Civil | Structural | Geo-Environmental | Transport Planning

Flood Risk Assessment and Drainage Strategy

Prepared for
Keepmoat Homes

Proposed Residential Development of
Land at Eakring Road, Bilsthorpe

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Civil | Structural | Geo-Environmental | Transport Planning

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-	15 October 2019	First Draft	Adrian Greenaway	Rob Travis
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C	26 May 2020	Revision C	Adrian Greenaway	Rob Travis

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Contents

1.0 INTRODUCTION

1.1 Background

1.1.1 Travis Baker were commissioned to prepare a flood risk assessment and drainage strategy to support a detailed planning application for proposed residential development on land at Eakring Road, Bilsthorpe.

1.1.2 The site area is in excess of 1 hectare and a flood risk assessment is therefore required. It has been prepared under the guidance of the National Planning Policy Framework (NPPF) and associated technical guidance. The site is located within flood zone 1 and is not affected by fluvial flooding from nearby rivers, the report will therefore focus on other possible flood risk to or from the development and the sustainable disposal of surface water.

1.1.3 The potential effects of climate change on future rainfall intensity will also be taken into account.

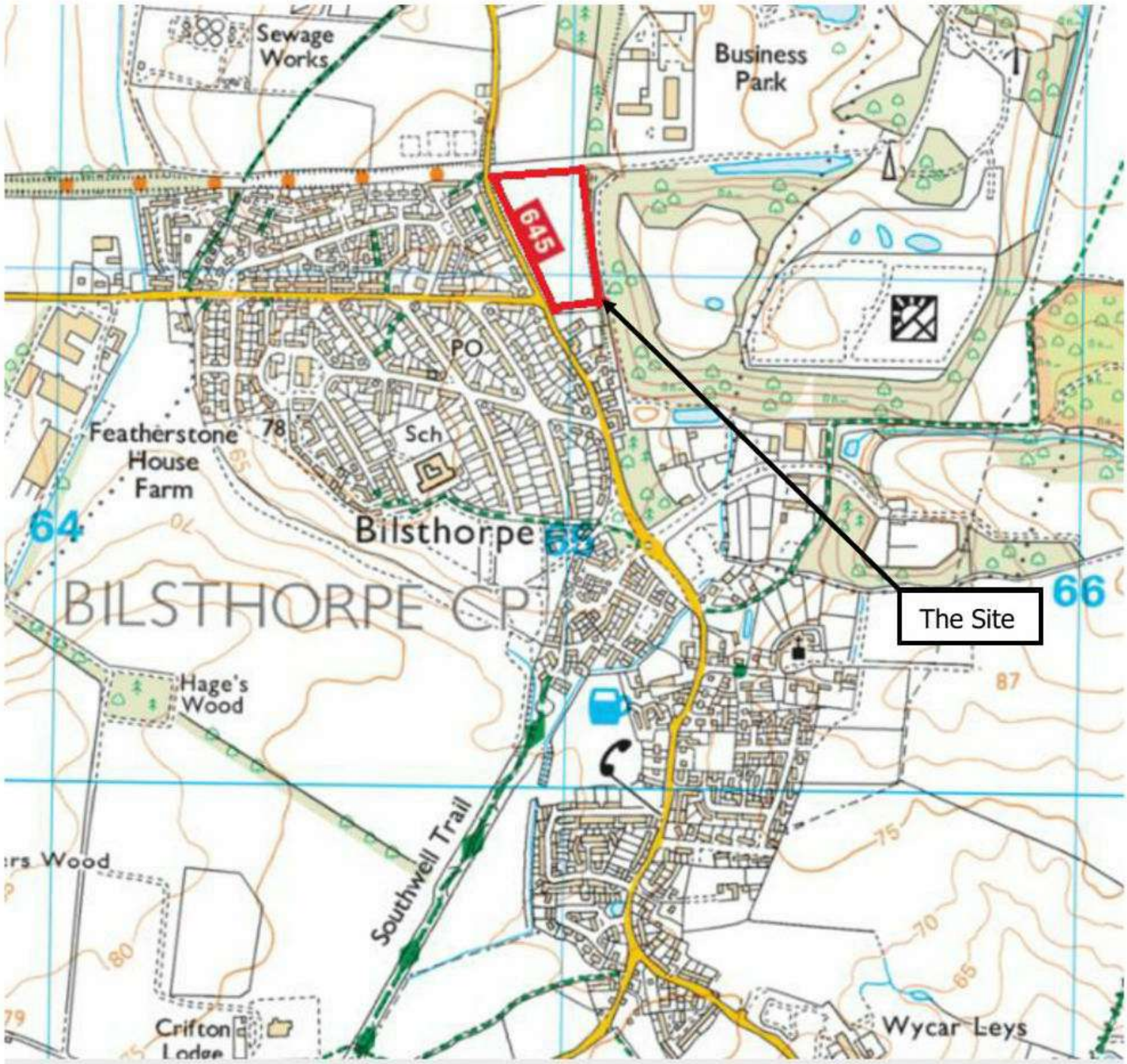
1.2 Site Location and Surroundings

1.2.1 The site is located to the northeast of Bilsthorpe Village, Nottinghamshire, approximately 12km to the east of Mansfield. The centre of the site is at approximate grid reference 464961, 361054 and extends over an area of approximately 3.8 hectares.

1.2.2 The site is rectangular with a footpath crossing the centre of the site, and comprised of open grassland with trees running along the boundary

1.2.3 There are fields to the north and east of the site, with residential developments to the west and factories to the south.

1.2.4 The site location is shown below.



1.3 Development Proposals

1.3.1 The proposed development will provide 103 new dwellings by Keepmoat Homes. The main access along with pedestrian access into the site will be from Eakring Road, on the western side of the site.

1.3.2 The proposed site layout, which also incorporates the proposed drainage strategy, is contained in the appendices.

2.0 EXISTING SITE CONDITIONS

2.1 Existing Topography and Drainage

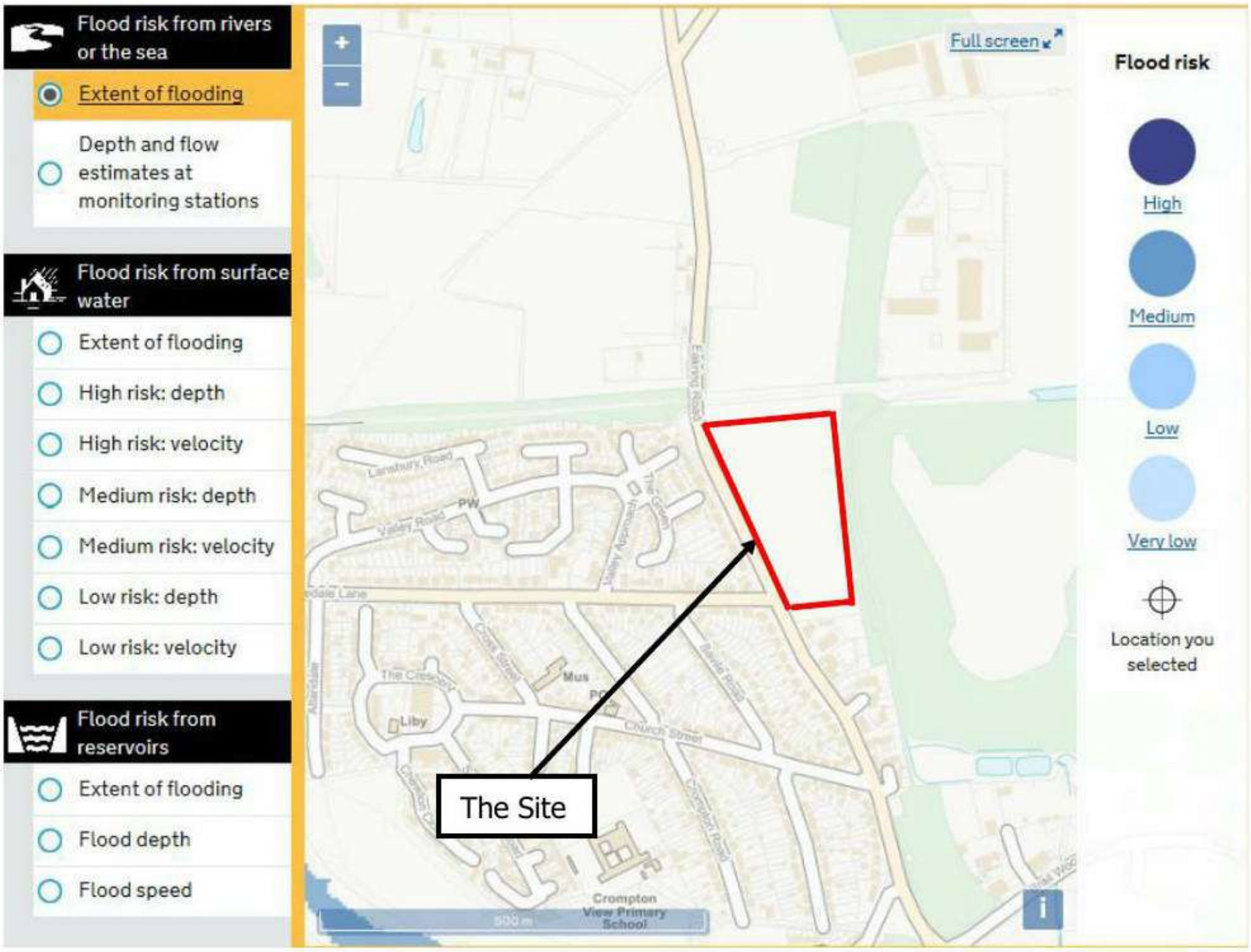
2.1.1 A copy of topographical survey is in the appendices.

2.1.2 The site falls from north to south, with levels ranging from approximately 73.7m AOD down to 70.12m. The site has an embankment up to Eakring road at the North West corner.

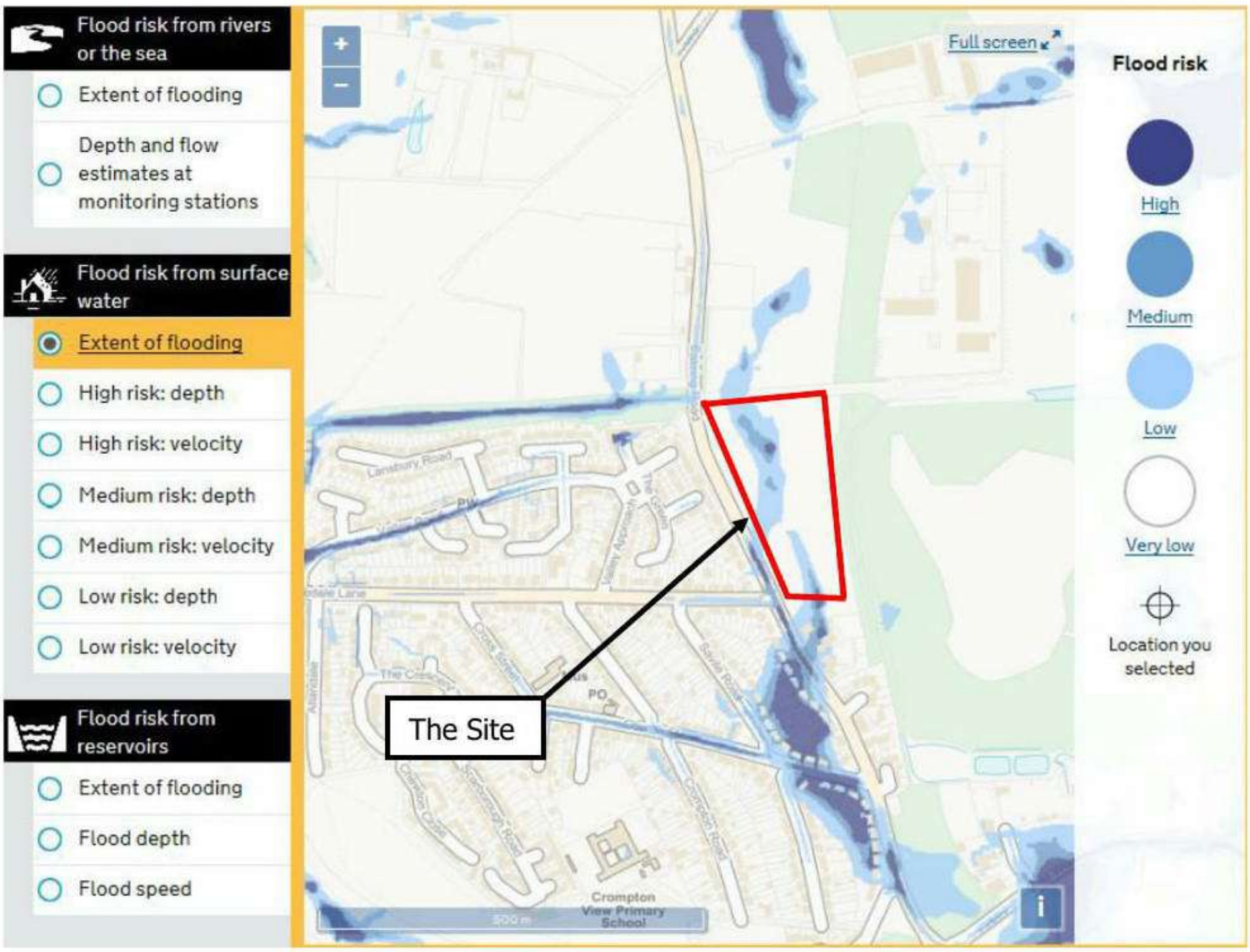
2.1.3 There is an existing foul sewer, highway sewer and combined sewer at the south western corner of the site.

2.2 Existing Flood Risk

2.2.1 The flood mapping available from the EA website (below) shows that there is no fluvial flooding apparent within the site.



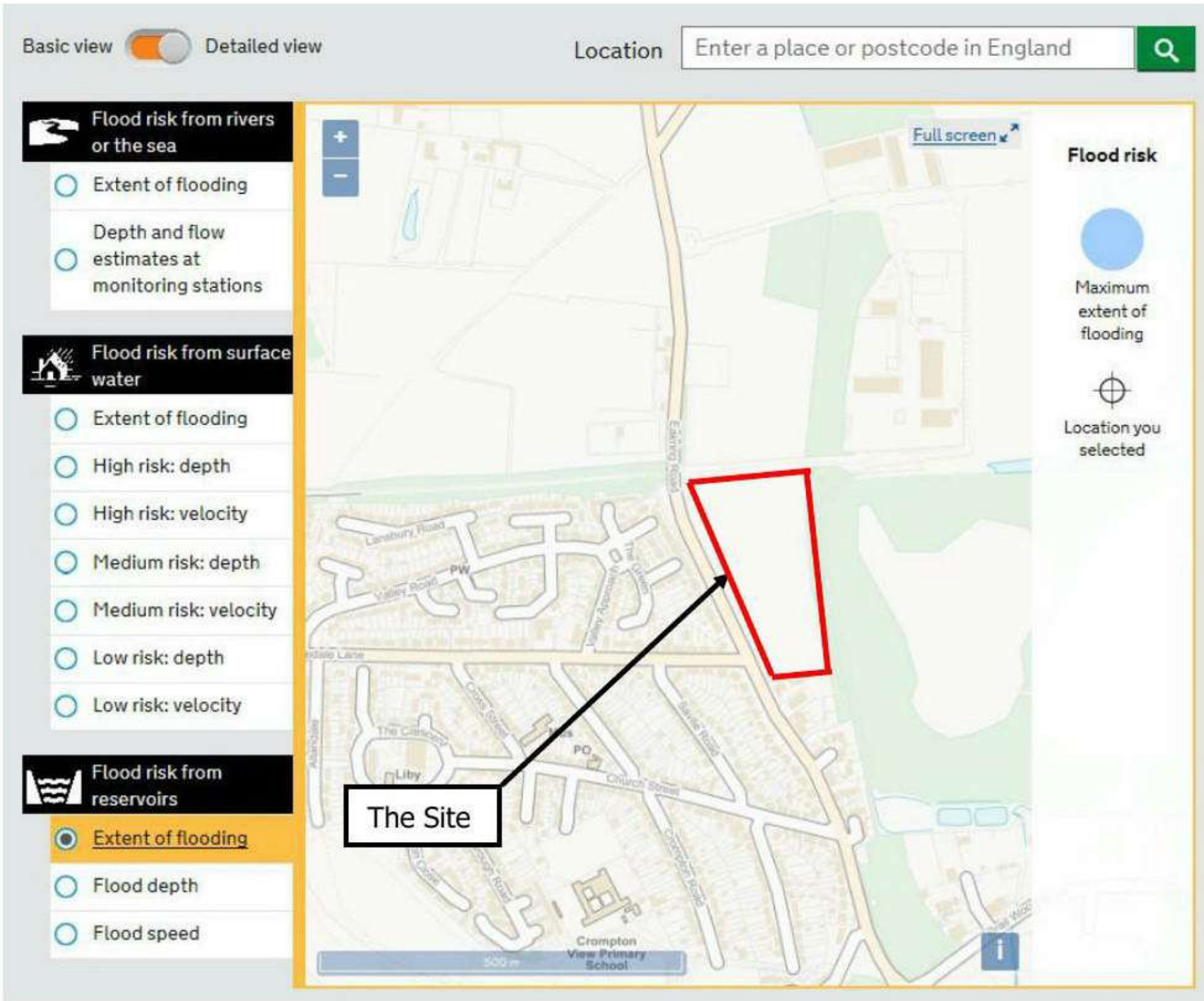
2.2.2 The Risk of Flooding from Surface Water mapping, available from the EA website (below) shows that there are areas of the site which could theoretically be subject to surface water flooding.



2.2.3 The mapping provided by the Environment Agency is based on aerial LIDAR survey and places surface water in areas where there are low points in the topography. It is accepted that the mapping is generally coarse in nature, and that the levels post development will be designed such that any surface water run-off generated will be directed towards the southern end of the site into the pond attenuation.

2.2.4 It is considered that the actual risk of flooding to the site from surface water sources is quite minimal.

2.2.5 The reservoir flood map from the Environment Agency website is shown below. It shows there is no risk from flooding from reservoirs.



2.3 Existing Drainage

2.3.1 As the areas of the site which are to be redeveloped currently consist mostly of grassland, surface water run-off would be at greenfield rates, and currently drains by overland flood routes.

2.3.2 Severn Trent Water have been approached via the developer enquiry procedure. A copy of their response including the public sewer records is in the appendices.

3.0 PROPOSED SITE LEVELS, FLOOD MITIGATION AND DRAINAGE SYSTEMS

3.1 Proposed Site Levels

3.1.1 It is proposed that upon redevelopment the existing site levels will be followed as far as is possible to tie into existing levels near the entrance. However, the majority of the development will require plot levels to be raised to ensure the site's foul discharge can drain through gravity sewers and avoid the need for a foul pumping station.

3.2 Proposed Flood Mitigation

3.2.1 As noted previously, the EA maps for fluvial and reservoir flooding do not show any risk of flooding. However, there is a high risk to surface water flooding in small areas of the site, with larger areas of site at low and medium risk to flooding.

3.2.2 In reality it is considered unlikely that there would be any surface water flooding as the proposed site levels will be designed to work with existing levels and drain towards the pond at the southern tip of the site.

3.3 Sustainable Surface Water Drainage

3.3.1 An intrusive site investigation report has been prepared by Travis Baker. With regard to the underlying strata this has shown that around 0.3m to 0.7m of topsoil and sub-soil is present across the site.

3.3.2 Six infiltration tests were undertaken within the area proposed for residential development and the location plan showing the trial pits (SA1 to SA6) where the tests were undertaken, and the test results themselves are in the appendices.

3.3.3 The tests results demonstrated: *Based on the results of the in-situ testing undertaken over a three day period, the materials underlying the site are not considered suitable for soakaway drainage.* A positive method of surface water disposal is therefore proposed.

3.3.4 Surface water from roofs and paved areas will be collected into down pipes, gullies and channels. Flows will then pass into subsurface piped drainage system, which will convey flows to the proposed pond in the south west corner of the site, and into the existing combined highway sewer on Eakring road.

3.3.5 The Qbar per Hectare value of 0.4l/s is too low for a flow control with risks of blockage. Hence, flows will be restricted to 5 litres per second for all storm events using a traditional vortex flow control downstream of the pond. The Qbar calc is shown in the appendices.

3.3.6 The proposed drainage strategy is in the appendices and a hydraulic model has been built using the WINDES modelling software. The input files and simulation results are also in the appendices.

3.4 Foul Water Drainage

3.4.1 As described previously there is a public combined water sewer running beyond the south western boundary. The developer enquiry response from STW advises that there is no known capacity issues with the network so can accommodate the additional flows from the proposed development.

3.4.2 The foul drainage will be split into two networks, one will drain by gravity towards the south western boundary near the site entrance and connect into an existing combined water sewer. The second network will drain by gravity to the south west corner of the site and drain into the existing combined water sewer on Eakring Road.

3.5 Ongoing Maintenance

3.5.1 It is proposed that the surface water drainage systems within the development will be adopted by Severn Trent Water under a section 104 agreement.

3.5.2 The foul water systems will also be adopted by Severn Trent Water under a section 104 agreement.

3.5.3 This ongoing maintenance will ensure that the drainage systems will operate as originally intended throughout the life of the development.

4.0 CONCLUSIONS

4.1 Flood Risk, Flood Consequences and Sustainable Design

4.1.1 There is no risk of flooding to the development from any nearby fluvial sources.

4.1.2 There is a theoretical risk of flooding from surface water but the actual risk is considered minimal as the proposed drainage will drain water to the pond at the southern boundary.

4.1.3 There is no risk of reservoir breach flooding.

4.1.4 The new surface water drainage systems will be designed in accordance with nationally agreed standards, and will provide protection from surface flooding under the critical 100 year rainfall event, including the recognised allowance for the effects of climate change.

4.1.5 The main drainage systems will be adopted by Severn Trent Water under a section 104 agreement. This will ensure long term maintenance throughout the life of the development.

4.1.6 It is considered that the proposed scheme is in accordance with relevant planning policy, and that approval to this application should not be withheld on flooding grounds or drainage grounds.

5.0 APPENDICES

Appendix A: Drainage Strategy – drawing number 8B

Appendix B: Topographical Survey

Appendix C: Developer Enquiry response and sewer records – Severn Trent Water

Appendix D: Trial Pit Location Plan and Infiltration Test Results – Travis Baker Geo-environmental

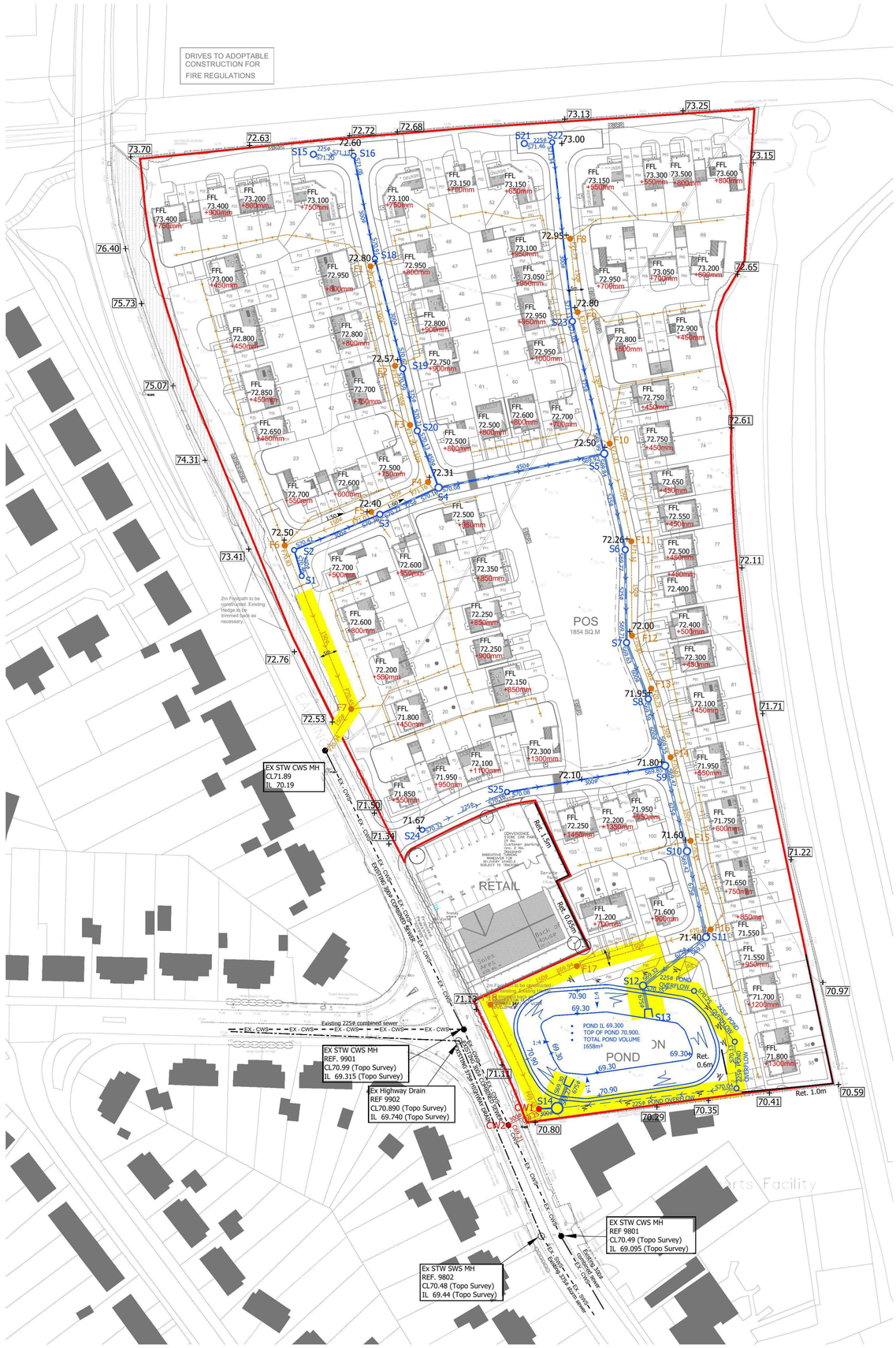
Appendix E: Hydraulic Calculations (100yr + 40%)

Appendix F: Qbar Calculation per Hectare

Appendix A

Drainage Strategy

Drawing number 8B



PROPOSED FOUL DRAINAGE HAS BEEN INDICATIVELY DESIGNED TO HAVE 1M COVER TO PROPOSED ROAD LEVELS TO REDUCE THE AMOUNT OF LEVEL LIFT REQUIRED. THIS RESULTS IN THE PROPOSED FOUL DRAINAGE REQUIRING CONCRETE SLAB PROTECTION TO ALLOW THE FOUL DRAINAGE TO DRAIN VIA GRAVITY TO THE EXISTING COMBINED WATER SEWER

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.
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KEY

—EX - CWS—	EXISTING COMBINED WATER SEWER
—EX - FWS—	EXISTING FOUL WATER SEWER
—EX - SWS—	EXISTING STORM WATER SEWER
	EXISTING HIGHWAY DRAIN
71.71 +	EXISTING GROUND LEVEL
71.80+	PROPOSED LEVEL
	PROPOSED STORM SEWER
	PROPOSED FOUL SEWER
	BANKING
RET 0.35m	RETAINING FEATURE
FFL 72.100	FINISHED FLOOR LEVEL
	HEADWALL
	EASEMENT
+1050mm	LEVEL DIFFERENCE BETWEEN PROPOSED AND EXISTING LEVELS

REV	DESCRIPTION	DATE	BY	AUTH
B	INSERTED NEW LAYOUT, AMENDMENTS TO SUIT	26.05.20	AG	GE
A	INSERTED NEW LAYOUT, AMENDMENTS TO FOUL NEAR PLOT 68	19.05.20	AG	GE

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CLIENT
KEEPMOAT HOMES

PROJECT
EAKRING ROAD, BILSTHORPE

TITLE
DRAINAGE STRATEGY - OPTION 5 (WITH ADDITIONAL PLOTS)

DRAWN	AUTHORISED	SCALE	DATE
GE	RWT	1:500@A0	21.02.20

PROJECT NO.	DRAWING NO.	REV
19017	8	B

STATUS.
INDICATIVE

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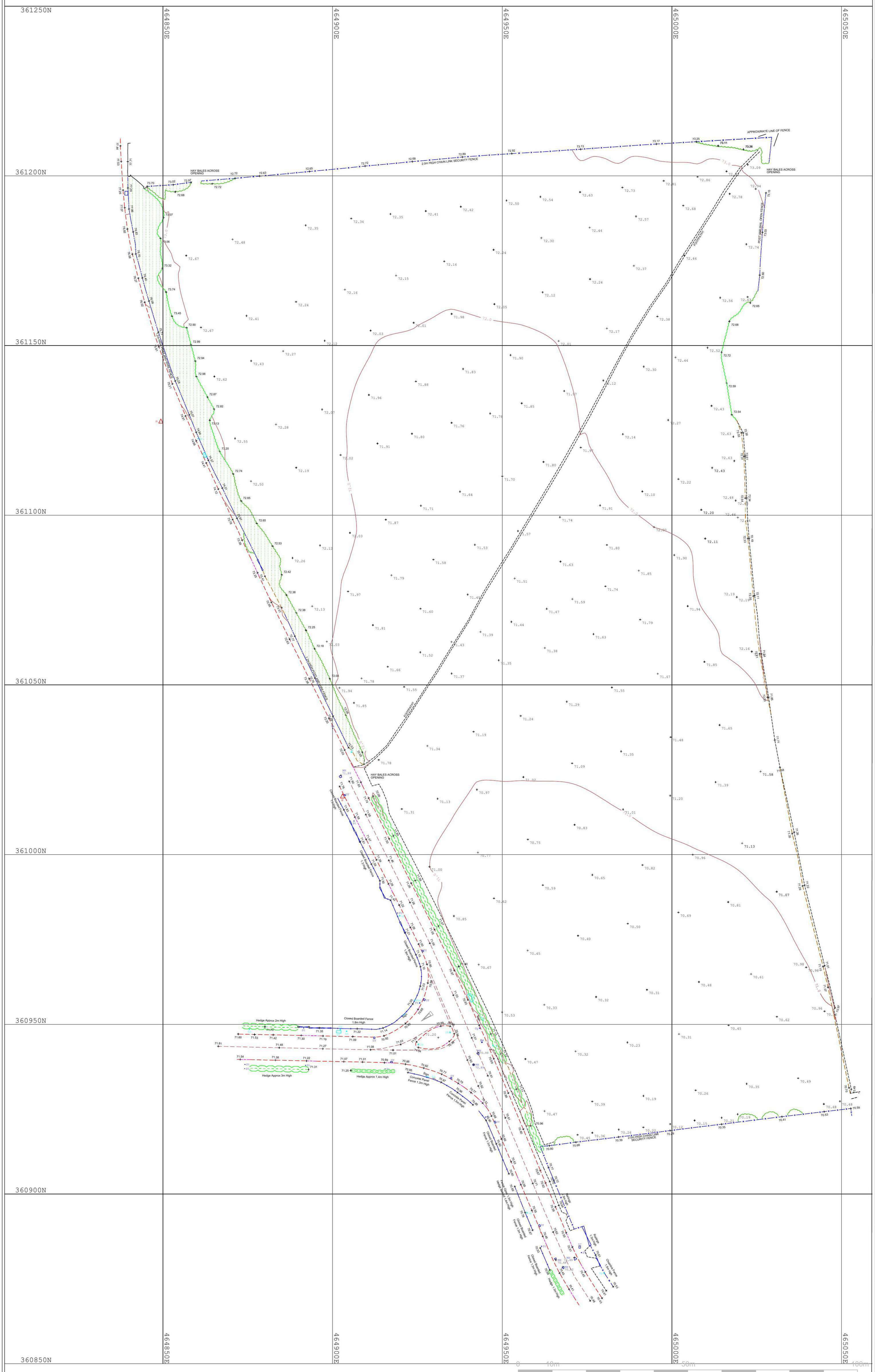
Appendix B

Topographical Survey



Comments:
The plan and digital data should only be used for its original intended purpose at the defined survey scale.

It is for the use only of the party to whom it has been addressed and no responsibility is accepted to any third party for the whole or part of its contents.

This survey has been prepared on the basis that all information and facts, which may affect the survey, have been disclosed to us by the parties concerned and no liability nor responsibility can be accepted, unless full disclosure has been made.

All ground features that were visible at the time of the survey have been located, however there may have been items obscured.

Pipe sizes and flow direction have been visually assessed from the surface and should be considered as approximate only.

All data remains the ownership of Oakes Survey Services until full payment has been received.

STATION SCHEDULE

Station	Easting	Northing	Level
I1	464849.371	361127.552	75.073
I2	464902.930	361017.080	71.817

LEGEND

Air Valve	Av
Belisha Beacon	BB
Borehole	BH
Rubbish Bin	Bin
Bollard	Boll
Bus Stop	Bs
Telecom Point	BT
Camera	Cam
Control Box	Cbox
Closed Circuit TV	Cctv
Cable TV Covers	Ctv
Down Pipe	Dp
Eaves Height	Eave
Electric Box	Ebox
Electric Post	Ep
Earth Rod	Er
Fire Hydrant	Fh
Flood light	Fl
Flag Staff	Fs
Gas Marker	Gmkr
Gate Post	Gp
Gas Valve	Gv
Gully	Gy
Illuminated Bollard	IB
Inspection Cover	IC
Inspection Cover Undefined	Icu
Floor Level	IFL
Invert Level	Inv
Letter Box	LBox
Lamp post	Lp
Manholes	MH
Marker Post	Mkr
Pipe Invert	PInv
Trial Pit	Pit
Parking Meter	PM
Posts	Post
Ridge Height	Rdge
Road Name Board	Rnb
Rodding Eye	Re
Sign Post	Sp
Stile	Stl
Tree Stump	Stmp
Stop Tap	St
Stop Valve	Sv
Cable Stay	Sy
Threshold Level	THL
Traffic Light	TL
Telegraph Post	Tp
Traffic Signal	TS
Top of Wall	TW
Unable to Lift	UTL
Valve	Va
Vent Pipe	Vp
Water Level	WL
Water Meter	Wm
Wash Out	Wo

STA1 Survey Station
Channel Line
Centre Line
Edge of Vegetation
Fence Open
Fence Panel
Fence Secure
Gate
Hedge
O/H Utilities
Top of Face

Revisions:

Ref:	Description:	Date:
1	Road Junction Added (IR)	08/03/17

OAKES SURVEYS LTD
8 The Heritage Business Centre, Derby Road, Belper, Derbyshire. DE56 1SW
Tel : 01773 820124 Fax : 01773 825407
E : iain@oakessurveys.com W : www.oakessurveys.com

Client
HARWORTH ESTATES

Location/Site:
LAND AT EAKRING RD
BILSTHORPE, NEWARK
NG22 8PZ

Drawing Title:
TOPOGRAPHICAL SURVEY

Level Datum:
ORDNANCE SURVEY

Grid Datum:
ORDNANCE SURVEY

Project Number:		Drawing Reference:	
3880		3880_REV1	
Surveyor:	Checked:	Date:	Scale:
IR	SRO	25/01/2017	1:500@A1

Note:
Do not scale, use figured dimensions only.
Please report any discrepancies immediately to Oakes Surveys Limited.
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Appendix C

Developer Enquiry Response and Sewer Records

Severn Trent Water

WONDERFUL ON TAP

SEVERN TRENT

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

Tel: 02477 716843
www.stwater.co.uk
net.dev.east@severntrent.co.uk

Contact: Belal Ali

Our ref 8363359

Travis Baker
Trinity Point
New Road
Halesowen
West Midlands
B63 3HY

F.A.O: Jordan Rageh

21st June 2019

Dear Sir/Madam,

Proposed Development: (85 mixed dwellings) – Land off Eakring Road, Bilsthorpe, NG22 8PZ

I refer to your Development Enquiry Request 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

No Sewers within site boundary.

Due to a change in legislation on 1 October 2011 there may be former private sewers on the site which have transferred to the responsibility of Severn Trent Water Ltd, which are not shown on the statutory sewer records, but are located in your client's land. These sewers would require protective strips of 3 metres either side of the sewer's centreline that we will not allow to be built over. If such sewers are identified to be present on the site, please contact us for further guidance.

Foul Water Drainage

Records show combined sewers on Eakring Road, downstream of MH 9901 is the most suitable connection point for your development. I can confirm the network has no known capacity issues and can accommodate these flows.

A gravity connection is therefore acceptable to the Company subject to formal S106 approval (see later)

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

If soakaways are not suitable and no watercourses or ditches are near the development site then connection to the surface water sewers (MH9802) will be acceptable with flows restricted at 5l/s/ha. All excess flows to be attenuated within site.

Subject to the above, Severn Trent Water expects all surface water from the development to be drained in a sustainable way to the nearest watercourse or land drainage channel, subject to the developer discussing all aspects of the developments surface water drainage with the Local Lead Flood Authority (LLFA). Any discharge rate to a watercourse or drainage ditch will be determined by the LLFA / EA.

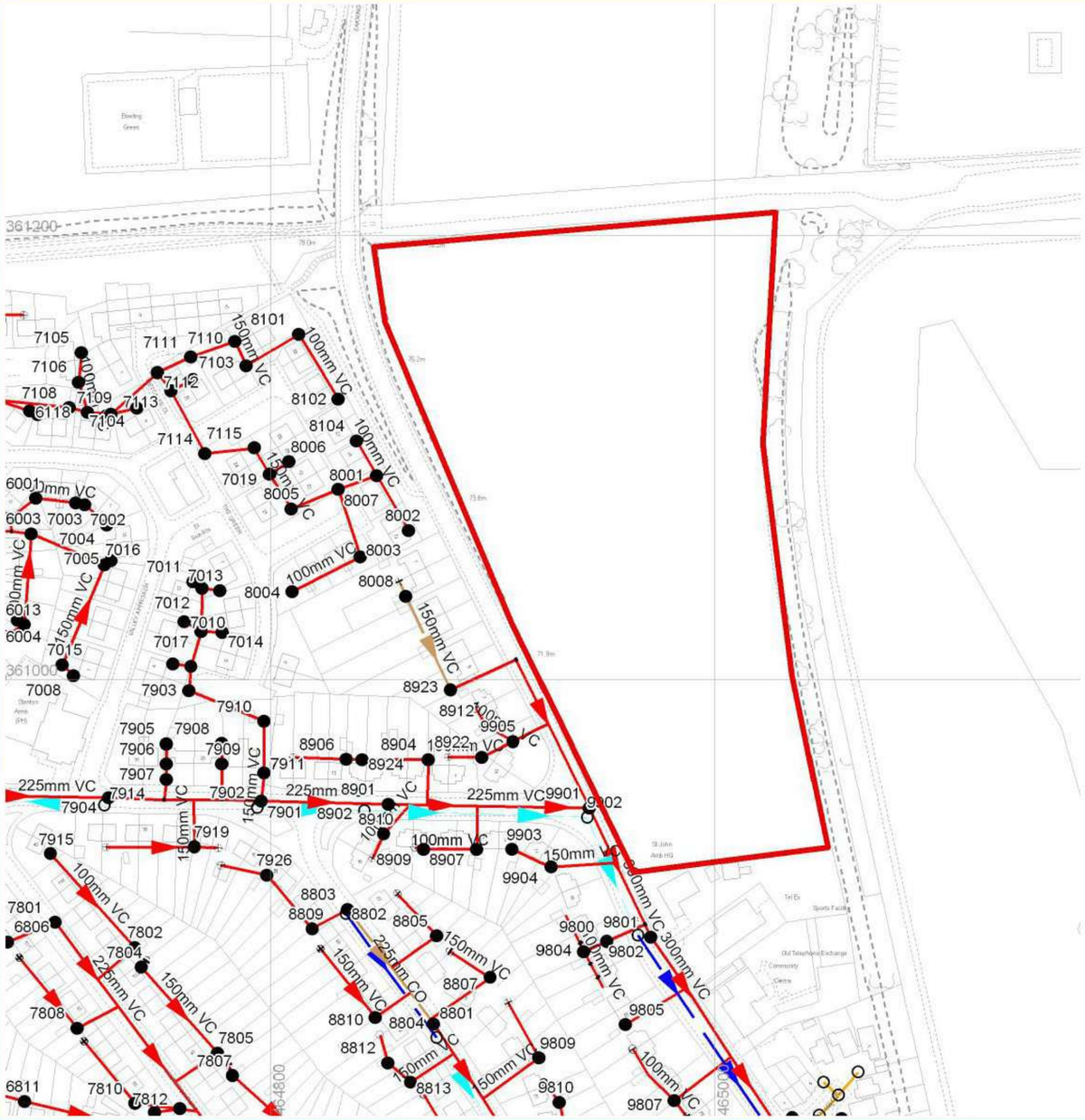
Connections

For any new connections (including the re-use of existing connections) to the public sewerage system, the developer will need to submit a Section 106 application form. Our Developer Services department are responsible for handling all new connections 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 the above reference in any future correspondence (including e-mails) with STW Limited. Please note that Developer Enquiry responses are only valid for 6 months from the date of this letter.

Yours sincerely

Belal Ali
Asset Protection Waste Water East
Wholesale Network Control and Asset Management



Sewer Node / Sewer Pipe Data

REFERENCE	COVER LEVEL	INV LEVEL UPSTR	INV LEVEL DOWNSTR	PURP	MATL	SHAPE	MAX SIZE	MIN SIZE	GRADIENT	YEAR LAID
SK64606806	nil	nil	73.91	C	VC	C	150	nil	0.00	nill
SK64606811	nil	nil	nil	C	nil	nil	nil	nil	0.00	nill
SK64607801	74.77	72.79	72.00	C	VC	C	225	nil	190.89	nill
SK64607802	nil	nil	nil	C	VC	C	150	nil	0.00	nill
SK64607804	nil	nil	nil	C	VC	C	150	nil	0.00	nill
SK64607805	nil	nil	nil	C	VC	C	150	nil	0.00	nill
SK64607807	nil	nil	nil	C	VC	C	100	nil	0.00	nill
SK64607808	nil	nil	nil	C	VC	C	150	nil	0.00	nill
SK64607810	nil	nil	nil	C	VC	C	150	nil	0.00	nill
SK64607812	nil	nil	nil	C	VC	C	150	nil	0.00	nill
SK64607813	nil	nil	nil	C	nil	nil	nil	nil	0.00	nill
SK64607901	73.27	70.98	70.53	C	VC	C	225	nil	126.69	nill
SK64607902	73.25	nil	nil	nil	nil	nil	nil	nil	0.00	nill
SK64607903	74.23	72.30	71.52	C	VC	C	150	nil	47.14	nill
SK64607904	74.42	72.24	nil	C	VC	C	225	nil	0.00	nill
SK64607905	74.12	73.61	73.45	C	VC	C	100	nil	56.25	nill
SK64607906	74.10	73.44	73.29	C	VC	C	100	nil	46.67	nill
SK64607907	74.15	73.27	nil	C	VC	C	100	nil	0.00	nill
SK64607908	74.03	nil	73.06	C	nil	nil	nil	nil	0.00	nill
SK64607909	74.08	73.02	nil	C	VC	C	100	nil	0.00	nill
SK64607910	73.72	71.50	71.31	C	VC	C	150	nil	121.05	nill
SK64607911	73.62	71.31	71.16	C	VC	C	150	nil	86.93	nill
SK64607914	74.53	nil	nil	nil	nil	nil	nil	nil	0.00	nill
SK64607915	nil	nil	nil	C	VC	C	100	nil	0.00	nill
SK64607919	nil	nil	nil	C	VC	C	150	nil	0.00	nill
SK64607926	nil	nil	nil	C	VC	C	100	nil	0.00	nill
SK64608801	72.06	70.17	69.86	C	CO	C	225	nil	249.65	nill
SK64608802	72.64	71.24	70.90	S	CO	C	225	nil	204.12	nill
SK64608803	72.74	71.03	70.18	F	VC	C	225	nil	76.47	nill
SK64608804	71.97	nil	nil	nil	nil	nil	nil	nil	0.00	nill
SK64608805	nil	nil	nil	C	VC	C	150	nil	0.00	nill
SK64608807	nil	nil	nil	C	VC	C	150	nil	0.00	nill
SK64608809	nil	nil	71.04	C	VC	C	150	nil	0.00	nill
SK64608810	nil	nil	nil	C	VC	C	150	nil	0.00	nill
SK64608812	nil	nil	nil	C	VC	C	150	nil	0.00	nill
SK64608813	nil	nil	nil	C	VC	C	150	nil	0.00	nill
SK64608901	72.23	70.49	69.48	C	VC	C	225	nil	89.13	nill
SK64608902	72.43	nil	nil	nil	nil	nil	nil	nil	0.00	nill
SK64608904	nil	nil	nil	C	VC	C	150	nil	0.00	nill
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SK64608907	nil	nil	nil	C	VC	C	150	nil	0.00	nill
SK64608909	nil	nil	nil	C	VC	C	100	nil	0.00	nill
SK64608910	nil	nil	nil	C	VC	C	100	nil	0.00	nill
SK64608912	nil	nil	nil	C	VC	C	100	nil	0.00	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
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DB - DAMBOARD
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FV - FLAP VALVE
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S - SIPHON
HD - HIGHWAY DRAIN
S104 - SECTION 104

N
W E
S

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Asset Data Management
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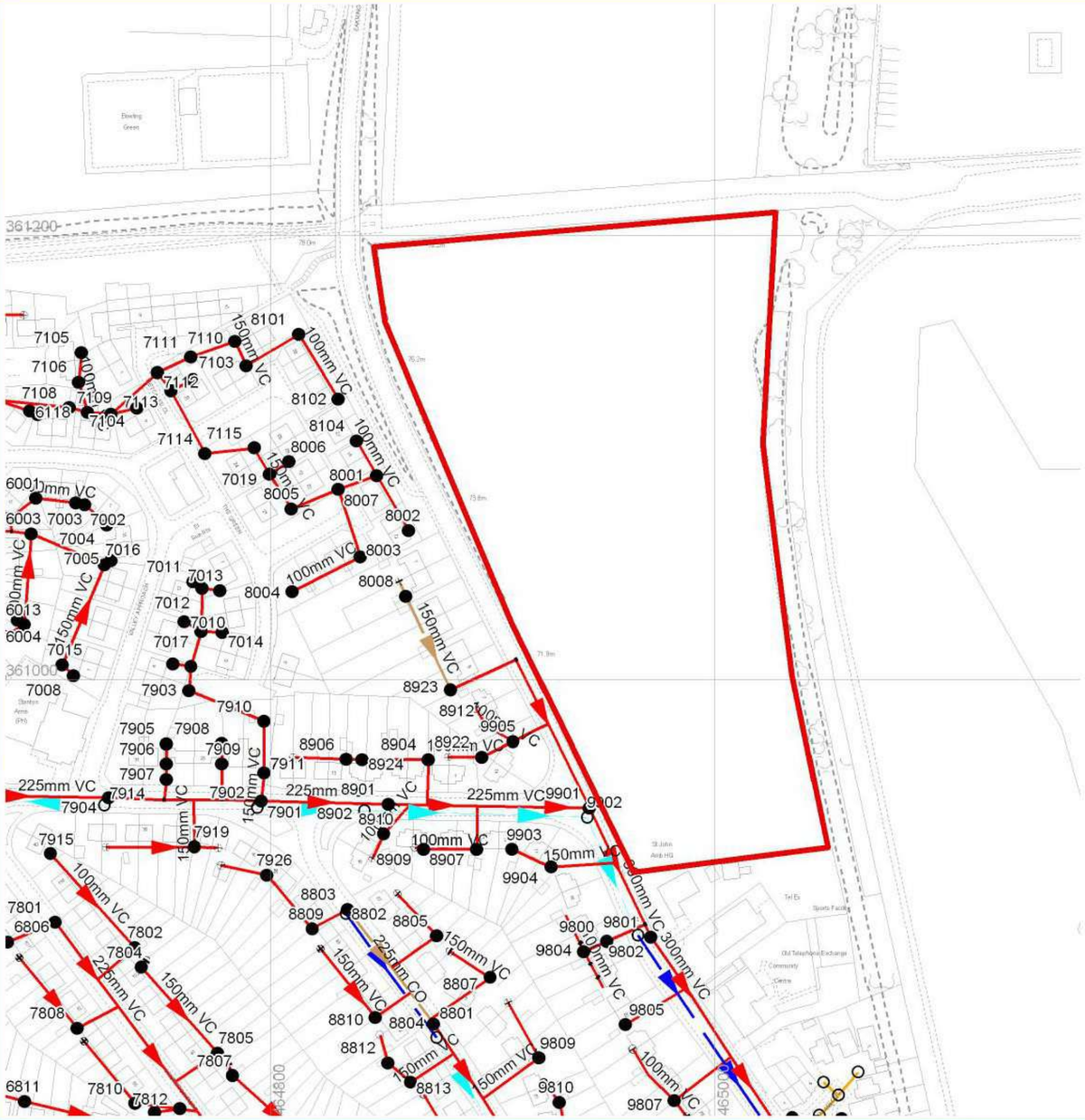

Sewer Node / Sewer Pipe Data

REFERENCE	COVER LEVEL	INV LEVEL UPSTR	INV LEVEL DOWNSTR	PURP	MATL	SHAPE	MAX SIZE	MIN SIZE	GRADIENT	YEAR LAID
SK64608922	nil	nil	nil	C	VC	C	100	nil	0.00	nill
SK64608923	nil	nil	nil	C	nil	nil	nil	nil	0.00	nill
SK64608924	nil	nil	nil	C	nil	nil	nil	nil	0.00	nill
SK64609800	nil	nil	nil	C	VC	C	150	nil	0.00	nill
SK64609801	70.70	69.30	69.01	C	VC	C	300	nil	387.03	nill
SK64609802	70.70	69.65	69.26	S	CO	C	375	nil	321.44	nill
SK64609804	nil	nil	nil	C	VC	C	150	nil	0.00	nill
SK64609805	nil	nil	nil	C	VC	C	150	nil	0.00	nill
SK64609807	nil	nil	nil	C	VC	C	150	nil	0.00	nill
SK64609809	nil	nil	nil	C	VC	C	150	nil	0.00	nill
SK64609810	nil	nil	nil	C	VC	C	150	nil	0.00	nill
SK64609901	71.19	69.48	69.31	C	VC	C	300	nil	378.82	nill
SK64609902	71.12	nil	nil	nil	nil	nil	nil	nil	0.00	nill
SK64609903	nil	nil	nil	C	VC	C	100	nil	0.00	nill
SK64609904	nil	nil	nil	C	VC	C	150	nil	0.00	nill
SK64609905	nil	nil	nil	C	nil	nil	nil	nil	0.00	nill
SK64616001	72.89	72.25	72.17	C	VC	C	100	nil	187.50	nill
SK64616003	73.50	71.56	nil	C	VC	C	150	nil	0.00	nill
SK64616004	74.12	73.52	73.23	C	VC	C	100	nil	12.45	nill
SK64616010	72.84	72.14	nil	C	VC	C	100	nil	0.00	nill
SK64616013	74.30	73.22	71.57	C	VC	C	100	nil	24.92	nill
SK64616107	72.30	70.62	nil	C	VC	C	100	nil	0.00	nill
SK64616118	nil	nil	69.54	C	nil	nil	nil	nil	0.00	nill
SK64617002	73.39	72.61	72.59	C	VC	C	100	nil	206.00	nill
SK64617003	73.07	72.58	72.25	C	VC	C	100	nil	54.88	nill
SK64617004	73.39	72.85	72.65	C	VC	C	100	nil	67.25	nill
SK64617005	73.77	72.96	nil	C	VC	C	100	nil	0.00	nill
SK64617008	74.53	73.79	73.56	C	VC	C	100	nil	30.74	nill
SK64617009	74.13	73.24	nil	C	VC	C	100	nil	0.00	nill
SK64617010	73.86	73.16	nil	C	VC	C	100	nil	0.00	nill
SK64617011	73.89	73.36	nil	C	VC	C	100	nil	0.00	nill
SK64617012	nil	nil	nil	C	nil	nil	nil	nil	0.00	nill
SK64617013	73.90	73.24	nil	C	VC	C	100	nil	0.00	nill
SK64617014	73.98	73.13	nil	C	VC	C	100	nil	0.00	nill
SK64617015	74.68	73.52	nil	C	VC	C	150	nil	0.00	nill
SK64617016	73.97	nil	71.57	C	nil	nil	nil	nil	0.00	nill
SK64617017	nil	nil	nil	C	nil	nil	nil	nil	0.00	nill
SK64617018	nil	nil	72.34	C	nil	nil	nil	nil	0.00	nill
SK64617019	nil	nil	nil	C	nil	nil	nil	nil	0.00	nill
SK64617102	73.66	nil	nil	C	nil	nil	nil	nil	0.00	nill
SK64617103	73.66	71.31	nil	C	VC	C	150	nil	0.00	nill
SK64617104	73.50	72.73	70.15	C	VC	C	100	nil	4.33	nill
SK64617105	72.57	71.93	71.69	C	VC	C	100	nil	54.33	nill
SK64617106	72.57	71.68	70.22	C	VC	C	100	nil	9.32	nill

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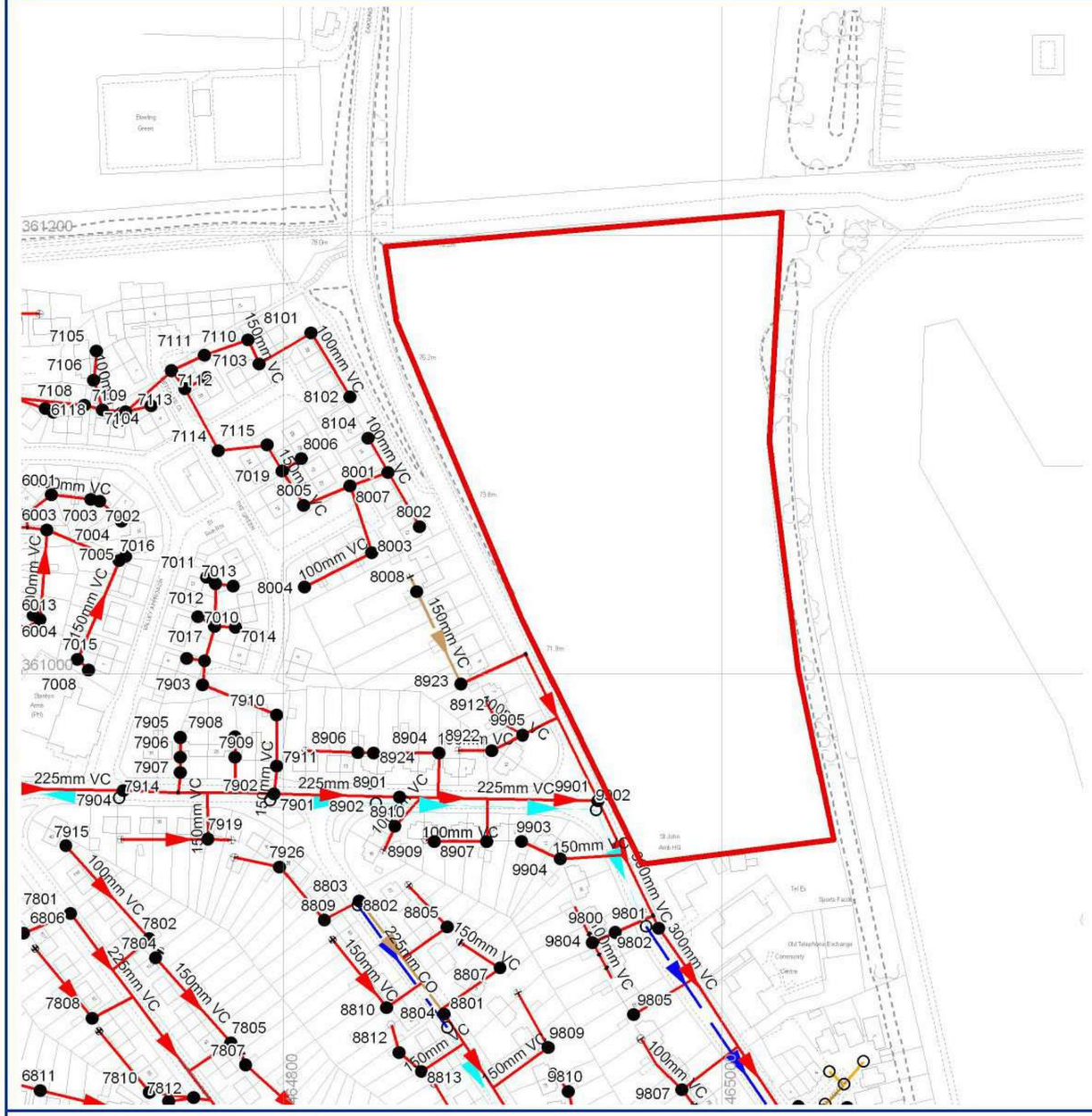

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SK64617107	72.49	70.06	70.26	C	VC	C	150	nil	0.00	nill
SK64617108	72.49	70.08	69.51	C	VC	C	150	nil	56.39	nill
SK64617109	73.07	70.21	70.08	C	VC	C	150	nil	63.46	nill
SK64617110	nil	nil	nil	C	nil	nil	nil	nil	0.00	nill
SK64617111	nil	nil	nil	C	nil	nil	nil	nil	0.00	nill
SK64617112	nil	nil	70.07	C	nil	nil	nil	nil	0.00	nill
SK64617113	nil	nil	nil	C	nil	nil	nil	nil	0.00	nill
SK64617114	nil	nil	nil	C	nil	nil	nil	nil	0.00	nill
SK64617115	nil	nil	nil	C	nil	nil	nil	nil	0.00	nill
SK64618001	73.64	72.15	nil	C	VC	C	150	nil	0.00	nill
SK64618002	73.52	72.51	72.19	C	VC	C	100	nil	88.44	nill
SK64618003	73.81	72.52	nil	C	VC	C	100	nil	0.00	nill
SK64618004	73.81	72.99	72.54	C	VC	C	100	nil	77.53	nill
SK64618005	73.93	71.71	nil	C	VC	C	150	nil	0.00	nill
SK64618006	73.76	72.87	nil	C	VC	C	100	nil	0.00	nill
SK64618007	nil	nil	71.71	C	nil	nil	nil	nil	0.00	nill
SK64618008	nil	nil	nil	F	VC	C	150	nil	0.00	nill
SK64618101	73.64	71.86	71.38	C	VC	C	100	nil	57.21	nill
SK64618102	73.62	72.35	71.90	C	VC	C	100	nil	75.84	nill
SK64618104	73.73	72.76	72.18	C	VC	C	100	nil	31.66	nill
nil	nil	nil	69.10	S	VC	C	150	nil	0.00	2007
nil	nil	69.10	69.07	S	CO	C	600	nil	420.67	2007
nil	nil	69.13	69.10	S	CO	C	600	nil	460.67	2007

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Additional Guidance Notes

If you experience difficulty in the provision of off-site sewers to serve your proposed development, an application for requisition sewers under Section 98 Water Act 2003 may be appropriate on request to this office.

If there are existing public sewers within the curtilage of the development site that may affect the proposed development, the option to divert them under Section 185 Water Act 2003 may be available. All costs incurred would lay with the Applicant.

All potentially adoptable sewers must be designed and constructed in accordance with the guidelines in Sewers for Adoption (6th Edition), after 1st May 2006. A Severn Trent Water Addendum for Foul Sewage Pumping Stations will be available at www.wrcplc.co.uk/sfa.

If the sewers are to be offered for adoption or if the development works could affect the public sewerage system, the Developer should approach Severn Trent Water Ltd to discuss their proposals in detail. This is to ensure the Developer is aware of the Company's requirements which could affect the development design and/or programme.

In cases where the complexity of both the existing receiving sewerage system and the proposed additional sewerage necessitates the construction of a suitable computer model, Severn Trent Water can offer this service. Enquiries should be addressed to Bob Garrington in our Infrastructure Strategy Team who can be contacted on Tues - Thurs only by email to: **sewer.capacity@severntrent.co.uk**

Severn Trent Water has no knowledge of any specific land drainage issues involving this site. The Developer is to contact and seek approval of The Environment Agency, Local Authority etc. regarding any means of surface water disposal to the land drainage system, required attenuation, discharge consent etc.

All enquiries with respect to the supply of sewer records only should be directed to Severn Trent Water Limited, Asset Data Management, PO Box 5344, Coventry. CV3 9FT (Tel. 0845 601 6616).

Asset Protection
Waste Water East

SUPPLEMENTARY GUIDANCE NOTES RELATING TO DISPOSAL OF SURFACE WATER

SEVERN TRENT WATER

Introduction

The purpose of this guidance note is to provide advice to applicants when completing the surface water drainage design for a new development, both for Greenfield and Brownfield sites. This does not affect foul drainage disposal which should be discussed with Severn Trent as early as possible to ensure additional flows can be accommodated without undue delay to the development.

Lead Local Flood Authority (LLFA) Consultation

Since April 2015, the LLFA have assumed the role of being a statutory consultee in the planning process for developments of 10 dwellings or more; or equivalent non-residential and/or mixed development. The LLFAs role is vital to ensure that surface water disposal on new development is adequately assessed so that the local planning authority can satisfy themselves that drainage proposals are satisfactory and to make sure, through the use of planning conditions or planning obligations, that there are clear arrangements in place for future maintenance of sustainable drainage systems (SuDS) over the lifetime of the development. This will also ensure surface water disposal aligns with local planning policies, flood risk strategies and national policies, such as the National Planning Policy Framework (NPPF).

It is strongly recommend that the LLFA are involved in early pre-application discussions when the development of a site is initially being considered. Pre-application discussions will help to ensure that SuDS are appropriately considered ahead of or as part of preliminary development layouts, and that they are fully integrated into the final development layout. Whilst Severn Trent are willing to advise on sewerage availability this does to negate the planning requirement relating to adequacy of SuDS on new development.

SuDS Hierarchy

Severn Trent is fully supportive of the fundamental SuDS principle that priority should be given to managing surface water as close to source as possible. In accordance with national standards and guidance a sequential series of checks should be undertaken to ensure the relevant SuDS features are being proposed whereby (in order of priority) rainwater re-use, infiltration to ground and controlled discharge to a water body are properly considered ahead of any controlled connection to a culverted watercourse/other drainage system or public surface water sewer.

A controlled connection to a public combined/foul sewer would only be considered under rare exceptional circumstances where all other options have been completely exhausted. Acceptance of surface water into a combined sewer is not only unsustainable because of the need to convey/treat rainwater but is also takes away existing capacity which could constraint the connection of foul flows on future development. It is also possible that connection of additional surface water flows will require capacity upgrades to the existing sewerage system which may delay development.

Connection to a Public Sewer

Whilst Severn Trent will be able to provide advice on potential public surface water sewer connection options, it is essential that a developer contacts the LLFA as early as possible to discuss surface water disposal as they will be able to provide guidance on surface water flood risk policy which may influence SuDS requirements. It is strongly recommended that LLFA discussions take place before contacting Severn Trent. Where the outcome of LLFA discussions concludes that a controlled discharge to the public sewerage system is the only viable option then Severn Trent would be pleased to discuss sewer connection options, satisfied that the LLFA have been consulted in line with their surface water management role and in their capacity as statutory consultee.

Evidence must be provided to demonstrate why the sequential SuDS checks have concluded that a connection to the public sewer is required. This must include a Site Investigation Report including percolation test data/graphs/calculations/results together with relevant correspondence with the LLFA.

Design Standards

Surface water disposal design should consider the interactions between the adoptable sewer design criteria based on a 30 year design storm (outlined in 'Sewers For Adoption') and the "Non-statutory technical standards for SuDS" requirement to restrict discharge from a site up to and including the 1 in 100 year critical storm event plus an allowance for climate change as required by the LLFA.

For Greenfield development, the peak runoff rate should never exceed the peak pre-development run-off rates/volumes for the same rainfall event irrespective of the design storm duration consistent with the national non-statutory technical standards. For developments which were previously developed (Brownfield), the peak runoff rate must be as close as reasonably practicable to the greenfield runoff rate from the development for the same rainfall event, but should never exceed the rate of discharge from the development prior to redevelopment again for the same rainfall event. This requirement to remove pre-development surface water discharges to the sewerage system will help remove capacity constraints and aid future development.

To establish the pre-development run-off rates a detailed existing drainage survey will be required indicating pipe locations including sizes and levels, impermeable area connectivity to each pipe and topographical information to support existing drainage assumptions. Photographs of the existing buildings and surface features should be provided and where necessary a CCTV sewer survey should be provided to support the drainage survey to demonstrate connectivity.

In line with 'Sewers for Adoption', the drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur on any part of the site for a 1 in 30 year rainfall event. For higher storm return periods the drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur during a 1 in 100 year rainfall event in any part of: a building (including a basement); or in any utility plant susceptible to water (e.g. pumping station, electricity substation, water booster station) within the development.

Small Developments

Whilst developments of fewer than 10 dwellings (or their equivalent) are excluded from the post April 2015 planning requirements the underlying principles regarding sustainable surface water management are still valid. The collective impacts of surface water discharges from smaller developments can have an adverse impact on flood risk, especially in smaller rural catchments where smaller sewerage systems are more susceptible to increases in surface water inflow. On small developments infiltration to ground and peak flow attenuation must be considered to mitigate flood risk in the community but where a sewer connection is envisaged then the developer is recommended to discuss surface water disposal options with Severn Trent as early as possible.

Contact

For further assistance please contact our Asset Protection teams via:

net.dev.west@severntrent.co.uk

(Birmingham & Black Country, Staffordshire, Shropshire, Worcestershire, Gloucestershire, Herefordshire, Powys)

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Appendix D

Trial Pit Location Plan and Infiltration Test Results

Travis Baker Geo-environmental

KEY:

- TP8 — TRIAL PIT LOCATION
- SA6 — SOAKAWAY LOCATION
- TRLDCP6 — DYNAMIC CONE PENETROMETER LOCATION
- DS4 — DYNAMIC SAMPLE LOCATION
- DS6 — BOREHOLE WITH GAS MONITORING STANDPIPE
- SITE BOUNDARY
- RECORDED WATER MAIN
- UNDERGROUND ELECTRICITY CABLE

REV	DESCRIPTION	DATE	BY	AUTH
A	SOAKAWAY LOCATIONS AMENDED.	06.08.19	TD	LG

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CLIENT
KEEPMOAT HOMES

PROJECT
EAKRING ROAD, BILSTHORPE

TITLE
EXPLORATORY HOLE LOCATION PLAN

DRAWN	AUTHORISED	SCALE	DATE
TD	LG	1:500-@A1	06.06.19

PROJECT NO.	DRAWING NO.	REV
19017	GE01	A

STATUS.
DRAFT

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Soakaway SA1A Test 1

Width (m):	0.70
Length (m):	2.50
Depth (m):	2.60
Natural depth (m):	0.00
Depth (m) of Water at T = 0	1.80
Effective depth (m)	0.80
Vp25 (m)	0.200
Depth (mbgl) at Vp25	2.400
Vp75 (m)	0.600
Depth (mbgl) at Vp75	2.000
Vp50 (m)	0.40
Vp75/Vp25 (m^3)	0.700
Effective volume * 0.3	0.210
a50 (m^2)	4.31
t between vp75 to vp25(secs)	26500
Soil Infiltration (m/s)	6.13E-06

Trial 1

Time (mins)	Time (secs)	Depth (mbgl)
1	60	1.8
2	120	1.82
3	180	1.83
4	240	1.83
5	300	1.84
6	360	1.85
7	420	1.855
8	480	1.86
9	540	1.86
10	600	1.87
11	660	1.88
12	720	1.885
13	780	1.89
15	900	1.91
17	1020	1.92
19	1140	1.92
21	1260	1.92
31	1860	1.94
36	2160	1.96
38	2280	1.96
67	4020	2.01
86	5160	2.06
123	7380	2.07
148	8880	2.09
170	10200	2.11
218	13080	2.15
264	15840	2.19
305	18300	2.22
329	19740	2.25

Soakaway SA1A Test 2

Width (m):	0.70
Length (m):	2.50
Depth (m):	2.60
Natural depth (m):	0.00
Depth (m) of Water at T = 0	1.60
Effective depth (m)	1.00
Vp25 (m)	0.250
Depth (mbgl) at Vp25	2.350
Vp75 (m)	0.750
Depth (mbgl) at Vp75	1.850
Vp50 (m)	0.50
Vp75/Vp25 (m^3)	0.875
Effective volume * 0.3	0.263
a50 (m^2)	4.95
t between vp75 to vp25(secs)	35500
Soil Infiltration (m/s)	4.98E-06

Trial 2

Time (mins)	Time (secs)	Depth (mbgl)
1	60	1.61
2	120	1.62
3	180	1.62
4	240	1.63
5	300	1.62
6	360	1.63
7	420	1.63
8	480	1.63
9	540	1.63
10	600	1.64
15	900	1.65
27	1620	1.63
34	2040	1.64
40	2400	1.64
62	3720	1.68
82	4920	1.71
106	6360	1.75
124	7440	1.77
152	9120	1.81
187	11220	1.84
211	12660	1.86
251	15060	1.9
291	17460	1.93
329	19740	1.96

Soakaway SA1A Test 3

Width (m):	0.00
Length (m):	0.00
Depth (m):	0.00
Natural depth (m):	0.00
Depth (m) of Water at T = 0	0.00
Effective depth (m)	0.00
Vp25 (m)	0.000
Depth (mbgl) at Vp25	0.000
Vp75 (m)	0.000
Depth (mbgl) at Vp75	0.000
Vp50 (m)	0.00
Vp75/Vp25 (m^3)	0.000
Effective volume * 0.3	0.000
a50 (m^2)	0.00
t between vp75 to vp25(secs)	0
Soil Infiltration (m/s)	#DIV/0!

Trial 3

Time (mins)	Time (secs)	Depth (mbgl)

Soakaway SA2 Test 1

Width (m):	0.70
Length (m):	2.40
Depth (m):	2.30
Natural depth (m):	0.00
Depth (m) of Water at T = 0	1.48
Effective depth (m)	0.82
Vp25 (m)	0.205
Depth (mbgl) at Vp25	2.095
Vp75 (m)	0.615
Depth (mbgl) at Vp75	1.685
Vp50 (m)	0.41
Vp75/Vp25 (m^3)	0.689
Effective volume * 0.3	0.000
a50 (m^2)	4.22
t between vp75 to vp25(secs)	44183
Soil Infiltration (m/s)	3.69E-06

Trial 1

Time (mins)	Time (secs)	Depth (mbgl)
1	60	1.485
2	120	1.49
3	180	1.5
4	240	1.5
5	300	1.5
6	360	1.5
7	420	1.505
8	480	1.505
9	540	1.51
10	600	1.51
11	660	1.51
12	720	1.52
13	780	1.52
14	840	1.52
15	900	1.52
16	960	1.52
17	1020	1.52
18	1080	1.525
19	1140	1.525
20	1200	1.53
22	1320	1.54
24	1440	1.54
26	1560	1.545
28	1680	1.55
30	1800	1.56
35	2100	1.56
40	2400	1.565
54	3240	1.59
59	3540	1.6
73	4380	1.61
85	5100	1.62
115	6900	1.66
132	7920	1.66
153	9180	1.68
190	11400	1.7
238	14280	1.74
248	14880	1.74
287	17220	1.77
311	18660	1.77

Soakaway SA2 Test 2

Width (m):	0.70
Length (m):	2.40
Depth (m):	2.14
Natural depth (m):	0.00
Depth (m) of Water at T = 0	1.10
Effective depth (m)	1.04
Vp25 (m)	0.260
Depth (mbgl) at Vp25	1.880
Vp75 (m)	0.780
Depth (mbgl) at Vp75	1.360
Vp50 (m)	0.52
Vp75/Vp25 (m^3)	0.874
Effective volume * 0.3	
a50 (m^2)	4.90
t between vp75 to vp25(secs)	44500
Soil Infiltration (m/s)	4.00E-06

Trial 2

Time (mins)	Time (secs)	Depth (mbgl)
1	60	1.1
2	120	1.13
3	180	1.13
4	240	1.14
5	300	1.15
6	360	1.15
7	420	1.155
8	480	1.16
9	540	1.17
10	600	1.17
16	960	1.18
20	1200	1.2
24	1440	1.21
28	1680	1.21
30	1800	1.21
32	1920	1.21
34	2040	1.21
36	2160	1.21
38	2280	1.21
40	2400	1.22
59	3540	1.3
99	5940	1.35
124	7440	1.4
145	8700	1.43
170	10200	1.46
188	11280	1.46
213	12780	1.48
227	13620	1.54
250	15000	1.55
272	16320	1.53
320	19200	1.55
366	21960	1.6
408	24480	1.62
437	26220	1.63
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0

Soakaway SA2 Test 3

Width (m):	0.70
Length (m):	2.40
Depth (m):	2.14
Natural depth (m):	0.00
Depth (m) of Water at T = 0	1.14
Effective depth (m)	1.00
Vp25 (m)	0.250
Depth (mbgl) at Vp25	1.890
Vp75 (m)	0.750
Depth (mbgl) at Vp75	1.390
Vp50 (m)	0.50
Vp75/Vp25 (m^3)	0.840
Effective volume * 0.3	
a50 (m^2)	4.78
t between vp75 to vp25(secs)	54166
Soil Infiltration (m/s)	3.24E-06

Trial 3

Time (mins)	Time (secs)	Depth (mbgl)
0	0	1.14
1	60	1.14
2	120	1.16
3	180	1.17
4	240	1.17
5	300	1.17
6	360	1.17
7	420	1.17
8	480	1.17
9	540	1.18
10	600	1.18
16	960	1.18
22	1320	1.19
44	2640	1.23
64	3840	1.25
88	5280	1.29
106	6360	1.31
134	8040	1.33
168	10080	1.38
206	12360	1.4
246	14760	1.44
283	16980	1.45
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0

Soakaway SA4 Test 1

Width (m):	0.70
Length (m):	2.30
Depth (m):	2.60
Natural depth (m):	0.00
Depth (m) of Water at T = 0	1.50
Effective depth (m)	1.10
Vp25 (m)	0.275
Depth (mbgl) at Vp25	2.325
Vp75 (m)	0.825
Depth (mbgl) at Vp75	1.775
Vp50 (m)	0.55
Vp75/Vp25 (m^3)	0.886
Effective volume * 0.3	0.266
a50 (m^2)	4.91
t between vp75 to vp25(secs)	30500
Soil Infiltration (m/s)	5.91E-06

Trial 1

Time (mins)	Time (secs)	Depth (mbgl)
1	60	1.53
2	120	1.54
3	180	1.54
4	240	1.55
5	300	1.55
6	360	1.56
7	420	1.57
8	480	1.57
9	540	1.57
10	600	1.58
12	720	1.59
14	840	1.6
16	960	1.6
18	1080	1.62
20	1200	1.65
25	1500	1.67
30	1800	1.67
35	2100	1.7
38	2280	1.71
53	3180	1.75
58	3480	1.75
67	4020	1.76
72	4320	1.77
92	5520	1.8
98	5880	1.81
121	7260	1.85
131	7860	1.87
140	8400	1.88
	0	
	0	
	0	
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	

Soakaway SA4 Test 2

Width (m):	0.70
Length (m):	2.30
Depth (m):	2.50
Natural depth (m):	0.00
Depth (m) of Water at T = 0	1.50
Effective depth (m)	1.00
Vp25 (m)	0.250
Depth (mbgl) at Vp25	2.250
Vp75 (m)	0.750
Depth (mbgl) at Vp75	1.750
Vp50 (m)	0.50
Vp75/Vp25 (m^3)	0.805
Effective volume * 0.3	0.242
a50 (m^2)	4.61
t between vp75 to vp25(secs)	44500
Soil Infiltration (m/s)	3.92E-06

Trial 2

Time (mins)	Time (secs)	Depth (mbgl)
1	60	1.51
2	120	1.52
3	180	1.53
4	240	1.53
5	300	1.54
6	360	1.54
7	420	1.55
8	480	1.55
9	540	1.55
10	600	1.555
11	660	1.56
12	720	1.56
14	840	1.57
16	960	1.59
18	1080	1.6
20	1200	1.6
22	1320	1.6
24	1440	1.6
26	1560	1.6
28	1680	1.6
30	1800	1.6
32	1920	1.61
34	2040	1.61
36	2160	1.61
38	2280	1.62
40	2400	1.62
42	2520	1.63
83	4980	1.7
107	6420	1.75
128	7680	1.77
153	9180	1.79
172	10320	1.8
196	11760	1.82
212	12720	1.83
233	13980	1.85
255	15300	1.88
303	18180	1.91
349	20940	1.93
392	23520	1.94
417	25020	1.96

Soakaway SA4 Test 3

Width (m):	0.70
Length (m):	2.30
Depth (m):	2.50
Natural depth (m):	0.00
Depth (m) of Water at T = 0	1.50
Effective depth (m)	1.00
Vp25 (m)	0.250
Depth (mbgl) at Vp25	2.250
Vp75 (m)	0.750
Depth (mbgl) at Vp75	1.750
Vp50 (m)	0.50
Vp75/Vp25 (m^3)	0.805
Effective volume * 0.3	0.242
a50 (m^2)	4.61
t between vp75 to vp25(secs)	49500
Soil Infiltration (m/s)	3.53E-06

Trial 3

Time (mins)	Time (secs)	Depth (mbgl)
0	0	1.5
1	60	1.5
2	120	1.5
3	180	1.5
4	240	1.5
5	300	1.5
6	360	1.51
7	420	1.5
8	480	1.51
9	540	1.52
10	600	1.52
38	2280	1.57
63	3780	1.63
87	5220	1.65
107	6420	1.68
142	8520	1.72
167	10020	1.75
205	12300	1.8
245	14700	1.81
291	17460	1.85
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0

Soakaway SA5 Test 1

Width (m):	0.70
Length (m):	2.60
Depth (m):	2.04
Natural depth (m):	0.00
Depth (m) of Water at T = 0	1.00
Effective depth (m)	1.04
Vp25 (m)	0.260
Depth (mbgl) at Vp25	1.780
Vp75 (m)	0.780
Depth (mbgl) at Vp75	1.260
Vp50 (m)	0.52
Vp75/Vp25 (m^3)	0.946
Effective volume * 0.3	0.284
a50 (m^2)	5.25
t between vp75 to vp25(secs)	47500
Soil Infiltration (m/s)	3.79E-06

Trial 1

Time (mins)	Time (secs)	Depth (mbgl)
1	60	1.02
2	120	1.025
3	180	1.03
4	240	1.035
5	300	1.04
6	360	1.045
7	420	1.05
11	660	1.06
12	720	1.065
13	780	1.07
14	840	1.075
32	1920	1.12
48	2880	1.15
59	3540	1.15
74	4440	1.17
84	5040	1.195
103	6180	1.22
122	7320	1.25
160	9600	1.27
189	11340	1.3
	0	
	0	
	0	
	0	
	0	
	0	
	0	
	0	
	0	
	0	
	0	
	0	
0	0	0

Soakaway SA5 Test 2

Width (m):	0.70
Length (m):	2.60
Depth (m):	1.96
Natural depth (m):	0.00
Depth (m) of Water at T = 0	0.93
Effective depth (m)	1.03
Vp25 (m)	0.258
Depth (mbgl) at Vp25	1.703
Vp75 (m)	0.773
Depth (mbgl) at Vp75	1.188
Vp50 (m)	0.52
Vp75/Vp25 (m^3)	0.937
Effective volume * 0.3	0.281
a50 (m^2)	5.22
t between vp75 to vp25(secs)	54500
Soil Infiltration (m/s)	3.30E-06

Trial 2

Time (mins)	Time (secs)	Depth (mbgl)
1	60	0.93
2	120	0.94
3	180	0.945
4	240	0.96
5	300	0.96
6	360	0.965
7	420	0.97
8	480	0.98
10	600	0.98
12	720	0.99
14	840	0.99
16	960	0.99
18	1080	1
21	1260	1.08
24	1440	1.12
26	1560	1.1
28	1680	1.03
30	1800	1.05
32	1920	1.06
34	2040	1.08
48	2880	1.07
65	3900	1.11
101	6060	1.15
122	7320	1.12
143	8580	1.13
162	9720	1.18
178	10680	1.2
229	13740	1.23
273	16380	1.25
316	18960	1.31
362	21720	1.33
388	23280	1.35

Soakaway SA5 Test 3

Width (m):	0.70
Length (m):	2.60
Depth (m):	1.96
Natural depth (m):	0.00
Depth (m) of Water at T = 0	0.96
Effective depth (m)	1.00
Vp25 (m)	0.250
Depth (mbgl) at Vp25	1.710
Vp75 (m)	0.750
Depth (mbgl) at Vp75	1.210
Vp50 (m)	0.50
Vp75/Vp25 (m^3)	0.910
Effective volume * 0.3	0.273
a50 (m^2)	5.12
t between vp75 to vp25(secs)	60000
Soil Infiltration (m/s)	2.96E-06

Trial 3

Time (mins)	Time (secs)	Depth (mbgl)
0	0	0.96
1	60	0.96
2	120	0.96
3	180	0.97
4	240	0.98
5	300	0.98
6	360	0.98
7	420	0.99
8	480	1
9	540	1
10	600	0.99
27	1620	1.02
50	3000	1.04
83	4980	1.07
111	6660	1.16
130	7800	1.14
167	10020	1.17
208	12480	1.2
253	15180	1.26
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0

Soakaway SA6 Test 1

Width (m):	0.70
Length (m):	2.30
Depth (m):	2.60
Natural depth (m):	0.00
Depth (m) of Water at T = 0	1.26
Effective depth (m)	1.34
Vp25 (m)	0.335
Depth (mbgl) at Vp25	2.265
Vp75 (m)	1.005
Depth (mbgl) at Vp75	1.595
Vp50 (m)	0.67
Vp75/Vp25 (m^3)	1.079
Effective volume * 0.3	0.324
a50 (m^2)	5.63
t between vp75 to vp25(secs)	35500
Soil Infiltration (m/s)	5.40E-06

Trial 1

Time (mins)	Time (secs)	Depth (mbgl)
1	60	1.29
2	120	1.3
3	180	1.315
4	240	1.325
5	300	1.33
6	360	1.34
7	420	1.35
8	480	1.355
11	660	1.375
18	1080	1.425
21	1260	1.44
33	1980	1.49
48	2880	1.53
62	3720	1.57
81	4860	1.61
116	6960	1.67
145	8700	1.72
154	9240	1.74

Soakaway SA6 Test 2

Width (m):	0.70
Length (m):	2.30
Depth (m):	2.40
Natural depth (m):	0.00
Depth (m) of Water at T = 0	1.40
Effective depth (m)	1.00
Vp25 (m)	0.250
Depth (mbgl) at Vp25	2.150
Vp75 (m)	0.750
Depth (mbgl) at Vp75	1.650
Vp50 (m)	0.50
Vp75/Vp25 (m^3)	0.805
Effective volume * 0.3	0.242
a50 (m^2)	4.61
t between vp75 to vp25(secs)	22000
Soil Infiltration (m/s)	7.94E-06

Trial 2

Time (mins)	Time (secs)	Depth (mbgl)
1	60	1.41
2	120	1.42
3	180	1.43
4	240	1.44
5	300	1.45
6	360	1.455
7	420	1.46
8	480	1.47
10	600	1.48
12	720	1.49
14	840	1.5
16	960	1.51
18	1080	1.52
20	1200	1.53
22	1320	1.55
24	1440	1.55
26	1560	1.56
28	1680	1.57
30	1800	1.58
32	1920	1.58
34	2040	1.59
36	2160	1.6
38	2280	1.6
40	2400	1.61
42	2520	1.62
44	2640	1.64
62	3720	1.67
80	4800	1.71
115	6900	1.79
136	8160	1.83
154	9240	1.87
175	10500	1.9
193	11580	1.91
216	12960	1.95
242	14520	2.01
286	17160	2.01
330	19800	2.06
375	22500	2.09
399	23940	2.12

Soakaway SA6 Test 3

Width (m):	0.70
Length (m):	2.30
Depth (m):	2.40
Natural depth (m):	0.00
Depth (m) of Water at T = 0	1.33
Effective depth (m)	1.07
Vp25 (m)	0.268
Depth (mbgl) at Vp25	2.133
Vp75 (m)	0.803
Depth (mbgl) at Vp75	1.598
Vp50 (m)	0.54
Vp75/Vp25 (m^3)	0.861
Effective volume * 0.3	0.258
a50 (m^2)	4.82
t between vp75 to vp25(secs)	31750
Soil Infiltration (m/s)	5.63E-06

Trial 3

Time (mins)	Time (secs)	Depth (mbgl)
1	60	1.34
2	120	1.35
3	180	1.36
4	240	1.37
5	300	1.38
6	360	1.39
7	420	1.39
8	480	1.4
9	540	1.41
10	600	1.41
20	1200	1.48
46	2760	1.55
71	4260	1.62
103	6180	1.67
132	7920	1.74
151	9060	1.75
187	11220	1.82
218	13080	1.86
264	15840	1.9

Appendix E

Hydraulic Calculations

(100yr + 40%)

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	2	Add Flow / Climate Change (%)	0
M5-60 (mm)	20.000	Minimum Backdrop Height (m)	0.000
Ratio R	0.403	Maximum Backdrop Height (m)	0.000
Maximum Rainfall (mm/hr)	50	Min Design Depth for Optimisation (m)	1.200
Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	1.00
Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	500
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
1.000	8.190	0.040	204.8	0.106	5.00	0.0	0.600	o	300	
1.001	27.460	0.110	249.6	0.129	0.00	0.0	0.600	o	300	
1.002	18.900	0.060	315.0	0.064	0.00	0.0	0.600	o	375	
2.000	10.470	0.070	149.6	0.091	5.00	0.0	0.600	o	225	
2.001	22.050	0.140	157.5	0.018	0.00	0.0	0.600	o	300	
2.002	7.130	0.040	178.3	0.057	0.00	0.0	0.600	o	300	
2.003	33.360	0.200	166.8	0.000	0.00	0.0	0.600	o	300	
2.004	18.580	0.380	48.9	0.100	0.00	0.0	0.600	o	375	
2.005	17.760	0.050	355.2	0.049	0.00	0.0	0.600	o	450	
1.003	49.520	0.165	300.1	0.101	0.00	0.0	0.600	o	450	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.12	70.450	0.106	0.0	0.0	0.0	1.10	77.4	14.4
1.001	50.00	5.59	70.410	0.235	0.0	0.0	0.0	0.99	70.0	31.8
1.002	50.00	5.90	70.220	0.299	0.0	0.0	0.0	1.02	112.2	40.5
2.000	50.00	5.16	71.200	0.091	0.0	0.0	0.0	1.07	42.4	12.3
2.001	50.00	5.46	71.050	0.109	0.0	0.0	0.0	1.25	88.4	14.8
2.002	50.00	5.56	70.910	0.166	0.0	0.0	0.0	1.17	83.0	22.5
2.003	50.00	6.02	70.870	0.166	0.0	0.0	0.0	1.21	85.9	22.5
2.004	50.00	6.14	70.590	0.266	0.0	0.0	0.0	2.60	286.8	36.0
2.005	50.00	6.41	70.130	0.315	0.0	0.0	0.0	1.07	170.6	42.7
1.003	50.00	7.12	70.080	0.715	0.0	0.0	0.0	1.17	185.8	96.8

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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
3.000	8.200	0.050	164.0	0.043	5.00	0.0	0.600	o	225	
3.001	52.770	0.230	229.4	0.107	0.00	0.0	0.600	o	300	
3.002	39.830	1.050	37.9	0.161	0.00	0.0	0.600	o	375	
1.004	28.780	0.070	411.1	0.065	0.00	0.0	0.600	o	525	
1.005	27.200	0.060	453.3	0.075	0.00	0.0	0.600	o	525	
1.006	17.700	0.040	442.5	0.064	0.00	0.0	0.600	o	600	
1.007	20.170	0.040	504.3	0.016	0.00	0.0	0.600	o	600	
4.000	27.180	0.160	169.9	0.051	5.00	0.0	0.600	o	225	
4.001	21.830	0.130	167.9	0.020	0.00	0.0	0.600	o	225	
4.002	25.190	0.100	251.9	0.134	0.00	0.0	0.600	o	300	
1.008	25.800	0.050	516.0	0.054	0.00	0.0	0.600	o	675	
1.009	25.800	0.050	516.0	0.049	0.00	0.0	0.600	o	675	
1.010	28.750	0.370	77.7	0.081	0.00	0.0	0.600	o	675	
5.000	11.000	0.030	366.7	0.000	5.00	0.0	0.600	o	675	
1.011	9.500	0.019	500.0	0.045	0.00	0.0	0.600	o	675	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
3.000	50.00	5.13	71.460	0.043	0.0	0.0	0.0	1.02	40.5	5.8
3.001	50.00	5.98	71.340	0.150	0.0	0.0	0.0	1.03	73.1	20.3
3.002	50.00	6.21	71.030	0.311	0.0	0.0	0.0	2.95	325.8	42.1
1.004	50.00	7.55	69.830	1.091	0.0	0.0	0.0	1.10	237.8	147.7
1.005	50.00	7.99	69.760	1.166	0.0	0.0	0.0	1.05	226.3	157.9
1.006	50.00	8.24	69.625	1.230	0.0	0.0	0.0	1.15	325.5	166.6
1.007	50.00	8.56	69.585	1.246	0.0	0.0	0.0	1.08	304.7	168.7
4.000	50.00	5.45	70.320	0.051	0.0	0.0	0.0	1.00	39.8	6.9
4.001	50.00	5.81	70.160	0.071	0.0	0.0	0.0	1.01	40.0	9.6
4.002	50.00	6.24	69.950	0.205	0.0	0.0	0.0	0.99	69.7	27.8
1.008	50.00	8.93	69.470	1.505	0.0	0.0	0.0	1.15	410.4	203.8
1.009	50.00	9.31	69.420	1.554	0.0	0.0	0.0	1.15	410.4	210.4
1.010	50.00	9.47	69.370	1.635	0.0	0.0	0.0	2.98	1064.7	221.4
5.000	50.00	5.13	69.130	0.000	0.0	0.0	0.0	1.36	487.7	0.0
1.011	50.00	9.60	69.000	1.680	0.0	0.0	0.0	1.17	417.0	227.5

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Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.011	S14	70.800	68.981	0.000	3000	0

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Online Controls for Storm

Pump Manhole: S12, DS/PN: 1.011, Volume (m³): 17.0

Invert Level (m) 69.000

Depth (m)	Flow (l/s)
1.400	5.0000

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Storage Structures for Storm

Tank or Pond Manhole: POND, DS/PN: 5.000

Invert Level (m) 69.130

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	731.9	1.670	1639.5

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

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.403
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	20.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 240, 1440
Return Period(s) (years)	100
Climate Change (%)	40

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	15 Winter	100	+40%	100/15 Summer	100/15 Winter			1
1.001	15 Winter	100	+40%	100/15 Summer				
1.002	15 Winter	100	+40%	100/15 Summer				
2.000	15 Winter	100	+40%	100/15 Summer	100/15 Summer			2
2.001	15 Winter	100	+40%	100/15 Summer				
2.002	15 Winter	100	+40%	100/15 Summer	100/15 Winter			1
2.003	15 Winter	100	+40%	100/15 Summer				
2.004	15 Winter	100	+40%	100/15 Summer	100/15 Winter			1
2.005	15 Winter	100	+40%	100/15 Summer	100/15 Winter			1
1.003	15 Winter	100	+40%	100/15 Summer	100/15 Winter			1
3.000	15 Winter	100	+40%	100/15 Summer				
3.001	15 Winter	100	+40%	100/15 Summer				
3.002	15 Winter	100	+40%	100/15 Summer				
1.004	15 Winter	100	+40%	100/15 Summer				
1.005	15 Winter	100	+40%	100/15 Summer				
1.006	15 Winter	100	+40%	100/15 Summer				
1.007	15 Winter	100	+40%	100/15 Summer				
4.000	15 Winter	100	+40%	100/15 Summer				
4.001	15 Winter	100	+40%	100/15 Summer				
4.002	15 Winter	100	+40%	100/15 Summer				

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

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.008	15 Winter	100	+40%	100/15 Summer				
1.009	15 Winter	100	+40%	100/15 Summer				
1.010	1440 Winter	100	+40%	100/15 Summer				
5.000	1440 Winter	100	+40%	100/240 Summer				
1.011	1440 Winter	100	+40%	100/15 Summer				

PN	US/MH Name	Water Level (m)	Surch'ed Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
1.000	S1	72.851	2.101	0.878	0.96	0.0	56.0	FLOOD
1.001	S2	72.791	2.081	0.000	1.82	0.0	114.8	FLOOD RISK
1.002	S3	72.465	1.870	0.000	1.51	0.0	140.7	FLOOD RISK
2.000	S15	72.902	1.477	2.468	1.47	0.0	52.2	FLOOD
2.001	S16	72.883	1.533	0.000	0.75	0.0	58.2	FLOOD RISK
2.002	S17	72.800	1.590	0.136	1.14	0.0	68.9	FLOOD
2.003	S18	72.723	1.553	0.000	0.93	0.0	73.4	FLOOD RISK
2.004	S19	72.570	1.605	0.152	0.46	0.0	110.2	FLOOD
2.005	S20	72.352	1.772	2.330	0.84	0.0	113.0	FLOOD
1.003	S4	72.313	1.783	3.151	1.70	0.0	286.5	FLOOD
3.000	S21	72.562	0.877	0.000	0.81	0.0	25.4	SURCHARGED
3.001	S22	72.475	0.835	0.000	1.26	0.0	87.0	SURCHARGED
3.002	S23	72.186	0.781	0.000	0.57	0.0	169.4	SURCHARGED
1.004	S5	71.966	1.611	0.000	2.26	0.0	447.5	SURCHARGED
1.005	S6	71.620	1.335	0.000	2.52	0.0	470.3	SURCHARGED
1.006	S7	71.248	1.023	0.000	2.29	0.0	488.6	SURCHARGED
1.007	S8	71.000	0.815	0.000	2.40	0.0	495.1	SURCHARGED
4.000	S24	71.199	0.654	0.000	0.74	0.0	27.5	SURCHARGED
4.001	S25	71.127	0.742	0.000	1.01	0.0	37.0	SURCHARGED
4.002	S26	71.012	0.762	0.000	1.82	0.0	113.3	SURCHARGED
1.008	S9	70.748	0.603	0.000	1.89	0.0	597.9	SURCHARGED
1.009	S10	70.519	0.424	0.000	1.92	0.0	608.5	SURCHARGED
1.010	S11	70.380	0.335	0.000	0.06	0.0	45.9	SURCHARGED
5.000	POND	70.370	0.565	0.000	0.02	0.0	5.5	SURCHARGED
1.011	S12	70.382	0.707	0.000	0.02	0.0	4.9	SURCHARGED

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Appendix F

Qbar Calculation per Hectare

ICP SUDS Mean Annual Flood

Input

Return Period (years)	1	Soil	0.150
Area (ha)	1.000	Urban	0.000
SAAR (mm)	700	Region Number	Region 4

Results l/s

QBAR Rural	0.4
QBAR Urban	0.4
Q1 year	0.3
Q1 year	0.3
Q30 years	0.8
Q100 years	1.0

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