05:24:00	0.000	0.000	0.000	0.161	0.032	0.194
05:30:00	0.000	0.000	0.000	0.151	0.033	0.184
05:36:00	0.000	0.000	0.000	0.142	0.033	0.175
05:42:00	0.000	0.000	0.000	0.133	0.034	0.167
05:48:00	0.000	0.000	0.000	0.125	0.034	0.159
05:54:00	0.000	0.000	0.000	0.119	0.034	0.154
06:00:00	0.000	0.000	0.000	0.114	0.035	0.148
06:06:00	0.000	0.000	0.000	0.109	0.035	0.144
06:12:00	0.000	0.000	0.000	0.104	0.035	0.140
06:18:00	0.000	0.000	0.000	0.100	0.036	0.136
06:24:00	0.000	0.000	0.000	0.097	0.036	0.133
06:30:00	0.000	0.000	0.000	0.094	0.036	0.130
06:36:00	0.000	0.000	0.000	0.091	0.037	0.128
06:42:00	0.000	0.000	0.000	0.089	0.037	0.126
06:48:00	0.000	0.000	0.000	0.087	0.037	0.124
06:54:00	0.000	0.000	0.000	0.085	0.037	0.122
07:00:00	0.000	0.000	0.000	0.083	0.038	0.120

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
07:06:00	0.000	0.000	0.000	0.081	0.038	0.118
07:12:00	0.000	0.000	0.000	0.078	0.038	0.116
07:18:00	0.000	0.000	0.000	0.076	0.038	0.115
07:24:00	0.000	0.000	0.000	0.074	0.038	0.113
07:30:00	0.000	0.000	0.000	0.072	0.039	0.111
07:36:00	0.000	0.000	0.000	0.070	0.039	0.109
07:42:00	0.000	0.000	0.000	0.068	0.039	0.107
07:48:00	0.000	0.000	0.000	0.066	0.039	0.105
07:54:00	0.000	0.000	0.000	0.064	0.039	0.103
08:00:00	0.000	0.000	0.000	0.062	0.039	0.101
08:06:00	0.000	0.000	0.000	0.060	0.040	0.099
08:12:00	0.000	0.000	0.000	0.058	0.040	0.097
08:18:00	0.000	0.000	0.000	0.056	0.040	0.095
08:24:00	0.000	0.000	0.000	0.053	0.040	0.093
08:30:00	0.000	0.000	0.000	0.051	0.040	0.091
08:36:00	0.000	0.000	0.000	0.049	0.040	0.089
08:42:00	0.000	0.000	0.000	0.047	0.040	0.087
08:48:00	0.000	0.000	0.000	0.045	0.040	0.085
08:54:00	0.000	0.000	0.000	0.043	0.040	0.083
09:00:00	0.000	0.000	0.000	0.041	0.040	0.081
09:06:00	0.000	0.000	0.000	0.039	0.040	0.079
09:12:00	0.000	0.000	0.000	0.037	0.041	0.077
09:18:00	0.000	0.000	0.000	0.035	0.041	0.075
09:24:00	0.000	0.000	0.000	0.033	0.041	0.073
09:30:00	0.000	0.000	0.000	0.031	0.041	0.071
09:36:00	0.000	0.000	0.000	0.028	0.041	0.069
09:42:00	0.000	0.000	0.000	0.026	0.041	0.067
09:48:00	0.000	0.000	0.000	0.024	0.041	0.065
09:54:00	0.000	0.000	0.000	0.022	0.041	0.063
10:00:00	0.000	0.000	0.000	0.020	0.041	0.061
10:06:00	0.000	0.000	0.000	0.018	0.041	0.059
10:12:00	0.000	0.000	0.000	0.016	0.041	0.056
10:18:00	0.000	0.000	0.000	0.014	0.040	0.054
10:24:00	0.000	0.000	0.000	0.012	0.040	0.052
10:30:00	0.000	0.000	0.000	0.010	0.040	0.050
10:36:00	0.000	0.000	0.000	0.008	0.040	0.048

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
10:42:00	0.000	0.000	0.000	0.006	0.040	0.046
10:48:00	0.000	0.000	0.000	0.004	0.040	0.044
10:54:00	0.000	0.000	0.000	0.002	0.040	0.042
11:00:00	0.000	0.000	0.000	0.001	0.040	0.041
11:06:00	0.000	0.000	0.000	0.001	0.040	0.041
11:12:00	0.000	0.000	0.000	0.000	0.040	0.040
11:18:00	0.000	0.000	0.000	0.000	0.040	0.040
11:24:00	0.000	0.000	0.000	0.000	0.040	0.040
11:30:00	0.000	0.000	0.000	0.000	0.040	0.040
11:36:00	0.000	0.000	0.000	0.000	0.039	0.039
11:42:00	0.000	0.000	0.000	0.000	0.039	0.039
11:48:00	0.000	0.000	0.000	0.000	0.039	0.039
11:54:00	0.000	0.000	0.000	0.000	0.039	0.039
12:00:00	0.000	0.000	0.000	0.000	0.039	0.039
12:06:00	0.000	0.000	0.000	0.000	0.039	0.039
12:12:00	0.000	0.000	0.000	0.000	0.039	0.039
12:18:00	0.000	0.000	0.000	0.000	0.039	0.039
12:24:00	0.000	0.000	0.000	0.000	0.039	0.039
12:30:00	0.000	0.000	0.000	0.000	0.039	0.039
12:36:00	0.000	0.000	0.000	0.000	0.038	0.038
12:42:00	0.000	0.000	0.000	0.000	0.038	0.038
12:48:00	0.000	0.000	0.000	0.000	0.038	0.038
12:54:00	0.000	0.000	0.000	0.000	0.038	0.038
13:00:00	0.000	0.000	0.000	0.000	0.038	0.038
13:06:00	0.000	0.000	0.000	0.000	0.038	0.038
13:12:00	0.000	0.000	0.000	0.000	0.038	0.038
13:18:00	0.000	0.000	0.000	0.000	0.038	0.038
13:24:00	0.000	0.000	0.000	0.000	0.038	0.038
13:30:00	0.000	0.000	0.000	0.000	0.038	0.038
13:36:00	0.000	0.000	0.000	0.000	0.038	0.038
13:42:00	0.000	0.000	0.000	0.000	0.037	0.037
13:48:00	0.000	0.000	0.000	0.000	0.037	0.037
13:54:00	0.000	0.000	0.000	0.000	0.037	0.037
14:00:00	0.000	0.000	0.000	0.000	0.037	0.037
14:06:00	0.000	0.000	0.000	0.000	0.037	0.037
14:12:00	0.000	0.000	0.000	0.000	0.037	0.037

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
14:18:00	0.000	0.000	0.000	0.000	0.037	0.037
14:24:00	0.000	0.000	0.000	0.000	0.037	0.037
14:30:00	0.000	0.000	0.000	0.000	0.037	0.037
14:36:00	0.000	0.000	0.000	0.000	0.037	0.037
14:42:00	0.000	0.000	0.000	0.000	0.037	0.037
14:48:00	0.000	0.000	0.000	0.000	0.036	0.036
14:54:00	0.000	0.000	0.000	0.000	0.036	0.036
15:00:00	0.000	0.000	0.000	0.000	0.036	0.036
15:06:00	0.000	0.000	0.000	0.000	0.036	0.036
15:12:00	0.000	0.000	0.000	0.000	0.036	0.036
15:18:00	0.000	0.000	0.000	0.000	0.036	0.036
15:24:00	0.000	0.000	0.000	0.000	0.036	0.036
15:30:00	0.000	0.000	0.000	0.000	0.036	0.036
15:36:00	0.000	0.000	0.000	0.000	0.036	0.036
15:42:00	0.000	0.000	0.000	0.000	0.036	0.036
15:48:00	0.000	0.000	0.000	0.000	0.036	0.036
15:54:00	0.000	0.000	0.000	0.000	0.035	0.035
16:00:00	0.000	0.000	0.000	0.000	0.035	0.035
16:06:00	0.000	0.000	0.000	0.000	0.035	0.035
16:12:00	0.000	0.000	0.000	0.000	0.035	0.035
16:18:00	0.000	0.000	0.000	0.000	0.035	0.035
16:24:00	0.000	0.000	0.000	0.000	0.035	0.035
16:30:00	0.000	0.000	0.000	0.000	0.035	0.035
16:36:00	0.000	0.000	0.000	0.000	0.035	0.035
16:42:00	0.000	0.000	0.000	0.000	0.035	0.035
16:48:00	0.000	0.000	0.000	0.000	0.035	0.035
16:54:00	0.000	0.000	0.000	0.000	0.035	0.035
17:00:00	0.000	0.000	0.000	0.000	0.035	0.035
17:06:00	0.000	0.000	0.000	0.000	0.034	0.034
17:12:00	0.000	0.000	0.000	0.000	0.034	0.034
17:18:00	0.000	0.000	0.000	0.000	0.034	0.034
17:24:00	0.000	0.000	0.000	0.000	0.034	0.034
17:30:00	0.000	0.000	0.000	0.000	0.034	0.034
17:36:00	0.000	0.000	0.000	0.000	0.034	0.034
17:42:00	0.000	0.000	0.000	0.000	0.034	0.034
17:48:00	0.000	0.000	0.000	0.000	0.034	0.034

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
17:54:00	0.000	0.000	0.000	0.000	0.034	0.034
18:00:00	0.000	0.000	0.000	0.000	0.034	0.034
18:06:00	0.000	0.000	0.000	0.000	0.034	0.034
18:12:00	0.000	0.000	0.000	0.000	0.034	0.034
18:18:00	0.000	0.000	0.000	0.000	0.033	0.033
18:24:00	0.000	0.000	0.000	0.000	0.033	0.033
18:30:00	0.000	0.000	0.000	0.000	0.033	0.033
18:36:00	0.000	0.000	0.000	0.000	0.033	0.033
18:42:00	0.000	0.000	0.000	0.000	0.033	0.033
18:48:00	0.000	0.000	0.000	0.000	0.033	0.033
18:54:00	0.000	0.000	0.000	0.000	0.033	0.033
19:00:00	0.000	0.000	0.000	0.000	0.033	0.033
19:06:00	0.000	0.000	0.000	0.000	0.033	0.033
19:12:00	0.000	0.000	0.000	0.000	0.033	0.033
19:18:00	0.000	0.000	0.000	0.000	0.033	0.033
19:24:00	0.000	0.000	0.000	0.000	0.033	0.033
19:30:00	0.000	0.000	0.000	0.000	0.032	0.032
19:36:00	0.000	0.000	0.000	0.000	0.032	0.032
19:42:00	0.000	0.000	0.000	0.000	0.032	0.032
19:48:00	0.000	0.000	0.000	0.000	0.032	0.032
19:54:00	0.000	0.000	0.000	0.000	0.032	0.032
20:00:00	0.000	0.000	0.000	0.000	0.032	0.032
20:06:00	0.000	0.000	0.000	0.000	0.032	0.032
20:12:00	0.000	0.000	0.000	0.000	0.032	0.032
20:18:00	0.000	0.000	0.000	0.000	0.032	0.032
20:24:00	0.000	0.000	0.000	0.000	0.032	0.032
20:30:00	0.000	0.000	0.000	0.000	0.032	0.032
20:36:00	0.000	0.000	0.000	0.000	0.032	0.032
20:42:00	0.000	0.000	0.000	0.000	0.032	0.032
20:48:00	0.000	0.000	0.000	0.000	0.031	0.031
20:54:00	0.000	0.000	0.000	0.000	0.031	0.031
21:00:00	0.000	0.000	0.000	0.000	0.031	0.031
21:06:00	0.000	0.000	0.000	0.000	0.031	0.031
21:12:00	0.000	0.000	0.000	0.000	0.031	0.031
21:18:00	0.000	0.000	0.000	0.000	0.031	0.031
21:24:00	0.000	0.000	0.000	0.000	0.031	0.031

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
21:30:00	0.000	0.000	0.000	0.000	0.031	0.031
21:36:00	0.000	0.000	0.000	0.000	0.031	0.031
21:42:00	0.000	0.000	0.000	0.000	0.031	0.031
21:48:00	0.000	0.000	0.000	0.000	0.031	0.031
21:54:00	0.000	0.000	0.000	0.000	0.031	0.031
22:00:00	0.000	0.000	0.000	0.000	0.031	0.031
22:06:00	0.000	0.000	0.000	0.000	0.030	0.030
22:12:00	0.000	0.000	0.000	0.000	0.030	0.030
22:18:00	0.000	0.000	0.000	0.000	0.030	0.030
22:24:00	0.000	0.000	0.000	0.000	0.030	0.030
22:30:00	0.000	0.000	0.000	0.000	0.030	0.030
22:36:00	0.000	0.000	0.000	0.000	0.030	0.030
22:42:00	0.000	0.000	0.000	0.000	0.030	0.030
22:48:00	0.000	0.000	0.000	0.000	0.030	0.030
22:54:00	0.000	0.000	0.000	0.000	0.030	0.030
23:00:00	0.000	0.000	0.000	0.000	0.030	0.030
23:06:00	0.000	0.000	0.000	0.000	0.030	0.030
23:12:00	0.000	0.000	0.000	0.000	0.030	0.030
23:18:00	0.000	0.000	0.000	0.000	0.030	0.030
23:24:00	0.000	0.000	0.000	0.000	0.029	0.029
23:30:00	0.000	0.000	0.000	0.000	0.029	0.029
23:36:00	0.000	0.000	0.000	0.000	0.029	0.029
23:42:00	0.000	0.000	0.000	0.000	0.029	0.029
23:48:00	0.000	0.000	0.000	0.000	0.029	0.029
23:54:00	0.000	0.000	0.000	0.000	0.029	0.029
24:00:00	0.000	0.000	0.000	0.000	0.029	0.029
24:06:00	0.000	0.000	0.000	0.000	0.029	0.029
24:12:00	0.000	0.000	0.000	0.000	0.029	0.029
24:18:00	0.000	0.000	0.000	0.000	0.029	0.029
24:24:00	0.000	0.000	0.000	0.000	0.029	0.029
24:30:00	0.000	0.000	0.000	0.000	0.029	0.029
24:36:00	0.000	0.000	0.000	0.000	0.029	0.029
24:42:00	0.000	0.000	0.000	0.000	0.029	0.029
24:48:00	0.000	0.000	0.000	0.000	0.028	0.028
24:54:00	0.000	0.000	0.000	0.000	0.028	0.028
25:00:00	0.000	0.000	0.000	0.000	0.028	0.028

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
25:06:00	0.000	0.000	0.000	0.000	0.028	0.028
25:12:00	0.000	0.000	0.000	0.000	0.028	0.028
25:18:00	0.000	0.000	0.000	0.000	0.028	0.028
25:24:00	0.000	0.000	0.000	0.000	0.028	0.028
25:30:00	0.000	0.000	0.000	0.000	0.028	0.028
25:36:00	0.000	0.000	0.000	0.000	0.028	0.028
25:42:00	0.000	0.000	0.000	0.000	0.028	0.028
25:48:00	0.000	0.000	0.000	0.000	0.028	0.028
25:54:00	0.000	0.000	0.000	0.000	0.028	0.028
26:00:00	0.000	0.000	0.000	0.000	0.028	0.028
26:06:00	0.000	0.000	0.000	0.000	0.028	0.028
26:12:00	0.000	0.000	0.000	0.000	0.028	0.028
26:18:00	0.000	0.000	0.000	0.000	0.027	0.027
26:24:00	0.000	0.000	0.000	0.000	0.027	0.027
26:30:00	0.000	0.000	0.000	0.000	0.027	0.027
26:36:00	0.000	0.000	0.000	0.000	0.027	0.027
26:42:00	0.000	0.000	0.000	0.000	0.027	0.027
26:48:00	0.000	0.000	0.000	0.000	0.027	0.027
26:54:00	0.000	0.000	0.000	0.000	0.027	0.027
27:00:00	0.000	0.000	0.000	0.000	0.027	0.027
27:06:00	0.000	0.000	0.000	0.000	0.027	0.027
27:12:00	0.000	0.000	0.000	0.000	0.027	0.027
27:18:00	0.000	0.000	0.000	0.000	0.027	0.027
27:24:00	0.000	0.000	0.000	0.000	0.027	0.027
27:30:00	0.000	0.000	0.000	0.000	0.027	0.027
27:36:00	0.000	0.000	0.000	0.000	0.027	0.027
27:42:00	0.000	0.000	0.000	0.000	0.027	0.027
27:48:00	0.000	0.000	0.000	0.000	0.026	0.026
27:54:00	0.000	0.000	0.000	0.000	0.026	0.026
28:00:00	0.000	0.000	0.000	0.000	0.026	0.026
28:06:00	0.000	0.000	0.000	0.000	0.026	0.026
28:12:00	0.000	0.000	0.000	0.000	0.026	0.026
28:18:00	0.000	0.000	0.000	0.000	0.026	0.026
28:24:00	0.000	0.000	0.000	0.000	0.026	0.026
28:30:00	0.000	0.000	0.000	0.000	0.026	0.026
28:36:00	0.000	0.000	0.000	0.000	0.026	0.026

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
28:42:00	0.000	0.000	0.000	0.000	0.026	0.026
28:48:00	0.000	0.000	0.000	0.000	0.026	0.026
28:54:00	0.000	0.000	0.000	0.000	0.026	0.026
29:00:00	0.000	0.000	0.000	0.000	0.026	0.026
29:06:00	0.000	0.000	0.000	0.000	0.026	0.026
29:12:00	0.000	0.000	0.000	0.000	0.026	0.026
29:18:00	0.000	0.000	0.000	0.000	0.026	0.026
29:24:00	0.000	0.000	0.000	0.000	0.025	0.025
29:30:00	0.000	0.000	0.000	0.000	0.025	0.025
29:36:00	0.000	0.000	0.000	0.000	0.025	0.025
29:42:00	0.000	0.000	0.000	0.000	0.025	0.025
29:48:00	0.000	0.000	0.000	0.000	0.025	0.025
29:54:00	0.000	0.000	0.000	0.000	0.025	0.025
30:00:00	0.000	0.000	0.000	0.000	0.025	0.025
30:06:00	0.000	0.000	0.000	0.000	0.025	0.025
30:12:00	0.000	0.000	0.000	0.000	0.025	0.025
30:18:00	0.000	0.000	0.000	0.000	0.025	0.025
30:24:00	0.000	0.000	0.000	0.000	0.025	0.025
30:30:00	0.000	0.000	0.000	0.000	0.025	0.025
30:36:00	0.000	0.000	0.000	0.000	0.025	0.025
30:42:00	0.000	0.000	0.000	0.000	0.025	0.025
30:48:00	0.000	0.000	0.000	0.000	0.025	0.025
30:54:00	0.000	0.000	0.000	0.000	0.025	0.025
31:00:00	0.000	0.000	0.000	0.000	0.024	0.024
31:06:00	0.000	0.000	0.000	0.000	0.024	0.024
31:12:00	0.000	0.000	0.000	0.000	0.024	0.024
31:18:00	0.000	0.000	0.000	0.000	0.024	0.024
31:24:00	0.000	0.000	0.000	0.000	0.024	0.024
31:30:00	0.000	0.000	0.000	0.000	0.024	0.024
31:36:00	0.000	0.000	0.000	0.000	0.024	0.024
31:42:00	0.000	0.000	0.000	0.000	0.024	0.024
31:48:00	0.000	0.000	0.000	0.000	0.024	0.024
31:54:00	0.000	0.000	0.000	0.000	0.024	0.024
32:00:00	0.000	0.000	0.000	0.000	0.024	0.024
32:06:00	0.000	0.000	0.000	0.000	0.024	0.024
32:12:00	0.000	0.000	0.000	0.000	0.024	0.024

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
32:18:00	0.000	0.000	0.000	0.000	0.024	0.024
32:24:00	0.000	0.000	0.000	0.000	0.024	0.024
32:30:00	0.000	0.000	0.000	0.000	0.024	0.024
32:36:00	0.000	0.000	0.000	0.000	0.024	0.024
32:42:00	0.000	0.000	0.000	0.000	0.023	0.023
32:48:00	0.000	0.000	0.000	0.000	0.023	0.023
32:54:00	0.000	0.000	0.000	0.000	0.023	0.023
33:00:00	0.000	0.000	0.000	0.000	0.023	0.023
33:06:00	0.000	0.000	0.000	0.000	0.023	0.023
33:12:00	0.000	0.000	0.000	0.000	0.023	0.023
33:18:00	0.000	0.000	0.000	0.000	0.023	0.023
33:24:00	0.000	0.000	0.000	0.000	0.023	0.023
33:30:00	0.000	0.000	0.000	0.000	0.023	0.023
33:36:00	0.000	0.000	0.000	0.000	0.023	0.023
33:42:00	0.000	0.000	0.000	0.000	0.023	0.023
33:48:00	0.000	0.000	0.000	0.000	0.023	0.023
33:54:00	0.000	0.000	0.000	0.000	0.023	0.023
34:00:00	0.000	0.000	0.000	0.000	0.023	0.023
34:06:00	0.000	0.000	0.000	0.000	0.023	0.023
34:12:00	0.000	0.000	0.000	0.000	0.023	0.023
34:18:00	0.000	0.000	0.000	0.000	0.023	0.023
34:24:00	0.000	0.000	0.000	0.000	0.023	0.023
34:30:00	0.000	0.000	0.000	0.000	0.022	0.022
34:36:00	0.000	0.000	0.000	0.000	0.022	0.022
34:42:00	0.000	0.000	0.000	0.000	0.022	0.022
34:48:00	0.000	0.000	0.000	0.000	0.022	0.022
34:54:00	0.000	0.000	0.000	0.000	0.022	0.022
35:00:00	0.000	0.000	0.000	0.000	0.022	0.022
35:06:00	0.000	0.000	0.000	0.000	0.022	0.022
35:12:00	0.000	0.000	0.000	0.000	0.022	0.022
35:18:00	0.000	0.000	0.000	0.000	0.022	0.022
35:24:00	0.000	0.000	0.000	0.000	0.022	0.022
35:30:00	0.000	0.000	0.000	0.000	0.022	0.022
35:36:00	0.000	0.000	0.000	0.000	0.022	0.022
35:42:00	0.000	0.000	0.000	0.000	0.022	0.022
35:48:00	0.000	0.000	0.000	0.000	0.022	0.022

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
35:54:00	0.000	0.000	0.000	0.000	0.022	0.022
36:00:00	0.000	0.000	0.000	0.000	0.022	0.022
36:06:00	0.000	0.000	0.000	0.000	0.022	0.022
36:12:00	0.000	0.000	0.000	0.000	0.022	0.022
36:18:00	0.000	0.000	0.000	0.000	0.021	0.021
36:24:00	0.000	0.000	0.000	0.000	0.021	0.021
36:30:00	0.000	0.000	0.000	0.000	0.021	0.021
36:36:00	0.000	0.000	0.000	0.000	0.021	0.021
36:42:00	0.000	0.000	0.000	0.000	0.021	0.021
36:48:00	0.000	0.000	0.000	0.000	0.021	0.021
36:54:00	0.000	0.000	0.000	0.000	0.021	0.021
37:00:00	0.000	0.000	0.000	0.000	0.021	0.021
37:06:00	0.000	0.000	0.000	0.000	0.021	0.021
37:12:00	0.000	0.000	0.000	0.000	0.021	0.021
37:18:00	0.000	0.000	0.000	0.000	0.021	0.021
37:24:00	0.000	0.000	0.000	0.000	0.021	0.021
37:30:00	0.000	0.000	0.000	0.000	0.021	0.021
37:36:00	0.000	0.000	0.000	0.000	0.021	0.021
37:42:00	0.000	0.000	0.000	0.000	0.021	0.021
37:48:00	0.000	0.000	0.000	0.000	0.021	0.021
37:54:00	0.000	0.000	0.000	0.000	0.021	0.021
38:00:00	0.000	0.000	0.000	0.000	0.021	0.021
38:06:00	0.000	0.000	0.000	0.000	0.021	0.021
38:12:00	0.000	0.000	0.000	0.000	0.020	0.020
38:18:00	0.000	0.000	0.000	0.000	0.020	0.020
38:24:00	0.000	0.000	0.000	0.000	0.020	0.020
38:30:00	0.000	0.000	0.000	0.000	0.020	0.020
38:36:00	0.000	0.000	0.000	0.000	0.020	0.020
38:42:00	0.000	0.000	0.000	0.000	0.020	0.020
38:48:00	0.000	0.000	0.000	0.000	0.020	0.020
38:54:00	0.000	0.000	0.000	0.000	0.020	0.020
39:00:00	0.000	0.000	0.000	0.000	0.020	0.020
39:06:00	0.000	0.000	0.000	0.000	0.020	0.020
39:12:00	0.000	0.000	0.000	0.000	0.020	0.020
39:18:00	0.000	0.000	0.000	0.000	0.020	0.020
39:24:00	0.000	0.000	0.000	0.000	0.020	0.020

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
39:30:00	0.000	0.000	0.000	0.000	0.020	0.020
39:36:00	0.000	0.000	0.000	0.000	0.020	0.020
39:42:00	0.000	0.000	0.000	0.000	0.020	0.020
39:48:00	0.000	0.000	0.000	0.000	0.020	0.020
39:54:00	0.000	0.000	0.000	0.000	0.020	0.020
40:00:00	0.000	0.000	0.000	0.000	0.020	0.020
40:06:00	0.000	0.000	0.000	0.000	0.020	0.020
40:12:00	0.000	0.000	0.000	0.000	0.020	0.020
40:18:00	0.000	0.000	0.000	0.000	0.019	0.019
40:24:00	0.000	0.000	0.000	0.000	0.019	0.019
40:30:00	0.000	0.000	0.000	0.000	0.019	0.019
40:36:00	0.000	0.000	0.000	0.000	0.019	0.019
40:42:00	0.000	0.000	0.000	0.000	0.019	0.019
40:48:00	0.000	0.000	0.000	0.000	0.019	0.019
40:54:00	0.000	0.000	0.000	0.000	0.019	0.019
41:00:00	0.000	0.000	0.000	0.000	0.019	0.019
41:06:00	0.000	0.000	0.000	0.000	0.019	0.019
41:12:00	0.000	0.000	0.000	0.000	0.019	0.019
41:18:00	0.000	0.000	0.000	0.000	0.019	0.019
41:24:00	0.000	0.000	0.000	0.000	0.019	0.019
41:30:00	0.000	0.000	0.000	0.000	0.019	0.019
41:36:00	0.000	0.000	0.000	0.000	0.019	0.019
41:42:00	0.000	0.000	0.000	0.000	0.019	0.019
41:48:00	0.000	0.000	0.000	0.000	0.019	0.019
41:54:00	0.000	0.000	0.000	0.000	0.019	0.019
42:00:00	0.000	0.000	0.000	0.000	0.019	0.019
42:06:00	0.000	0.000	0.000	0.000	0.019	0.019
42:12:00	0.000	0.000	0.000	0.000	0.019	0.019
42:18:00	0.000	0.000	0.000	0.000	0.019	0.019
42:24:00	0.000	0.000	0.000	0.000	0.018	0.018
42:30:00	0.000	0.000	0.000	0.000	0.018	0.018
42:36:00	0.000	0.000	0.000	0.000	0.018	0.018
42:42:00	0.000	0.000	0.000	0.000	0.018	0.018
42:48:00	0.000	0.000	0.000	0.000	0.018	0.018
42:54:00	0.000	0.000	0.000	0.000	0.018	0.018
43:00:00	0.000	0.000	0.000	0.000	0.018	0.018

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m³/s)	Baseflow (m³/s)	Total Flow (m³/s)
43:06:00	0.000	0.000	0.000	0.000	0.018	0.018
43:12:00	0.000	0.000	0.000	0.000	0.018	0.018
43:18:00	0.000	0.000	0.000	0.000	0.018	0.018
43:24:00	0.000	0.000	0.000	0.000	0.018	0.018
43:30:00	0.000	0.000	0.000	0.000	0.018	0.018
43:36:00	0.000	0.000	0.000	0.000	0.018	0.018
43:42:00	0.000	0.000	0.000	0.000	0.018	0.018
43:48:00	0.000	0.000	0.000	0.000	0.018	0.018
43:54:00	0.000	0.000	0.000	0.000	0.018	0.018
44:00:00	0.000	0.000	0.000	0.000	0.018	0.018
44:06:00	0.000	0.000	0.000	0.000	0.018	0.018
44:12:00	0.000	0.000	0.000	0.000	0.018	0.018
44:18:00	0.000	0.000	0.000	0.000	0.018	0.018
44:24:00	0.000	0.000	0.000	0.000	0.018	0.018
44:30:00	0.000	0.000	0.000	0.000	0.018	0.018
44:36:00	0.000	0.000	0.000	0.000	0.018	0.018
44:42:00	0.000	0.000	0.000	0.000	0.017	0.017
44:48:00	0.000	0.000	0.000	0.000	0.017	0.017
44:54:00	0.000	0.000	0.000	0.000	0.017	0.017
45:00:00	0.000	0.000	0.000	0.000	0.017	0.017
45:06:00	0.000	0.000	0.000	0.000	0.017	0.017
45:12:00	0.000	0.000	0.000	0.000	0.017	0.017
45:18:00	0.000	0.000	0.000	0.000	0.017	0.017
45:24:00	0.000	0.000	0.000	0.000	0.017	0.017
45:30:00	0.000	0.000	0.000	0.000	0.017	0.017
45:36:00	0.000	0.000	0.000	0.000	0.017	0.017
45:42:00	0.000	0.000	0.000	0.000	0.017	0.017
45:48:00	0.000	0.000	0.000	0.000	0.017	0.017
45:54:00	0.000	0.000	0.000	0.000	0.017	0.017
46:00:00	0.000	0.000	0.000	0.000	0.017	0.017
46:06:00	0.000	0.000	0.000	0.000	0.017	0.017
46:12:00	0.000	0.000	0.000	0.000	0.017	0.017
46:18:00	0.000	0.000	0.000	0.000	0.017	0.017
46:24:00	0.000	0.000	0.000	0.000	0.017	0.017
46:30:00	0.000	0.000	0.000	0.000	0.017	0.017
46:36:00	0.000	0.000	0.000	0.000	0.017	0.017

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
46:42:00	0.000	0.000	0.000	0.000	0.017	0.017
46:48:00	0.000	0.000	0.000	0.000	0.017	0.017
46:54:00	0.000	0.000	0.000	0.000	0.017	0.017
47:00:00	0.000	0.000	0.000	0.000	0.017	0.017
47:06:00	0.000	0.000	0.000	0.000	0.016	0.016
47:12:00	0.000	0.000	0.000	0.000	0.016	0.016
47:18:00	0.000	0.000	0.000	0.000	0.016	0.016
47:24:00	0.000	0.000	0.000	0.000	0.016	0.016
47:30:00	0.000	0.000	0.000	0.000	0.016	0.016
47:36:00	0.000	0.000	0.000	0.000	0.016	0.016
47:42:00	0.000	0.000	0.000	0.000	0.016	0.016
47:48:00	0.000	0.000	0.000	0.000	0.016	0.016
47:54:00	0.000	0.000	0.000	0.000	0.016	0.016
48:00:00	0.000	0.000	0.000	0.000	0.016	0.016
48:06:00	0.000	0.000	0.000	0.000	0.016	0.016
48:12:00	0.000	0.000	0.000	0.000	0.016	0.016
48:18:00	0.000	0.000	0.000	0.000	0.016	0.016
48:24:00	0.000	0.000	0.000	0.000	0.016	0.016
48:30:00	0.000	0.000	0.000	0.000	0.016	0.016
48:36:00	0.000	0.000	0.000	0.000	0.016	0.016
48:42:00	0.000	0.000	0.000	0.000	0.016	0.016
48:48:00	0.000	0.000	0.000	0.000	0.016	0.016
48:54:00	0.000	0.000	0.000	0.000	0.016	0.016
49:00:00	0.000	0.000	0.000	0.000	0.016	0.016
49:06:00	0.000	0.000	0.000	0.000	0.016	0.016
49:12:00	0.000	0.000	0.000	0.000	0.016	0.016
49:18:00	0.000	0.000	0.000	0.000	0.016	0.016
49:24:00	0.000	0.000	0.000	0.000	0.016	0.016
49:30:00	0.000	0.000	0.000	0.000	0.016	0.016
49:36:00	0.000	0.000	0.000	0.000	0.015	0.015
49:42:00	0.000	0.000	0.000	0.000	0.015	0.015
49:48:00	0.000	0.000	0.000	0.000	0.015	0.015
49:54:00	0.000	0.000	0.000	0.000	0.015	0.015
50:00:00	0.000	0.000	0.000	0.000	0.015	0.015
50:06:00	0.000	0.000	0.000	0.000	0.015	0.015
50:12:00	0.000	0.000	0.000	0.000	0.015	0.015

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
50:18:00	0.000	0.000	0.000	0.000	0.015	0.015
50:24:00	0.000	0.000	0.000	0.000	0.015	0.015
50:30:00	0.000	0.000	0.000	0.000	0.015	0.015
50:36:00	0.000	0.000	0.000	0.000	0.015	0.015
50:42:00	0.000	0.000	0.000	0.000	0.015	0.015
50:48:00	0.000	0.000	0.000	0.000	0.015	0.015
50:54:00	0.000	0.000	0.000	0.000	0.015	0.015
51:00:00	0.000	0.000	0.000	0.000	0.015	0.015
51:06:00	0.000	0.000	0.000	0.000	0.015	0.015
51:12:00	0.000	0.000	0.000	0.000	0.015	0.015
51:18:00	0.000	0.000	0.000	0.000	0.015	0.015
51:24:00	0.000	0.000	0.000	0.000	0.015	0.015
51:30:00	0.000	0.000	0.000	0.000	0.015	0.015
51:36:00	0.000	0.000	0.000	0.000	0.015	0.015
51:42:00	0.000	0.000	0.000	0.000	0.015	0.015
51:48:00	0.000	0.000	0.000	0.000	0.015	0.015
51:54:00	0.000	0.000	0.000	0.000	0.015	0.015
52:00:00	0.000	0.000	0.000	0.000	0.015	0.015
52:06:00	0.000	0.000	0.000	0.000	0.015	0.015
52:12:00	0.000	0.000	0.000	0.000	0.015	0.015
52:18:00	0.000	0.000	0.000	0.000	0.014	0.014
52:24:00	0.000	0.000	0.000	0.000	0.014	0.014
52:30:00	0.000	0.000	0.000	0.000	0.014	0.014
52:36:00	0.000	0.000	0.000	0.000	0.014	0.014
52:42:00	0.000	0.000	0.000	0.000	0.014	0.014
52:48:00	0.000	0.000	0.000	0.000	0.014	0.014
52:54:00	0.000	0.000	0.000	0.000	0.014	0.014
53:00:00	0.000	0.000	0.000	0.000	0.014	0.014
53:06:00	0.000	0.000	0.000	0.000	0.014	0.014
53:12:00	0.000	0.000	0.000	0.000	0.014	0.014
53:18:00	0.000	0.000	0.000	0.000	0.014	0.014
53:24:00	0.000	0.000	0.000	0.000	0.014	0.014
53:30:00	0.000	0.000	0.000	0.000	0.014	0.014
53:36:00	0.000	0.000	0.000	0.000	0.014	0.014
53:42:00	0.000	0.000	0.000	0.000	0.014	0.014
53:48:00	0.000	0.000	0.000	0.000	0.014	0.014

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
53:54:00	0.000	0.000	0.000	0.000	0.014	0.014
54:00:00	0.000	0.000	0.000	0.000	0.014	0.014
54:06:00	0.000	0.000	0.000	0.000	0.014	0.014
54:12:00	0.000	0.000	0.000	0.000	0.014	0.014
54:18:00	0.000	0.000	0.000	0.000	0.014	0.014
54:24:00	0.000	0.000	0.000	0.000	0.014	0.014
54:30:00	0.000	0.000	0.000	0.000	0.014	0.014
54:36:00	0.000	0.000	0.000	0.000	0.014	0.014
54:42:00	0.000	0.000	0.000	0.000	0.014	0.014
54:48:00	0.000	0.000	0.000	0.000	0.014	0.014
54:54:00	0.000	0.000	0.000	0.000	0.014	0.014
55:00:00	0.000	0.000	0.000	0.000	0.014	0.014
55:06:00	0.000	0.000	0.000	0.000	0.014	0.014
55:12:00	0.000	0.000	0.000	0.000	0.013	0.013
55:18:00	0.000	0.000	0.000	0.000	0.013	0.013
55:24:00	0.000	0.000	0.000	0.000	0.013	0.013
55:30:00	0.000	0.000	0.000	0.000	0.013	0.013
55:36:00	0.000	0.000	0.000	0.000	0.013	0.013
55:42:00	0.000	0.000	0.000	0.000	0.013	0.013
55:48:00	0.000	0.000	0.000	0.000	0.013	0.013
55:54:00	0.000	0.000	0.000	0.000	0.013	0.013
56:00:00	0.000	0.000	0.000	0.000	0.013	0.013
56:06:00	0.000	0.000	0.000	0.000	0.013	0.013
56:12:00	0.000	0.000	0.000	0.000	0.013	0.013
56:18:00	0.000	0.000	0.000	0.000	0.013	0.013
56:24:00	0.000	0.000	0.000	0.000	0.013	0.013
56:30:00	0.000	0.000	0.000	0.000	0.013	0.013
56:36:00	0.000	0.000	0.000	0.000	0.013	0.013
56:42:00	0.000	0.000	0.000	0.000	0.013	0.013
56:48:00	0.000	0.000	0.000	0.000	0.013	0.013
56:54:00	0.000	0.000	0.000	0.000	0.013	0.013
57:00:00	0.000	0.000	0.000	0.000	0.013	0.013
57:06:00	0.000	0.000	0.000	0.000	0.013	0.013
57:12:00	0.000	0.000	0.000	0.000	0.013	0.013
57:18:00	0.000	0.000	0.000	0.000	0.013	0.013
57:24:00	0.000	0.000	0.000	0.000	0.013	0.013

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
57:30:00	0.000	0.000	0.000	0.000	0.013	0.013
57:36:00	0.000	0.000	0.000	0.000	0.013	0.013
57:42:00	0.000	0.000	0.000	0.000	0.013	0.013
57:48:00	0.000	0.000	0.000	0.000	0.013	0.013
57:54:00	0.000	0.000	0.000	0.000	0.013	0.013
58:00:00	0.000	0.000	0.000	0.000	0.013	0.013
58:06:00	0.000	0.000	0.000	0.000	0.013	0.013
58:12:00	0.000	0.000	0.000	0.000	0.013	0.013
58:18:00	0.000	0.000	0.000	0.000	0.013	0.013
58:24:00	0.000	0.000	0.000	0.000	0.012	0.012
58:30:00	0.000	0.000	0.000	0.000	0.012	0.012
58:36:00	0.000	0.000	0.000	0.000	0.012	0.012
58:42:00	0.000	0.000	0.000	0.000	0.012	0.012
58:48:00	0.000	0.000	0.000	0.000	0.012	0.012
58:54:00	0.000	0.000	0.000	0.000	0.012	0.012
59:00:00	0.000	0.000	0.000	0.000	0.012	0.012
59:06:00	0.000	0.000	0.000	0.000	0.012	0.012
59:12:00	0.000	0.000	0.000	0.000	0.012	0.012
59:18:00	0.000	0.000	0.000	0.000	0.012	0.012
59:24:00	0.000	0.000	0.000	0.000	0.012	0.012
59:30:00	0.000	0.000	0.000	0.000	0.012	0.012
59:36:00	0.000	0.000	0.000	0.000	0.012	0.012
59:42:00	0.000	0.000	0.000	0.000	0.012	0.012
59:48:00	0.000	0.000	0.000	0.000	0.012	0.012
59:54:00	0.000	0.000	0.000	0.000	0.012	0.012
60:00:00	0.000	0.000	0.000	0.000	0.012	0.012
60:06:00	0.000	0.000	0.000	0.000	0.012	0.012
60:12:00	0.000	0.000	0.000	0.000	0.012	0.012
60:18:00	0.000	0.000	0.000	0.000	0.012	0.012
60:24:00	0.000	0.000	0.000	0.000	0.012	0.012
60:30:00	0.000	0.000	0.000	0.000	0.012	0.012
60:36:00	0.000	0.000	0.000	0.000	0.012	0.012
60:42:00	0.000	0.000	0.000	0.000	0.012	0.012
60:48:00	0.000	0.000	0.000	0.000	0.012	0.012
60:54:00	0.000	0.000	0.000	0.000	0.012	0.012
61:00:00	0.000	0.000	0.000	0.000	0.012	0.012

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
61:06:00	0.000	0.000	0.000	0.000	0.012	0.012
61:12:00	0.000	0.000	0.000	0.000	0.012	0.012
61:18:00	0.000	0.000	0.000	0.000	0.012	0.012
61:24:00	0.000	0.000	0.000	0.000	0.012	0.012
61:30:00	0.000	0.000	0.000	0.000	0.012	0.012
61:36:00	0.000	0.000	0.000	0.000	0.012	0.012
61:42:00	0.000	0.000	0.000	0.000	0.012	0.012
61:48:00	0.000	0.000	0.000	0.000	0.011	0.011
61:54:00	0.000	0.000	0.000	0.000	0.011	0.011
62:00:00	0.000	0.000	0.000	0.000	0.011	0.011
62:06:00	0.000	0.000	0.000	0.000	0.011	0.011
62:12:00	0.000	0.000	0.000	0.000	0.011	0.011
62:18:00	0.000	0.000	0.000	0.000	0.011	0.011
62:24:00	0.000	0.000	0.000	0.000	0.011	0.011
62:30:00	0.000	0.000	0.000	0.000	0.011	0.011
62:36:00	0.000	0.000	0.000	0.000	0.011	0.011
62:42:00	0.000	0.000	0.000	0.000	0.011	0.011
62:48:00	0.000	0.000	0.000	0.000	0.011	0.011
62:54:00	0.000	0.000	0.000	0.000	0.011	0.011
63:00:00	0.000	0.000	0.000	0.000	0.011	0.011
63:06:00	0.000	0.000	0.000	0.000	0.011	0.011
63:12:00	0.000	0.000	0.000	0.000	0.011	0.011
63:18:00	0.000	0.000	0.000	0.000	0.011	0.011
63:24:00	0.000	0.000	0.000	0.000	0.011	0.011
63:30:00	0.000	0.000	0.000	0.000	0.011	0.011
63:36:00	0.000	0.000	0.000	0.000	0.011	0.011
63:42:00	0.000	0.000	0.000	0.000	0.011	0.011
63:48:00	0.000	0.000	0.000	0.000	0.011	0.011
63:54:00	0.000	0.000	0.000	0.000	0.011	0.011
64:00:00	0.000	0.000	0.000	0.000	0.011	0.011
64:06:00	0.000	0.000	0.000	0.000	0.011	0.011
64:12:00	0.000	0.000	0.000	0.000	0.011	0.011
64:18:00	0.000	0.000	0.000	0.000	0.011	0.011
64:24:00	0.000	0.000	0.000	0.000	0.011	0.011
64:30:00	0.000	0.000	0.000	0.000	0.011	0.011
64:36:00	0.000	0.000	0.000	0.000	0.011	0.011

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
64:42:00	0.000	0.000	0.000	0.000	0.011	0.011
64:48:00	0.000	0.000	0.000	0.000	0.011	0.011
64:54:00	0.000	0.000	0.000	0.000	0.011	0.011
65:00:00	0.000	0.000	0.000	0.000	0.011	0.011
65:06:00	0.000	0.000	0.000	0.000	0.011	0.011
65:12:00	0.000	0.000	0.000	0.000	0.011	0.011
65:18:00	0.000	0.000	0.000	0.000	0.011	0.011
65:24:00	0.000	0.000	0.000	0.000	0.011	0.011
65:30:00	0.000	0.000	0.000	0.000	0.010	0.010
65:36:00	0.000	0.000	0.000	0.000	0.010	0.010
65:42:00	0.000	0.000	0.000	0.000	0.010	0.010
65:48:00	0.000	0.000	0.000	0.000	0.010	0.010
65:54:00	0.000	0.000	0.000	0.000	0.010	0.010
66:00:00	0.000	0.000	0.000	0.000	0.010	0.010
66:06:00	0.000	0.000	0.000	0.000	0.010	0.010
66:12:00	0.000	0.000	0.000	0.000	0.010	0.010
66:18:00	0.000	0.000	0.000	0.000	0.010	0.010
66:24:00	0.000	0.000	0.000	0.000	0.010	0.010
66:30:00	0.000	0.000	0.000	0.000	0.010	0.010
66:36:00	0.000	0.000	0.000	0.000	0.010	0.010
66:42:00	0.000	0.000	0.000	0.000	0.010	0.010
66:48:00	0.000	0.000	0.000	0.000	0.010	0.010
66:54:00	0.000	0.000	0.000	0.000	0.010	0.010
67:00:00	0.000	0.000	0.000	0.000	0.010	0.010
67:06:00	0.000	0.000	0.000	0.000	0.010	0.010
67:12:00	0.000	0.000	0.000	0.000	0.010	0.010
67:18:00	0.000	0.000	0.000	0.000	0.010	0.010
67:24:00	0.000	0.000	0.000	0.000	0.010	0.010
67:30:00	0.000	0.000	0.000	0.000	0.010	0.010
67:36:00	0.000	0.000	0.000	0.000	0.010	0.010
67:42:00	0.000	0.000	0.000	0.000	0.010	0.010
67:48:00	0.000	0.000	0.000	0.000	0.010	0.010
67:54:00	0.000	0.000	0.000	0.000	0.010	0.010
68:00:00	0.000	0.000	0.000	0.000	0.010	0.010
68:06:00	0.000	0.000	0.000	0.000	0.010	0.010
68:12:00	0.000	0.000	0.000	0.000	0.010	0.010

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m³/s)	Baseflow (m³/s)	Total Flow (m³/s)
68:18:00	0.000	0.000	0.000	0.000	0.010	0.010
68:24:00	0.000	0.000	0.000	0.000	0.010	0.010
68:30:00	0.000	0.000	0.000	0.000	0.010	0.010
68:36:00	0.000	0.000	0.000	0.000	0.010	0.010
68:42:00	0.000	0.000	0.000	0.000	0.010	0.010
68:48:00	0.000	0.000	0.000	0.000	0.010	0.010
68:54:00	0.000	0.000	0.000	0.000	0.010	0.010
69:00:00	0.000	0.000	0.000	0.000	0.010	0.010
69:06:00	0.000	0.000	0.000	0.000	0.010	0.010
69:12:00	0.000	0.000	0.000	0.000	0.010	0.010
69:18:00	0.000	0.000	0.000	0.000	0.010	0.010
69:24:00	0.000	0.000	0.000	0.000	0.010	0.010
69:30:00	0.000	0.000	0.000	0.000	0.009	0.009
69:36:00	0.000	0.000	0.000	0.000	0.009	0.009
69:42:00	0.000	0.000	0.000	0.000	0.009	0.009
69:48:00	0.000	0.000	0.000	0.000	0.009	0.009
69:54:00	0.000	0.000	0.000	0.000	0.009	0.009
70:00:00	0.000	0.000	0.000	0.000	0.009	0.009
70:06:00	0.000	0.000	0.000	0.000	0.009	0.009
70:12:00	0.000	0.000	0.000	0.000	0.009	0.009
70:18:00	0.000	0.000	0.000	0.000	0.009	0.009
70:24:00	0.000	0.000	0.000	0.000	0.009	0.009
70:30:00	0.000	0.000	0.000	0.000	0.009	0.009
70:36:00	0.000	0.000	0.000	0.000	0.009	0.009
70:42:00	0.000	0.000	0.000	0.000	0.009	0.009
70:48:00	0.000	0.000	0.000	0.000	0.009	0.009
70:54:00	0.000	0.000	0.000	0.000	0.009	0.009
71:00:00	0.000	0.000	0.000	0.000	0.009	0.009
71:06:00	0.000	0.000	0.000	0.000	0.009	0.009
71:12:00	0.000	0.000	0.000	0.000	0.009	0.009
71:18:00	0.000	0.000	0.000	0.000	0.009	0.009
71:24:00	0.000	0.000	0.000	0.000	0.009	0.009
71:30:00	0.000	0.000	0.000	0.000	0.009	0.009
71:36:00	0.000	0.000	0.000	0.000	0.009	0.009
71:42:00	0.000	0.000	0.000	0.000	0.009	0.009
71:48:00	0.000	0.000	0.000	0.000	0.009	0.009

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
71:54:00	0.000	0.000	0.000	0.000	0.009	0.009
72:00:00	0.000	0.000	0.000	0.000	0.009	0.009
72:06:00	0.000	0.000	0.000	0.000	0.009	0.009
72:12:00	0.000	0.000	0.000	0.000	0.009	0.009
72:18:00	0.000	0.000	0.000	0.000	0.009	0.009
72:24:00	0.000	0.000	0.000	0.000	0.009	0.009
72:30:00	0.000	0.000	0.000	0.000	0.009	0.009
72:36:00	0.000	0.000	0.000	0.000	0.009	0.009
72:42:00	0.000	0.000	0.000	0.000	0.009	0.009
72:48:00	0.000	0.000	0.000	0.000	0.009	0.009
72:54:00	0.000	0.000	0.000	0.000	0.009	0.009
73:00:00	0.000	0.000	0.000	0.000	0.009	0.009
73:06:00	0.000	0.000	0.000	0.000	0.009	0.009
73:12:00	0.000	0.000	0.000	0.000	0.009	0.009
73:18:00	0.000	0.000	0.000	0.000	0.009	0.009
73:24:00	0.000	0.000	0.000	0.000	0.009	0.009
73:30:00	0.000	0.000	0.000	0.000	0.009	0.009
73:36:00	0.000	0.000	0.000	0.000	0.009	0.009
73:42:00	0.000	0.000	0.000	0.000	0.009	0.009
73:48:00	0.000	0.000	0.000	0.000	0.009	0.009
73:54:00	0.000	0.000	0.000	0.000	0.009	0.009
74:00:00	0.000	0.000	0.000	0.000	0.009	0.009
74:06:00	0.000	0.000	0.000	0.000	0.008	0.008
74:12:00	0.000	0.000	0.000	0.000	0.008	0.008
74:18:00	0.000	0.000	0.000	0.000	0.008	0.008
74:24:00	0.000	0.000	0.000	0.000	0.008	0.008
74:30:00	0.000	0.000	0.000	0.000	0.008	0.008
74:36:00	0.000	0.000	0.000	0.000	0.008	0.008
74:42:00	0.000	0.000	0.000	0.000	0.008	0.008
74:48:00	0.000	0.000	0.000	0.000	0.008	0.008
74:54:00	0.000	0.000	0.000	0.000	0.008	0.008
75:00:00	0.000	0.000	0.000	0.000	0.008	0.008
75:06:00	0.000	0.000	0.000	0.000	0.008	0.008
75:12:00	0.000	0.000	0.000	0.000	0.008	0.008
75:18:00	0.000	0.000	0.000	0.000	0.008	0.008
75:24:00	0.000	0.000	0.000	0.000	0.008	0.008

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
75:30:00	0.000	0.000	0.000	0.000	0.008	0.008
75:36:00	0.000	0.000	0.000	0.000	0.008	0.008
75:42:00	0.000	0.000	0.000	0.000	0.008	0.008
75:48:00	0.000	0.000	0.000	0.000	0.008	0.008
75:54:00	0.000	0.000	0.000	0.000	0.008	0.008
76:00:00	0.000	0.000	0.000	0.000	0.008	0.008
76:06:00	0.000	0.000	0.000	0.000	0.008	0.008
76:12:00	0.000	0.000	0.000	0.000	0.008	0.008
76:18:00	0.000	0.000	0.000	0.000	0.008	0.008
76:24:00	0.000	0.000	0.000	0.000	0.008	0.008
76:30:00	0.000	0.000	0.000	0.000	0.008	0.008
76:36:00	0.000	0.000	0.000	0.000	0.008	0.008
76:42:00	0.000	0.000	0.000	0.000	0.008	0.008
76:48:00	0.000	0.000	0.000	0.000	0.008	0.008
76:54:00	0.000	0.000	0.000	0.000	0.008	0.008
77:00:00	0.000	0.000	0.000	0.000	0.008	0.008
77:06:00	0.000	0.000	0.000	0.000	0.008	0.008
77:12:00	0.000	0.000	0.000	0.000	0.008	0.008
77:18:00	0.000	0.000	0.000	0.000	0.008	0.008
77:24:00	0.000	0.000	0.000	0.000	0.008	0.008
77:30:00	0.000	0.000	0.000	0.000	0.008	0.008
77:36:00	0.000	0.000	0.000	0.000	0.008	0.008
77:42:00	0.000	0.000	0.000	0.000	0.008	0.008
77:48:00	0.000	0.000	0.000	0.000	0.008	0.008
77:54:00	0.000	0.000	0.000	0.000	0.008	0.008
78:00:00	0.000	0.000	0.000	0.000	0.008	0.008
78:06:00	0.000	0.000	0.000	0.000	0.008	0.008
78:12:00	0.000	0.000	0.000	0.000	0.008	0.008
78:18:00	0.000	0.000	0.000	0.000	0.008	0.008
78:24:00	0.000	0.000	0.000	0.000	0.008	0.008

Appendix

Catchment descriptors

Name	Value	User-defined value used?
Area (km^2)	0.9	No
ALTBAR	61	No
ASPBAR	261	No
ASPVAR	0.66	No
BFIHOST	0.65	No
DPLBAR (km)	0.94	No
DPSBAR (mkm^{-1})	18.5	No
FARL	1	No
LDP	1.44	No
PROPWET (mm)	0.3	No
RMED1H	10.8	No
RMED1D	29.1	No
RMED2D	37.7	No
SAAR (mm)	610	No
SAAR4170 (mm)	638	No
SPRHOST	35.8	No
Urbext2000	0.14	No
Urbext1990	0.11	No
URBCONC	0.85	No
URBLOC	0.49	No
DDF parameter C	-0.03	No
DDF parameter D1	0.33	No
DDF parameter D2	0.29	No
DDF parameter D3	0.23	No
DDF parameter E	0.31	No
DDF parameter F	2.42	No
DDF parameter C (1km grid value)	-0.03	No
DDF parameter D1 (1km grid value)	0.33	No
DDF parameter D2 (1km grid value)	0.3	No
DDF parameter D3 (1km grid value)	0.24	No
DDF parameter E (1km grid value)	0.31	No
DDF parameter F (1km grid value)	2.42	No

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D Appendix D - Key Hydraulic Structures

D.1 Queenborough Road Culvert

Included in model?	Yes
Model label:	SYS1_0994
Type:	Concrete culvert
How has structure been modelled? Culvert length → Roughness coefficient → Upstream invert level → Downstream invert level → For loss (for single span bridges) → Culvert width or diameter* → Culvert height* → Contraction coefficients → Loss coefficients →	The structure was modelled as a circular culvert unit using ESTRY. The following modelling parameters were used: ID: SYS_994C Type: C Ignore: F UCS: T Len_or_ANA: 11.3 n_or_n_F: 0.025 US_Invert: 60.59 DS_Invert: 60.49 Form_Loss: 0 pBlockage: 0 Inlet_Type: Conn_2D: Conn_No: 0 Width_or_Dia: 0.75 Height_or_WF: 0 Number_of: 0 Height_Cont: 0 Width_Cont: 0 Entry_Loss: 0.5 Exit_Loss: 1 Overtopping of the structure was represented within the 2D domain.

Upstream face	Downstream face, looking upstream
	

D.2 Field access

Included in model?	Yes
Model label:	SYS_843C
Type:	Concrete culvert
How has structure been modelled?	The structure was modelled as a culvert unit using ESTRY. The following modelling parameters were used: ID: SYS_843C Type: C Ignore: F UCS: T Len_or_ANA: 6.2 n_or_n_F: 0.025 US_Invert: 58.83 DS_Invert: 58.78 Form_Loss: 0 pBlockage: 0 Inlet_Type: Conn_2D: Conn_No: 0 Width_or_Dia: 0.45 Height_or_WF: 0 Number_of: 0 Height_Cont: 0 Width_Cont: 0 Entry_Loss: 0.5 Exit_Loss: 1 Overtopping of the structure was represented within the 1D domain

Upstream face, looking downstream	Downstream face, looking upstream
	NO PHOTO AVAILABLE

D.3 Concrete through embankment (western site boundary)

Included in model?	Yes
Model label:	SYS_712C
Type:	Concrete pipe
How has structure been modelled?	The structure was modelled as a culvert unit using ESTRY. The following modelling parameters were used: ID: SYS_712C Type: C Ignore: F UCS: T Len_or_ANA: 13.8 n_or_n_F: 0.025 US_Invert: 58.15 DS_Invert: 58.11 Form_Loss: 0 pBlockage: 0 Inlet_Type: Conn_2D: Conn_No: 0 Width_or_Dia: 0.45 Height_or_WF: 0 Number_of: 0 Height_Cont: 0 Width_Cont: 0 Entry_Loss: 0.5 Exit_Loss: 1 Overtopping of the structure was represented within the 2D domain.
Upstream face, looking downstream	Downstream face, looking upstream
	NO PHOTO AVAILABLE

D.4 Empingham Drive culvert

Included in model?	Yes
Model label:	SYS_513C
Type:	Concrete pipe
How has structure been modelled?	The structure was modelled as a culvert unit using ESTRY. The following modelling parameters were used: ID: SYS_513C Type: C Ignore: F UCS: T Len_or_ANA: 19 n_or_n_F: 0.02 US_Invert: 57.27 DS_Invert: 57.22 Form_Loss: 0 pBlockage: 0 Inlet_Type: Conn_2D: Conn_No: 0 Width_or_Dia: 0.75 Height_or_WF: 0 Number_of: 0 Height_Cont: 0 Width_Cont: 0 Entry_Loss: 0.5 Exit_Loss: 1 Overtopping of the structure was represented within the 2D domain.

Upstream face, looking downstream	Downstream face, looking upstream
	NO PHOTO AVAILABLE

D.5 Barkby Road culvert

Included in model?	Yes
Model label:	SYS_409C
Type:	Concrete pipe
How has structure been modelled?	The structure was modelled as a culvert unit using ESTRY. The following modelling parameters were used: ID: SYS_409C Type: C Ignore: F UCS: T Len_or_ANA: 28.9 n_or_n_F: 0.025 US_Invert: 57.07 DS_Invert: 57.02 Form_Loss: 0 pBlockage: 0 Inlet_Type: Conn_2D: Conn_No: 0 Width_or_Dia: 0.9 Height_or_WF: 0 Number_of: 0 Height_Cont: 0 Width_Cont: 0 Entry_Loss: 0.5 Exit_Loss: 1 Overtopping of the structure was represented within the 2D domain.
Upstream face, looking downstream	Downstream face, looking upstream
	NO PHOTO AVAILABLE

D.6 Disused footbridge

Included in model?	Yes
Model label:	SYS_336C
Type:	Concrete pipe
How has structure been modelled?	The structure was modelled as a culvert unit using ESTRY. The following modelling parameters were used: ID: SYS_336C Type: C Ignore: F UCS: T Len_or_ANA: 18.7 n_or_n_F: 0.02 US_Invert: 56.9 DS_Invert: 56.85 Form_Loss: 0 pBlockage: 0 Inlet_Type: Conn_2D: Conn_No: 0 Width_or_Dia: 0.9 Height_or_WF: 0 Number_of: 0 Height_Cont: 0 Width_Cont: 0 Entry_Loss: 0.5 Exit_Loss: 1 Overtopping of the structure was represented within the 2D domain.

Upstream face, looking downstream	Downstream face, looking upstream
	NO PHOTO AVAILABLE

D.7 Access Bridge at End of Saxby Drive

Included in model?	Yes
Model label:	SYS_212C
Type:	Concrete pipe
How has structure been modelled?	The structure was modelled as a culvert unit using ESTRY. The following modelling parameters were used: ID: SYS_212C Type: C Ignore: F UCS: T Len_or_ANA: 18.7 n_or_n_F: 0.02 US_Invert: 56.5 DS_Invert: 56.45 Form_Loss: 0 pBlockage: 15 Inlet_Type: Conn_2D: Conn_No: 0 Width_or_Dia: 0.9 Height_or_WF: 0 Number_of: 0 Height_Cont: 0 Width_Cont: 0 Entry_Loss: 0.5 Exit_Loss: 1 Overtopping of the structure was represented within the 2D domain.
Upstream face, looking downstream	Downstream face, looking upstream
	NO PHOTO AVAILABLE

D.8 Footbridge at End of Whissendinve Way

Included in model?	No The bridge capacity is significantly bigger than the upstream circular culverts and unlikely to have any effect to model results within the site. This location also marks the end of the model. The channel geometry was represented in the model though. Sensitivity analysis to downstream boundary conditions was undertaken to overcome potential concerns and uncertainties with this approach.	
Model label:		
Type:	Wooden bridge	
How has structure been modelled?		
Upstream face, looking downstream		Downstream face, looking upstream
		

E Appendix E - Model Sensitivity Analysis

The hydraulic model was tested for sensitivity to key model parameters which might impact the flood risk at the proposed development site. This included the following scenarios:

- Increasing the Manning's 'n' value by 20%.
- Increasing the downstream boundary conditions by 250mm
- Increasing the rainfall intensity by 20%

The following sections discuss the impacts of this sensitivity scenarios.

E.1 Sensitivity to Roughness

Figure C-1 shows the changes in flood depths in the 2D domain compared to the baseline 100-year event when an increase of 20% is applied Manning's 'n' in both the 1D and 2D domains.

Figure C-1: Change in peak water levels with the 100-year +20% increase in Manning's 'n'

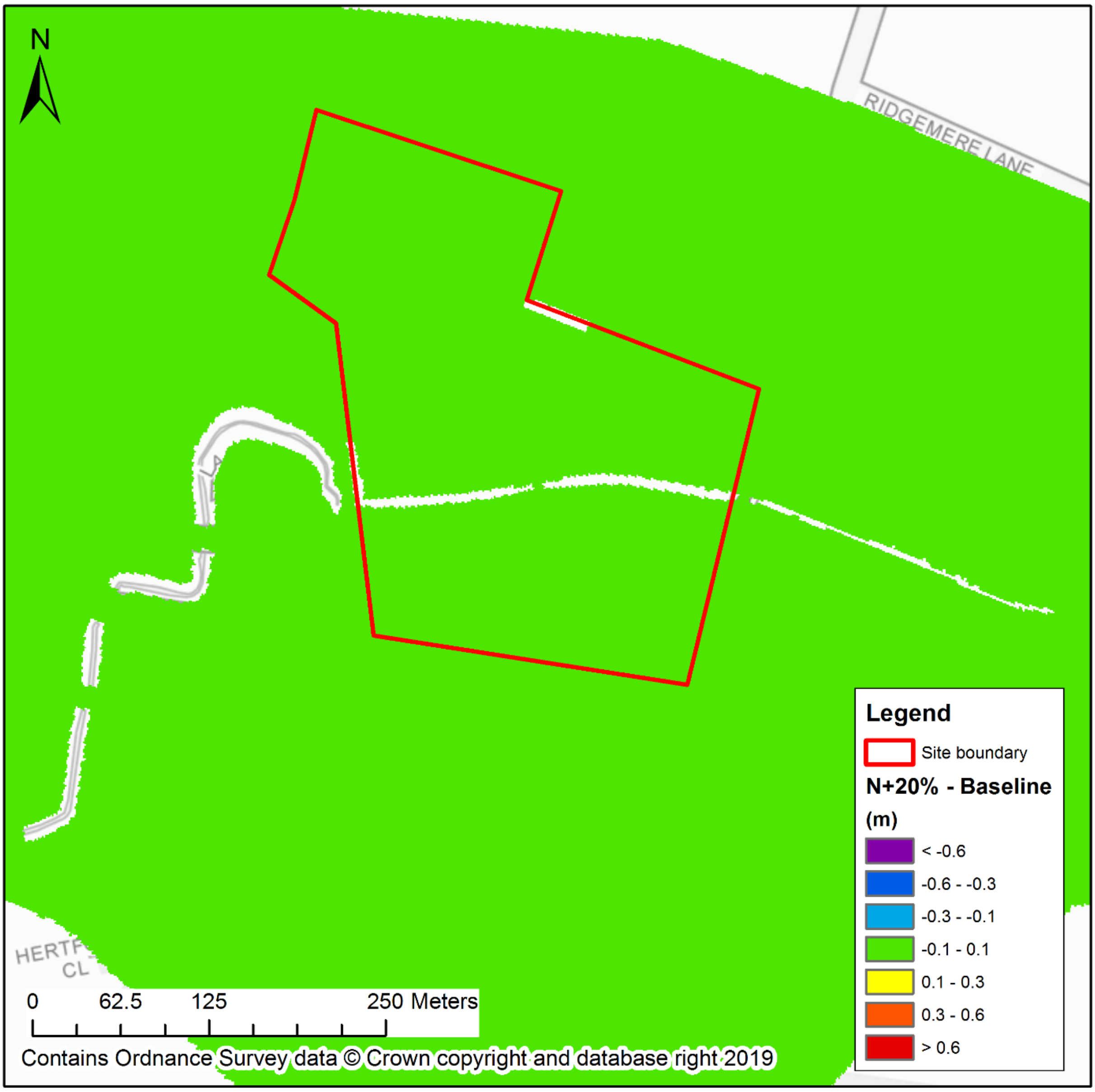


Figure C-1 shows that model results are generally insensitive to changes in roughness value (n).

E.2 Sensitivity to Downstream Boundary Conditions – Test 1

Figure C-2 shows the changes in flood depths in the 2D domain compared to the baseline 100-year event when an increase of 250mm is applied to the model's downstream boundary.

Figure C-2: Change in peak water levels with the 100-year +250mm increase in downstream boundary conditions

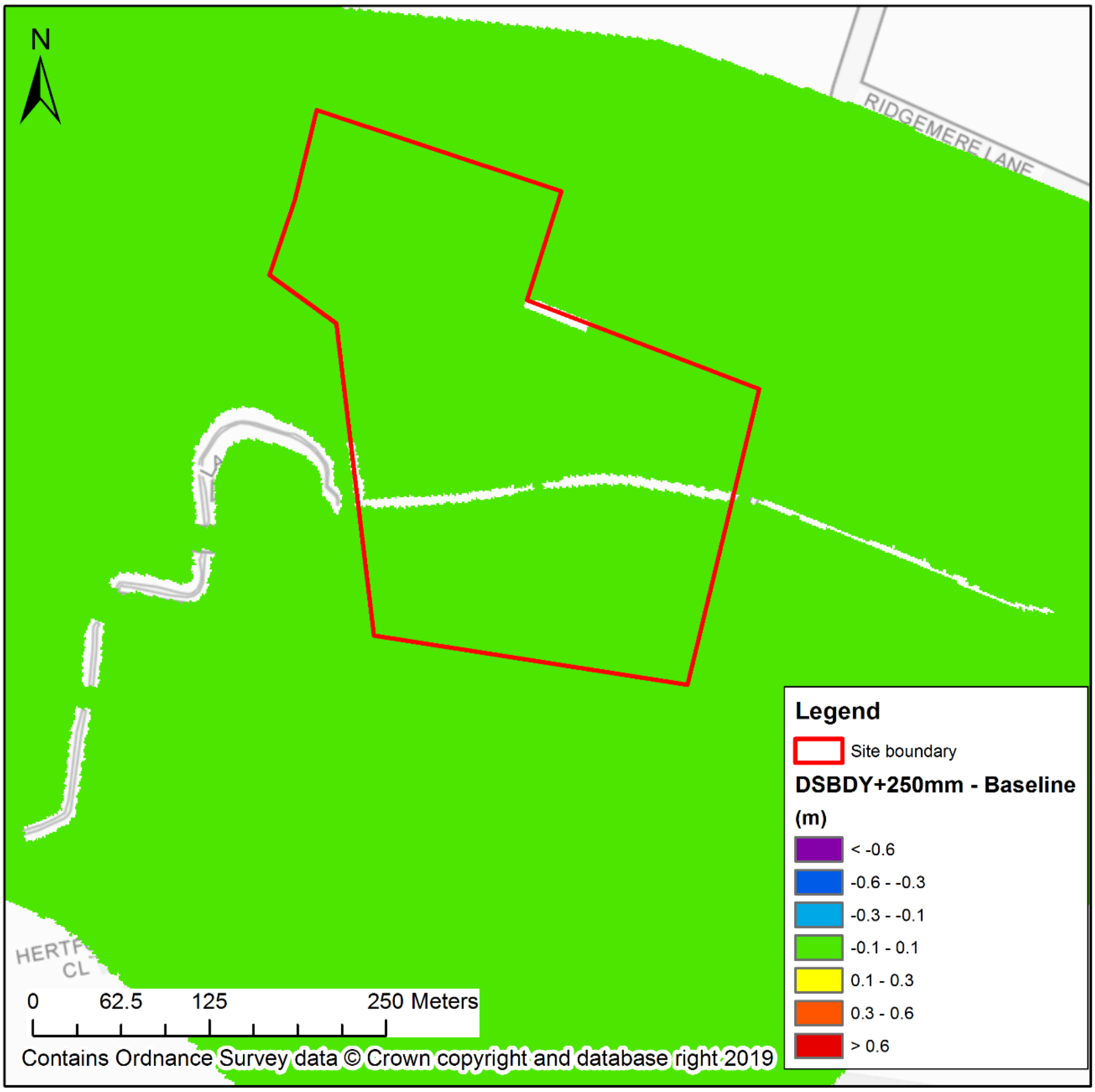


Figure C-2 shows that model results at the site are insensitive to changes in downstream boundary conditions in the model.

E.3 Sensitivity to Downstream Boundary Conditions – Test 2

Figure C-3 shows the changes in flood depths in the 2D domain compared to the baseline 100-year event when the peak water level at the downstream end of the model is set to 57.86m AOD.

Figure C-3: Change in peak water levels when the peak water level at the downstream end of the model is set to 57.86mAOD

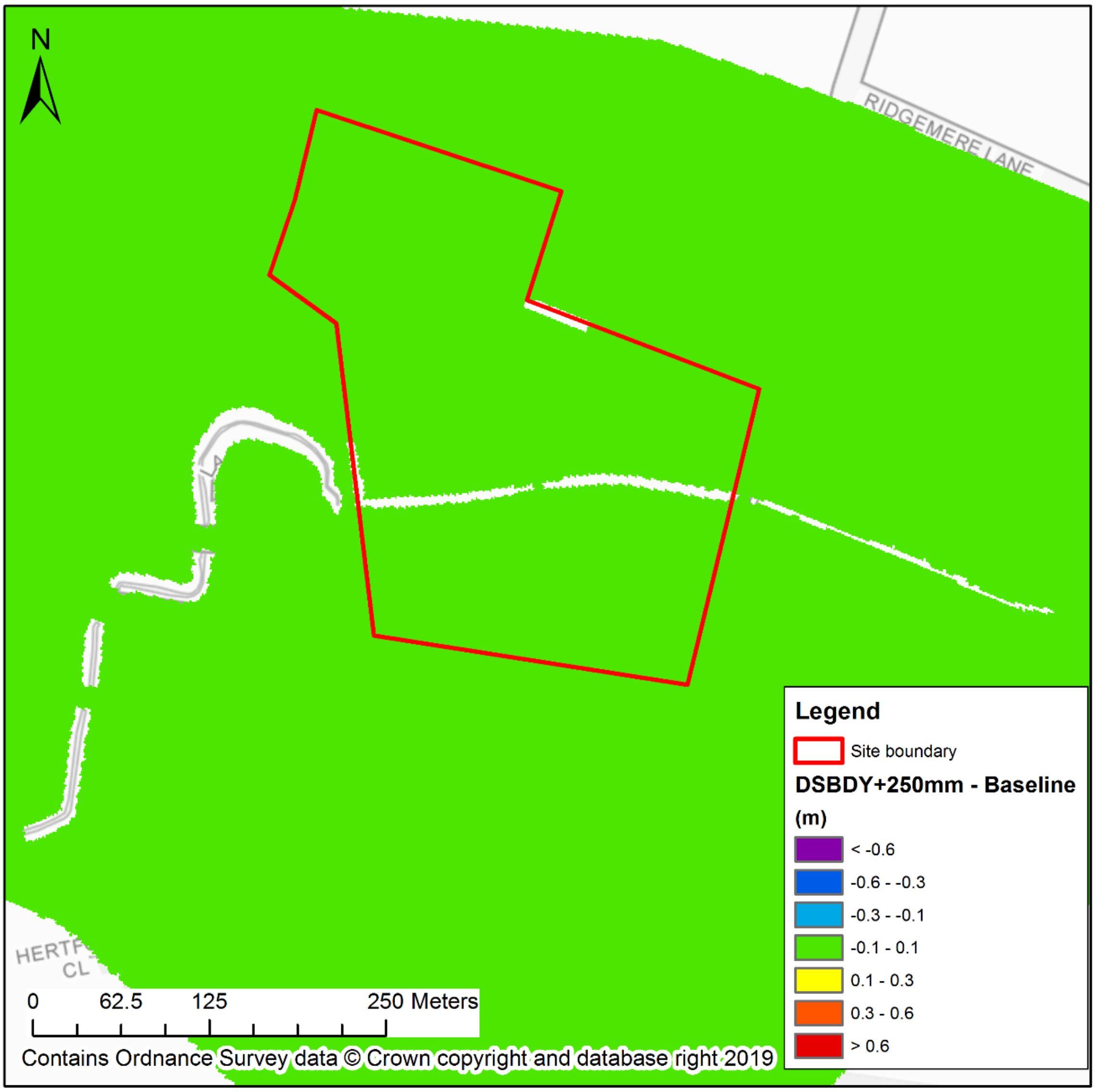


Figure C-3 shows that the 2D model results at the site are insensitive to changes when the peak water level at the downstream end of the model is set to 57.86m AOD. A detailed review of the model results indicates that the change in water level is only perceived in the 1D domain, i.e. within the river channel and along its banks.

E.4 Sensitivity to Rainfall Intensity

Figure C-4 shows the changes in flood depths in the 2D domain compared to the baseline 100-year event when an increase of 20% is applied to the model hyetographs

Figure C-4: Change in peak water levels with the 100-year (+20%) increase in rainfall intensity

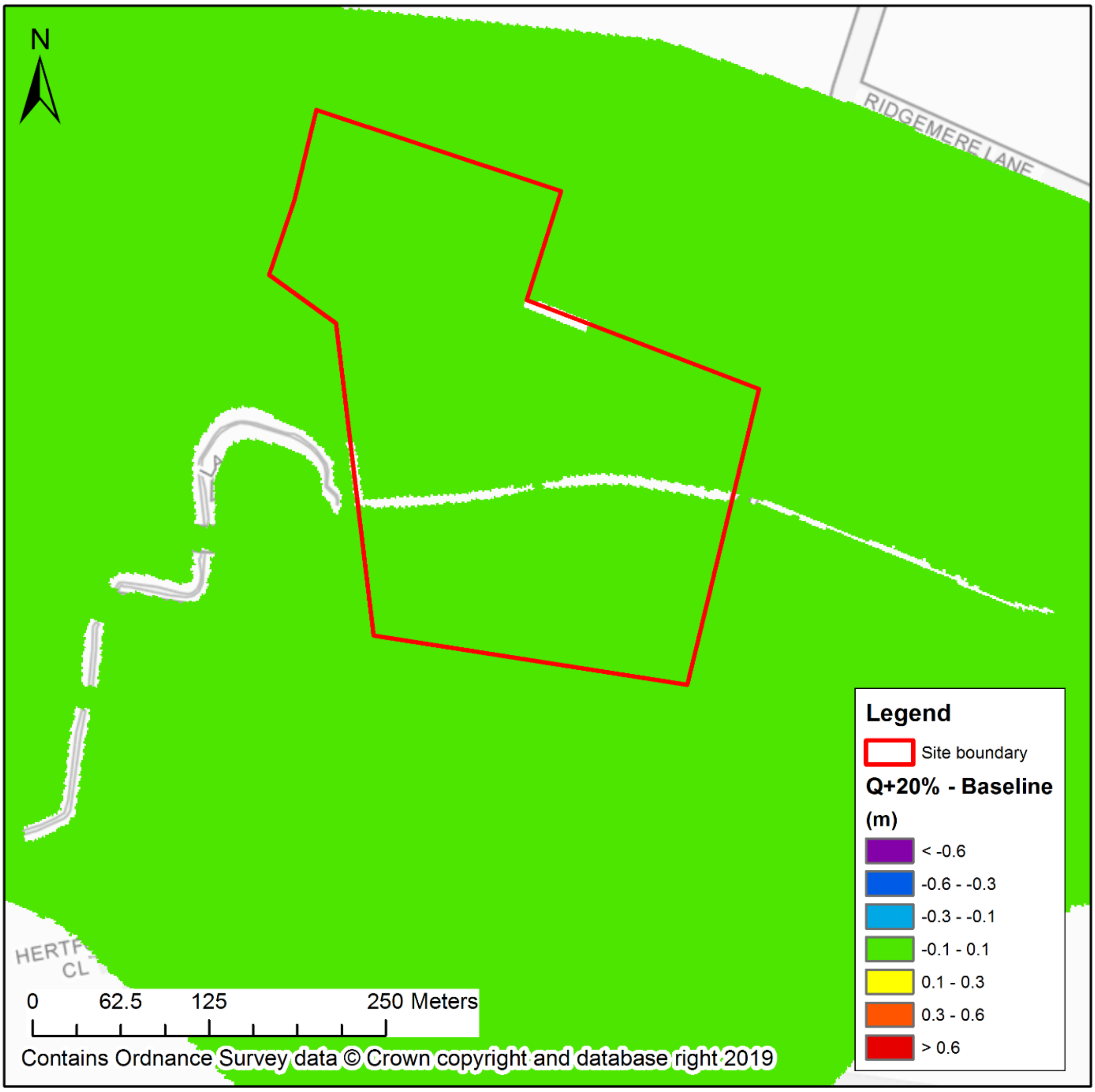
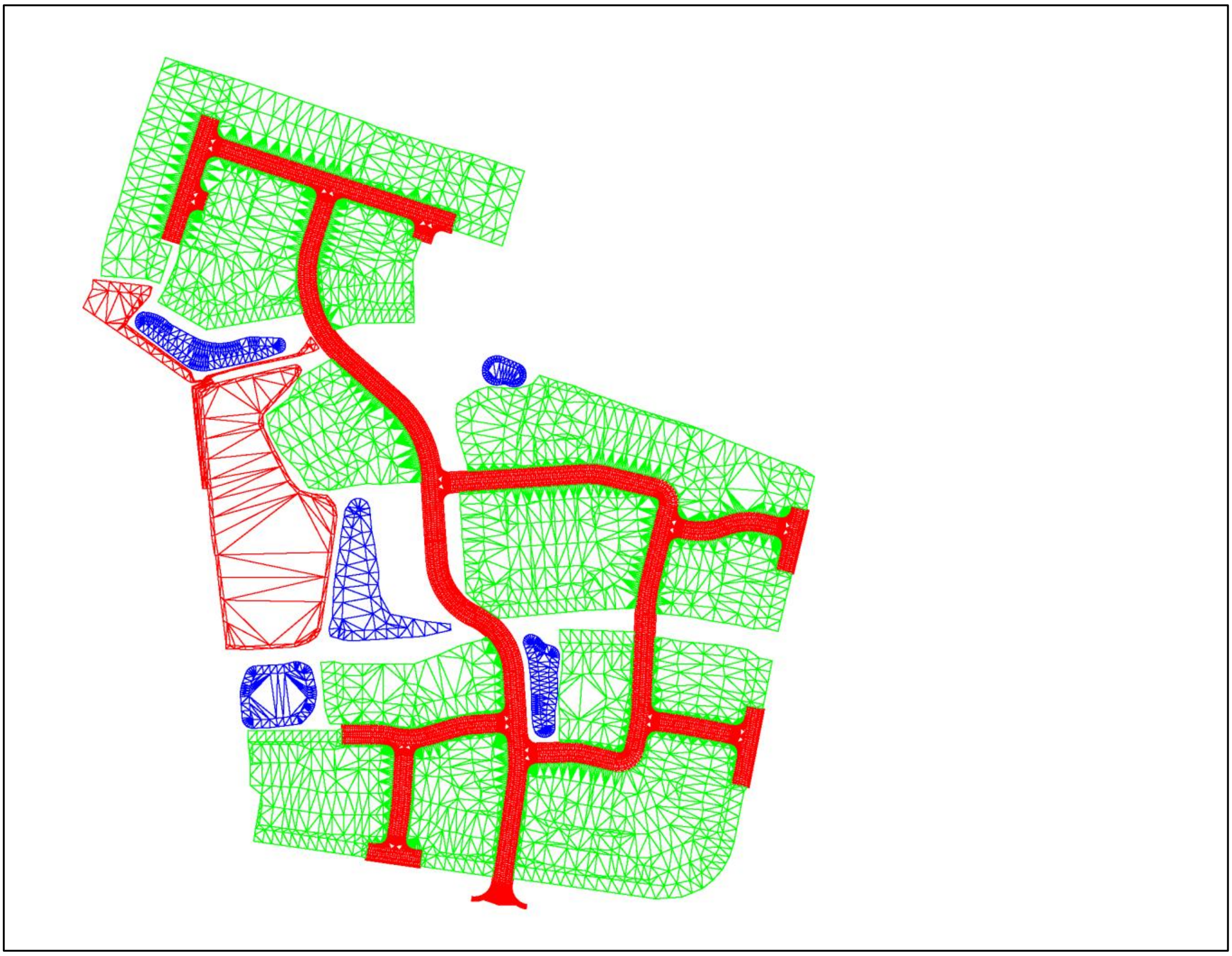


Figure C-4 shows that model results at the site are relatively insensitive to increase in flows.

F Appendix F – The Proposal

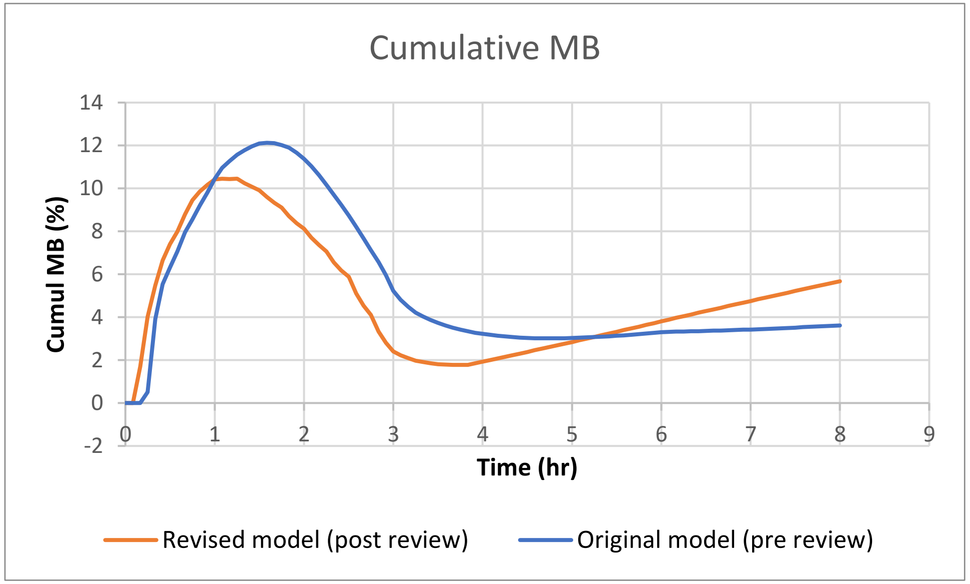
Figure F-1: Proposed site layout

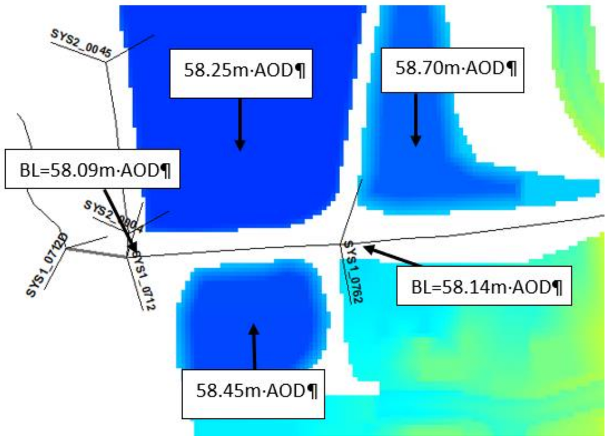
Figure F-2: Proposed ground model



G Appendix G – Initial model review and amendments made to the model

Model Element	Potential Issue	BWB recommendation	Amendment made by JBA to the model
Model Approach	Re runs undertaken in 2021 on different version of TUFLOW	Use latest TUFLOW simulations for any future runs as a sense check and comment on implications within the report.	The latest simulations were all run using ESTRY-TUFLOW Build: 2020-10-AC-iDP-w64
Hydrology	FEH99 and ReFH1 used	Provide justification in the report to confirm why the net rainfall hyetographs were considered the most suitable method. Consider re calculating rainfall using FEH13 or provide justification as to why FEH99 was used at the time of the study.	See revised hydrological assessment documented in Appendix C.
1D Structures	Height contraction coefficients used for circular culverts	Ensure Appendix D of the model report is consistent with the model files and provide justification for using nonstandard values.	Height and width contraction coefficients are not used by TUFLOW for 'C' type 1D network / culverts. To avoid confusion, these were removed from the attribute tables of the 1d network files and screenshots under Appendix D were updated.
2D Topography	Buildings and roads modelled at ground level	Either undertake a sensitivity test with the suggested modifications to buildings and roads, or, as a minimum, justify why this would not be required within the report e.g., rural catchment.	As pointed out, the site is located upstream of the urban catchment / within a rural catchment and thus these changes have virtually no / very little effects on modelled flood levels / depths at the site. To minimise concerns, these recommendations have been implemented anyway.
2D Roughness	Depth varying Mannings not used for buildings	Apply depth varying Mannings to buildings to improve flow routing	Notwithstanding the rural location of the site, depth varying Mannings have been applied to existing buildings in the model.
Boundary conditions	HX link loss coefficients of 0.5 used	Provide reasoning for applying high losses.	HX link loss coefficients of 0.5 were kept along some of the 1D-2D links to improve modelling stability (particularly in areas were water ponding occurs) and removed elsewhere.
Boundary conditions	Downstream boundary sensitivity value not clarified.	Consider a conservative downstream boundary sensitivity test by using a constant level within a HT boundary representing the downstream footbridge as surcharged (using a deck level of 57.86mAOD). Alternatively, provide	A second sensitivity analysis (to changes in downstream boundary conditions) was carried out and is documented in Appendix E.3.

Model Element	Potential Issue	BWB recommendation	Amendment made by JBA to the model
		evidence for why the peak stage of 57.15mAOD is the most appropriate value.	
Model Stability	High Mass Balance Error	As a minimum, a section needs to be added to the report acknowledging the mass error and detailing what has been done to reduce this in line with acceptable values.	See Section 2.6. The mass-balance of rainfall-runoff models is notoriously difficult to keep within the 'ideal' +/-1% target, particularly a) within steep catchments and b) where surface water ponding occurs. As both these conditions are met, it was always expected that the mass-balance of the model would exceed the +/-1% range. Admittedly, the recommended changes made to the model appear to have improved the cumulative mass balance, as illustrated below. 
Proposed scenario	Initial water levels not applied to permanently wet ponds and modelled evidence on how the	Add initial water levels to permanently wet ponds and provide clarity on how the compensation area will drain.	Given the outline nature of the planning application, it is currently unknown which attenuation area will ultimately be designed as permanently wet and which as dry. To alleviate concerns, ponds bed levels were dropped by 300mm and initially water levels set 300mm above the pond's bed levels were used.

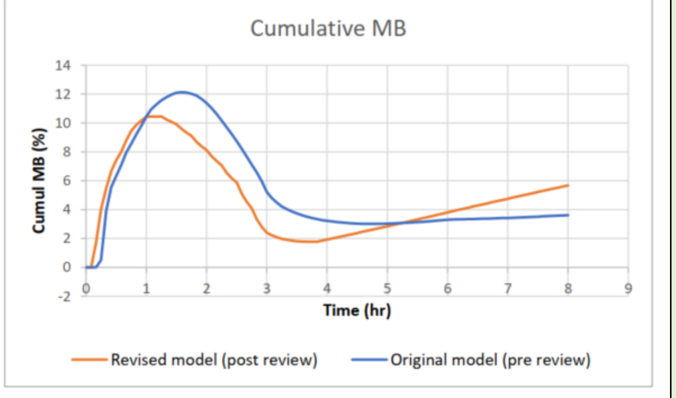
Model Element	Potential Issue	BWB recommendation	Amendment made by JBA to the model
	compensation area will drain		This modelling study aims to support a flood risk assessment and is limited to flood related issues, i.e. how flood water will be stored on site during the peak of the event. Given the outline nature of the planning application, details specific to the operation of each pond (including how these will drain once water levels start receding in the channel will be addressed as part of detailed design stage / reserved matter application. To support initial design assumption, the proposed pond's bed levels (assuming no permanent water level below) was set following a review of the bed levels in the adjacent channel (which runs dry most of the time). Design parameters are expected to be refined as part of later planning stages. 
Proposed scenario	Baseline field access culvert has the same diameter as the proposed	Provide clarity on the discrepancies between the modelled diameter and the proposed diameter of the culvert within the report.	The total flow leaving the site is predominantly conveyed via the watercourse flowing in an east-to-west direction. To ensure the flow leaving the site does not increase (e.g. due to an increase in the head of water building up at the downstream end of the site), a flow control unit will be required upstream within the site boundary. Different flow control units were initially considered prior the final selection of a 0.45m diameter orifice unit / culvert. Given the uncertainties associated with their structural integrity, all existing culverts within the site will be removed.

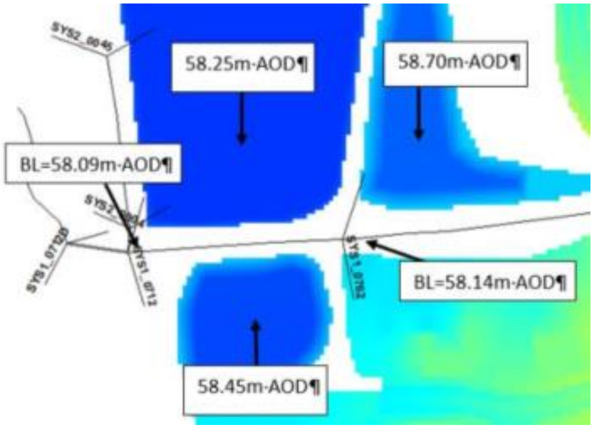
H Appendix H – Second model review and validation

BWB

Model Element	Potential Issue	Recommendation	JBA Response	BWB Final Comment
Model Approach	Re runs undertaken in 2021 on different version of TUFLOW	Use latest TUFLOW simulations for any future runs as a sense check and comment on implications within the report.	The latest simulations were all run using ESTRY-TUFLOW Build: 2020-10-AC-iDP-w64	Resolved
Hydrology	FEH99 and ReFH1 used	Provide justification in the report to confirm why the net rainfall hyetographs were considered the most suitable method. Consider re calculating rainfall using FEH13 or provide justification as to why FEH99 was used at the time of the study.	See revised hydrological assessment documented in Appendix C	FEH13 has been used and the model extent divided into urban and rural rainfall regions. The urban areas apply a12mm/hr sewer loss on the design rainfall. This avoid double counting urban drainage and is therefore considered resolved
1D Structures	Height contraction coefficients used for circular culverts	Ensure Appendix D of the model report is consistent with the model files and provide justification for using non- standard values.	Height and width contraction coefficients are not used by TUFLOW for 'C' type 1D network / culverts. To avoid confusion, these were removed from the attribute tables of the 1d network files and screenshots under Appendix D were updated.	Resolved
2D Topography	Buildings and roads modelled at ground level	Either undertake a sensitivity test with the suggested modifications to buildings and roads, or, as a minimum, justify why this would not be required within the report e.g., rural catchment.	As pointed out, the site is located upstream of the urban catchment / within a rural catchment and thus these changes have virtually no / very little effects on modelled flood levels / depths at the site. To minimise concerns, these recommendations have been implemented anyway.	Road levels have been reduced by 100mm and buildings increased by 150mm - Resolved

Model Element	Potential Issue	Recommendation	JBA Response	BWB Final Comment
2D Roughness	Depth varying Mannings not used for buildings	Apply depth varying Mannings to buildings to improve flow routing.	Notwithstanding the rural location of the site, depth varying Mannings have been applied to existing buildings in the model.	Depth varying roughness has been applied to buildings, with a lower mannings value used up to depths of 150mm - Resolved
Boundary conditions	HX link loss coefficients of 0.5 used	Provide reasoning for applying high losses.	HX link loss coefficients of 0.5 were kept along some of the 1D-2D links to improve modelling stability (particularly in areas were water ponding occurs) and removed elsewhere.	Resolved
Boundary conditions	Downstream boundary sensitivity value not clarified.	Consider a conservative downstream boundary sensitivity test by using a constant level within a HT boundary representing the downstream footbridge as surcharged (using a deck level of 57.86mAOD). Alternatively, provide evidence for why the peak stage of 57.15mAOD is the most appropriate value.	A second sensitivity analysis (to changes in downstream boundary conditions) was carried out and is documented in Appendix E.3.	Negligible impact at the site - Resolved
Model Stability	High Mass Balance Error	As a minimum, a section needs to be added to the report acknowledging the mass error and detailing what has been done to reduce this in line with acceptable values.	See Section 2.6. The mass-balance of rainfall-runoff models is notoriously difficult to keep within the 'ideal' +/-1% target, particularly a) within steep catchments and b) where surface water ponding occurs. As both these conditions are met, it was always expected that the mass-balance of the model would exceed the +/-1% range. Admittedly, the recommended changes	A section has been added to the report and peak CME values are between 9% and 4% pre and post development respectively for the 100yr+40% event (6 hour storm duration). Whilst the

Model Element	Potential Issue	Recommendation	JBA Response	BWB Final Comment
			made to the model appear to have improved the cumulative mass balance, as illustrated below. 	CME is still above ideal values during the baseline event, the mass error within the site itself is generally acceptable for a pluvial model.
Proposed scenario	Initial water levels not applied to permanently wet ponds and modelled evidence on how the compensation area will drain	Add initial water levels to permanently wet ponds and provide clarity on how the compensation area will drain.	Given the outline nature of the planning application, it is currently unknown which attenuation area will ultimately be designed as permanently wet and which as dry. To alleviate concerns, ponds bed levels were dropped by 300mm and initially water levels set 300mm above the pond's bed levels were used. This modelling study aims to support a flood risk assessment and is limited to flood related issues, i.e. how flood water will be stored on site during the peak of the event. Given the outline nature of the planning application, details specific to the operation of each pond (including how these will drain once water levels start receding in the channel will be addressed as part of detailed design stage / reserved matter application. To support initial design assumption, the proposed pond's bed levels (assuming no permanent water level below) was set following a review of the bed levels in the adjacent channel (which runs dry most of the time). Design parameters are expected to be refined as part of later planning stages.	Clarity provided in that a gravity connection to the watercourse should be achievable with further details to be confirmed at later planning stages - Resolved

Model Element	Potential Issue	Recommendation	JBA Response	BWB Final Comment
				
Proposed scenario	Baseline field access culvert has the same diameter as the proposed	Provide clarity on the discrepancies between the modelled diameter and the proposed diameter of the culvert within the report.	The total flow leaving the site is predominantly conveyed via the watercourse flowing in an east-to-west direction. To ensure the flow leaving the site does not increase (e.g. due to an increase in the head of water building up at the downstream end of the site), a flow control unit will be required upstream within the site boundary. Different flow control units were initially considered prior the final selection of a 0.45m diameter orifice unit/culvert. Given the uncertainties associated with their structural integrity, all existing culverts within the site will be removed.	Clarity provided in that existing culverts will be removed and replaced with a 450mm orifice as a flow control - Resolved

BWB

Reviewer	**Alexandros Petrakis BSc. (Hons)**	**Date: 01/07/2022**
Checker	**Matthew Day BA (Hons) MSc FRGS MCIWEM C.WEM C.Sci C.Env**	**Date: 01/07/2022**
Is the model fit for purpose?		**Yes**

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