3201505 58 P

BAE SAMLESBURY LOGISTICS FACILITY

SURFACE WATER DRAINAGE DESIGN

6751
REVISION S1

Prepared for

AEW Architects

JUNE 2015

TRP Consulting
The Landmark
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General Principals

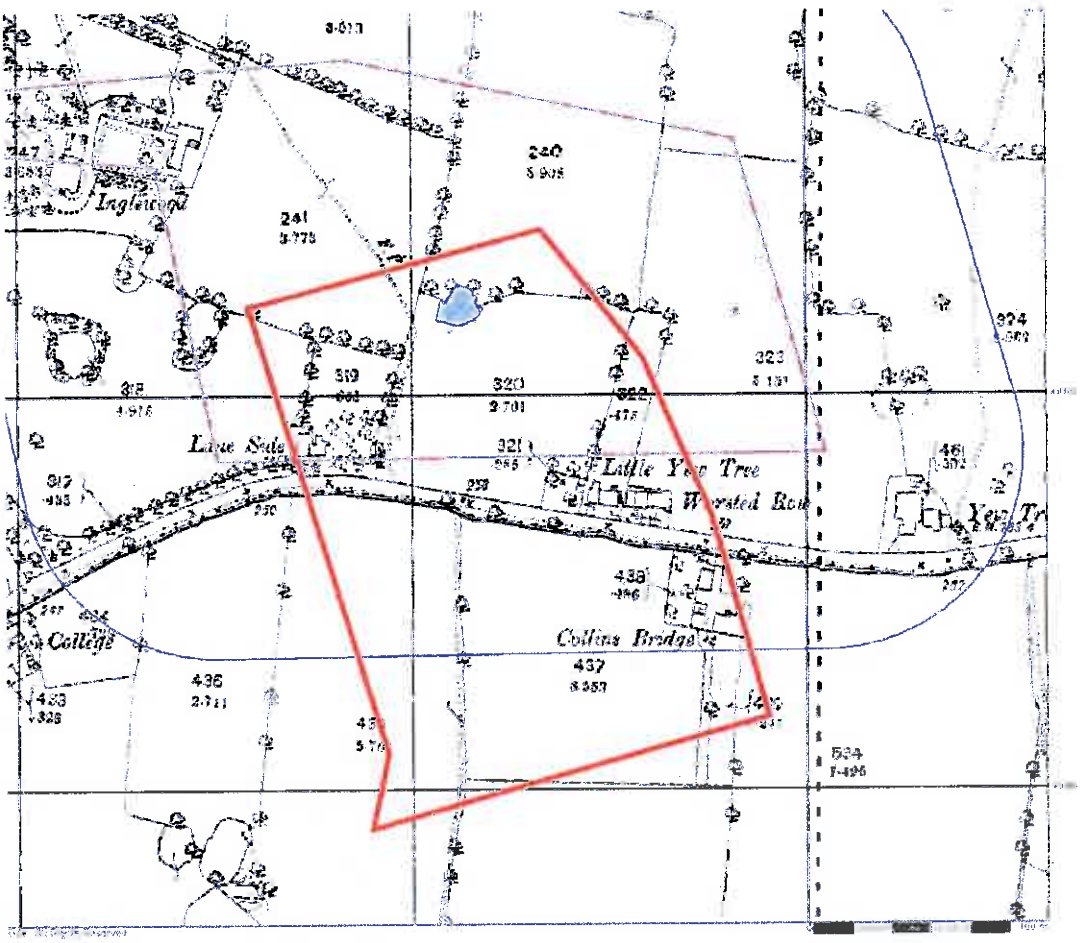
The Logistics Facility to be constructed on the Samlesbury Enterprise Zone, formerly part of the BAE Systems site at Samlesbury. The building is a single storey steel framed warehouse of approximately 130,000 sq.ft incorporating a small single storey internal office and a first floor mezzanine storage area. In addition to the main warehouse building there are associated roads, service areas, car parks and landscaped mounding.

The total Logistics development site area is approximately 4.56 hectares. The impermeable area associated with the first phase development is approximately 2.37 hectares.

Environment Agency Flood Mapping indicates that the site is located in Flood Zone 1 (low probability of flooding). Flood Zone 1 land has been assessed as having 0.1% (1 in 1000 year) chance of flooding from rivers or the sea in any given year.

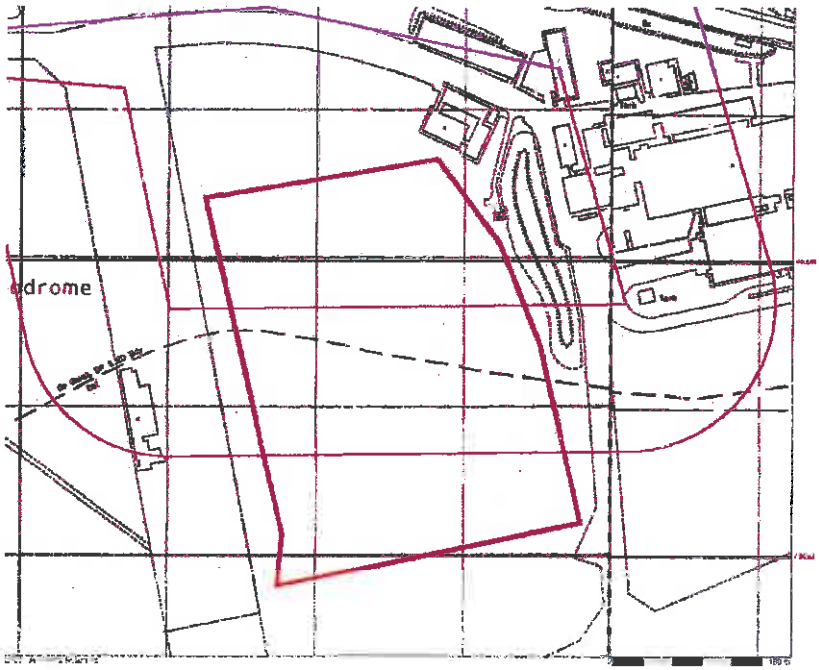
The Samlesbury site was formerly a World War 2 airfield which was subsequently developed for aircraft component manufacture and assembly.

Prior to construction of the airfield in the late 1930's the site was formerly undeveloped open farmland. An extract from historic mapping with the site outlined in red is shown below.



Site layout superimposed on OS Survey plan 1892

The site is currently largely open grass land with earth mounding along the southern and western boundaries. The existing former runways lie beyond the site boundary to the south and west.



Site layout superimposed on OS Survey plan 1992

The site area is served by a land drainage system dating back to construction of the wartime airfield.

Existing drainage superimposed on proposed site layout

A number of existing surface water drains cross the development site picking up run off from the runway and land drainage generally.

A pair of 150mm diameter surface water sewers cross the south west corner of the site. These sewers run across the BAE site and discharge to Huntley Brook to the west of the site. These sewers are to be diverted around the southern boundary of the development site connecting back to the existing on the western boundary.

A 450mm diameter sewer crosses the central area of the development site which then continues across the BAE site to discharge into Mellor Brook to the North West. This sewer is to be diverted around the northern boundary of the development site to connect back into the existing just beyond the western boundary.

A ground investigation comprising of 5Nr shell and auger boreholes and 8Nr trial pits was undertaken on site by Sub Surface North West in June 2015. The investigation confirmed that ground conditions on the site generally comprised 200-300mm of topsoil overlying natural clay strata extending to depths of at least 15 metres.

Soakaway tests were undertaken in the natural cohesive strata. Water was added to the pits from a bowser and water levels were subsequently monitored over a period of 330 to 375 minutes. The soil infiltration rate was unable to be determined in either test due to the relative impermeability of the test strata in both trial pits and the influx of perched groundwater. Copies of trial pit logs and soakaway test results are included in appendix B

The nature of the natural clay soils on the site is such that infiltration drainage systems are unlikely to be effective or practical.

It is therefore proposed that surface water drainage from the site should discharge to the existing surface water network with flows limited to the equivalent green field run off.

QBAR has been calculated using the IH124 method based on a site area of 50 hectares giving an equivalent run off of 6.6 litres/second/hectare. Preliminary design of the surface water drainage systems has been based on a permissible discharge of 5.5 litres/second/hectare. A copy of the calculation for QBAR is included in Appendix A.

The site areas are summarised as follows:

Location	Area		Permissable discharge
Main building roof	1.16		
Service Yard	0.50		
Fire access road	0.16		
Roads	0.15		
Car Parks	0.40		
Total Phase 1 area	**2.37**	**Hectares**	**13.04 l/s**

The total impremable site area equates to 2.37 hectares giving a maximum permitted discharge to the existing surface water sewers of 13.04 l/s

The design should where possible adopt the principles of SUDS as set out in CIRIA Best Practice Manual C523 and Design Manual C522, and as summarised in PPS25.

Run off from external paved areas, car parks and service yard slabs initially discharge to a series of dry swale features, with a total length of approximately 200 metres, to provide a SUDS element to the scheme. The dry swales will provide a degree of retention in the system but it is not anticipated that there will be any significant infiltration. Further storage, in the form of below ground cellular tanks will be incorporated in design of the surface water drainage system and flows attenuated by use of a hydobrake in the final manhole.

All discharge from car park areas should be passed through a class 1 bypass interceptor prior to discharge to surface water sewers.

The surface water drainage system is split into two networks to cover the eastern and western halves of the site. The western network discharges to the diverted 450mm diameter sewer which ultimately discharges to Mellor Brook. The eastern network discharges to the diverted 150mm diameter sewer which ultimately discharges to Huntley Brook.

The following criteria should be adopted for design of the surface water drainage system.

- The drainage network is to be designed as a gravity system to accommodate run off from a 1 in 2 year storm event with no surcharge.
- The network is to be checked for a 1 in 30 year storm event with surcharge permitted but with no surface flooding
- The network is to be checked for a 1 in 100 year storm event with surface flooding permitted providing that there is no risk of flooding to buildings and there is no off site overland flow.
- An allowance to be made for a 30% increase in peak rainfall intensity to account for climate change.
- The discharge from the system will be limited to the peak rural run off rate of 5.5 l/sec/hectare.

Flow from the site will be restricted to 13.04 litres/second by use of a hydrobrake in the final manhole. The design of the surface water drainage system incorporates approximately 200 linear metres of dry swale and 1600-1800m3 of cellular storage located in the car park to the east of the building.

Copies of Micro Drainage simulation output is included in appendix C for reference

All car park drainage will pass through a Class 1 by pass separator prior to discharge to the site sewers.

The surface water drainage system and attenuation has been designed to accept run off from the first phase of the Logistics Facility development. It has been assumed that the Logistics Centre extension and additional car parking will be provided with its own attenuation in the form of below ground cellular storage located at the southern end of the site.

APPENDIX A

GREEN FIELD RUN OFF QBAR

TRP Consulting		Page 1
The Landmark 21 Back Turner Street Manchester		
Date 20/01/2015 08:14 File QBAR.SRCX	Designed by timr Checked by	
Micro Drainage	Source Control 2014.1	

IH 124 Mean Annual Flood

Input

Return Period (years) 2 SAAR (mm) 1000 Urban 0.000
Area (ha) 50.000 Soil 0.450 Region Number Region 10

Results	l/s
QBAR Rural	333.4
QBAR Urban	333.4
Q2 years	310.5
Q1 year	290.1
Q2 years	310.5
Q5 years	396.8
Q10 years	460.1
Q20 years	524.2
Q25 years	546.8
Q30 years	568.3
Q50 years	616.8
Q100 years	696.5
Q200 years	784.8
Q250 years	816.9
Q1000 years	1013.6

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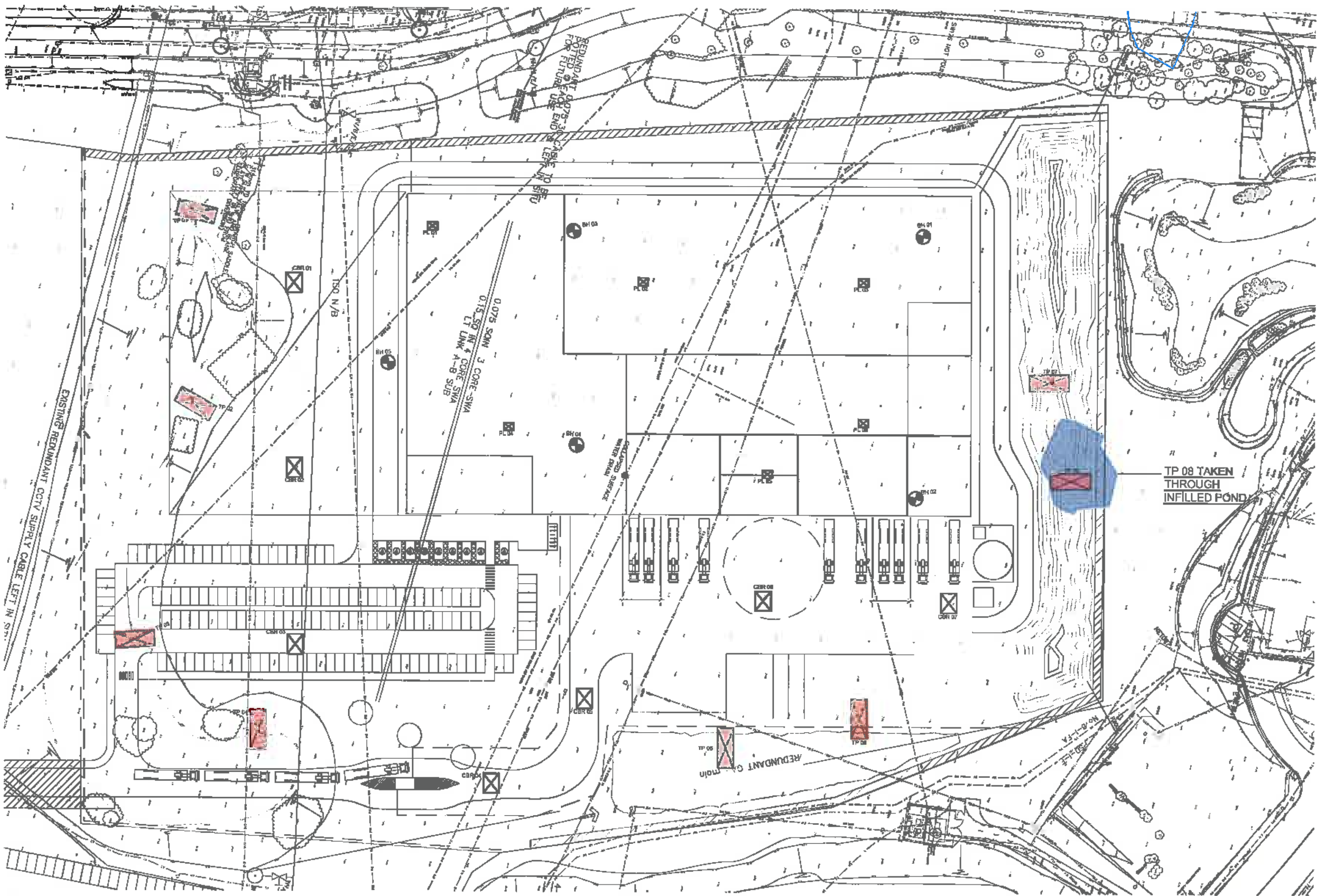
APPENDIX B

SOAK AWAY TEST RESULTS AND TRIAL HOLE LOGS



EXISTING SERVICE DIVERSION PLAN

SCALE 1:500

Notes

1. This Drawing is to be read in conjunction with all other TRP, Architects, Service Engineers and Subcontractor drawings.
2. Review all drawings and report any discrepancies to TRP Consulting prior to commencement.
3. Do not scale from this drawing. All dimensions and levels including any abutment to existing structures to be checked on site prior to commencement.
4. Work from figured dimensions only.
5. No deviation from details shown on this drawing is allowed without TRP Consulting's prior permission in writing.
6. All work is to be carried out in accordance with the relevant specifications issued by TRP Consulting, British Standard Codes of Practice, Statutory requirements and the Contract Documents.

Borehole S.O.P's		
BH-SOP	Position X	Position Y
BH 01	382778.856	431391.135
BH 02	382843.398	431408.934
BH 03	382801.129	431304.587
BH 04	382853.374	431319.894
BH 05	382848.034	431267.810

Trial Pit S.O.P's		
TP-SOP	Position X	Position Y
TP 01	382822.028	431219.139
TP 02	382890.212	431222.925
TP 03	382931.480	431223.769
TP 04	382946.280	431260.391
TP 05	382917.727	431378.801
TP 06	382901.569	431407.864
TP 07	382805.561	431431.976
TP 08	382828.608	431443.911

CBR S.O.P's		
CBR-SOP	Position X	Position Y
CBR 01	382832.674	431284.878
CBR 02	382876.154	431251.821
CBR 03	382921.884	431263.769
CBR 04	382912.438	431321.486
CBR 05	382915.237	431330.788
CBR 06	382879.186	431376.282
CBR 07	382857.005	431422.139

PLATE TEST S.O.P's		
PLATE-SOP	Position X	Position Y
PL 01	382809.497	431359.373
PL 02	382808.851	431325.951
PL 03	382794.035	431379.848
PL 04	382883.497	431301.871
PL 05	382847.890	431398.716
PL 06	382838.400	431358.096

REVISION STATUS

S = Information issued for feasibility, scheme or tender purposes only.

C = Information issued for Construction

Note = Only C Revision Drawings to be used for Construction.

Rev	Description	Date / By
S3	Historical Topo and TP 08 added	23.03.15 WC
S2	Topo updated	12.03.15 WC
S1	Issued for Information	04.03.15 WC

Project

BAE SYSTEMS PROJECT LASER

Client

BAE SYSTEMS

Drawing Title

PROPOSED BOREHOLE TRIAL PIT AND CBR TEST LOCATIONS

TRP Consulting
The Landmark
21 Back Turner Street
Manchester
M4 1FR

Tel 0161 839 9113
Fax 0161 839 9114
Email manchester@trpconsult.com

Drawn By	Date	Scale	Checked
WC.	MARCH 15	1:500	TR

Project No.	Drawing No.	Revision
6751	E501	S3

BOREHOLE DEPTHS

BH-01 - 15m
BH-02 - 10m
BH-03 - 10m
BH-04 - 10m
BH-05 - 10m

KEY

- TP — MACHINE DUG TRIAL PITS APPROXIMATELY 4m x 1m
- CBR — 1m x 1m SQUARE PIT APPROXIMATELY 0.6m DEEP
- PL — PLATE BEARING TEST 1m x 1m SQUARE PIT APPROXIMATELY 0.6m DEEP
- BH — SHELL AND AUGER BOREHOLE

A1

SUB SURFACE
SITE INVESTIGATION AND SPECIALIST GEOTECHNICAL CONSULTANTS
3 Peel Street, Preston, PR2 2DS. Tel. (01772) 561135 Fax (01772) 204907

Insitu Test Results

Site: LOGISTICS SITE, BAE SAMLESBURY, BALDERSTONE, LANCASHIRE

Client: AEW ARCHITECTS AND DESIGNERS LIMITED

Engineer: TRP CONSULTING

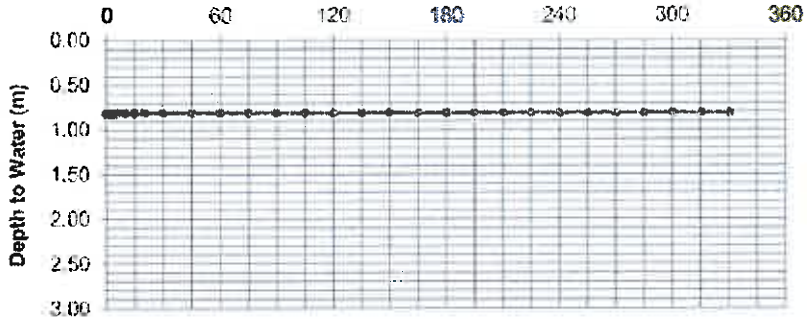
Job Number: 6019

Sheet: 1 / 1

Soakaway Test

Hole No: TP5

TEST NO: 1
DATE: 07/04/15



Length of pit:	L =	1.50	m
Width of pit:	W =	0.47	m
Depth of pit	D =	1.80	m
Base area of pit:	A =	0.71	m^2
100% effective depth	D100 =	0.83	m
75% effective depth	D75 =	1.07	m
50% effective depth	D50 =	1.32	m
25% effective depth	D25 =	1.56	m
time to D75	T75 =	–	sec
time to D25	T25 =	–	sec
time from D75 to D25 (T25 - T75)	t_{p75-25} =	–	sec
volume between D75 & D25 (A x (D25 - D75))	V_{p75-25} =	0.34	m^3
surface area to D50 inc. base ((2x(D-D50)x(W+L)) + A)	a_{p50} =	2.62	m^2

SOIL INFILTRATION RATE $f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$

f = N/A* m/sec

Time (min)	Depth (m)
0	0.83
0.5	0.83
1	0.83
2	0.83
3	0.83
4	0.83
5	0.83
7	0.82
10	0.82
15	0.82
20	0.82
30	0.82
45	0.82
60	0.82
75	0.82
90	0.82
105	0.82
120	0.82
135	0.82
150	0.82
165	0.82
180	0.82
195	0.82
210	0.82
225	0.82
240	0.82
255	0.82
270	0.82
285	0.82
300	0.82
315	0.82
330	0.82

Test Strata:
(see Trial Pit)

Remarks: *Unable to determine soil infiltration rate due to relative impermeability of tests strata.

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Insitu Test Results

Site: LOGISTICS SITE, BAE SAMLESBURY, BALDERSTONE, LANCASHIRE

Client: AEW ARCHITECTS AND DESIGNERS LIMITED

Engineer: TRP CONSULTING

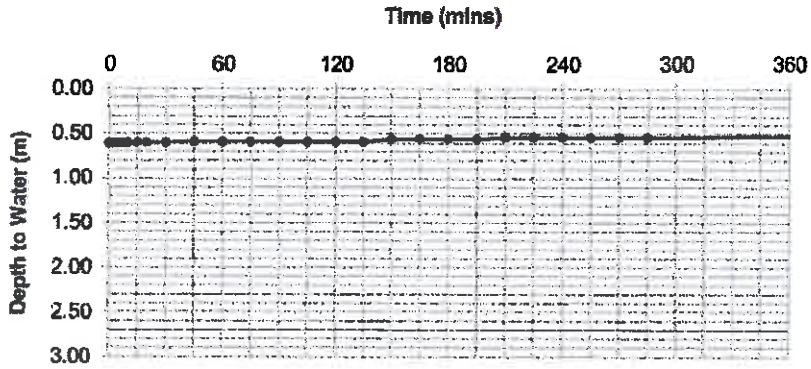
Job Number: 6019

Sheet: 1 / 1

Soakaway Test

Hole No: TP7

TEST NO: 1
DATE: 07/04/15



Length of pit:	L =	1.20	m
Width of pit:	W =	0.47	m
Depth of pit	D =	1.80	m
Base area of pit:	A =	0.56	m^2
100% effective depth	D100 =	0.61	m
75% effective depth	D75 =	0.91	m
50% effective depth	D50 =	1.21	m
25% effective depth	D25 =	1.50	m
time to D75	T75 =	_	sec
time to D25	T25 =	_	sec
time from D75 to D25 (T25 - T75)	t_{p75-25} =	_	sec
volume between D75 & D25 (A x (D25 - D75))	V_{p75-25} =	0.34	m^3
surface area to D50 inc. base ((2x(D-D50)x(W+L)) + A)	a_{p50} =	2.55	m^2

SOIL INFILTRATION RATE $f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$

f = N/A* m/sec

Time (min)	Depth (m)
0	0.61
0.5	0.61
1	0.61
2	0.61
3	0.61
4	0.61
5	0.61
7	0.61
10	0.60
15	0.60
20	0.60
30	0.60
45	0.59
60	0.59
75	0.59
90	0.59
105	0.59
120	0.59
135	0.59
150	0.56
165	0.56
180	0.56
195	0.56
210	0.54
225	0.54
240	0.54
255	0.54
270	0.54
285	0.54
375	0.52

Test Strata:
(see Trial Pit)

Remarks: *Unable to determine soil infiltration rate due to influx of groundwater

SUB SURFACE

SITE INVESTIGATION, GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

3 Peel Street, Preston, PR2 2QS. Tel. (01772) 561135 Fax (01772) 204907

		Site: LOGISTICS SITE, BAE SAMLESBURY LANCASHIRE		Trial Pit Number: TP4
Excavation Method: MECHANICAL EXCAVATOR	Dimensions: 0.70m x 3.40m	Ground Level (mOD)	Client: AEW ARCHITECTS & DESIGNERS LTD	Job Number: 6019
	Location: AS PLAN	Dates: 09/04/2015	Engineer: TRP CONSULTING LTD	Sheet: 2/2

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
4.20-4.40	A				4.20	MADE GROUND: dark grey and dark grey brown slightly sandy very gravelly clay with medium cobble content of sandstone, slate and stone and with occasional rootlets. Gravel sized fragments are fine to coarse stone, sandstone, slate, glass, ceramics and brick.		
4.20-4.40	B				(0.30)			
4.20-4.40	D				4.50			
4.20-4.40	V		09/04/2015:			Complete at 4.50m		

Plan

Remarks

Scale (approx)	Logged By	Figure No.
1:25	ALM/SJ	6019.TP4

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3 Peel Street, Preston, PR2 2QS. Tel. (01772) 561135 Fax (01772) 204907

Site	Trial Pit Number
LOGISTICS SITE, BAE SAMLESBURY, LANCASHIRE	TP5

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
MECHANICAL EXCAVATOR	0.47m x 1.50m		AEW ARCHITECTS & DESIGNERS LTD	6019
	Location	**Dates**	**Engineer**	**Sheet**
	AS PLAN	07/04/2015	TRP CONSULTING LTD	1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.10-0.30	A				(0.40)	MADE GROUND: long grasses over dark grey and dark brown and brown mottled slightly sandy slightly gravelly clay (topsoil) with many roots and rootlets. Gravel sized fragments are fine to coarse stone and occasional brick.		
0.10-0.30	B							
0.10-0.30	D							
0.10-0.30	V							
0.40-0.60	B				0.40			
0.60-0.80	B		HV@0.60m, c=97kPa		(0.50)	Stiff high strength brown, orange brown, light grey, red brown, greenish brown and yellow brown mottled sandy gravelly CLAY with low cobble content of quartz and with some rootlets and lenses of silty fine to medium sand. Gravel is subangular fine to coarse quartz, sandstone and siltstone.		
0.90	D		HV@0.90m, c=102kPa		0.90			
			HV@1.20m, c=100kPa			Stiff high strength brown and light grey mottled slightly sandy slightly gravelly CLAY with some root remains and lenses of fine to coarse sand and fine gravel. Gravel is subangular to rounded fine to coarse quartz, sandstone and siltstone.		
			HV@1.50m, c=130+kPa		(0.90)			
						.... below 1.60m : with some plant remains		
1.80	D		07/04/2015:DRY		1.80	Complete at 1.80m		

Plan

Remarks

Pit sides remained stable and vertical.
No groundwater encountered.
A = Amber glass jar sample
V = Vial sample
HV = Hand Shear Vane test
On completion a soakaway test was carried out before being backfilled with arisings.

Scale (approx)	Logged By	Figure No.
1:25	ALM/SJ	6019.TP5

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Site LOGISTICS SITE, BAE SAMLESBURY, LANCASHIRE				**Trial Pit Number** TP6
Excavation Method MECHANICAL EXCAVATOR	**Dimensions** 0.70m x 2.00m	**Ground Level (mOD)**	**Client** AEW ARCHITECTS & DESIGNERS LTD	**Job Number** 6013
	Location AS PLAN	**Dates** 09/04/2015	**Engineer** TRP CONSULTING LTD	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.10-0.30 0.10-0.30 0.10-0.30 0.10-0.30	A B D V				(0.30)	MADE GROUND: dark brown slightly sandy slightly gravelly clay (topsoil) with some roots and rootlets and low cobble content of brick. Gravel sized fragments are fine to coarse stone and occasional brick.		
					0.30			
					(0.39)	MADE GROUND: dark brown slightly sandy gravelly clay (subsoil) with some rootlets. Gravel sized fragments are fine to coarse stone.		
					0.69			
0.70-0.90	B		HV@0.70m, c=68kPa		(0.40)	Firm, high strength brown, orange brown, grey and grey brown mottled slightly sandy gravelly CLAY with occasional lenses of silty fine sand and with some rootlets. Gravel is subangular to rounded fine to coarse quartz, sandstone and siltstone.		
					1.09			
1.20	D		HV@1.20m, c=122kPa			Stiff high strength brown and grey mottled slightly sandy gravelly CLAY with some rootlets. Gravel is subangular to rounded fine to coarse quartz, sandstone, mudstone and siltstone.		
			HV@1.60m, c=130+kPa					
					(1.50)			
						... below 1.80m: low cobble content of quartz slightly fissured and with occasional peat/plant remains and occasional lenses of greenish fine to coarse sand		
2.00	D		HV@2.00m, c=130+kPa					
					2.59			
2.50	D		HV@2.50m, c=130+kPa 09/04/2015:DRY			Complete at 2.59m		

Plan

Remarks

Pit sides remained stable and vertical.
No groundwater encountered
A = Amber glass jar sample
V = Vial sample
HV = Hand Shear Vane test
On completion backfilled with arisings

Scale (approx)	Logged By	Figure No.
1:25	ALM/SJ	6013.TP6

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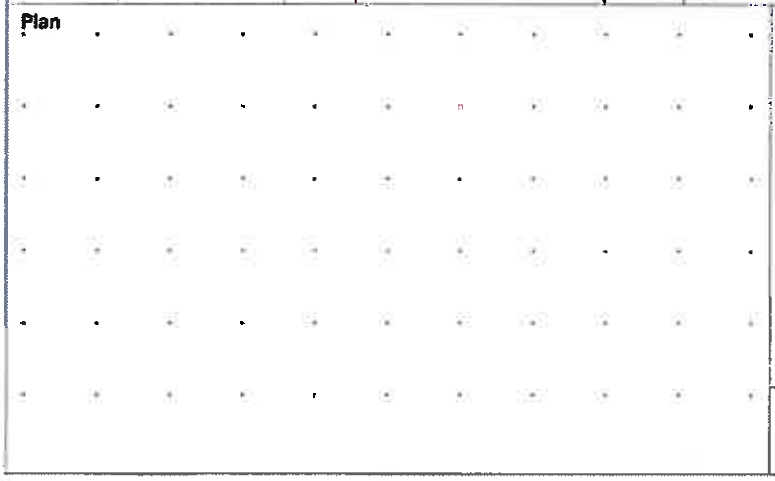
Site	Trial Pit Number
LOGISTICS SITE, BAE SAMLESBURY, LANCASHIRE	TP7

Excavation Method	Dimensions	Ground Level (mOD)	Client	Job Number
MECHANICAL EXCAVATOR	0.47m x 1.20m		AEW ARCHITECTS & DESIGNERS LTD	6019
	Location	**Dates**	**Engineer**	**Sheet**
	AS PLAN	07/04/2015	TRP CONSULTING LTD	1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.05-0.15	A				(0.15)	MADE GROUND: grass over dark grey brown slightly sandy slightly gravelly clay (topsoil) with many rootlets. Gravel sized fragments are fine to coarse stone and occasional brick.		
0.05-0.15	D				0.15			
0.05-0.15	V							
0.30-0.50	A				(0.55)	MADE GROUND: dark grey, dark grey brown and brown slightly sandy slightly gravelly clay with some plant and root remains and some rootlets. Gravel sized fragments are fine to coarse stone and occasional brick.		
0.30-0.50	D							
0.50-0.50	V				0.70			
			HV@0.70m: c=93kPa			Stiff high strength brown, light brown, light grey and greenish brown slightly sandy slightly gravelly CLAY with occasional rootlets and lenses of silty fine to medium sand. Gravel is subangular to subrounded fine to coarse quartz, sandstone and siltstone.		
0.80	D				(0.40)			
					1.10			
1.20	D		HV@1.20m: c=91kPa			Stiff high strength brown and grey mottled slightly sandy slightly gravelly CLAY with occasional rootlets, plant and root remains. Gravel is subangular to rounded fine to coarse quartz.		
					(0.70)			
			HV@1.60m: c=125kPa					
1.80	D		07/04/2015:DRY		1.80	Complete at 1.80m		

Plan



Remarks

Pit sides remained stable and vertical.
Slight seepage at base.
A = Amber glass jar sample
V = Vial sample
HV = Hand Shear Vane test
On completion a soakaway test was carried out bedore being backfilled with arisings.

Scale (approx)	Logged By	Figure No.
1:25	ALM/SJ	6019.TP7

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APPENDIX C

MICRO DRAINAGE SIMULATION OUTPUT

APPENDIX C1

MICRO DRAINAGE SIMULATION OUTPUT – Western site network

The Landmark
21 Back Turner Street
Manchester

Date 23/06/2015 09:28 | Designed by timr
File 6751 Logistics drainage | Checked by
Micro Drainage | Network 2014.1

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for West Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	Add Flow / Climate Change (%)	30
M5-60 (mm)	18.900	Minimum Backdrop Height (m)	0.200
Ratio R	0.300	Maximum Backdrop Height (m)	1.500
Maximum Rainfall (mm/hr)	75	Min Design Depth for Optimisation (m)	0.900
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)	250
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits

Network Design Table for West 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
SW1.000	8.120	0.057	142.5	0.164	5.00	0.0	0.600	o	300	
SW1.001	37.488	0.193	194.2	0.000	0.00	0.0	0.600	o	300	
SW2.000	6.072	0.175	34.7	0.268	5.00	0.0	0.600	o	225	
SW1.002	41.120	0.164	250.0	0.000	0.00	0.0	0.600	o	375	
SW3.000	6.173	0.339	18.2	0.154	5.00	0.0	0.600	o	150	
SW1.003	48.703	0.262	186.0	0.000	0.00	0.0	0.600	o	450	
SW4.000	42.110	0.175	241.2	0.264	5.00	0.0	0.600	o	300	
SW4.001	106.697	0.427	250.0	0.161	0.00	0.0	0.600	o	375	

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)
SW1.000	75.00	5.10	76.225	0.164	0.0	0.0	10.0	1.32	93.0	43.2
SW1.001	75.00	5.66	76.168	0.164	0.0	0.0	10.0	1.12	79.5	43.2
SW2.000	75.00	5.05	76.225	0.268	0.0	0.0	16.3	2.23	88.6	70.8
SW1.002	75.00	6.26	75.900	0.432	0.0	0.0	26.3	1.14	126.1	114.1
SW3.000	75.00	5.04	76.300	0.154	0.0	0.0	9.4	2.37	41.9	40.6
SW1.003	75.00	6.80	75.661	0.586	0.0	0.0	35.7	1.49	236.6	154.6
SW4.000	75.00	5.70	76.150	0.264	0.0	0.0	16.1	1.01	71.2	69.8
SW4.001	75.00	7.25	75.900	0.425	0.0	0.0	25.9	1.14	126.1	112.2

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Network Design Table for West 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
SW1.004	6.263	0.025	250.0	0.000	0.00	0.0	0.600	o	525	
SW1.005	47.982	0.192	250.0	0.000	0.00	0.0	0.600	o	525	
SW1.006	3.080	0.012	250.0	0.000	0.00	0.0	0.600	o	525	

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)
SW1.004	75.00	7.33	75.324	1.011	0.0	0.0	61.6	1.41	305.7	266.9
SW1.005	75.00	7.89	75.299	1.011	0.0	0.0	61.6	1.41	305.7	266.9
SW1.006	75.00	5.04	75.107	0.000	5.6	0.0	1.3	1.41	305.7	5.6

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Manhole Schedules for West Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
SW1	77.350	1.125	Open Manhole	1200	SW1.000	76.225	300				
SW2	77.300	1.132	Open Manhole	1200	SW1.001	76.168	300	SW1.000	76.168	300	
SW3	77.350	1.125	Open Manhole	1200	SW2.000	76.225	225				
SW4	77.175	1.275	Open Manhole	1350	SW1.002	75.900	375	SW1.001	75.975	300	
								SW2.000	76.050	225	
SW5	77.350	1.050	Open Manhole	1200	SW3.000	76.300	150				
SW6	77.175	1.514	Open Manhole	1350	SW1.003	75.661	450	SW1.002	75.736	375	
								SW3.000	75.961	150	
SW7	77.350	1.200	Open Manhole	1200	SW4.000	76.150	300				
SW8	77.350	1.450	Open Manhole	1350	SW4.001	75.900	375	SW4.000	75.975	300	
SW9	77.350	2.026	Open Manhole	1500	SW1.004	75.324	525	SW1.003	75.399	450	
								SW4.001	75.474	375	
SW10	77.000	1.701	Open Manhole	1500	SW1.005	75.299	525	SW1.004	75.299	525	
SW11	77.000	1.893	Open Manhole	1500	SW1.006	75.107	525	SW1.005	75.107	525	
SW	76.000	0.906	Open Manhole	0		OUTFALL		SW1.006	75.094	525	

Free Flowing Outfall Details for West Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
SW1.006	SW	76.000	75.094	73.000	0	0

Simulation Criteria for West Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.900	Storm Duration (mins)	30
Ratio R	0.300		

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Online Controls for West Storm

Hydro-Brake Optimum® Manhole: SW11, DS/PN: SW1.006, Volume (m³): 13.4

Unit Reference	MD-SHE-0104-5600-1500-5600
Design Head (m)	1.500
Design Flow (l/s)	5.6
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	104
Invert Level (m)	75.107
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	5.6	Kick-Flo®	0.921	4.4
Flush-Flo™	0.452	5.6	Mean Flow over Head Range	-	4.9

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.5	0.800	5.1	2.000	6.4	4.000	8.8	7.000	11.5
0.200	5.0	1.000	4.6	2.200	6.7	4.500	9.3	7.500	11.9
0.300	5.4	1.200	5.0	2.400	6.9	5.000	9.8	8.000	12.3
0.400	5.5	1.400	5.4	2.600	7.2	5.500	10.3	8.500	12.6
0.500	5.5	1.600	5.7	3.000	7.7	6.000	10.7	9.000	13.0
0.600	5.5	1.800	6.1	3.500	8.3	6.500	11.1	9.500	13.3

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Storage Structures for West Storm

Cellular Storage Manhole: SW10, DS/PN: SW1.005

Invert Level (m) 75.299 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	685.0	0.0	3.600	0.0	0.0	7.200	0.0	0.0
0.400	685.0	0.0	4.000	0.0	0.0	7.600	0.0	0.0
0.800	685.0	0.0	4.400	0.0	0.0	8.000	0.0	0.0
1.200	0.0	0.0	4.800	0.0	0.0	8.400	0.0	0.0
1.600	0.0	0.0	5.200	0.0	0.0	8.800	0.0	0.0
2.000	0.0	0.0	5.600	0.0	0.0	9.200	0.0	0.0
2.400	0.0	0.0	6.000	0.0	0.0	9.600	0.0	0.0
2.800	0.0	0.0	6.400	0.0	0.0	10.000	0.0	0.0
3.200	0.0	0.0	6.800	0.0	0.0			

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Summary of Critical Results by Maximum Level (Rank 1) for West Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
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 Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm)	18.900
Region	England and Wales	Ratio R	0.300
Cv (Summer)	0.750		
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	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 (%)	30, 30, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
SW1.000	960 Winter	100	+30%	30/15 Winter				
SW1.001	960 Winter	100	+30%	30/15 Winter				
SW2.000	15 Winter	100	+30%	30/15 Summer				
SW1.002	960 Winter	100	+30%	30/15 Summer				
SW3.000	15 Winter	100	+30%	30/15 Summer				
SW1.003	960 Winter	100	+30%	30/15 Summer				
SW4.000	15 Winter	100	+30%	30/15 Summer				
SW4.001	960 Winter	100	+30%	30/15 Summer				
SW1.004	960 Winter	100	+30%	30/15 Summer				
SW1.005	960 Winter	100	+30%	30/120 Winter				
SW1.006	960 Winter	100	+30%	30/30 Winter				

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
SW1.000	SW1	76.960	0.435	0.000	0.11	0.0	6.8	SURCHARGED
SW1.001	SW2	76.959	0.491	0.000	0.09	0.0	6.8	SURCHARGED
SW2.000	SW3	77.254	0.804	0.000	1.89	0.0	111.2	FLOOD RISK
SW1.002	SW4	76.958	0.683	0.000	0.16	0.0	17.9	FLOOD RISK
SW3.000	SW5	77.310	0.860	0.000	1.76	0.0	61.7	FLOOD RISK
SW1.003	SW6	76.956	0.845	0.000	0.11	0.0	24.3	FLOOD RISK
SW4.000	SW7	77.298	0.848	0.000	1.63	0.0	108.3	FLOOD RISK
SW4.001	SW8	76.957	0.681	0.000	0.15	0.0	17.6	SURCHARGED
SW1.004	SW9	76.954	1.105	0.000	0.24	0.0	41.9	SURCHARGED
SW1.005	SW10	76.953	1.129	0.000	0.06	0.0	15.1	FLOOD RISK

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Summary of Critical Results by Maximum Level (Rank 1) for West Storm

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
SW1.006	SW11	76.951	1.319	0.000	0.04	0.0	6.0	FLOOD RISK

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APPENDIX C1

MICRO DRAINAGE SIMULATION OUTPUT – Eastern site network

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for East storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	Add Flow / Climate Change (%)	0
M5-60 (mm)	18.900	Minimum Backdrop Height (m)	0.200
Ratio R	0.300	Maximum Backdrop Height (m)	1.500
Maximum Rainfall (mm/hr)	75	Min Design Depth for Optimisation (m)	0.900
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)	250
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits

Network Design Table for East 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
SE1.000	24.118	0.783	30.8	0.023	5.00	0.0	0.600	o	150	
SE2.000	16.615	0.284	58.5	0.022	5.00	0.0	0.600	o	150	
SE1.001	96.998	0.667	145.4	0.092	0.00	0.0	0.600	o	225	
SE1.002	7.776	0.200	38.9	0.014	0.00	0.0	0.600	o	225	
SE3.000	53.647	0.616	87.1	0.036	5.00	0.0	0.600	o	150	
SE3.001	46.150	0.193	239.1	0.538	0.00	0.0	0.600	o	450	
SE4.000	4.297	0.061	70.4	0.000	5.00	0.0	0.600	o	150	
SE3.002	7.881	0.026	308.0	0.000	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)
SE1.000	75.00	5.22	78.100	0.023	0.0	0.0	0.0	1.82	32.2	4.7
SE2.000	75.00	5.21	77.700	0.022	0.0	0.0	0.0	1.32	23.3	4.5
SE1.001	75.00	6.71	77.242	0.138	0.0	0.0	0.0	1.08	43.0	27.9
SE1.002	75.00	6.78	76.575	0.152	0.0	0.0	0.0	2.10	83.7	30.9
SE3.000	75.00	5.83	76.450	0.036	0.0	0.0	0.0	1.08	19.0	7.2
SE3.001	75.00	6.42	75.534	0.573	0.0	0.0	0.0	1.31	208.4	116.5
SE4.000	75.00	5.06	76.500	0.000	0.0	0.0	0.0	1.20	21.2	0.0
SE3.002	75.00	6.53	75.341	0.573	0.0	0.0	0.0	1.15	183.4	116.5

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Network Design Table for East 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
SE1.003	14.288	0.051	278.7	0.000	0.00	0.0	0.600	o	450	
SE5.000	26.223	0.264	99.2	0.051	5.00	0.0	0.600	o	150	
SE1.004	23.253	0.054	429.9	0.000	0.00	0.0	0.600	o	525	
SE1.005	4.033	0.104	38.7	0.000	0.00	0.0	0.600	o	525	
SE6.000	5.600	0.133	42.1	0.000	5.00	0.0	0.600	o	150	
SE6.001	15.782	0.209	75.5	0.036	0.00	0.0	0.600	o	150	
SE7.000	5.600	0.272	20.6	0.047	5.00	0.0	0.600	o	150	
SE6.002	5.365	0.104	51.7	0.000	0.00	0.0	0.600	o	150	
SE8.000	5.600	0.123	45.5	0.066	5.00	0.0	0.600	o	150	
SE8.001	22.983	0.228	100.8	0.000	0.00	0.0	0.600	o	225	
SE9.000	10.905	0.122	89.4	0.170	5.00	0.0	0.600	o	300	
SE8.002	8.281	0.035	236.6	0.036	0.00	0.0	0.600	o	375	
SE6.003	13.277	0.053	250.0	0.000	0.00	0.0	0.600	o	375	

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)
SE1.003	75.00	6.97	75.316	0.725	0.0	0.0	0.0	1.21	192.9	147.3
SE5.000	75.00	5.43	76.250	0.051	0.0	0.0	0.0	1.01	17.8	10.4
SE1.004	75.00	7.33	75.190	0.777	0.0	0.0	0.0	1.07	232.5	157.7
SE1.005	75.00	7.35	75.135	0.777	0.0	0.0	0.0	3.61	780.7	157.7
SE6.000	75.00	5.06	76.270	0.000	0.0	0.0	0.0	1.56	27.5	0.0
SE6.001	75.00	5.29	76.137	0.036	0.0	0.0	0.0	1.16	20.5	7.3
SE7.000	75.00	5.04	76.250	0.047	0.0	0.0	0.0	2.23	39.4	9.5
SE6.002	75.00	5.35	75.928	0.083	0.0	0.0	0.0	1.40	24.8	16.8
SE8.000	75.00	5.06	76.210	0.066	0.0	0.0	0.0	1.50	26.4	13.4
SE8.001	75.00	5.36	76.012	0.066	0.0	0.0	0.0	1.30	51.8	13.4
SE9.000	75.00	5.11	76.397	0.170	0.0	0.0	0.0	1.66	117.6	34.4
SE8.002	75.00	5.47	75.634	0.272	0.0	0.0	0.0	1.17	129.6	55.2
SE6.003	75.00	5.67	75.599	0.354	0.0	0.0	0.0	1.14	126.1	72.0

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Network Design Table for East 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
SE10.000	16.998	0.171	99.3	0.040	5.00	0.0	0.600	o	150	
SE6.004	23.406	0.095	245.2	0.040	0.00	0.0	0.600	o	375	
SE6.005	2.791	0.026	106.6	0.000	0.00	0.0	0.600	o	375	
SE11.000	7.342	1.594	4.6	0.091	5.00	0.0	0.600	o	150	
SE1.006	1.516	0.006	252.7	0.000	0.00	0.0	0.600	o	150	

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)
SE10.000	75.00	5.28	76.450	0.040	0.0	0.0	0.0	1.01	17.9	8.2
SE6.004	75.00	6.01	75.546	0.435	0.0	0.0	0.0	1.15	127.3	88.3
SE6.005	75.00	6.03	75.450	0.435	0.0	0.0	0.0	1.75	193.8	88.3
SE11.000	75.00	5.03	76.675	0.091	0.0	0.0	0.0	4.73	83.6	18.6
SE1.006	75.00	5.04	75.031	0.000	7.1	0.0	0.0	0.63	11.1	7.1

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Manhole Schedules for East storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
SE1	79.200	1.100	Open Manhole	1200	SE1.000	78.100	150				
SE2	78.700	1.000	Open Manhole	1200	SE2.000	77.700	150				
SE3	78.500	1.258	Open Manhole	1200	SE1.001	77.242	225	SE1.000	77.317	150	
								SE2.000	77.416	150	99
SE4	77.700	1.125	Open Manhole	1200	SE1.002	76.575	225	SE1.001	76.575	225	
SE5	77.500	1.050	Open Manhole	1200	SE3.000	76.450	150				
SE6	77.500	1.966	Open Manhole	1350	SE3.001	75.534	450	SE3.000	75.834	150	
SE7	77.520	1.020	Open Manhole	1200	SE4.000	76.500	150				
SE8	77.400	2.059	Open Manhole	1350	SE3.002	75.341	450	SE3.001	75.341	450	
								SE4.000	76.439	150	798
SE9	77.600	2.284	Open Manhole	1350	SE1.003	75.316	450	SE1.002	76.375	225	834
								SE3.002	75.316	450	
SE10	77.300	1.050	Open Manhole	1200	SE5.000	76.250	150				
SE11	77.700	2.510	Open Manhole	1500	SE1.004	75.190	525	SE1.003	75.265	450	
								SE5.000	75.986	150	421
SE12	78.000	2.865	Open Manhole	1500	SE1.005	75.135	525	SE1.004	75.135	525	
SE13	77.270	1.000	Open Manhole	1200	SE6.000	76.270	150				
SE14	77.137	1.000	Open Manhole	1200	SE6.001	76.137	150	SE6.000	76.137	150	
SE15	77.250	1.000	Open Manhole	1200	SE7.000	76.250	150				
SE16	77.137	1.209	Open Manhole	1200	SE6.002	75.928	150	SE6.001	75.928	150	
								SE7.000	75.978	150	50
SE17	77.260	1.050	Open Manhole	1200	SE8.000	76.210	150				
SE18	77.137	1.125	Open Manhole	1200	SE8.001	76.012	225	SE8.000	76.087	150	
SE19	77.450	1.053	Open Manhole	1200	SE9.000	76.397	300				
SE20	77.137	1.503	Open Manhole	1350	SE8.002	75.634	375	SE8.001	75.784	225	
								SE9.000	76.275	300	566
SE21	77.137	1.538	Open Manhole	1350	SE6.003	75.599	375	SE6.002	75.824	150	
								SE8.002	75.599	375	
SE22	77.500	1.050	Open Manhole	1200	SE10.000	76.450	150				
SE23	77.500	1.954	Open Manhole	1350	SE6.004	75.546	375	SE6.003	75.546	375	
								SE10.000	76.279	150	508
SE24	78.000	2.550	Open Manhole	1350	SE6.005	75.450	375	SE6.004	75.450	375	
SE25	77.800	1.125	Open Manhole	1200	SE11.000	76.675	150				
SE26	77.800	2.769	Open Manhole	1500	SE1.006	75.031	150	SE1.005	75.031	525	
								SE6.005	75.424	375	618
								SE11.000	75.081	150	50
SE	77.810	2.785	Open Manhole	0		OUTFALL		SE1.006	75.025	150	

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PIPELINE SCHEDULES for East storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
SE1.000	c	150	SE1	79.200	78.100	0.950	Open Manhole	1200
SE2.000	c	150	SE2	78.700	77.700	0.850	Open Manhole	1200
SE1.001	o	225	SE3	78.500	77.242	1.033	Open Manhole	1200
SE1.002	c	225	SE4	77.700	76.575	0.900	Open Manhole	1200
SE3.000	c	150	SE5	77.500	76.450	0.900	Open Manhole	1200
SE3.001	o	450	SE6	77.500	75.534	1.516	Open Manhole	1350
SE4.000	o	150	SE7	77.520	76.500	0.870	Open Manhole	1200
SE3.002	c	450	SE8	77.400	75.341	1.609	Open Manhole	1350
SE1.003	o	450	SE9	77.600	75.316	1.834	Open Manhole	1350
SE5.000	c	150	SE10	77.300	76.250	0.900	Open Manhole	1200
SE1.004	o	525	SE11	77.700	75.190	1.985	Open Manhole	1500
SE1.005	o	525	SE12	78.000	75.135	2.340	Open Manhole	1500
SE6.000	o	150	SE13	77.270	76.270	0.850	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
SE1.000	24.118	30.8	SE3	78.500	77.317	1.033	Open Manhole	1200
SE2.000	16.615	58.5	SE3	78.500	77.416	0.934	Open Manhole	1200
SE1.001	96.998	145.4	SE4	77.700	76.575	0.900	Open Manhole	1200
SE1.002	7.776	38.9	SE9	77.600	76.375	1.000	Open Manhole	1350
SE3.000	53.647	87.1	SE6	77.500	75.834	1.516	Open Manhole	1350
SE3.001	46.150	239.1	SE8	77.400	75.341	1.609	Open Manhole	1350
SE4.000	4.297	70.4	SE8	77.400	76.439	0.811	Open Manhole	1350
SE3.002	7.881	308.0	SE9	77.600	75.316	1.834	Open Manhole	1350
SE1.003	14.288	278.7	SE11	77.700	75.265	1.985	Open Manhole	1500
SE5.000	26.223	99.2	SE11	77.700	75.986	1.564	Open Manhole	1500
SE1.004	23.253	429.9	SE12	78.000	75.135	2.340	Open Manhole	1500
SE1.005	4.033	38.7	SE26	77.800	75.031	2.244	Open Manhole	1500
SE6.000	5.600	42.1	SE14	77.137	76.137	0.850	Open Manhole	1200

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PIPELINE SCHEDULES for East storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
SE6.001	o	150	SE14	77.137	76.137	0.850	Open Manhole	1200
SE7.000	o	150	SE15	77.250	76.250	0.850	Open Manhole	1200
SE6.002	o	150	SE16	77.137	75.928	1.059	Open Manhole	1200
SE8.000	o	150	SE17	77.260	76.210	0.900	Open Manhole	1200
SE8.001	o	225	SE18	77.137	76.012	0.900	Open Manhole	1200
SE9.000	o	300	SE19	77.450	76.397	0.753	Open Manhole	1200
SE8.002	o	375	SE20	77.137	75.634	1.128	Open Manhole	1350
SE6.003	o	375	SE21	77.137	75.599	1.163	Open Manhole	1350
SE10.000	o	150	SE22	77.500	76.450	0.900	Open Manhole	1200
SE6.004	o	375	SE23	77.500	75.546	1.579	Open Manhole	1350
SE6.005	o	375	SE24	78.000	75.450	2.175	Open Manhole	1350
SE11.000	o	150	SE25	77.800	76.675	0.975	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
SE6.001	15.782	75.5	SE16	77.137	75.928	1.059	Open Manhole	1200
SE7.000	5.600	20.6	SE16	77.137	75.978	1.009	Open Manhole	1200
SE6.002	5.365	51.7	SE21	77.137	75.824	1.163	Open Manhole	1350
SE8.000	5.600	45.5	SE18	77.137	76.087	0.900	Open Manhole	1200
SE8.001	22.983	100.8	SE20	77.137	75.784	1.128	Open Manhole	1350
SE9.000	10.905	89.4	SE20	77.137	76.275	0.562	Open Manhole	1350
SE8.002	8.281	236.6	SE21	77.137	75.599	1.163	Open Manhole	1350
SE6.003	13.277	250.0	SE23	77.500	75.546	1.579	Open Manhole	1350
SE10.000	16.998	99.3	SE23	77.500	76.279	1.071	Open Manhole	1350
SE6.004	23.406	245.2	SE24	78.000	75.450	2.175	Open Manhole	1350
SE6.005	2.791	106.6	SE26	77.800	75.424	2.001	Open Manhole	1500
SE11.000	7.342	4.6	SE26	77.800	75.081	2.569	Open Manhole	1500

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PIPELINE SCHEDULES for East storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
SE1.006	o	150	SE26	77.800	75.031	2.619	Open Manhole	1500

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
SE1.006	1.516	252.7	SE	77.810	75.025	2.635	Open Manhole	0

Free Flowing Outfall Details for East storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
SE1.006	SE	77.810	75.025	75.000	0	0

Simulation Criteria for East storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 7 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.900	Storm Duration (mins)	30
Ratio R	0.300		

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Online Controls for East storm

Hydro-Brake Optimum® Manhole: SE26, DS/PN: SE1.006, Volume (m³): 5.7

Unit Reference	MD-SHE-0118-7200-1500-7200
Design Head (m)	1.500
Design Flow (l/s)	7.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	118
Invert Level (m)	75.031
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	7.2	Kick-Flo®	0.926	5.7
Flush-Flo™	0.447	7.2	Mean Flow over Head Range	-	6.3

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.2	0.800	6.6	2.000	8.2	4.000	11.4	7.000	14.9
0.200	6.5	1.000	6.0	2.200	8.6	4.500	12.1	7.500	15.4
0.300	7.0	1.200	6.5	2.400	9.0	5.000	12.7	8.000	15.9
0.400	7.2	1.400	7.0	2.600	9.3	5.500	13.3	8.500	16.4
0.500	7.2	1.600	7.4	3.000	10.0	6.000	13.9	9.000	16.8
0.600	7.1	1.800	7.8	3.500	10.7	6.500	14.4	9.500	17.3

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Storage Structures for East storm

Dry Swale Manhole: SE6, DS/PN: SE3.001

Warning:- Volume should always be included unless the upstream pipe is being used for storage and/or as a carrier

Infiltration Coefficient Base (m/hr)	0.00000	Trench Length (m)	88.4
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	4.0
Safety Factor	2.0	Slope (1:X)	0.0
Porosity	0.90	Cap Volume Depth (m)	0.900
Invert Level (m)	75.534	Cap Infiltration Depth (m)	0.000
Trench Height (m)	0.600	Include Swale Volume	Yes
Trench Width (m)	1.0		

Cellular Storage Manhole: SE11, DS/PN: SE1.004

Invert Level (m)	75.190	Safety Factor	2.0
Infiltration Coefficient Base (m/hr)	0.00000	Porosity	0.95
Infiltration Coefficient Side (m/hr)	0.00000		

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	650.0	0.0	3.600	0.0	0.0	7.200	0.0	0.0
0.400	650.0	0.0	4.000	0.0	0.0	7.600	0.0	0.0
0.800	650.0	0.0	4.400	0.0	0.0	8.000	0.0	0.0
1.200	0.0	0.0	4.800	0.0	0.0	8.400	0.0	0.0
1.600	0.0	0.0	5.200	0.0	0.0	8.800	0.0	0.0
2.000	0.0	0.0	5.600	0.0	0.0	9.200	0.0	0.0
2.400	0.0	0.0	6.000	0.0	0.0	9.600	0.0	0.0
2.800	0.0	0.0	6.400	0.0	0.0	10.000	0.0	0.0
3.200	0.0	0.0	6.800	0.0	0.0			

Dry Swale Manhole: SE13, DS/PN: SE6.000

Warning:- Volume should always be included unless the upstream pipe is being used for storage and/or as a carrier

Infiltration Coefficient Base (m/hr)	0.00000	Trench Length (m)	10.6
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	4.0
Safety Factor	2.0	Slope (1:X)	0.0
Porosity	0.90	Cap Volume Depth (m)	0.850
Invert Level (m)	76.270	Cap Infiltration Depth (m)	0.000
Trench Height (m)	0.600	Include Swale Volume	Yes
Trench Width (m)	0.4		

Dry Swale Manhole: SE15, DS/PN: SE7.000

Warning:- Volume should always be included unless the upstream pipe is being used for storage and/or as a carrier

Infiltration Coefficient Base (m/hr)	0.00000	Porosity	0.90
Infiltration Coefficient Side (m/hr)	0.00000	Invert Level (m)	76.250
Safety Factor	2.0	Trench Height (m)	0.600

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Dry Swale Manhole: SE15, DS/PN: SE7.000

Trench Width (m)	0.4	Cap Volume Depth (m)	0.850
Trench Length (m)	24.4	Cap Infiltration Depth (m)	0.000
Side Slope (1:X)	4.0	Include Swale Volume	Yes
Slope (1:X)	0.0		

Dry Swale Manhole: SE19, DS/PN: SE9.000

Warning:- Volume should always be included unless the upstream pipe is being used for storage and/or as a carrier

Infiltration Coefficient Base (m/hr)	0.00000	Trench Length (m)	16.7
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	4.0
Safety Factor	2.0	Slope (1:X)	0.0
Porosity	0.90	Cap Volume Depth (m)	0.950
Invert Level (m)	76.397	Cap Infiltration Depth (m)	0.000
Trench Height (m)	0.600	Include Swale Volume	Yes
Trench Width (m)	0.4		

Cellular Storage Manhole: SE24, DS/PN: SE6.005

Invert Level (m)	75.419	Safety Factor	2.0
Infiltration Coefficient Base (m/hr)	0.00000	Porosity	0.95
Infiltration Coefficient Side (m/hr)	0.00000		

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	650.0	0.0	3.600	0.0	0.0	7.200	0.0	0.0
0.400	650.0	0.0	4.000	0.0	0.0	7.600	0.0	0.0
0.800	650.0	0.0	4.400	0.0	0.0	8.000	0.0	0.0
1.200	0.0	0.0	4.800	0.0	0.0	8.400	0.0	0.0
1.600	0.0	0.0	5.200	0.0	0.0	8.800	0.0	0.0
2.000	0.0	0.0	5.600	0.0	0.0	9.200	0.0	0.0
2.400	0.0	0.0	6.000	0.0	0.0	9.600	0.0	0.0
2.800	0.0	0.0	6.400	0.0	0.0	10.000	0.0	0.0
3.200	0.0	0.0	6.800	0.0	0.0			

Dry Swale Manhole: SE25, DS/PN: SE11.000

Warning:- Volume should always be included unless the upstream pipe is being used for storage and/or as a carrier

Infiltration Coefficient Base (m/hr)	0.00000	Trench Length (m)	42.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	4.0
Safety Factor	2.0	Slope (1:X)	0.0
Porosity	0.30	Cap Volume Depth (m)	1.000
Invert Level (m)	76.675	Cap Infiltration Depth (m)	0.000
Trench Height (m)	0.600	Include Swale Volume	Yes
Trench Width (m)	0.4		

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Summary of Critical Results by Maximum Level (Rank 1) for East storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
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 Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 7 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model		FSR M5-60 (mm) 18.900 Cv (Summer)	0.750
Region	England and Wales	Ratio R 0.300 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	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 (%)	30, 30, 30

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
SE1.000	15 Winter	100	+30%					
SE2.000	15 Winter	100	+30%	100/15 Summer				
SE1.001	15 Winter	100	+30%	30/15 Summer				
SE1.002	15 Winter	100	+30%					
SE3.000	15 Winter	100	+30%					
SE3.001	30 Winter	100	+30%	100/15 Winter				
SE4.000	15 Winter	30	+30%					
SE3.002	960 Winter	100	+30%	30/15 Winter				
SE1.003	960 Winter	100	+30%	30/15 Summer				
SE5.000	15 Winter	100	+30%	30/15 Summer				
SE1.004	960 Winter	100	+30%	30/240 Winter				
SE1.005	960 Winter	100	+30%	30/120 Winter				
SE6.000	15 Winter	100	+30%	100/15 Winter				
SE6.001	15 Winter	100	+30%	30/15 Summer				
SE7.000	15 Winter	100	+30%	100/15 Summer				
SE6.002	15 Winter	100	+30%	30/15 Summer				
SE8.000	15 Winter	100	+30%	30/15 Summer				
SE8.001	15 Winter	100	+30%	30/15 Winter				
SE9.000	15 Winter	100	+30%					
SE8.002	15 Winter	100	+30%	30/15 Summer				
SE6.003	15 Winter	100	+30%	30/15 Summer				
SE10.000	15 Winter	100	+30%	100/15 Summer				
SE6.004	15 Winter	100	+30%	30/15 Summer				
SE6.005	960 Winter	100	+30%	100/240 Winter				
SE11.000	15 Winter	100	+30%					
SE1.006	960 Winter	100	+30%	1/15 Summer				

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Summary of Critical Results by Maximum Level (Rank 1) for East storm

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
SE1.000	SE1	78.164	-0.086	0.000	0.37	0.0	11.4	OK
SE2.000	SE2	78.124	0.274	0.000	0.56	0.0	12.1	SURCHARGED
SE1.001	SE3	78.075	0.608	0.000	1.31	0.0	55.0	SURCHARGED
SE1.002	SE4	76.749	-0.051	0.000	0.94	0.0	59.4	OK
SE3.000	SE5	76.565	-0.035	0.000	0.92	0.0	17.1	OK
SE3.001	SE6	76.039	0.054	0.000	0.88	0.0	164.7	SURCHARGED
SE4.000	SE7	76.500	-0.150	0.000	0.00	0.0	0.0	OK
SE3.002	SE8	75.985	0.193	0.000	0.19	0.0	22.4	SURCHARGED
SE1.003	SE9	75.984	0.218	0.000	0.19	0.0	28.3	SURCHARGED
SE5.000	SE10	76.631	0.231	0.000	1.36	0.0	23.1	SURCHARGED
SE1.004	SE11	75.983	0.268	0.000	0.06	0.0	11.7	SURCHARGED
SE1.005	SE12	75.985	0.324	0.000	0.04	0.0	11.1	SURCHARGED
SE6.000	SE13	76.440	0.020	0.000	0.21	0.0	4.8	SURCHARGED
SE6.001	SE14	76.448	0.161	0.000	0.72	0.0	13.6	SURCHARGED
SE7.000	SE15	76.462	0.062	0.000	0.60	0.0	19.4	SURCHARGED
SE6.002	SE16	76.390	0.312	0.000	1.58	0.0	32.0	SURCHARGED
SE8.000	SE17	76.658	0.298	0.000	1.34	0.0	29.1	SURCHARGED
SE8.001	SE18	76.430	0.193	0.000	0.63	0.0	30.0	SURCHARGED
SE9.000	SE19	76.630	-0.067	0.000	0.93	0.0	81.7	OK
SE8.002	SE20	76.331	0.322	0.000	1.37	0.0	125.0	SURCHARGED
SE6.003	SE21	76.230	0.256	0.000	1.51	0.0	148.8	SURCHARGED
SE10.000	SE22	76.655	0.055	0.000	1.16	0.0	19.2	SURCHARGED
SE6.004	SE23	76.085	0.164	0.000	1.69	0.0	184.9	SURCHARGED
SE6.005	SE24	75.981	0.156	0.000	0.12	0.0	11.8	SURCHARGED
SE11.000	SE25	76.762	-0.063	0.000	0.62	0.0	44.5	OK
SE1.006	SE26	75.984	0.803	0.000	0.66	0.0	7.2	SURCHARGED

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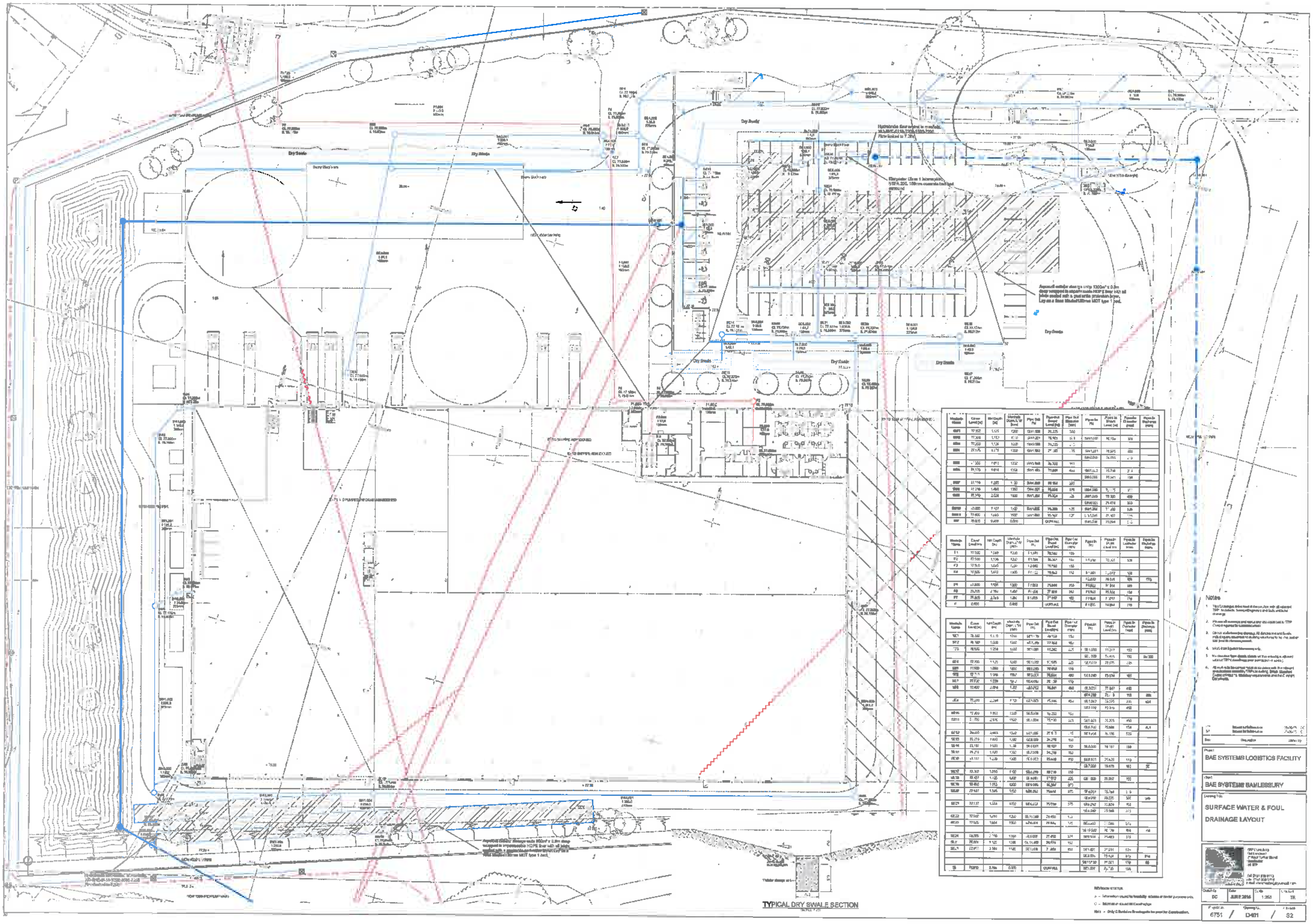
APPENDIX D

Drawing 6751 D401 – Surface Water Drainage Layout

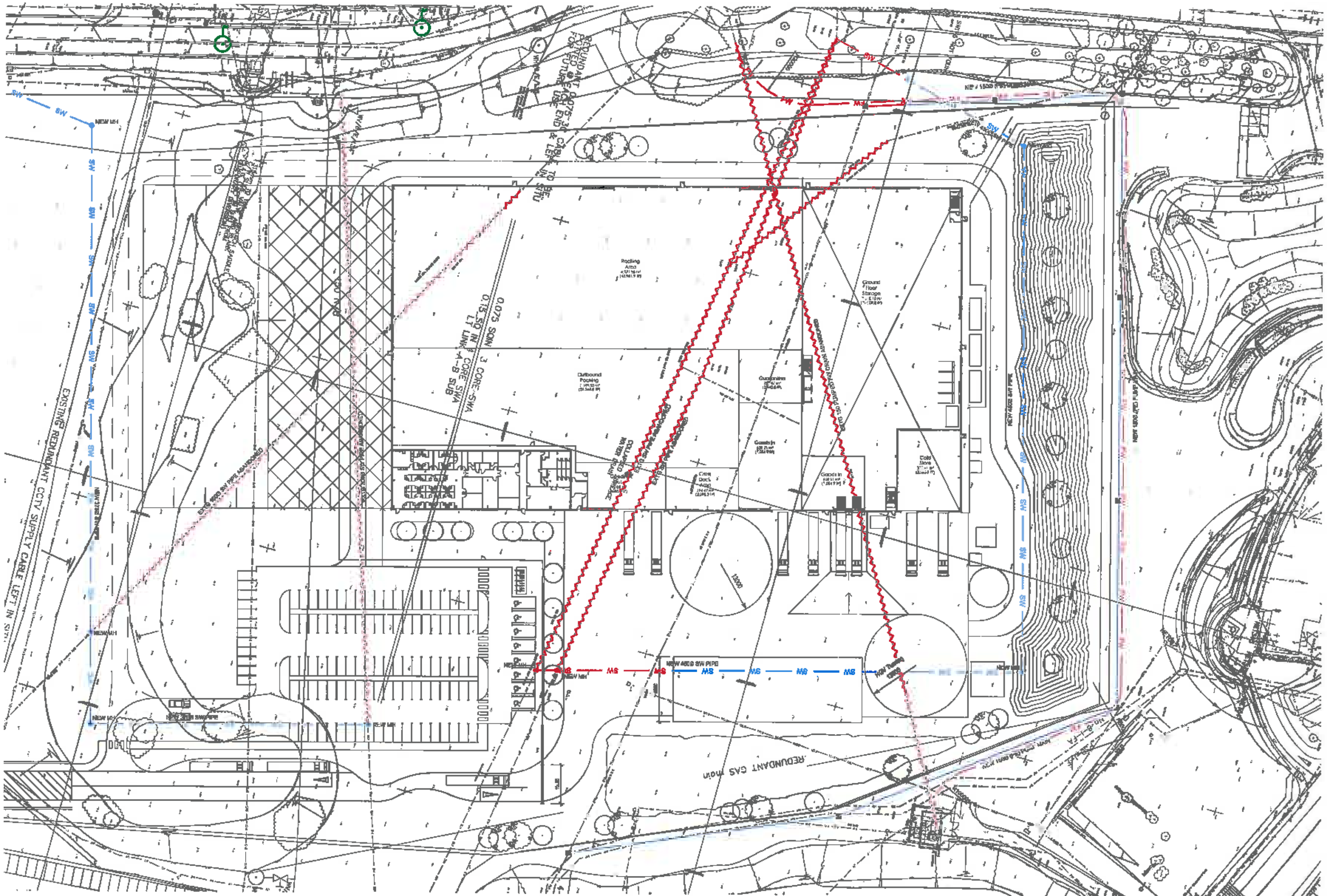

Dry Swale
Notes
TYPICAL DRY SWALE SECTION
Rev
Description
Project
BAE SYSTEMS LOGISTICS FACILITY
BAE SYSTEMS SAMLESBURY
SURFACE WATER & FOUL
DRAINAGE LAYOUT
DC
JUNE 2016
1:250
TR
6751 / D401 / S2

APPENDIX E

Drawing 6751 E500 – Surface Water Diversions

Notes

1. This Drawing is to be read in conjunction with all relevant TRP, Architects, Service Engineers and Subcontractor drawings.
2. Review all drawings and report any discrepancies to TRP Consulting prior to commencement.
3. Do not scale from this drawing. All dimensions and levels including any abutment to existing structures to be checked on site prior to commencement.
4. Work from figured dimensions only.
5. No deviation from details shown on this drawing is allowed without TRP Consulting's prior permission in writing.
6. All work is to be carried out in accordance with the relevant specifications issued by TRP Consulting, British Standard Codes of Practice, Statutory requirements and the Contract Documents.



EXISTING SERVICE DIVERSION PLAN

SCALE 1:500

Legend	
SW	PROPOSED SURFACE WATER DIVERSION ROUTE
FW	PROPOSED FOUL WATER DIVERSION ROUTE
(zigzag line)	EXISTING ROUTE TO BE ABANDONED
(dashed line)	SITE BOUNDARY

REVISION STATUS

S - Information issued for feasibility, scheme or tender purposes only.

C - Information issued for Construction

Note - Only C Revision Drawings to be used for Construction.

Rev	Description	Date / By
[illegible]	Carpark Layout Updated	22.05.15 WC
S5	Overall Site Layout Updated & Pump main Route Amended	11.05.15 WC
S4	Overall Site Layout Updated	11.05.15 WC
S3	Pipe bend radius amended	28.04.15 WC
S2	Topo updated	12.03.15 WC
S1	Issued for Information	04.03.15 WC

Project: BAE SAMLESBURY LOGISTICS FACILITY

Client: BAE SYSTEMS

Drawing Title: PROPOSED DIVERSIONS OF EXISTING SERVICES AND PUMP MAIN

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Drawn By	Date	Scale	Checked
WC	MARCH 15	1:500	TR

Project No.	Drawing No.	Revision
6751	E500	S6

A1