

Welsh Ambulance Service Trust

WAST AFSRC

Proposed Drainage Strategy

14-9227 | P030-ARU-RP-ARC-C011

Issue | 18 June 2014

This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 213833

Ove Arup & Partners Ltd
4 Pierhead Street
Capital Waterside
Cardiff CF10 4QP
United Kingdom
www.arup.com

ARUP

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1 Introduction

Arup has been commissioned by the Welsh Ambulance Service Trust (WAST) to provide engineering services for the proposed Ambulance and Fire Service Resource Centre (AFSRC) in Wrexham. It is understood that the proposed development is intended to replace the existing fire station at Bradley Road and the existing ambulance station at Chirk in Wrexham.

This report describes the proposed drainage strategy for the development.

2 The Site

The site is an area of grassed undeveloped land immediately south of the Wrexham Maelor Hospital and is located at approximate National Grid Reference SJ 320 502.

The site is bound by a car park associated with the hospital to the north, the River Gwenfro to the east and the south, and Croesnewydd Road to the west which provides access to the site.

The site has natural watershed from north east to south west. The elevation across the site varies from approximately 93m AOD in the north east to approximately 88m AOD in the south west. The site is an area of greenfield comprising of rough grass and scrub. There are a number of trees within the site boundary, typically along the site perimeter.

3 Proposed Development

It is proposed to redevelop the site as a combined facility consisting of an Ambulance Resource Centre for WAST and a multi-bay Fire Station for the North Wales Fire Rescue Service (NWFRS).

The development will include an ambulance and fire station which can accommodate up to eight fire vehicles and six ambulances, as well as a cleaning and maintenance area which can accommodate another nine vehicles. In addition, the facility will consist of temporary accommodation, rest rooms, administration offices, staff car park, vehicle wash and refuelling area, and a training area to simulate road traffic collisions situations.

4 Storm Drainage

4.1 Existing Network

There is no existing storm drainage within the site. Storm water runoff generated by the site either infiltrates into the ground or drains into the Afon Gwenfro.

4.2 Proposed Strategy

The proposed storm drainage strategy for the site is shown on the drawing P030-ARU-C-A00-BG-GA-100 included in Appendix A.

The storm water drainage from the proposed development will be discharged to the Afon Gwenfro to the south at a restricted discharge rate.

Natural Resources Wales (NRW), previously the Environment Agency Wales, has agreed that the storm water discharge rate from the proposed development should be restricted to the equivalent Greenfield Runoff Rate (GRR) for the storm return period (see correspondence included in Appendix A). Typically, this involves restricting the runoff from the 1 in 1 year storm event to the 1 in 1 year GRR, the 1 in 30 year storm event to the 1 in 30 year GRR and the 1 in 100 year storm event (including 30% allowance for climate change) to the 1 in 100 year GRR. The estimated GRR and the maximum allowable discharge for the various return periods are shown in Table 1 below.

Table 1 – Summary of Estimated Greenfield Runoff Rates and Maximum Allowable Discharge

Storm Return Period	Greenfield Runoff Rate (litres/second/hectare)	Maximum Discharge (litres/second)
1 in 1 year	4.8	8.54
1 in 30 year	9.6	17.1
1 in 100 year	11.9	21.2

In order to allow for different discharge rates for different storm events, storm water flows from the proposed development will be attenuated using a flow control device consisting of a dual orifice plates. The orifice plates will be 70mm and 69mm in diameter. Two storage tanks accommodate the attenuated storm water runoff with a combined total storage volume of 895m³.

There is also a surface water pump within the system at the east end of the site. This will have a duty standby arrangement, with each pump capable of pumping 4.5 l/s with a pumping head of approximately 7m. In addition to the storage volume required to accommodate extreme storm events, the pumping station will also consist of an additional 40m³ of emergency storage to accommodate the inflows in the event of a pump failure. The pumping station will also consist of an alarm system to alert the estate maintenance staff in the event of a failure.

The proposed storm drainage network will be capable of accommodating storm events up to and including the 1 in 100 year return period with 30% allowance for climate change.

Storm water petrol interceptors are included within the design. These will be Type 1 bypass separators, in accordance with Environment Agency Pollution Prevention Guidelines PPG3.

Overland flow within the site has been considered. As flooding is contained within the drainage network for a 1 in 100 year return period storm event (including 30% allowance for climate change), a 15 minute duration 1 in 1000 year return period storm event with a summer profile was simulated to determine the overland flow routes. The result of this analysis indicates that during extreme events beyond the capacity of the proposed drainage network, storm water is likely to collect in localised areas away from the buildings. The results of the overland flow route analysis are shown in Appendix B.

The storm manhole schedule (P030-ARU-C-A00-C-BG-SH-110) and the MicroDrainage calculations for the proposed storm drainage strategy are included in Appendix B.

5 Foul Drainage

5.1 Existing Network

A public combined sewer is located in the vicinity of the northern site boundary. This sewer is owned and maintained by Dwr Cymru Welsh Water (DCWW) and gravitates from west to east. A foul pumping station also exists to the east of the site. It is understood that this pumping station is also owned and maintained by DCWW and accepts flows from the developments to the south of the site.

5.2 Proposed Strategy

The proposed foul drainage strategy is shown on drawing P030-ARU-C-A00-BG-GA-100 included in Appendix A.

DCWW has confirmed that the foul sewage likely to be generated from the proposed development can be accommodated within the public combined sewer in the vicinity of the northern site boundary. Due to the topography of the site, the proposed foul drainage system will consist of two separate networks. The foul sewage from the development located in the western half of the site will be conveyed by gravity to the existing DCWW combined sewer, and the foul sewage from the development in the eastern half of the site will be pumped to a break pressure chamber before being discharged to the same public combined sewer. The pumped network is likely to comprise of a packaged pumping station.

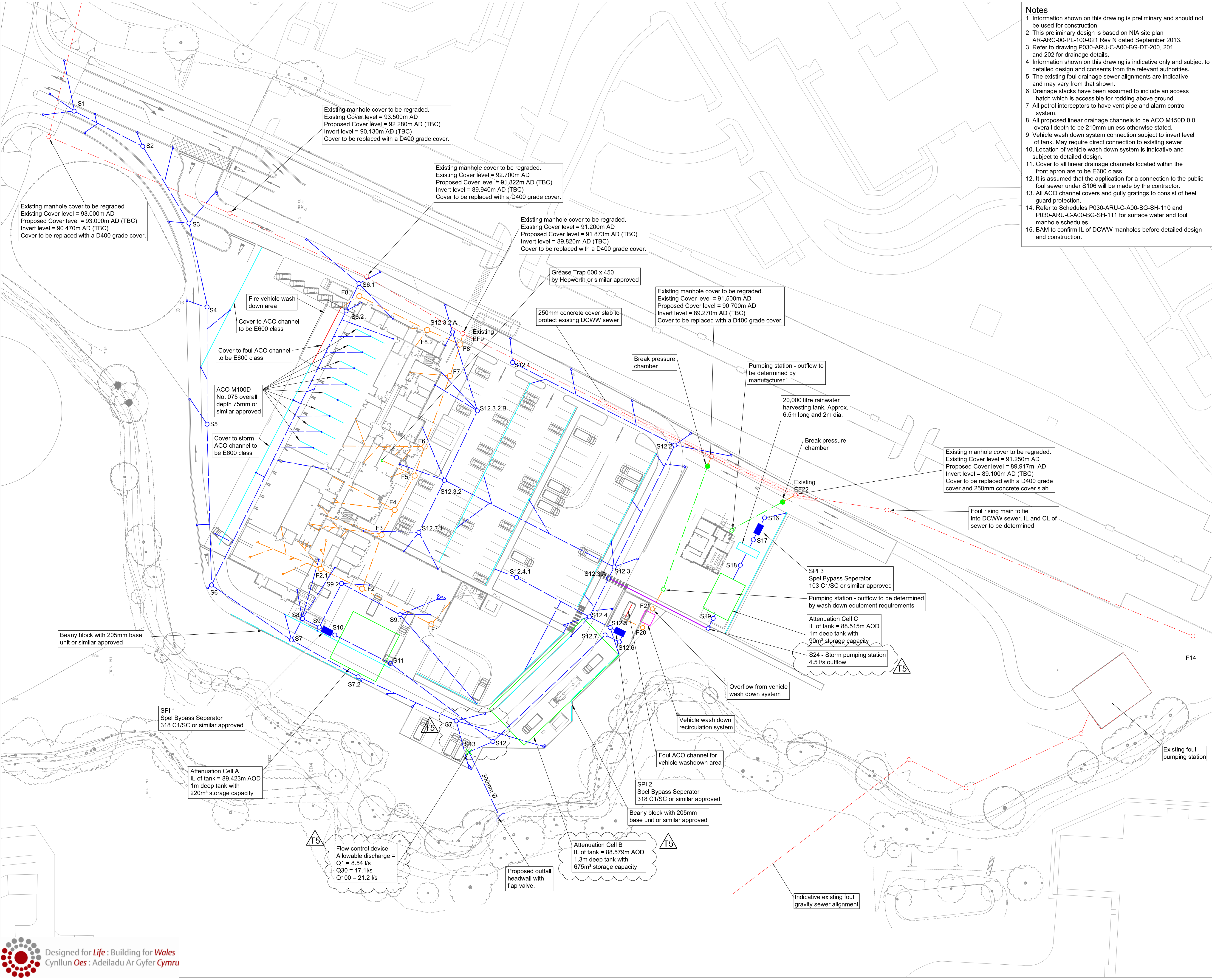
Calculations for the proposed foul drainage strategy, including the manhole schedule are included in Appendix C, along with a DCWW letter confirming that the public combined sewer on the northern site boundary has capacity for the foul flows from the site.

6 Ownership and Maintenance

The proposed storm and foul drainage systems, including the proposed foul pumping station, will be maintained and operated by the estates management team of WAST and NWFRS. The systems will be subjected to regular maintenance and inspection to allow them to operate efficiently minimise flood risk.

Appendix A

Storm Drainage Layout and Documents



- Notes**
1. Information shown on this drawing is preliminary and should not be used for construction.
 2. This preliminary design is based on NIA site plan AR-ARC-00-PL-100-021 Rev N dated September 2013.
 3. Refer to drawing P030-ARU-C-A00-BG-DT-200, 201 and 202 for drainage details.
 4. Information shown on this drawing is indicative only and subject to detailed design and consents from the relevant authorities.
 5. The existing foul drainage sewer alignments are indicative and may vary from that shown.
 6. Drainage stacks have been assumed to include an access hatch which is accessible for rodding above ground.
 7. All petrol interceptors to have vent pipe and alarm control system.
 8. All proposed linear drainage channels to be ACO M150D 0.0, overall depth to be 210mm unless otherwise stated.
 9. Vehicle wash down system connection subject to invert level of tank. May require direct connection to existing sewer.
 10. Location of vehicle wash down system is indicative and subject to detailed design.
 11. Cover to all linear drainage channels located within the front apron are to be E600 class.
 12. It is assumed that the application for a connection to the public foul sewer under S106 will be made by the contractor.
 13. All ACO channel covers and gully gratings to consist of heel guard protection.
 14. Refer to Schedules P030-ARU-C-A00-BG-SH-110 and P030-ARU-C-A00-BG-SH-111 for surface water and foul manhole schedules.
 15. BAM to confirm IL of DCWW manholes before detailed design and construction.

- Legend**
- Proposed foul sewer
 - Proposed storm sewer
 - Proposed storm manhole
 - Proposed storm manhole
 - Existing foul sewer
 - Existing foul manhole
 - Proposed road gully
 - Proposed attenuation cell
 - Proposed storm manhole with flow control device
 - Proposed petrol interceptor
 - Proposed outfall headwall
 - Proposed storm linear drainage channel
 - Proposed foul linear drainage channel
 - Proposed foul and storm stack / sump locations
 - Proposed rainwater harvesting tank
 - Proposed kerb drainage
 - Proposed filter drain
 - Proposed storm pumping station
 - Proposed storm rising main 80mm diameter HDPE
 - Proposed foul rising main 80mm diameter HDPE
 - Concrete slab

T5	12/06/14	Amended for planning conditions	DL	PC
T4	16/01/14	Lower Car Park removed	DS	MOC
T3	04/10/13	Reissued with amended site layout	DO	MOC
T2	19/02/13	Reissued with new site layout	DL	MOC
T1	20/09/12	Issued for FBC	LW	MOC
Mark	Date	Details	By	Rvd

Trust:

Welsh Ambulance Services NHS Trust
North Wales Fire and Rescue Services

Supply Chain Partner:

Project Title:

WAST AFSRC
Wrexham

Key Plan:

Scales: 1:500 for the Original Drawing Size: A1

Drn By: DS Chkd By: PC Passed By: GD Date: APR '12

Drawing Status:

Preliminary

Drawing Originator:

ARUP
4 Plarhead St, Capital Waterside
Cardiff, CF10 4QP
T +44(0)29 20473727 F +44(0)29 20472277
www.arup.com

Drawing Title:

Proposed Drainage Layout

Job No:	Drawing No:	Revision:
213833	P030-ARU-C-A00-BG-GA-100	T5

Do NOT scale this drawing.
Refer to Architects for details of current building layouts

David Leak

From: Barry, Ruairi <ruairi.barry@environment-agency.wales.gov.uk>
Sent: 28 March 2012 09:23
To: Sion Williams
Cc: Hemsworth, Deborah
Subject: FW: WAST ARC: Greenfield Run-off Rate
Attachments: WinDES Calcs (Submitted to EA).pdf

Hi Sion,

Just a quick follow up e-mail. Would it be possible to provide me with a grid reference or location map of the site in question. We can then record this correspondance as a pre-app enquiry on our database allowing me or a colleague to retrieve the agreed rates quickly (without the need to go through the exercise again) should a future planning application be submitted.

Regards

Ruairí

From: Barry, Ruairi
Sent: 26 March 2012 15:26
To: 'Sion Williams'
Subject: RE: WAST ARC: Greenfield Run-off Rate

Thanks Sion

Those figures are pretty much typical of what I would expect.

Regards

Ruairí

From: Sion Williams [mailto:sion.williams@arup.com]
Sent: 23 March 2012 14:35
To: Barry, Ruairi
Subject: WAST ARC: Greenfield Run-off Rate

Click [here](#) to report this email as spam.

Ruairi,

Thanks for the information below. We've reviewed the information and decided to use our own software to calculate the greenfield run-off rate. Please find attached a summary of our results.

If you have any comments on the attached then please let us know.

Regards,

Siôn

Siôn Williams

Engineer | Infrastructure

Arup

4 Pierhead Street, Capital Waterside, Cardiff CF10 4QP United Kingdom

t +44 29 2047 3727 **d** +44 29 2026 6515

f +44 29 2047 2277

www.arup.com

From: Barry, Ruairi [mailto:ruairi.barry@environment-agency.wales.gov.uk]

Sent: 21 March 2012 12:30

To: Sion Williams

Subject: FW: <http://www.uksuds.com/uksd/sudsguidancedocument.htm>

Hi Sion,

As discussed.

I just remembered that there is now some guidance and tools relating to greenfield runoff on the above website (link provided above).

The second tool on the left (Greenfield Runoff Estimation Tool) is just what you are after. Unfortunately it doesn't appear to be working for me at the moment. Possibly due to our IT system? Perhaps you could try it and let me know if you have any joy. The only requirements needed are the site size and location. Note there are additional useful tools relating to estimating storage requirements etc.

The formula's and methodology behind the tools can be found within the SUDS Guidance (R&D Technical Report W5-074/A/TR/1 Revision E). This can be downloaded from the link on the right hand side of the website.

Regards

Ruairí

Ruairí Barry

Development & Flood Risk Engineer

Environment Agency Wales

Chester Road

Buckley

Flintshire

CH7 3AJ

Phone: 01244 894582

e-mail: Ruairi.Barry@environment-agency.gov.uk

From: Huws, Iwan

Sent: 21 March 2012 11:42

To: Barry, Ruairi

Subject: <http://www.uksuds.com/uksd/sudsguidancedocument.htm>

<http://www.uksuds.com/uksd/sudsguidancedocument.htm>

Iwan Huws

Development and Flood Risk Engineer
Environment Agency Wales
Ffordd Penlan
Parc Menai
Bangor
Gwynedd
LL57 4DE

☎ 01248 484027

📠 01248 670561

✉ iwan.huws@environment-agency.gov.uk

Gall yr wybodaeth yn y neges hon fod yn gyfrinachol, ac yn gyfreithiol freiniol. Os ydych wedi derbyn y neges hon trwy gamgymeriad, rhoddwch wybod ar unwaith i'r sawl a'i gyrrodd, os gwelwch yn dda. Yna dilëwch hi, a pheidiwch â gyrru copi at neb arall.

Bu inni fwrw golwg ar yr e-bost hwn a'i atodiadau, rhag bod feirysau ynddo. Serch hynny, dylech chwilio unrhyw atodiad cyn ei agor.

Efallai bydd rhaid inni ryddhau'r neges hon, ac unrhyw ateb iddi, i sylw'r cyhoedd pe gofynnid inni tan y Ddeddf Rhyddid Gwybodaeth, y Ddeddf Gwarchod Data neu at ddibenion ymgyswiltio. Y mae'n bosib hefyd y darllenir negesau ac atodiadau e-bost a yrrir at unrhyw gyfeiriad Asiantaeth yr Amgylchedd, neu a dderbynnir oddi yno, gan rywun arall na'r gyrrwr a'r derbynnydd. Hynny at ddibenion busnes.

Os ydym wedi gyrru gwybodaeth atoch, a chithau'n dymuno'i defnyddio, yna ddarllenwch ein telerau a'n hamodau, os gwelwch yn dda. Gellir eu cael trwy ein galw ar 08708 506 506. Am ragor o wybodaeth ynghylch Asiantaeth yr Amgylchedd Cymru, ewch at www.asiantaeth-amgylchedd.cymru.gov.uk.

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Ove Arup & Partners International Ltd		Page 1
The Arup Campus Blyth Gate Solihull B90 8AE		
Date 23/03/2012 14:06 File	Designed by sion.will... Checked by	
Micro Drainage	Source Control W.12.6.1	

IH 124 Mean Annual Flood

Input

Return Period (years) 1 Soil 0.450
Area (ha) 50.000 Urban 0.000
SAAR (mm) 840 Region Number Region 9

Results	l/s	DEVELOPMENT RESULTS (2.3 Ha)
QBAR Rural	271.9	
QBAR Urban	271.9	
Q1 year	239.3	
Q1 year	239.3	$Q_{1YR} \times (A/50) = 11.0 \text{ l/s}$
Q2 years	252.5	
Q5 years	329.0	
Q10 years	386.1	
Q20 years	443.4	
Q25 years	463.3	
Q30 years	479.4	$Q_{30YR} \times (A/50) = 22.1 \text{ l/s}$
Q50 years	526.4	
Q100 years	592.7	$Q_{100YR} \times (A/50) = 27.3 \text{ l/s}$
Q200 years	671.6	
Q250 years	698.7	
Q1000 years	867.3	

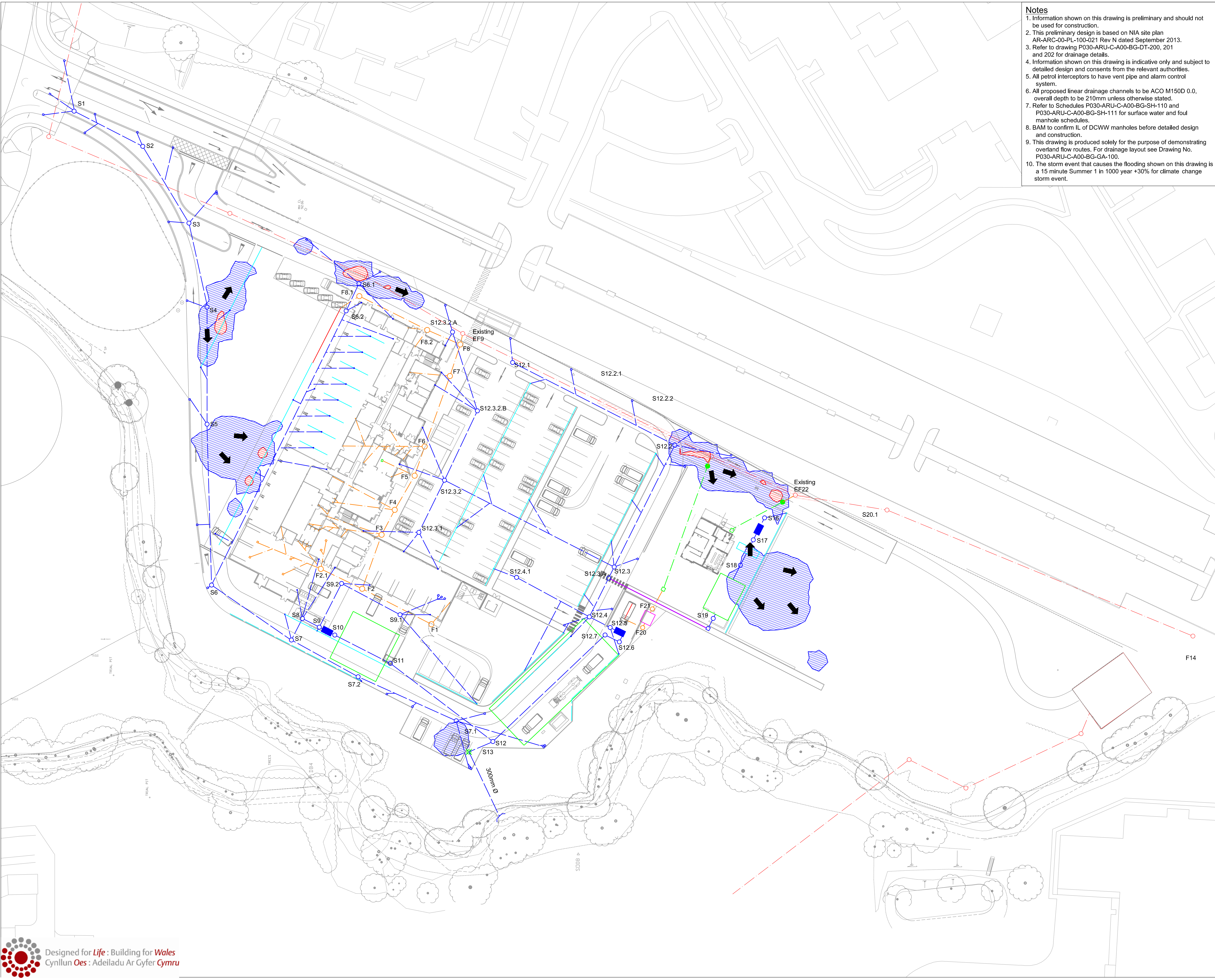
DEVELOPMENT AREA EXC. PUBLIC OPEN SPACE (A) = 2.3 Ha

PEAK DISCHARGE RATE OF RUN-OFF PER UNIT AREA:

- $Q_{1YR} = 4.8 \text{ l/s/Ha}$
- $Q_{30YR} = 9.6 \text{ l/s/Ha}$
- $Q_{100YR} = 11.9 \text{ l/s/Ha}$

Appendix B

Storm Drainage Calculations



- Notes**
1. Information shown on this drawing is preliminary and should not be used for construction.
 2. This preliminary design is based on NIA site plan AR-ARC-00-PL-100-021 Rev N dated September 2013.
 3. Refer to drawing P030-ARU-C-A00-BG-DT-200, 201 and 202 for drainage details.
 4. Information shown on this drawing is indicative only and subject to detailed design and consents from the relevant authorities.
 5. All petrol interceptors to have vent pipe and alarm control system.
 6. All proposed linear drainage channels to be ACO M150D 0.0, overall depth to be 210mm unless otherwise stated.
 7. Refer to Schedules P030-ARU-C-A00-BG-SH-110 and P030-ARU-C-A00-BG-SH-111 for surface water and foul manhole schedules.
 8. BAM to confirm IL of DCWW manholes before detailed design and construction.
 9. This drawing is produced solely for the purpose of demonstrating overland flow routes. For drainage layout see Drawing No. P030-ARU-C-A00-BG-GA-100.
 10. The storm event that causes the flooding shown on this drawing is a 15 minute Summer 1 in 1000 year +30% for climate change storm event.

- Legend**
- Proposed foul sewer
 - Proposed storm sewer
 - Proposed foul manhole
 - Proposed storm manhole
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 - Proposed foul linear drainage channel
 - Proposed foul and storm stack / sump locations
 - Proposed rainwater harvesting tank
 - Proposed kerb drainage
 - Proposed filter drain
 - Proposed storm pumping station
 - Proposed storm rising main 80mm diameter HDPE
 - Proposed foul rising main 80mm diameter HDPE
 - Concrete slab
 - Extent of Flooded Area <50mm
 - Extent of flooding 50 - 100mm
 - Direction of flow

12/06/14			Preliminary Issue		DS	DL
Mark	Date	Details			By	Rvd
REVISIONS						
Trust: Welsh Ambulance Services NHS Trust North Wales Fire and Rescue Services						
Supply Chain Partner: 						
Project Title: WAST AFSRC Wrexham						
Key Plan:						
Scales: 1:500 for the Original Drawing Size: A1						
Drn By: DS		Chkd By: DO		Passed By: GD		Date: JUN'14
Drawing Status: Preliminary						
Drawing Originator: ARUP 4 Pierhead St, Capital Waterside Cardiff, CF10 4QP T +44(0)29 20473727 F +44(0)29 20472277 www.arup.com						
Drawing Title: Overland Flow Routes						
Job No: 213833		Drawing No: P030-ARU-C-A00-BG-SK-150			Revision: P0	
Do NOT scale this drawing. Refer to Architects for details of current building layouts						

ARUP	Ove Arup & Partners 4 Pierhead street Capital Waterside Cardiff CF1 5QP Tel - 01222 473727		WAST AFSRC Wrexham		SURFACE WATER DRAINAGE MANHOLE SCHEDULE					Sheet No. 1		Job No. 213833		Made by DL		Date 17-Jun-14		Chkd DL		Approved PC	
	Plan Ref. P030-ARU-C-A00-BG-GA-100 T5										Drg. No. P030-ARU-C-A00-C-BG-SH-110				Rev T5						
MH No.	Manhole Details							Cover Details		Pipe Details					Remarks				Revision		
	Size	Types			Levels		Depth to IL	BS EN 124	Cover Size clear opening	Size in	Size out	Invert level in	Backdrop	Invert level out							
		Poly	Brick	Conc.	App.Cover	Invert															
															GENERAL NOTES:						
S1	1200			X	94.894	93.544	1.350	D400	675x675		300				93.539						
S2	1200			X	93.528	92.178	1.350	D400	675x675	300	300	92.183			92.173						
S3	1200			X	92.690	91.340	1.350	D400	675x675	300	300	91.345			91.335						
S4	1200			X	92.540	91.191	1.349	D400	675x675	300	300	91.196			91.186						
S5	1200			X	92.441	91.056	1.385	D400	675x675	300	300	91.061			91.051						
S6.1	1350			X	92.007	90.550	1.457	D400	675x675		450				90.545						
S6.2	1350			X	92.178	90.507	1.671	D400	675x675	450	450	90.512			90.502						
S6	1350			X	92.025	90.042	1.983	D400	675x675	300	450	90.197			90.037						
										450		90.047									
S7.1	1350			X	91.380	89.963	1.417	D400	675x675		375				89.958						
S7.2	1350			X	91.604	89.854	1.750	D400	675x675	375	375	89.859			89.849						
S7	1350			X	91.799	89.595	2.204	D400	675x675	450	450	89.600			89.590						
										375		89.675									
S8	1350			X	92.033	89.581	2.452	D400	675x675	450	450	89.586			89.576						
S9.1	1200			X	92.016	90.591	1.425	D400	675x675		225				90.586						
S9.2	1200			X	92.141	90.464	1.677	D400	675x675	225	225	90.469			90.459						
S9	1350			X	91.943	89.570	2.373	D400	675x675	450	450	89.575			89.570						
										225		90.300	0.500								
SPI1	1350			X	91.897	89.465	2.432	D400	675x675	450	450	89.565	0.100	89.465	SPEL Bypass separator 318 C1/SC or similar approved						
S10	1350			X	91.871	89.460	2.411	D400	675x675	450	450	89.460			89.455	Attenuation cell A. Storage capacity 220m3.					
S11	1350			X	91.751	89.423	2.328	D400	675x675	450	450	89.428			89.418						
S12.1	1350			X	91.588	90.538	1.050	D400	675x675		450				90.533						
S12.2	1350			X	90.672	89.322	1.350	D400	675x675	450	450	89.327			89.317						
S12.3.1	1200			X	91.623	90.497	1.126	D400	675x675		300				90.492						
S12.3.2A	1200			X	91.913	91.013	0.900	D400	675x675		150				91.008						
S12.3.2B	1200			X	91.638	90.663	0.975	D401	675x675	150	225	90.743			90.658						
S12.3.2	1350			X	91.629	90.236	1.393	D400	675x675	300	375	90.316			90.231						
										225		90.391									
S12.3	1350			X	90.755	88.986	1.769	D400	675x675	450	450	88.991			88.981						
										375		89.066									
S16	1200			X	90.182	88.757	1.425	D400	675x675		225				88.752						
SPI3	1200			X	90.193	88.618	1.575	D400	675x675	225	225	88.673	0.050	88.613	SPEL Bypass separator 103 C1/SC or similar approved into rainwater harvesting tank						
S17	1200			X	90.227	88.580	1.647	D399	675x675	225	225	88.585			88.575						
S18	1200			X	90.270	88.515	1.755	D400	675x675	225	225	88.520			88.510	Attenuation Cell C. Storage volume 90m3				T5	
S19	1200			X	90.176	87.981	2.195	D400	675x675	225	225	87.986			87.976						
Pumping Station	1200			X	89.435	87.447	1.988	D400	675x675	225	225	87.452			87.442	Surface water pump. Pumping rate 4.5l/s. Pressure main specification to be provided by pumping station manufacturer				T5	
S12.3A	1350			X	90.744	88.936	1.808	D400	675x675	450	450	88.941			88.931	Incoming surface water rising main					
										225		88.941									
S12.4.1	1200			X	91.144	89.794	1.350	D400	675x675		150				89.789						
S12.4	1350			X	90.805	88.886	1.919	D400	675x675	450	450	88.891			88.881						
										150		89.191									
S12.5	1350			X	90.651	88.868	1.783	D400	675x675	450	450	88.873			88.863						
SPI2	1350			X	90.629	88.764	1.865	D400	675x675	450	450	88.819	0.050	88.764	SPEL Bypass separator 318C1/SC or similar approved.						
S12.6	1350			X	90.617	88.754	1.863	D400	675x675	450	450	88.754			88.754						
S12.7	1500			X	90.690	88.668	2.022	D400	675x675	450	525	88.743			88.663	Attenuation Cell B. Storage capacity 675m3. Storage increase				T5	
S12	1500			X	91.234	88.579	2.655	D400	675x675	450	525	88.584			88.579						
										525		88.584									
S13	1500			X	91.223	88.569	2.654	D400	675x675	525	300	88.569			88.564	Flow control chamber with dual orifice plate as shown on Details Drawing DT-202. Chamber to be 1500mm dia					
S					90.691	OUTFALL				300	-	88.534				Precast concrete headwall. Althton H3C or similar approved					

Notes:

1. Where depth to cover from soffit of pipe is less than 1.2m, DMRB SHW 150mm thick Class Z bedding and surround to be used.

Ove Arup & Partners International Ltd		Page 1																						
The Arup Campus Blyth Gate Solihull B90 8AE																								
Date 17/06/2014 10:24 File cdps_pump 2014-06-17.mdx	Designed by David.Leak Checked by																							
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Surcharged Outfall Details for Storm <table><thead><tr><th>Outfall Pipe Number</th><th>Outfall Name</th><th>C. Level (m)</th><th>I. Level (m)</th><th>Min I. Level (m)</th><th>D,L (mm)</th><th>W (mm)</th></tr></thead><tbody><tr><td>1.013</td><td>S</td><td>90.691</td><td>88.554</td><td>89.575</td><td>0</td><td>0</td></tr></tbody></table> Datum (m) 0.000 Offset (mins) 0 <table><thead><tr><th>Time (mins)</th><th>Depth (m)</th><th>Time (mins)</th><th>Depth (m)</th></tr></thead><tbody><tr><td>1220</td><td>89.022</td><td>2440</td><td>89.022</td></tr></tbody></table>			Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)	1.013	S	90.691	88.554	89.575	0	0	Time (mins)	Depth (m)	Time (mins)	Depth (m)	1220	89.022	2440	89.022
Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)																		
1.013	S	90.691	88.554	89.575	0	0																		
Time (mins)	Depth (m)	Time (mins)	Depth (m)																					
1220	89.022	2440	89.022																					
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Online Controls for Storm

Pump Manhole: S19, DS/PN: 9.004, Volume (m³): 3.0

Invert Level (m) 87.447

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.010	4.5000	1.988	4.5000

Complex Manhole: S12, DS/PN: 1.012, Volume (m³): 18.1

Orifice

Diameter (m) 0.070 Discharge Coefficient 0.600 Invert Level (m) 88.604

Orifice

Diameter (m) 0.069 Discharge Coefficient 0.600 Invert Level (m) 89.204

Non Return Valve Manhole: S13, DS/PN: 1.013, Volume (m³): 3.7

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Storage Structures for Storm

Cellular Storage Manhole: S11, DS/PN: 1.011

Invert Level (m)	89.459	Infiltration Coefficient Side (m/hr)	0.00000	Porosity	0.95
Infiltration Coefficient Base (m/hr)	0.00000	Safety Factor	2.0		

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	220.0	220.0	1.000	220.0	220.0	1.010	0.0	220.0

Cellular Storage Manhole: S19, DS/PN: 9.004

Invert Level (m)	87.447	Infiltration Coefficient Side (m/hr)	0.03600	Porosity	0.95
Infiltration Coefficient Base (m/hr)	0.03600	Safety Factor	2.0		

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	50.0	50.0	1.000	50.0	50.0	1.001	0.0	50.0

Cellular Storage Manhole: S12, DS/PN: 1.012

Invert Level (m)	88.604	Infiltration Coefficient Side (m/hr)	0.03600	Porosity	0.95
Infiltration Coefficient Base (m/hr)	0.03600	Safety Factor	2.0		

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	545.0	545.0	1.000	545.0	545.0	1.300	545.0	545.0	1.301	0.0	545.0

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

Simulation Criteria

Areal Reduction Factor	1.000	Manhole Headloss Coeff (Global)	0.500	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Foul Sewage per hectare (l/s)	0.000	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Additional Flow - % of Total Flow	0.000	Flow per Person per Day (l/per/day)	0.000

Number of Input Hydrographs	0	Number of Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	3	Number of Storage Structures	3	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR M5-60 (mm)	18.000	Cv (Summer)	0.750	
Region	England and Wales	Ratio R	0.327	Cv (Winter)	0.840

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

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 30

PN	Storm	Return Climate Period Change	First X Surcharge	First Y Flood	First Z Overflow	First Z Act.	O/F Exc.	Lvl
1.000	15 Winter	1	0%					
1.001	15 Winter	1	0%					
1.002	15 Winter	1	0%	100/15	Summer			
1.003	15 Winter	1	0%	100/15	Summer			

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

PN	Storm	Return	Climate	First X		First Y	First Z	O/F	Lvl
		Period	Change	Surcharge		Flood	Overflow	Act.	Exc.
1.004	15 Winter	1	0%	100/15	Summer				
2.000	15 Winter	1	0%	100/15	Summer				
2.001	15 Winter	1	0%	100/15	Summer				
1.005	15 Winter	1	0%	100/15	Summer				
3.000	15 Winter	1	0%	30/15	Winter				
3.001	15 Winter	1	0%	30/15	Summer				
1.006	15 Winter	1	0%	30/15	Summer				
1.007	15 Winter	1	0%	30/15	Summer				
4.000	15 Winter	1	0%	100/15	Summer				
4.001	15 Winter	1	0%	100/15	Summer				
1.008	15 Winter	1	0%	30/15	Summer				
1.009	15 Winter	1	0%	30/15	Summer				
1.010	15 Winter	1	0%	30/15	Summer				
1.011	30 Winter	1	0%	100/15	Summer				
5.000	15 Winter	1	0%	100/15	Summer				
6.000	60 Winter	1	0%	100/15	Winter				
6.001	60 Winter	1	0%	100/15	Summer				
5.001	15 Winter	1	0%	100/15	Summer				
7.000	15 Winter	1	0%						
8.000	15 Winter	1	0%						
8.001	15 Winter	1	0%						
7.001	15 Winter	1	0%	100/15	Summer				
5.002	15 Winter	1	0%	30/15	Summer				
9.000	15 Winter	1	0%	30/15	Summer				
9.001	15 Winter	1	0%	30/15	Summer				
9.002	15 Winter	1	0%	30/15	Summer				
9.003	15 Winter	1	0%	100/60	Winter				

1 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.
9.004	30 Winter	1	0%	30/15 Summer				
5.003	15 Winter	1	0%	30/15 Summer				
10.000	15 Winter	1	0%	100/15 Summer				
5.004	15 Winter	1	0%	30/15 Summer				
5.005	15 Winter	1	0%	30/15 Summer				
5.006	15 Winter	1	0%	30/15 Summer				
5.007	15 Winter	1	0%	30/15 Summer				
5.008	480 Winter	1	0%	30/60 Winter				
1.012	480 Winter	1	0%	30/60 Summer				
1.013	1440 Winter	1	0%					

PN	US/MH Name	Water		Flooded			Pipe	Status
		Level (m)	Surch'ed Depth (m)	Volume (m³)	Flow / Cap.	O'flow (l/s)	Flow (l/s)	
1.000	S1	93.559	-0.285	0.000	0.01	0.0	2.6	OK
1.001	S2	92.221	-0.257	0.000	0.05	0.0	8.9	OK
1.002	S3	91.417	-0.223	0.000	0.15	0.0	11.2	OK
1.003	S4	91.309	-0.182	0.000	0.32	0.0	20.8	OK
1.004	S5	91.136	-0.220	0.000	0.16	0.0	22.8	OK
2.000	S6.1	90.647	-0.353	0.000	0.02	0.0	3.4	OK
2.001	S6.2	90.646	-0.311	0.000	0.20	0.0	43.5	OK
1.005	S6	90.178	-0.314	0.000	0.20	0.0	69.4	OK
3.000	S7.1	90.014	-0.324	0.000	0.04	0.0	4.5	OK
3.001	S7.2	89.905	-0.324	0.000	0.03	0.0	4.2	OK
1.006	S7	89.882	-0.162	0.000	0.72	0.0	72.2	OK
1.007	S8	89.860	-0.171	0.000	0.66	0.0	75.1	OK

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

PN	US/MH Name	Water	Surch'ed Depth (m)	Flooded	Flow / Cap.	O'flow	Pipe	Status
		Level (m)		Volume (m³)		Flow (l/s)	Flow (l/s)	
4.000	S9.1	90.675	-0.141	0.000	0.29	0.0	11.1	OK
4.001	S9.2	90.542	-0.147	0.000	0.26	0.0	12.5	OK
1.008	S9	89.844	-0.176	0.000	0.68	0.0	85.2	OK
1.009	SPI1	89.827	-0.124	0.000	0.68	0.0	85.3	OK
1.010	S10	89.818	-0.128	0.000	0.86	0.0	84.5	OK
1.011	S11	89.632	-0.277	0.000	0.32	0.0	47.7	OK
5.000	S12.1	90.288	-0.100	0.000	0.25	0.0	4.6	OK
6.000	S12.2.1	90.270	-0.150	0.000	0.00	0.0	0.0	OK
6.001	S12.2.2	90.136	-0.150	0.000	0.00	0.0	0.0	OK
5.001	S12.2	89.403	-0.369	0.000	0.07	0.0	17.2	OK
7.000	S12.3.1	90.546	-0.251	0.000	0.06	0.0	6.2	OK
8.000	S12.3.2A	91.051	-0.112	0.000	0.14	0.0	2.6	OK
8.001	S12.3.2B	90.706	-0.183	0.000	0.08	0.0	4.2	OK
7.001	S12.3.2	90.322	-0.289	0.000	0.12	0.0	32.5	OK
5.002	S12.3	89.186	-0.250	0.000	0.29	0.0	48.7	OK
9.000	S16	88.868	-0.114	0.000	0.48	0.0	20.1	OK
9.001	SPI3	88.756	-0.087	0.000	0.67	0.0	20.1	OK
9.002	S17	88.702	-0.103	0.000	0.57	0.0	20.3	OK
9.003	S18	88.580	-0.160	0.000	0.19	0.0	20.3	OK
9.004	S19	87.573	-0.099	0.000	0.37	0.0	4.5	OK
5.003	S12.3A	89.180	-0.206	0.000	0.35	0.0	52.8	OK
10.000	S12.4.1	89.844	-0.100	0.000	0.24	0.0	6.5	OK
5.004	S12.4	89.164	-0.172	0.000	0.65	0.0	66.6	OK
5.005	S12.5	89.145	-0.098	0.000	0.74	0.0	66.5	OK
5.006	SPI2	89.134	-0.105	0.000	0.82	0.0	66.5	OK
5.007	S12.6	89.121	-0.109	0.000	0.85	0.0	66.2	OK

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

PN	US/MH Name	Water	Surch'ed Depth (m)	Flooded	Flow / Cap.	O'flow	Pipe	Status
		Level (m)		Volume (m³)		(1/s)	Flow (1/s)	
5.008	S12.7	88.998	-0.220	0.000	0.07	0.0	14.1	OK
1.012	S12	88.997	-0.132	0.000	0.03	0.0	5.6	OK
1.013	S13	88.860	-0.260	0.000	0.03	0.0	5.1	OK

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

Simulation Criteria

Areal Reduction Factor	1.000	Manhole Headloss Coeff (Global)	0.500	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Foul Sewage per hectare (l/s)	0.000	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Additional Flow - % of Total Flow	0.000	Flow per Person per Day (l/per/day)	0.000

Number of Input Hydrographs	0	Number of Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	3	Number of Storage Structures	3	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR M5-60 (mm)	18.000 Cv (Summer)	0.750
Region	England and Wales	Ratio R	0.327 Cv (Winter) 0.840

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

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 30

PN	Storm	Return Climate Period Change	First X Surcharge	First Y Flood	First Z Overflow	First Z Act.	O/F	Lvl Exc.
1.000	15 Winter	30	0%					
1.001	15 Winter	30	0%					
1.002	15 Winter	30	0%	100/15	Summer			
1.003	15 Winter	30	0%	100/15	Summer			

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

		Return	Climate	First X		First Y	First Z	O/F	Lvl
PN	Storm	Period	Change	Surcharge		Flood	Overflow	Act.	Exc.
1.004	15 Winter	30	0%	100/15	Summer				
2.000	15 Winter	30	0%	100/15	Summer				
2.001	15 Winter	30	0%	100/15	Summer				
1.005	15 Winter	30	0%	100/15	Summer				
3.000	15 Winter	30	0%	30/15	Winter				
3.001	15 Winter	30	0%	30/15	Summer				
1.006	15 Winter	30	0%	30/15	Summer				
1.007	15 Winter	30	0%	30/15	Summer				
4.000	15 Winter	30	0%	100/15	Summer				
4.001	15 Winter	30	0%	100/15	Summer				
1.008	15 Winter	30	0%	30/15	Summer				
1.009	15 Winter	30	0%	30/15	Summer				
1.010	15 Winter	30	0%	30/15	Summer				
1.011	30 Winter	30	0%	100/15	Summer				
5.000	15 Winter	30	0%	100/15	Summer				
6.000	60 Winter	30	0%	100/15	Winter				
6.001	60 Winter	30	0%	100/15	Summer				
5.001	15 Winter	30	0%	100/15	Summer				
7.000	15 Winter	30	0%						
8.000	15 Winter	30	0%						
8.001	15 Winter	30	0%						
7.001	15 Winter	30	0%	100/15	Summer				
5.002	15 Winter	30	0%	30/15	Summer				
9.000	15 Winter	30	0%	30/15	Summer				
9.001	15 Winter	30	0%	30/15	Summer				
9.002	15 Winter	30	0%	30/15	Summer				
9.003	15 Winter	30	0%	100/60	Winter				

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

PN	Storm	Return Period	Climate Change	First X Surchage	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
9.004	60 Winter	30	0%	30/15 Summer				
5.003	15 Winter	30	0%	30/15 Summer				
10.000	15 Winter	30	0%	100/15 Summer				
5.004	15 Winter	30	0%	30/15 Summer				
5.005	15 Winter	30	0%	30/15 Summer				
5.006	480 Winter	30	0%	30/15 Summer				
5.007	480 Winter	30	0%	30/15 Summer				
5.008	480 Winter	30	0%	30/60 Winter				
1.012	480 Winter	30	0%	30/60 Summer				
1.013	1440 Winter	30	0%					

PN	US/MH Name	Water	Surch'd Depth (m)	Flooded	Flow / Cap.	O'flow	Pipe	Status
		Level (m)		Volume (m³)		Flow (l/s)	Flow (l/s)	
1.000	S1	93.576	-0.268	0.000	0.03	0.0	6.3	OK
1.001	S2	92.254	-0.224	0.000	0.14	0.0	26.0	OK
1.002	S3	91.484	-0.156	0.000	0.42	0.0	32.5	OK
1.003	S4	91.429	-0.062	0.000	0.96	0.0	61.6	OK
1.004	S5	91.200	-0.156	0.000	0.46	0.0	66.3	OK
2.000	S6.1	90.768	-0.232	0.000	0.06	0.0	8.9	OK
2.001	S6.2	90.766	-0.191	0.000	0.59	0.0	130.5	OK
1.005	S6	90.458	-0.033	0.000	0.50	0.0	175.0	OK
3.000	S7.1	90.376	0.038	0.000	0.09	0.0	9.0	SURCHARGED
3.001	S7.2	90.370	0.141	0.000	0.19	0.0	30.0	SURCHARGED
1.006	S7	90.366	0.321	0.000	1.64	0.0	165.2	SURCHARGED
1.007	S8	90.320	0.289	0.000	1.49	0.0	169.2	SURCHARGED

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

PN	US/MH Name	Water	Surch'd Depth (m)	Flooded	Flow / Cap.	O'flow	Pipe	Status
		Level (m)		Volume (m³)		Flow (l/s)	Flow (l/s)	
4.000	S9.1	90.735	-0.081	0.000	0.71	0.0	27.3	OK
4.001	S9.2	90.598	-0.091	0.000	0.65	0.0	31.1	OK
1.008	S9	90.247	0.227	0.000	1.55	0.0	194.3	SURCHARGED
1.009	SPI1	90.128	0.177	0.000	1.55	0.0	194.0	SURCHARGED
1.010	S10	90.008	0.062	0.000	1.97	0.0	194.4	SURCHARGED
1.011	S11	89.800	-0.109	0.000	0.93	0.0	140.2	OK
5.000	S12.1	90.322	-0.066	0.000	0.59	0.0	11.2	OK
6.000	S12.2.1	90.270	-0.150	0.000	0.00	0.0	0.0	OK
6.001	S12.2.2	90.136	-0.150	0.000	0.00	0.0	0.0	OK
5.001	S12.2	89.745	-0.027	0.000	0.18	0.0	42.8	OK
7.000	S12.3.1	90.576	-0.221	0.000	0.15	0.0	15.3	OK
8.000	S12.3.2A	91.075	-0.088	0.000	0.35	0.0	6.3	OK
8.001	S12.3.2B	90.734	-0.155	0.000	0.21	0.0	11.1	OK
7.001	S12.3.2	90.389	-0.222	0.000	0.34	0.0	94.1	OK
5.002	S12.3	89.726	0.290	0.000	0.66	0.0	112.0	SURCHARGED
9.000	S16	89.066	0.084	0.000	1.13	0.0	47.3	SURCHARGED
9.001	SPI3	88.954	0.111	0.000	1.58	0.0	47.2	SURCHARGED
9.002	S17	88.841	0.036	0.000	1.31	0.0	46.9	SURCHARGED
9.003	S18	88.619	-0.121	0.000	0.43	0.0	46.9	OK
9.004	S19	87.944	0.272	0.000	0.37	0.0	4.5	SURCHARGED
5.003	S12.3A	89.708	0.322	0.000	0.78	0.0	117.2	SURCHARGED
10.000	S12.4.1	89.877	-0.067	0.000	0.59	0.0	15.9	OK
5.004	S12.4	89.672	0.336	0.000	1.45	0.0	149.8	SURCHARGED
5.005	S12.5	89.632	0.389	0.000	1.67	0.0	149.9	SURCHARGED
5.006	SPI2	89.534	0.295	0.000	0.34	0.0	27.1	SURCHARGED
5.007	S12.6	89.533	0.303	0.000	0.35	0.0	27.1	SURCHARGED

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

PN	US/MH Name	Water	Surch'd Depth (m)	Flooded	Flow / Cap.	O'flow	Pipe	Status
		Level (m)		Volume (m³)		(1/s)	Flow (1/s)	
5.008	S12.7	89.531	0.313	0.000	0.14	0.0	26.4	SURCHARGED
1.012	S12	89.529	0.399	0.000	0.08	0.0	13.5	SURCHARGED
1.013	S13	89.023	-0.096	0.000	0.08	0.0	12.0	OK

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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	Manhole Headloss Coeff (Global)	0.500	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Foul Sewage per hectare (l/s)	0.000	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Additional Flow - % of Total Flow	0.000	Flow per Person per Day (l/per/day)	0.000

Number of Input Hydrographs	0	Number of Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	3	Number of Storage Structures	3	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR M5-60 (mm)	18.000	Cv (Summer)	0.750
Region	England and Wales	Ratio R	0.327	Cv (Winter)

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

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 30

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	+30%					
1.001	15 Winter	100	+30%					
1.002	15 Winter	100	+30%	100/15 Summer				
1.003	15 Winter	100	+30%	100/15 Summer				

Ove Arup & Partners International Ltd				Page 15				
The Arup Campus Blyth Gate Solihull B90 8AE								
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XP Solutions		Network 2013.1.1						
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.
1.004	15 Winter	100	+30%	100/15	Summer			
2.000	15 Winter	100	+30%	100/15	Summer			
2.001	15 Winter	100	+30%	100/15	Summer			
1.005	15 Winter	100	+30%	100/15	Summer			
3.000	15 Winter	100	+30%	30/15	Winter			
3.001	15 Winter	100	+30%	30/15	Summer			
1.006	15 Winter	100	+30%	30/15	Summer			
1.007	15 Winter	100	+30%	30/15	Summer			
4.000	15 Winter	100	+30%	100/15	Summer			
4.001	15 Winter	100	+30%	100/15	Summer			
1.008	15 Winter	100	+30%	30/15	Summer			
1.009	15 Winter	100	+30%	30/15	Summer			
1.010	480 Winter	100	+30%	30/15	Summer			
1.011	480 Winter	100	+30%	100/15	Summer			
5.000	15 Winter	100	+30%	100/15	Summer			
6.000	15 Winter	100	+30%	100/15	Winter			
6.001	15 Winter	100	+30%	100/15	Summer			
5.001	15 Winter	100	+30%	100/15	Summer			
7.000	15 Winter	100	+30%					
8.000	15 Winter	100	+30%					
8.001	15 Winter	100	+30%					
7.001	15 Winter	100	+30%	100/15	Summer			
5.002	15 Winter	100	+30%	30/15	Summer			
9.000	15 Winter	100	+30%	30/15	Summer			
9.001	15 Winter	100	+30%	30/15	Summer			
9.002	120 Winter	100	+30%	30/15	Summer			
9.003	120 Winter	100	+30%	100/60	Winter			
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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.
9.004	120 Winter	100	+30%	30/15 Summer				
5.003	15 Winter	100	+30%	30/15 Summer				
10.000	15 Winter	100	+30%	100/15 Summer				
5.004	480 Winter	100	+30%	30/15 Summer				
5.005	480 Winter	100	+30%	30/15 Summer				
5.006	480 Winter	100	+30%	30/15 Summer				
5.007	480 Winter	100	+30%	30/15 Summer				
5.008	480 Winter	100	+30%	30/60 Winter				
1.012	480 Winter	100	+30%	30/60 Summer				
1.013	1440 Winter	100	+30%					

PN	US/MH Name	Water		Flooded			Pipe		Status
		Level (m)	Surch'd Depth (m)	Volume (m³)	Flow / Cap.	O'flow (l/s)	Flow (l/s)		
1.000	S1	93.584	-0.260	0.000	0.04	0.0	10.5	OK	
1.001	S2	92.278	-0.200	0.000	0.24	0.0	43.7	OK	
1.002	S3	91.808	0.168	0.000	0.69	0.0	52.7	SURCHARGED	
1.003	S4	91.765	0.275	0.000	1.55	0.0	99.2	SURCHARGED	
1.004	S5	91.604	0.248	0.000	0.65	0.0	93.3	SURCHARGED	
2.000	S6.1	91.520	0.520	0.000	0.08	0.0	12.3	SURCHARGED	
2.001	S6.2	91.518	0.561	0.000	0.89	0.0	197.7	SURCHARGED	
1.005	S6	91.333	0.841	0.000	0.70	0.0	245.3	SURCHARGED	
3.000	S7.1	91.140	0.802	0.000	0.12	0.0	12.2	FLOOD RISK	
3.001	S7.2	91.130	0.901	0.000	0.24	0.0	36.7	SURCHARGED	
1.006	S7	91.123	1.078	0.000	2.46	0.0	248.4	SURCHARGED	
1.007	S8	90.925	0.894	0.000	2.27	0.0	256.9	SURCHARGED	

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

PN	US/MH Name	Water	Surch'd Depth (m)	Flooded	Flow / Cap.	O'flow	Pipe	Status
		Level (m)		Volume (m³)		O'flow (l/s)	Flow (l/s)	
4.000	S9.1	90.906	0.090	0.000	1.18	0.0	45.1	SURCHARGED
4.001	S9.2	90.802	0.113	0.000	1.02	0.0	49.0	SURCHARGED
1.008	S9	90.710	0.690	0.000	2.35	0.0	294.5	SURCHARGED
1.009	SPI1	90.431	0.480	0.000	2.35	0.0	294.9	SURCHARGED
1.010	S10	90.193	0.247	0.000	0.58	0.0	57.3	SURCHARGED
1.011	S11	90.188	0.279	0.000	0.41	0.0	61.3	SURCHARGED
5.000	S12.1	90.860	0.472	0.000	0.81	0.0	15.3	SURCHARGED
6.000	S12.2.1	90.515	0.095	0.000	0.02	0.0	0.3	SURCHARGED
6.001	S12.2.2	90.515	0.229	0.000	0.22	0.0	7.2	SURCHARGED
5.001	S12.2	90.515	0.743	0.000	0.23	0.0	54.5	FLOOD RISK
7.000	S12.3.1	90.724	-0.073	0.000	0.25	0.0	25.4	OK
8.000	S12.3.2A	91.097	-0.066	0.000	0.59	0.0	10.7	OK
8.001	S12.3.2B	90.756	-0.132	0.000	0.35	0.0	18.6	OK
7.001	S12.3.2	90.703	0.092	0.000	0.53	0.0	145.1	SURCHARGED
5.002	S12.3	90.488	1.052	0.000	0.99	0.0	167.8	FLOOD RISK
9.000	S16	89.607	0.625	0.000	1.80	0.0	75.8	SURCHARGED
9.001	SPI3	89.310	0.467	0.000	2.51	0.0	74.9	SURCHARGED
9.002	S17	89.126	0.321	0.000	0.83	0.0	29.9	SURCHARGED
9.003	S18	89.120	0.380	0.000	0.28	0.0	29.9	SURCHARGED
9.004	S19	89.111	1.439	0.000	0.37	0.0	4.5	SURCHARGED
5.003	S12.3A	90.451	1.065	0.000	1.15	0.0	171.8	FLOOD RISK
10.000	S12.4.1	90.717	0.773	0.000	0.75	0.0	20.3	SURCHARGED
5.004	S12.4	90.503	1.166	0.000	0.40	0.0	41.3	SURCHARGED
5.005	S12.5	90.549	1.306	0.000	0.46	0.0	41.1	FLOOD RISK
5.006	SPI2	90.582	1.343	0.000	0.51	0.0	40.9	FLOOD RISK
5.007	S12.6	90.599	1.370	0.000	0.52	0.0	40.8	FLOOD RISK

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

PN	US/MH Name	Water	Surch'd Depth (m)	Flooded	Flow / Cap.	O'flow	Pipe	Status
		Level (m)		Volume (m³)		(l/s)	Flow (l/s)	
5.008	S12.7	90.626	1.408	0.000	0.21	0.0	40.5	FLOOD RISK
1.012	S12	90.658	1.529	0.000	0.13	0.0	21.2	SURCHARGED
1.013	S13	89.025	-0.095	0.000	0.13	0.0	19.0	OK

Appendix C

Foul Drainage Calculations

Ove Arup & Partners International Ltd		Page 1
The Arup Campus Blyth Gate Solihull B90 8AE		
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XP Solutions	Network 2013.1.1	

FOUL SEWERAGE DESIGN

Design Criteria for Storm

Pipe Sizes Foul Manhole Sizes Concrete

Industrial Flow (l/s/ha)	0.00	Domestic (l/s/ha)	0.00	Maximum Backdrop Height (m)	1.500
Industrial Peak Flow Factor	0.00	Domestic Peak Flow Factor	6.00	Min Design Depth for Optimisation (m)	0.750
Flow Per Person (l/per/day)	222.00	Add Flow / Climate Change (%)	0	Min Vel for Auto Design only (m/s)	0.74
Persons per House	3.00	Minimum Backdrop Height (m)	0.200	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Houses	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)
1.000	22.391	0.276	81.1	0.000	0	0.1	1.500	o	100

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Hse (l/s)	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	90.797	0.000	0.1	0	0.0	9	0.27	0.74	5.8	0.1

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XP Solutions

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Houses	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)
2.000	13.216	0.165	80.1	0.000	0	1.1	1.500	o	100
1.001	16.532	0.204	81.0	0.000	0	0.0	1.500	o	100
1.002	8.111	0.058	141.0	0.000	0	1.4	1.500	o	150
1.003	11.373	0.081	141.0	0.000	0	1.1	1.500	o	150
1.004	8.893	0.063	141.0	0.000	0	0.4	1.500	o	150
1.005	21.552	0.154	140.0	0.000	0	1.2	1.500	o	150
1.006	9.564	0.068	140.0	0.000	0	0.0	1.500	o	150
3.000	21.840	0.270	80.9	0.000	0	0.3	1.500	o	100

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Hse	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
2.000	90.686	0.000	1.1	0	0.0	30	0.57	0.74	5.8	1.1
1.001	90.521	0.000	1.2	0	0.0	31	0.58	0.74	5.8	1.2
1.002	90.267	0.000	2.6	0	0.0	46	0.57	0.74	13.0	2.6
1.003	90.209	0.000	3.7	0	0.0	55	0.63	0.74	13.0	3.7
1.004	90.129	0.000	4.1	0	0.0	58	0.65	0.74	13.0	4.1
1.005	90.066	0.000	5.3	0	0.0	67	0.70	0.74	13.1	5.3
1.006	89.912	0.000	5.3	0	0.0	67	0.70	0.74	13.1	5.3
3.000	90.830	0.000	0.3	0	0.0	16	0.38	0.74	5.8	0.3

Ove Arup & Partners International Ltd		Page 3
The Arup Campus Blyth Gate Solihull B90 8AE		
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XP Solutions	Network 2013.1.1	

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Houses	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)
3.001	10.420	0.167	62.4	0.000	0	0.0	1.500	o	100
1.007	3.233	0.023	140.0	0.000	0	0.0	1.500	o	150
4.000	6.073	0.111	54.7	0.000	0	0.0	1.500	o	100
4.001	5.404	0.108	50.0	0.000	0	0.0	1.500	o	100

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Hse	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
3.001	90.560	0.000	0.3	0	0.0	15	0.41	0.84	6.6	0.3
1.007	89.843	0.000	5.6	0	0.0	69	0.71	0.74	13.1	5.6
4.000	89.109	0.000	0.0	0	0.0	0	0.00	0.90	7.1	0.0
4.001	88.998	0.000	0.0	0	0.0	0	0.00	0.94	7.4	0.0

ARUP	Ove Arup & Partners 4 Pierhead street Capital Waterside Cardiff CF1 5QP Tel - 01222 473727		WAST - AFSRC		FOUL DRAINAGE MANHOLE SCHEDULE										Sheet No. 1	Job No. 213833	Made by RM	Date 04-Oct-13	Chkd DL	Approved MOC
					Plan Ref. P030-ARU-C-A00-BG-GA-100										Drg. No. P030-ARU-C-A00-BG-SH111		Rev T3			
MH No.	Size	Manhole Details						Cover Details		Pipe Details					Remarks			Revision		
		Types			Levels		Depth to IL	BS EN 124	Cover Size clear opening	Size in	Size out	Invert level in	Backdrop	Invert level out						
Poly	Brick	Conc.	App.Cover	Invert																
															GENERAL NOTES:					
F1	1200			X	91.977	90.797	1.180	D400	675x675		100			90.792						
F2.1	1200			X	92.156	90.686	1.470	D400	675x675		100			90.681						
F2	1200			X	92.135	90.521	1.614	D400	675x675	100	100	90.526		90.516						
										100		90.526								
F3	1200			X	92.174	90.267	1.907	D400	675x675	100	150	90.322		90.262						
F4	1200			X	92.166	90.209	1.957	D400	675x675	150	150	90.214		90.204						
F5	1200			X	92.122	90.129	1.993	D400	675x675	150	150	90.134		90.124						
F6	1200			X	92.155	90.066	2.089	D400	675x675	150	150	90.071		90.061						
F7	1200			X	92.159	89.912	2.247	D400	675x675	150	150	89.917		89.907						
F8.1	1200			X	92.132	90.830	1.302	D400	675x675		100			90.825						
F8.2	1200			X	92.071	90.560	1.511	D400	675x675	100	100	90.565		90.555						
F8	1200			X	91.948	89.843	2.105	D400	675x675	150	150	89.848		89.838						
										100		90.398	0.500							
Existing EF9	1200			X	91.822	89.820	2.002	D400	675x675	150	-	89.825			Tie invert to invert to existing foul drainage MH, IL= 89.820					
20	475	X			90.242	89.109	1.133	D400	440		100			89.104						
21	1200			X	90.349	88.998	1.351	D400	675x675	100	100	89.003		88.993						
Pumping station	1200			X	90.450	88.890	1.560	D400	675x675	100	-	88.895			Pumped to existing foul drainage via break pressure chamber					

Notes:
1. Where depth to cover from soffit of pipe is less than 1.2m, DMRB SHW 150mm thick Class Z bedding and surround to be used

ARUP CARDIFF			
REC'D	06 JUN 2012		
JOB No.	213833	FILE No.	6-10
PROJ MAN	DB	INTL	DP
ACTION RESPONSE	Saved under 6-10		

Developer Services
PO Box 3146
Cardiff
CF30 0EH

Gwasanaethau Datblygu
Blwch Post 3146
Caerdydd
CF30 0EH

Tel: +44 (0)800 917 2652
Fax: +44 (0)2920 740472
E-mail: developer.services@dwrcymru.com

Ffôn: +44 (0)800 917 2652
Ffacs: +44 (0)2920 740472
E.bost: developer.services@dwrcymru.com

Sion Williams
ARUP
4 Pierhead Street
Capital Waterside
Cardiff
CF10 4QP

Date: 28/05/2012
Enquiries Tel.: 08009172652
Our Ref.: 2012/DCWW/78322
Your Ref.:
Grid Ref.: SJ3216250276

Dear Sir/Madam

Re: Welsh Ambulance Services NHS Trust to undertake the foul water drainage design for a proposed development located to the east of, Croesnewydd Road, Wrexham

Further to the above consultation we would provide the following comments:-

SEWERAGE

In relation to capacity to accept sewage flows from the proposed development we would confirm the following:

As you may observe from the attached public sewer record plan, the public sewerage system in the vicinity of the proposed development is generally of a combined type.

The foul only discharge from the proposed development can be accommodated within the public sewerage system.

In relation to the surface water flows from the proposed development, these will have to be disposed of separately by other means, such as using soakaways or discharging directly to a watercourse in liaison with the Land Drainage Authority and / or Environment Agency.

Please note that no highway or land drainage run-off will be permitted to discharge directly or indirectly into the public sewerage system.

If any onsite or offsite sewers are to be offered for adoption they must be constructed to conform with the publication "Sewers for Adoption"- 6th Edition.

If a connection is required to the public sewerage system, the developer is advised to contact us on Tel: 0800 917 2652.

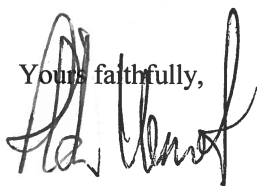
A 150mm public combined sewer crosses the development site. Under the Water Industry Act 1991, we have the rights of access to our apparatus at all times. Please note that no development (including the raising or lowering of ground levels) will be permitted within the safety zone of the public sewer, which is measured 3 metres either side of the centreline of these pipes.

SEWAGE TREATMENT

No problems are envisaged with the Waste Water Treatment Works for the treatment of domestic discharges from this site.

We hope the above is satisfactory. However, should you require further assistance please contact us on the above telephone number, quoting our reference.

Yours faithfully,



Rhidian Clement
Principal Planner

Demands upon the water and sewerage systems change continually; consequently the information given above should be regarded as reliable for a maximum period of 12 months from the date of this letter.

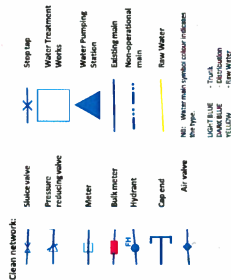
Enc- Sewer Plan
Receipt



Croesnewydd Road, Wrexham



LEGEND



Notes:

Only *Cymru Cyf* gives this information as to the position of its underground apparatus by way of general guidance only on the strict understanding that it is based on the best information available and no warranty as to correctness is relied upon in the event of reconnoitres or other works made in the vicinity of the Company's apparatus and any omission of locating the apparatus before carrying out any excavations rests entirely on you. It must be understood that the Company's position is not without prejudice to the provisions of the New Roads and Streetworks Act 1991 and of the Company's right to be compensated for any damage to its apparatus.

Service pipes are not generally shown but their presence should be anticipated.

**EXACT LOCATIONS OF ALL APPARATUS
TO BE DETERMINED ON SITE.**

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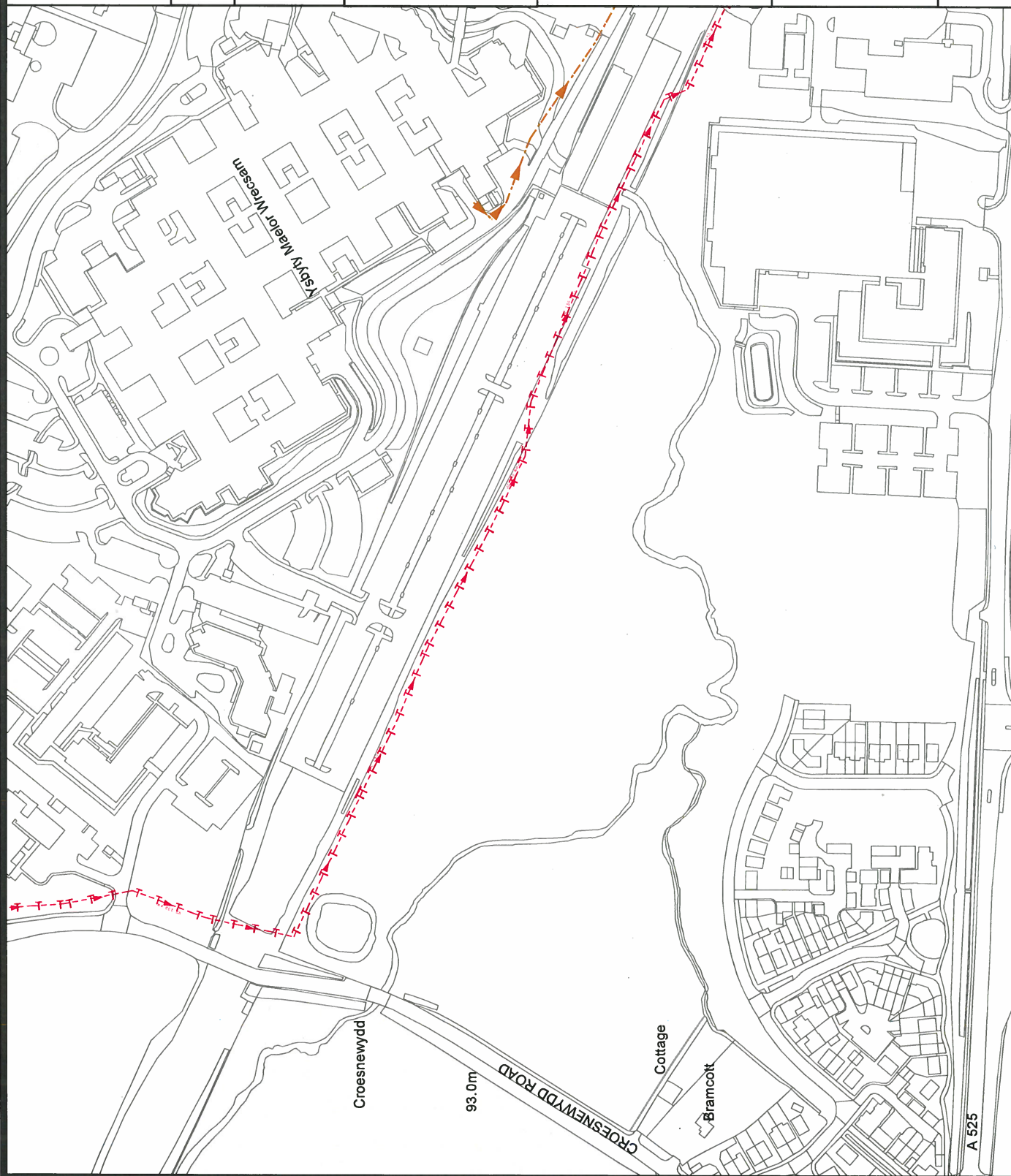
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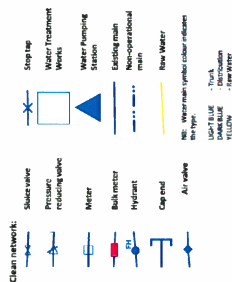




Croesnewydd Road, Wrexham



LEGEND



Notes:

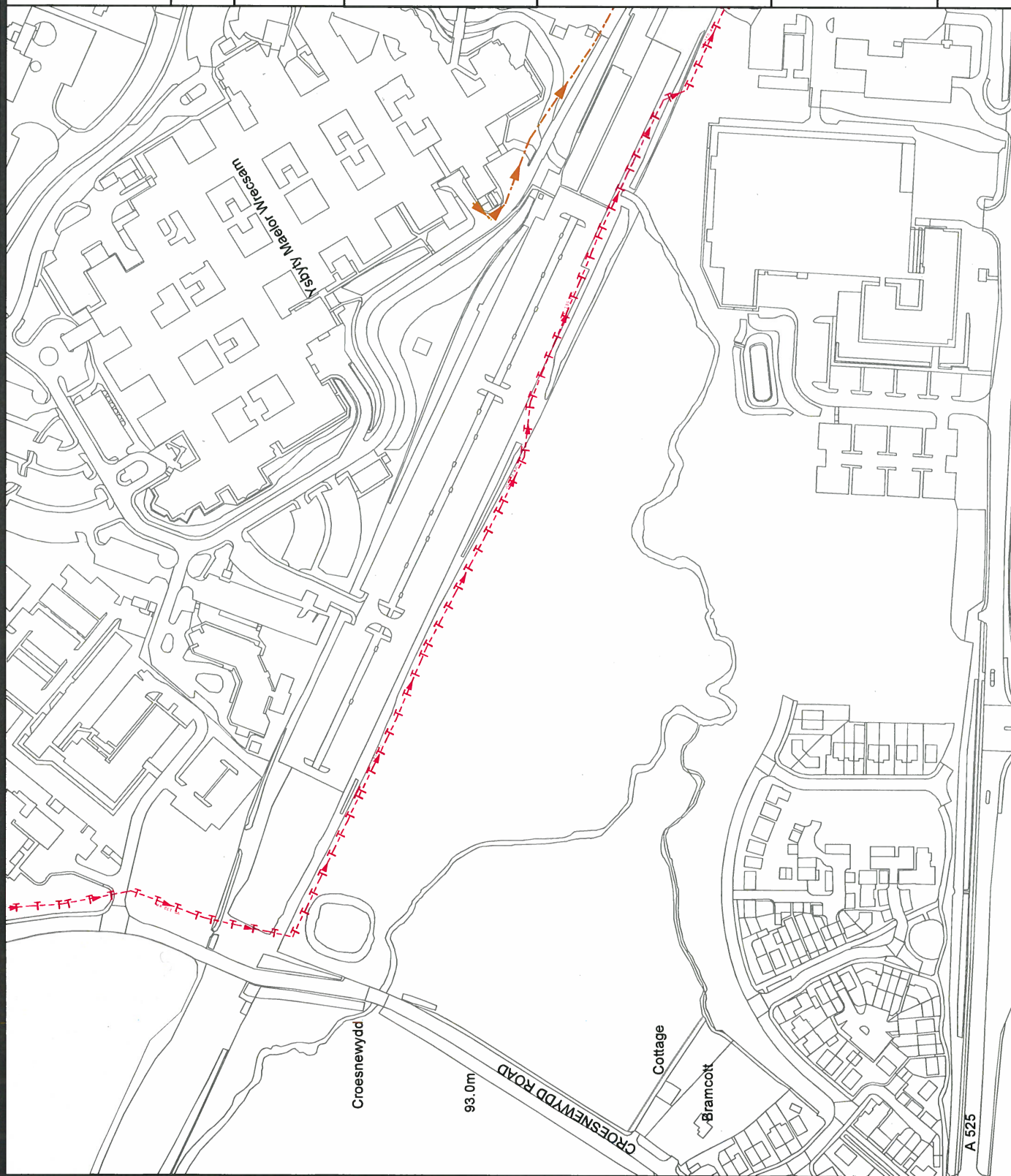
Owr Cymru Cyf gives this information as to the position of its underground apparatus by way of general guidance only on the strict understanding that it is based on the best information available and is not to be relied on for completeness in the event of accidents or other emergencies. The Company's policy is to compensate its employees for any loss or damage to their property or apparatus before carrying out any excavations near to the underground apparatus. It must be understood that the furnishing of this information is entirely without prejudice to the provision of the New Roads and Streetworks Act 1991 and of the Company's right to be compensated for any damage to its apparatus.

**EXACT LOCATIONS OF ALL APPARATUS
TO BE DETERMINED ON SITE.**

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28/5/2012



VAT Registration Number : GB771 1231 59

To: Arup
4 Pierhead Street
Capital Waterside
Cardiff
CF10 4QP

Date : 21 March 2012

VAT Receipt Number : RFP/DS001

Quantity	Details	Unit Price	VAT	Amount
1	Your Reference: 218833/SW Pre-Planning Enquiry East Of Croesnewydd Road, Wrexham Payment Received With Thanks	71.50	14.30	85.80
Total				85.80