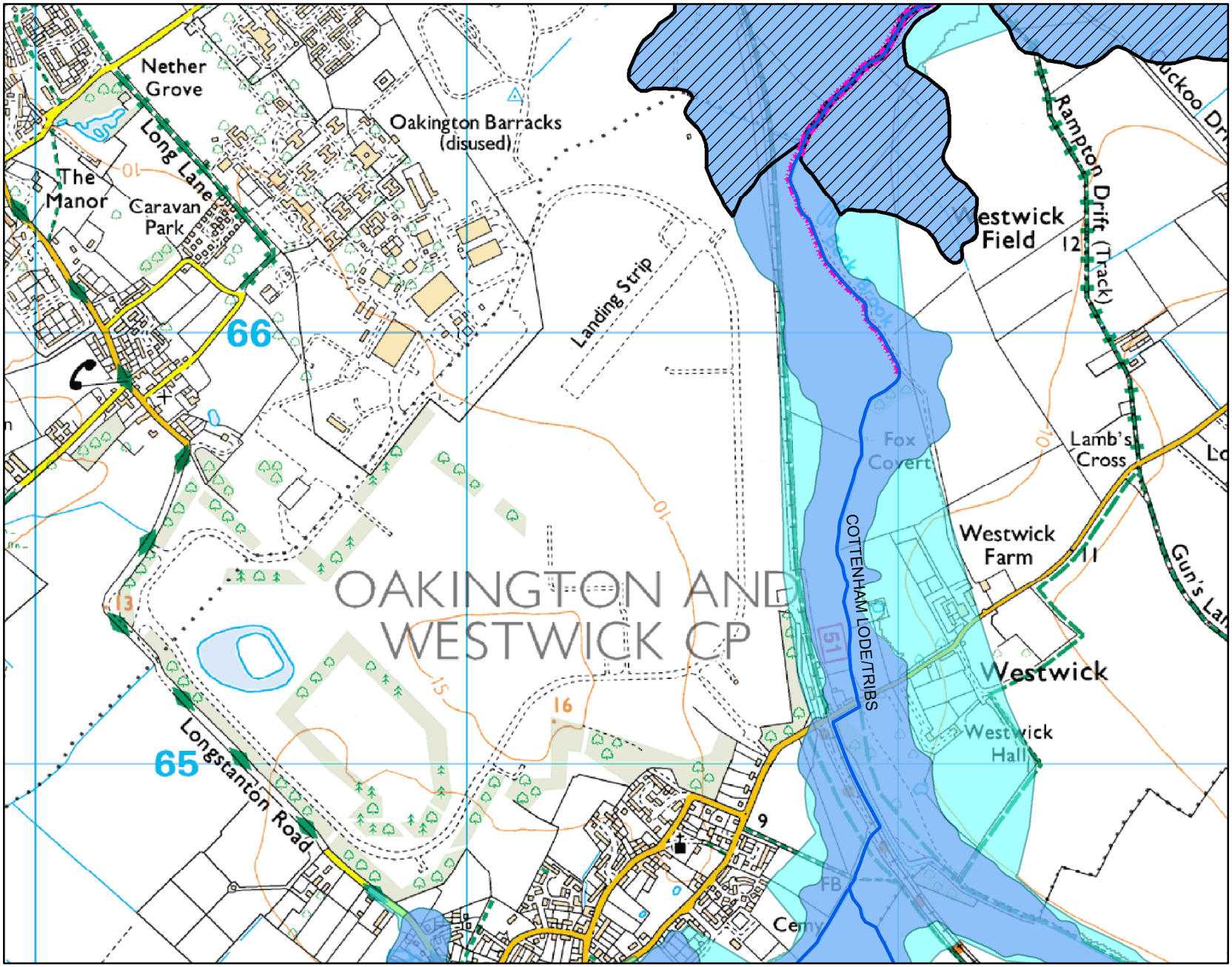
Appendix 5

The Environment Agency's Flood Map

Historical Flood Records

Flood Map Centred on - Northstowe Site, Oakington, Cambridge - created 15/04/2014.
Ref: CCC/2014/19988



Environment Agency

Scale 1:13,000

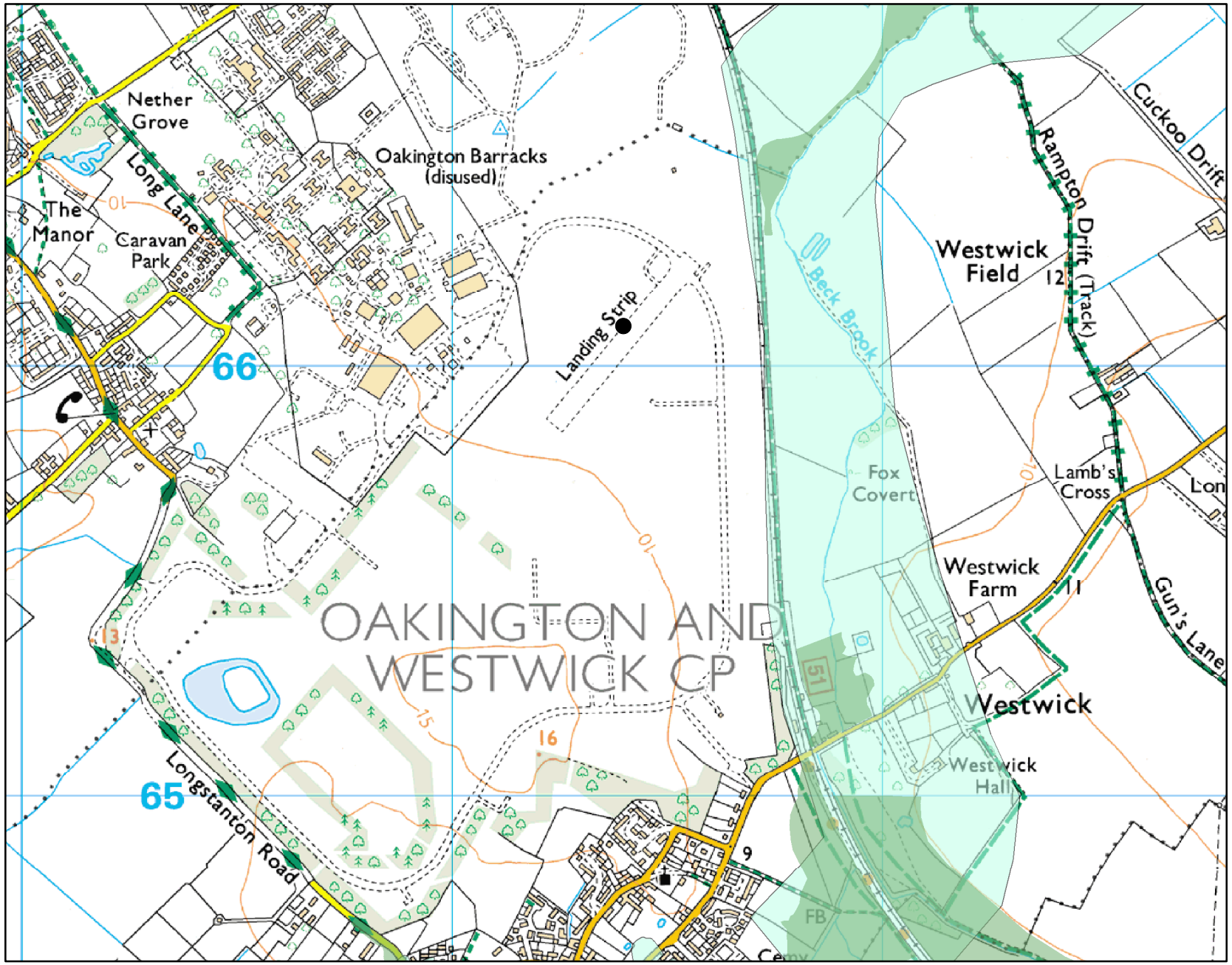
280 140 0 280 Meters

Legend

- Main River
- Flood Map Defences
- Areas Benefiting From Defences
- Flood Map - Flood Storage Areas
- Flood Map - Flood Zone 3
- Flood Map - Flood Zone 2

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

Map Showing Historic Flood Events Centred on - Northstowe Site, Oakington, Cambridge - created 15/04/2014 .
Ref: CCC/2014/19988



Environment Agency

Scale 1:13,000

N W E S

Legend

- October 2001
- Outline May 1978

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Appendix 6

Flood Estimation and Greenfield Runoff Rates Calculations

TECHNICAL NOTE

Issue date	09 April 2014
Author	Aimee Hart
Reviewer	Claire French
Subject	Northstowe Greenfield Runoff Calculations
Reference	UA006156

Introduction

This technical note summarises the hydrological calculations undertaken for the Northstowe site as part of the Northstowe Sustainable Water Management Strategy (WSP, 2007) and compares the previous calculations to the calculations undertaken as part of the Flood Risk Assessment for the Phase 2 site (Hyder, 2014).

Sustainable Water Management Strategy (WSP, 2007)

Project aspirations for the Northstowe Sustainable Water Management Strategy study state that no additional water discharges will be made to the surrounding watercourses or on to the surrounding land compared with that naturally discharging from the site in its current form, with rates of 2 to 3 l/s/ha to be achieved across the development.

WSP's study assessed the surface water discharge from the site using an onsite flow monitoring survey and has been checked against the predicted greenfield runoff rate calculated using the FEH method (1999) and the ADAS method.

Flow monitoring

Flow monitoring was undertaken in 2003. The flow monitoring used six flow monitors and two rain gauges, which enabled flows from the impermeable hardstanding and building areas to be measured as well as the rural runoff. There are two distinct catchments within the site, one which drains to Environment Agency watercourses (Beck Brook and Cottenham Lode) and a second which drains to IDB watercourses (Reynolds Drain and Ditch).

The recorded mean annual flood figure for the EA catchment of 1.48 l/s/ha has been used to calculate flows for six return periods using an FSR multiplier. The results derived by WSP are presented in Table 1 below.

Table 1- Estimated off site discharge from the Barracks and Airfield to Beck Brook/Cottenham Lode (WSP, 2007)

	Return Period (years)					
	2	5	10	25	50	100
FSR Multiplier (Anglian Region)	0.89	1.29	1.65	2.25	2.83	3.56
Estimated Discharge (l/s/ha)	1.32	1.91	2.44	3.33	4.19	5.26

* Using a recorded Mean Annual Flood figure of 1.48 l/s/ha

Runoff from the site to the Beck Brook and Cottenham Lode catchments is much greater than the runoff to the IDB watercourses due to the large impermeable surfaces within the former barracks. The recorded mean annual flood figure for the IDB catchment of 0.46 l/s/ha has been used to calculate flows for six return periods using an FSR multiplier. The results are presented in Table 2.

Table 2- Estimated off site discharge from the farmland and golf course to Reynolds Drain and Ditch (WSP, 2007)

	Return Period (years)					
	2	5	10	25	50	100
FSR Multiplier (Anglian Region)	0.89	1.29	1.65	2.25	2.83	3.56
Estimated Discharge (l/s/ha)	0.41	0.59	0.76	1.03	1.30	1.64

* Using a recorded Mean Annual Flood figure of 0.46 l/s/ha

ADAS Methodology

ADAS Report 345 is an older approach, developed as a way of designing field drainage systems. It is only suitable for small rural catchments with no formal drainage system. Flow is estimated from land use, soil type and rainfall, using a graphical solution to an equation based on the rational method. ADAS 345 relies on coarse-resolution soil maps with only five classes. These are less likely to be representative of local soil conditions than the HOST mapping (which is available at a 1 km grid size and allows 29 different soil classes).

Science Project SC090031 found that ADAS 345 tends to underestimate QMED and has a mean error that is much higher than any other method tested. The research report also pointed out that ADAS 345 is based on a very small dataset of limited length. Therefore, the latest guidance advises users to avoid ADAS 345 for flood or greenfield runoff estimation on small catchments (Environment Agency, 2012).

The ADAS method generated a mean annual flood event of 1.7l/s/ha using Soil Type 4 and based on the assumption that the site was grassed farmland. The method ignored the effect of the existing roads, hard standing and buildings.

Table 3- Greenfield Runoff Rates- ADAS Methodology (Soil Type 4) (WSP, 2007)

	Return Period (years)						
	2	5	10	25	50	100	200
FSR Multiplier (Anglian Region)	0.89	1.25	1.65	2.25	2.83	3.56	4.65
Estimated Discharge (l/s/ha)	1.5	2.2	2.8	3.8	4.8	6.0	7.9

* Using a recorded Mean Annual Flood figure of 1.7 l/s/ha

The rates presented in Table 3 are based on the assumption that soil type is Type 4 (clay/loam relatively impermeable at shallow depth). The ADAS method generated a mean annual flood event of 0.85 l/s/ha using Soil Type 2 and based on the assumption that the site was grassed farmland. The 2007 study altered the soil type as a sensitivity test which indicated that if the soil type is altered to Soil Type 2 (very permeable soil) the existing discharge rate decreases by approximately 50% (Table 4).

Table 4- Greenfield Runoff Rates- ADAS Methodology (Soil Type 2) (WSP, 2007)

	Return Period (years)						
	2	5	10	25	50	100	200
FSR Multiplier (Anglian Region)	0.89	1.25	1.65	2.25	2.83	3.56	4.65
Estimated Discharge (l/s/ha)	0.75	1.1	1.4	1.9	2.4	3.0	3.95

* Using a recorded Mean Annual Flood figure of 0.85 l/s/ha

During the 2007 study, the site was found to comprise shallow permeable strata over an impermeable clay layer that creates a perched groundwater table and shallow aquifer. The study concluded that the site was neither fully soil Type 4 nor 2 and additionally the runoff would be affected by the existing built development within the site.

FEH Methodology

The 2007 study also used the FSR/FEH rainfall runoff method to calculate the existing discharge rate. This method did make an allowance for the effect of increased runoff from existing roads, hard standings and buildings.

Table 5- Existing Runoff Rates- FEH Methodology (WSP,2007)

	Return Period	
	1 in 10 year	1 in 100 year
Average runoff (l/s/ha)	4.39	8.60

The 2007 study showed there was a significant difference between the ADAS and FEH methodologies and recommended taking forward the newer FEH method than the older ADAS method. However, following the 2007 study the rainfall runoff method has been replaced by the Revitalised Flood Hydrograph (ReFH) method as it tends to give results that are more consistent with the statistical method. However, versions of the rainfall runoff method are still applicable for reservoir safety work and on pumped catchments (Environment Agency, 2012).

Guideline Runoff Rates

For the 2007 study the IDB confirmed that the 1.1 l/s/ha design criteria adopted for the pumped catchments (Reynolds Drain and Ditch) would need to be maintained. The guideline runoff rate provided by the IDB is approximately equivalent to the 1 in 25 year recorded runoff rate for the IDB catchment (see Table 2).

The EA provided a guideline figure of 3 l/s/ha to be used for runoff control purposes from the area of the site discharging to the Cottenham Lode and Beck Brook catchment. The guideline runoff rate provided by the EA is approximately equivalent to the 1 in 25 year recorded runoff rate for the Beck Brook/Cottenham Lode catchment (see Table 1).

Runoff rates for both the EA and IDB watercourses have been estimated as greater than the guideline runoff rates provided by the EA and IDB for the events greater than 1 in 25 year annual chance.

2014 Runoff Calculations

The greenfield runoff rate calculations undertaken as part of the 2014 study used the FEH statistical method and Revitalised Flood Hydrograph (ReFH) method.

FEH Statistical Methodology

Because the statistical method is based on a much larger dataset of flood events, and has been more directly calibrated to reproduce flood frequency on UK catchments, it is recommended over any rainfall-runoff approach (Environment Agency, 2012).

Table 6- Greenfield Runoff Rates*- FEH Statistical Method

Return Period	Peak flow (m3/s)	l/s/ha
1 in 2	0.14	2.7
1 in 30	0.37	7.2
1 in 100	0.54	10.6

* Based on a BFIHOST value of 0.227

FEH Revitalised Flood Hydrograph (ReFH) Methodology

The ReFH method was developed to address several problems in the FEH rainfall-runoff method, which was largely unchanged from the earlier Flood Studies Report method (Environment Agency, 2012).

Table 6- Greenfield Runoff Rates*- FEH ReFH Method

Return Period	Peak flow (m3/s)	l/s/ha
1 in 2	0.19	3.7
1 in 30	0.42	8.2
1 in 100	0.57	11.1

* Based on a BFIHOST value of 0.227

Conclusions

The 2014 calculations have followed the latest guidance (Environment Agency, 2012) and have been calculated using the statistical method. The methods used to calculate runoff rates in the 2007 study have largely been superseded and in particular the study concluded the ADAS method was not applicable to the Northstowe site. The statistical method has been selected over the ReFH method, as it represents a precautionary approach, with runoff rates that are lower than from the ReFH model, therefore requiring a more conservative drainage design. Additionally, since there is no local hydrometric data available for optimising the ReFH model, preference has been given to the statistical method. This method allows the use of data transfer from geographically, and/or hydrologically, similar gauged catchments to improve the flow frequency estimates at the subject site. Therefore it is recommended that the results of the statistical method are taken forward.

However, during the 2007 study the IDB stipulated a maximum design allowable discharge of 1.1 l/s/ha for the catchment discharging to their pumping stations (Reynolds Drain and Ditch catchment) and the EA

provided a guideline figure of 3 l/s/ha to be used to estimate runoff control from the area of the site discharging to the Cottenham Lode and Beck Brook catchment. The estimated discharges for the 2014 study are greater than those provided and estimated runoff rates for the site amount to considerably more than the 1.1 and 3 l/s/ha provided. The EA's previous guideline figure of 3 l/s/ha equates approximately to 1 in 2 annual chance flows according to the latest 2014 estimates undertaken by Hyder. Therefore, it is recommended that the discharge rates calculated as part of the 2014 study are reviewed by the EA and IDB. The maximum allowable runoff rates then needs to be confirmed by the IDB and EA for the Phase 2 site.

References

Environment Agency, 2012. Flood Estimation Guidelines. Operational Instruction 197_08

WSP, 2007. Northstowe Sustainable Water Management Strategy

Appendix 7

SW Drainage Strategy & SuDS Sizing

PHASE 1

APPROX IL: 7.92

APPROX IL: 8.05

APPROX IL: 8.10

APPROX IL: 8.52

APPROX IL: 8.26

APPROX IL: 8.50

APPROX IL: 8.75

APPROX IL: 8.82

POTENTIAL CULVERT LINKING PHASE 1 POND WITH POND 2 (CONTROLLED VIA SLUICE VALVES AS AGREED)

POND 2

BED LEVEL: 2.5m
PERMANENT WATER LEVEL: 4.5m

INDICATIVE POND OUTLINE. ACTUAL POND EDGE PROFILE TO BE DETERMINED AT LANDSCAPING STAGE. REFER TO DRAWING C019-UA006156-01 FOR TYPICAL POND EDGE PROFILE.

LINK BETWEEN POND 2: & 3

POND 3
INITIAL CONSTRUCTION

PUMPED OUTLET TO BECK BROOK
(RATE OF DISCHARGE 3l/s/ha)

BED LEVEL: 2.5m
PERMANENT WATER LEVEL: 4.5m

POND 3
CONSTRUCTED FOR PHASE 3

PHASE 3

NOTES

1. DO NOT SCALE OFF DRAWING, USE FIGURED DIMENSIONS ONLY.
2. DRAWING DOES NOT PURPORT TO BE A DESIGN FOR CONSTRUCTION AND IS PROVIDED FOR DISCUSSION AND FUTURE ITERATION OF THE DESIGN PROPOSALS
3. SITE LAYOUT TAKEN FROM ARUP DRAWING "NS-AUL-04-1 REV D - APPLICATION 1 LAND USE PARAMATER PLAN". REFER TO DRAWING FOR DETAILS OF LAND USE.
4. ADDITIONAL STORM WATER ATTENUATION SYSTEMS MAY BE REQUIRED IN THE FINAL SCHEME.
5. LOCALISED SUDS FEATURES ARE TO BE UTILISED WITHIN PLOTS AND FLOW CONTROL PROVIDED TO LIMIT DISCHARGE RATE FROM PLOT.
6. FLOW ARROWS SHOW GENERAL DIRECTION OF DRAINAGE OUTLET FROM PLOT AREA INTO ADJACENT SWALE.
7. REFER TO DRAWING C019-UA006156-01 FOR DETAILS OF DRAINAGE FEATURES.

DRAINAGE STRATEGY MANAGEMENT TRAIN

PLOT DRAINAGE (LOCALISED SOURCE CONTROL & ATTENUATION TO BE PROVIDED)
↓
SUB-SWALE SYSTEM
↓
MAIN SWALE SYSTEM
↓
REGIONAL CONTROL (WATER PARK)

KEY

- RESIDENTIAL
- TOWN CENTRE (INCLUDING RESIDENTIAL)
- SCHOOL (PRIMARY & SECONDARY)
- GREEN SEPARATION
- GREENWAY
- SPORTS HUB
- PRIMARY SWALE
- SUB SWALE / FEN

Issue	Description	Date
01	FIRST ISSUE	MAY 14

100mm on Original

Client: Homes & Communities Agency

Status: PRELIMINARY

		Current Issue Signatures	
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Original Size	A1	Checker S. A. DAVIES	
Height Datum	A.O.D.	Approver S. A. DAVIES	
Grid	O.S. GRID	© Copyright reserved	

File name: C025-UA006156-UP3D-01- PHASE 2 SURFACE WATER DRAINAGE STRATEGY V2.DWG

Project: NORTHSTOWE

Title: NORTHSTOWE - PHASE 2 SURFACE WATER DRAINAGE STRATEGY

Hyder Consulting (UK) Limited
HCL House
St Mellons Business Park
Fortran Road, St Mellons
Cardiff
CF3 0EY
Tel: +44 (0)292 092 5000
Fax: +44 (0)292 092 5222

Drawing No.	Project No.	Issue
C025	— UA006156 —	01

V1

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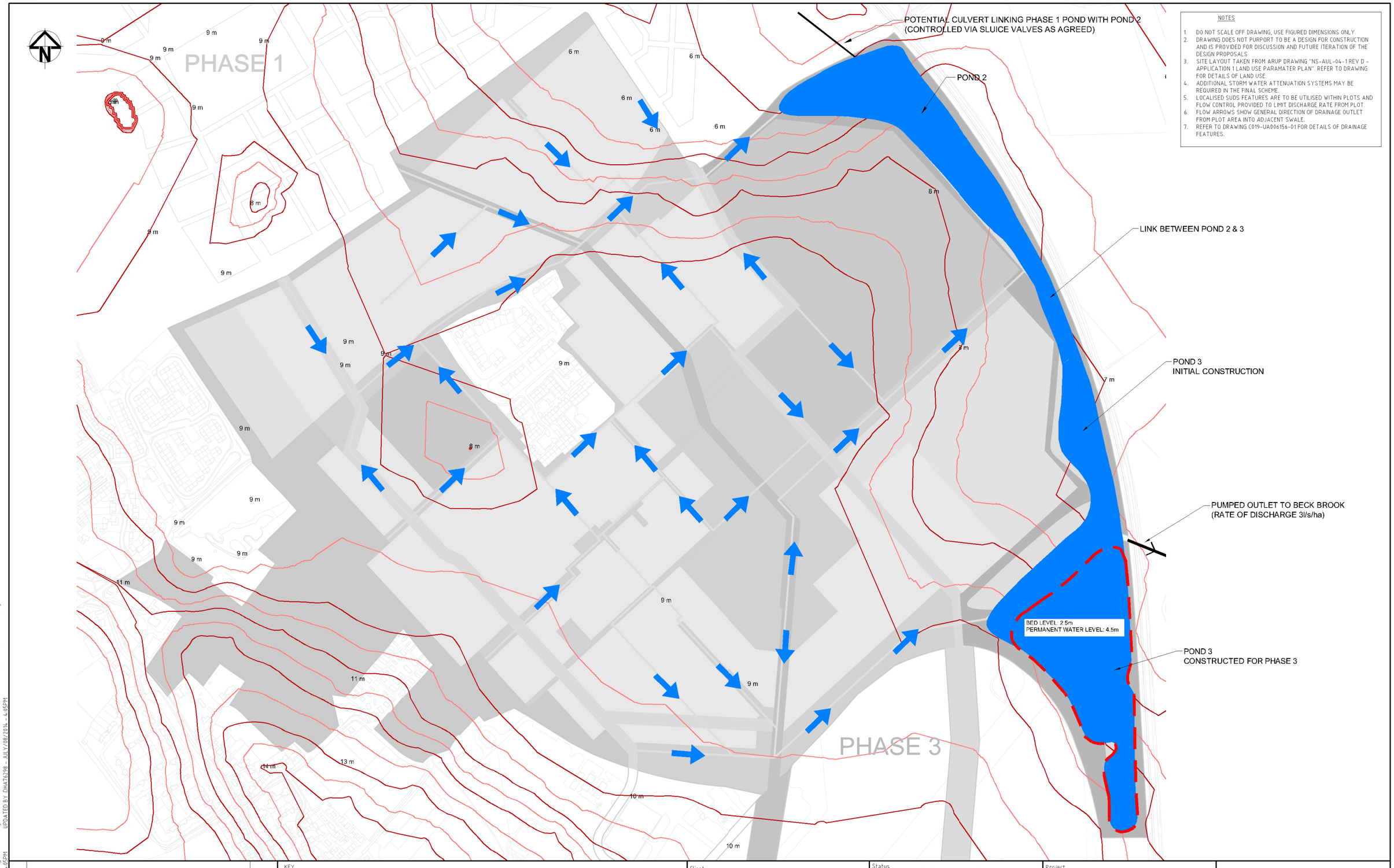

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7. REFER TO DRAWING C019-UA006156-01 FOR DETAILS OF DRAINAGE FEATURES.

Issue	Description	Date
01	FIRST ISSUE	MAY 14

KEY

- OVERLAND FLOW PATH DURING EXCEEDENCE EVENT
- MAJOR CONTOUR
- MINOR CONTOUR

Client: Homes & Communities Agency

Status: PRELIMINARY

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Height Datum	A.O.D.	Checker S. A. DAVIES	
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Filename	C027-UA006156-UP3D-01- PHASE 2 SURFACE WATER OVERLAND FLOW PATHS.DWG	© Copyright reserved	

Project: NORTHSTOWE

Title: NORTHSTOWE - PHASE 2 EXISTING CONTOURS & POST DEVELOPMENT OVERLAND FLOW

Hyder Consulting (UK) Limited
HCL House
St Mellons Business Park
Fortran Road, St Mellons
Cardiff
CF3 0EY
Tel: +44 (0)292 092 5000
Fax: +44 (0)292 092 5222

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C027	UA006156	01

V1

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