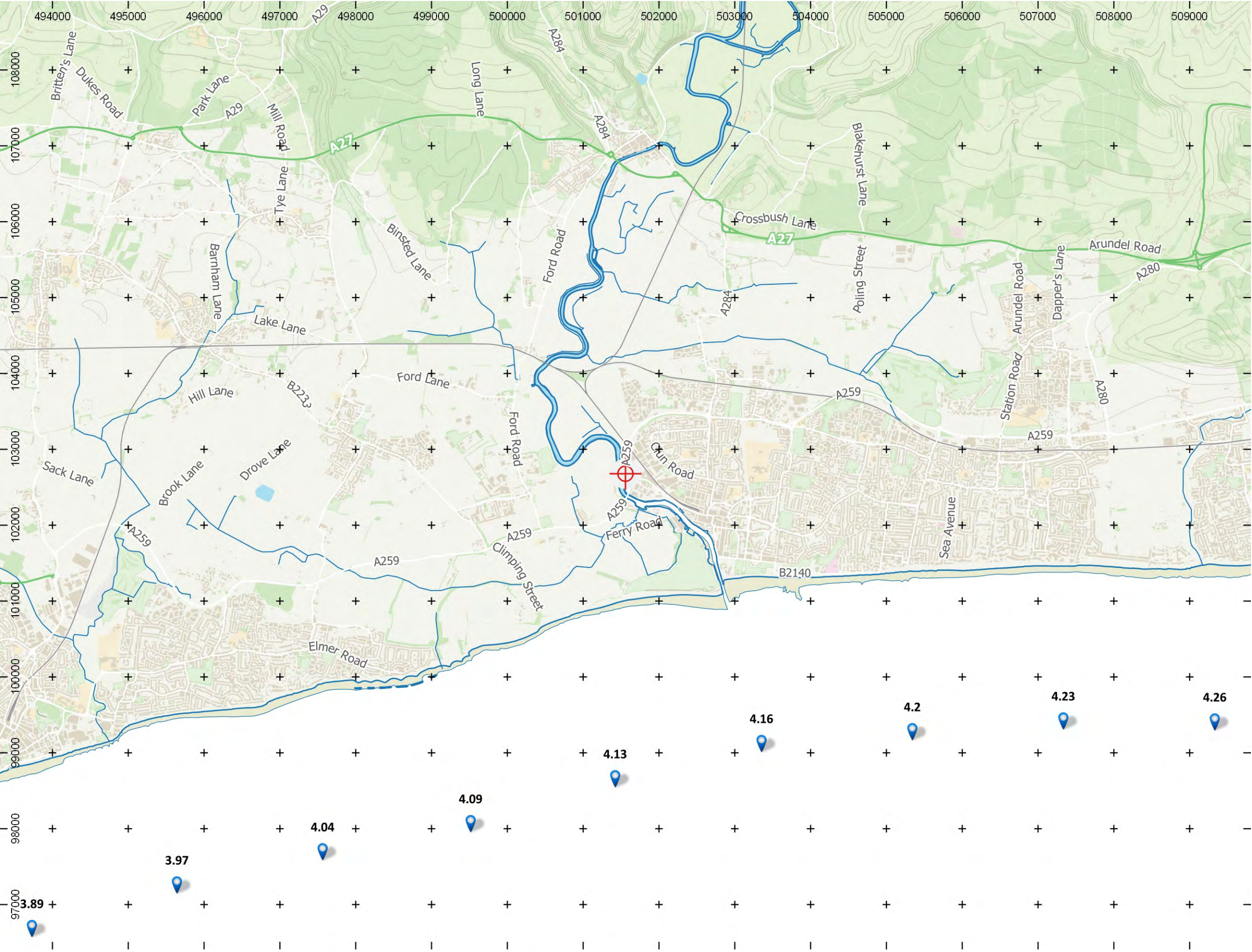




NOTE:
Extreme Sea Level values is part of Coastal Design/
Extreme Sea Levels, a GIS dataset and supporting
information providing design / extreme sea level and
typical surge information around the coastline of the UK,
including England, Wales, Scotland, Northern Ireland, Isle
of Man and Jersey. The information is relevant under
present day (year 2018) conditions and does not account
for future changes due to climate change, such as sea
level rise. This is a specialist dataset which informs on
work commenced around the coast ranging from coastal
flood modelling, scheme design, strategic planning and
flood risk assessments.

Extreme Sea Level values describes the extreme sea
levels for 16 different annual probabilities of exceedance.
Confidence levels relating to the 5% and 95% lower and
upper bounds of confidence are included. Mean High
Water Spring (MHWS) and Highest Astronomical Tide
(HAT) predicted tide levels are also included in the
dataset for some sites but may not be used for
navigational purposes.

This 2018 update to the Coastal Design Sea Levels
dataset was carried out in partnership for the UK Coastal
Flood Forecasting partnership, which includes the
Environment Agency (EA), Scottish Environment
Protection Agency (SEPA), Natural Resources Wales
(NRW) and the Department for Infrastructure Northern
Ireland (DfNI).

Contains data, © Environment Agency, © Ordnance
Survey. Data has been relied upon in the format
provided and has not been independently validated.

- LEGEND**
- Site Location
 - Application Boundary
 - EXTREME SEA LEVELS

Client
**The Littlehampton Yacht
Club**

Site
Hampton Quay

Project No.
4732

ENVIRONMENT AGENCY 1:1000 RETURN PERIOD TIDAL FLOOD LEVELS

Part B: Permeable Paving (Outfall Set to Zero l/s)

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.000	4-8	0.309	8-12	0.171
Total Area Contributing (ha) = 0.480					
Total Pipe Volume (m³) = 1.590					

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STORM SEWER DESIGN by the Modified Rational Method

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	10.000	0.001	10000.0	0.480	4.00	0.0	0.600	ooo	150	Triple Pipe	
1.001	10.000	0.001	10000.0	0.000	0.00	0.0	0.600	ooo	150	Triple Pipe	
1.002	10.000	0.001	10000.0	0.000	0.00	0.0	0.600	ooo	150	Triple Pipe	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	I.Area (ha)	Base Flow (l/s)	Foul Flow (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	0.00	5.81	1.600	0.480	0.0	0.0	0.0	0.09	4.9	0.0
1.001	0.00	7.62	1.599	0.480	0.0	0.0	0.0	0.09	4.9	0.0
1.002	0.00	9.42	1.598	0.480	0.0	0.0	0.0	0.09	4.9	0.0

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall C. Name	Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.002		2.000	1.597	0.000	0	0

Simulation Criteria for 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 Coefficient	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 Online Controls	1	Number of Time/Area Diagrams	0
		Number of Storage Structures	1
		Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	1	Cv (Summer)	0.750
Region England and Wales		Cv (Winter)	0.840
M5-60 (mm)	19.000	Storm Duration (mins)	30
Ratio R	0.350		

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Online Controls for Storm

Pump Manhole: 2, DS/PN: 1.001, Volume (m³): 1.0

Invert Level (m) 1.599

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)
0.200	0.0000	1.400	0.0000	2.600	0.0000	3.800	0.0000	5.000	0.0000
0.400	0.0000	1.600	0.0000	2.800	0.0000	4.000	0.0000	5.200	0.0000
0.600	0.0000	1.800	0.0000	3.000	0.0000	4.200	0.0000	5.400	0.0000
0.800	0.0000	2.000	0.0000	3.200	0.0000	4.400	0.0000	5.600	0.0000
1.000	0.0000	2.200	0.0000	3.400	0.0000	4.600	0.0000	5.800	0.0000
1.200	0.0000	2.400	0.0000	3.600	0.0000	4.800	0.0000	6.000	0.0000

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Storage Structures for Storm

Porous Car Park Manhole: 1, DS/PN: 1.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	65.0
Membrane Percolation (mm/hr)	1000	Length (m)	65.0
Max Percolation (l/s)	1173.6	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	1.600	Membrane Depth (mm)	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 Additional Flow - % of Total Flow 0.000
 Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
 Hot Start Level (mm) 0 Inlet Coefficient 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) 19.000 Cv (Summer) 0.750
 Region England and Wales Ratio R 0.350 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
 Analysis Timestep 2.5 Second Increment (Extended)
 DTS Status ON
 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 (%) 0, 0, 40

US/MH		Storm	Return Climate		First (X)	First (Y)	First (Z)	Overflow	Water	Surcharged
PN	Name		Period	Change	Surcharge	Flood	Overflow	Act.	Level (m)	Depth (m)
1.000	1 1440	Winter	1	+0%	30/960	Summer			1.688	-0.062
1.001	2 1440	Winter	1	+0%	30/480	Winter			1.690	-0.059
1.002	3 480	Winter	1	+0%					1.598	-0.150

Flooded		Pipe		Level	
US/MH	Volume	Flow / Overflow	Pipe	Status	Exceeded
PN	Name	(m³)	Cap. (l/s)	(l/s)	
1.000	1	0.000	0.02	0.3	OK
1.001	2	0.000	0.00	0.0	OK
1.002	3	0.000	0.00	0.0	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 Additional Flow - % of Total Flow 0.000
 Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
 Hot Start Level (mm) 0 Inlet Coefficient 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) 19.000 Cv (Summer) 0.750
 Region England and Wales Ratio R 0.350 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
 Analysis Timestep 2.5 Second Increment (Extended)
 DTS Status ON
 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 (%) 0, 0, 40

US/MH		Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water	Surcharged
PN	Name								Level (m)	Depth (m)
1.000	1 1440	Winter	30	+0%	30/960 Summer				1.797	0.047
1.001	2 1440	Winter	30	+0%	30/480 Winter				1.800	0.051
1.002	3 480	Winter	30	+0%					1.598	-0.150

Flooded		Pipe		Level Exceeded
US/MH PN	Name	Volume (m ³)	Flow / Overflow Cap. (l/s)	
1.000	1	0.000	0.03	0.5 FLOOD RISK
1.001	2	0.000	0.00	0.0 FLOOD RISK
1.002	3	0.000	0.00	0.0 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 Additional Flow - % of Total Flow 0.000
 Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
 Hot Start Level (mm) 0 Inlet Coefficient 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) 19.000 Cv (Summer) 0.750
 Region England and Wales Ratio R 0.350 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
 Analysis Timestep 2.5 Second Increment (Extended)
 DTS Status ON
 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 (%) 0, 0, 40

US/MH		Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water	Surcharged
PN	Name								Level (m)	Depth (m)
1.000	1 1440	Winter	100	+40%	30/960	Summer			1.961	0.211
1.001	2 1440	Winter	100	+40%	30/480	Winter			1.973	0.224
1.002	3 960	Summer	100	+40%					1.598	-0.150

Flooded		Pipe		Level Exceeded
US/MH PN	Name	Volume (m³)	Flow / Cap. (l/s)	
1.000	1	0.000	0.03	0.6 FLOOD RISK
1.001	2	0.000	0.00	0.0 FLOOD RISK
1.002	3	0.000	0.00	0.0 OK

Part C: Swale & Roof Drainage

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.020	4-8	0.054	8-12	0.432	12-16	0.348	16-20	0.031

Total Area Contributing (ha) = 0.885

Total Pipe Volume (m³) = 362.007

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STORM SEWER DESIGN by the Modified Rational Method

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	75.000	0.001	75000.0	0.085	4.00	0.0	0.600	1 _ /	4300	1:1 Ditch	
1.001	17.000	0.001	17000.0	0.074	0.00	0.0	0.600	1 _ /	4300	1:1 Ditch	
2.000	48.000	0.001	48000.0	0.726	4.00	0.0	0.600	1 _ /	4300	1:1 Ditch	
2.001	29.000	0.001	29000.0	0.000	0.00	0.0	0.600	1 _ /	4300	1:1 Ditch	
1.002	10.000	0.001	10000.0	0.000	0.00	0.0	0.600	ooo	150	Triple Pipe	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	0.00	14.55	4.850	0.085	0.0	0.0	0.0	0.12	163.4	0.0
1.001	0.00	15.65	4.849	0.159	0.0	0.0	0.0	0.26	355.5	0.0
2.000	0.00	9.34	4.850	0.726	0.0	0.0	0.0	0.15	206.8	0.0
2.001	0.00	11.81	4.849	0.726	0.0	0.0	0.0	0.20	269.3	0.0
1.002	0.00	17.46	4.848	0.885	0.0	0.0	0.0	0.09	4.9	0.0

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Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.085	0.085	0.085
1.001	-	-	100	0.074	0.074	0.074
2.000	-	-	100	0.726	0.726	0.726
2.001	-	-	100	0.000	0.000	0.000
1.002	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.885	0.885	0.885

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.002		5.000	4.847	0.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m ³ /ha Storage	2.000
Hot Start (mins)	0	Inlet Coefficient	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 Online Controls	0	Number of Time/Area Diagrams	0
		Number of Storage Structures	0
		Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	10	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Storm Duration (mins)	30
Ratio R	0.350		

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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 Additional Flow - % of Total Flow 0.000
 Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
 Hot Start Level (mm) 0 Inlet Coefficient 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 0 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.000 Cv (Summer) 0.750
 Region England and Wales Ratio R 0.350 Cv (Winter) 0.840

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

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, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	Saltings	120 Winter	1	+0%					4.974
1.001	North Court	120 Winter	1	+0%					4.974
2.000	south court	60 Winter	1	+0%		100/120 Summer			4.997
2.001	bridge	120 Winter	1	+0%					4.981
1.002	Outfall	120 Winter	1	+0%	30/15 Summer				4.974

PN	US/MH Name	Surcharged		Flooded		Pipe		Level Exceeded
		Depth (m)	Volume (m³)	Flow / Cap.	Overflow (l/s)	Flow (l/s)	Status	
1.000	Saltings	-0.326	0.000	0.00		3.5	OK	
1.001	North Court	-0.326	0.000	0.00		5.1	OK	
2.000	south court	-0.303	0.000	0.02		44.9	OK	
2.001	bridge	-0.319	0.000	0.01		21.1	OK	
1.002	Outfall	-0.024	0.000	0.86		14.5	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 Additional Flow - % of Total Flow 0.000
 Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
 Hot Start Level (mm) 0 Inlet Coefficient 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 0 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.000 Cv (Summer) 0.750
 Region England and Wales Ratio R 0.350 Cv (Winter) 0.840

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

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, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	Saltings	120 Winter	30	+0%					5.065
1.001	North Court	120 Winter	30	+0%					5.064
2.000	south court	120 Winter	30	+0%		100/120 Summer			5.159
2.001	bridge	120 Winter	30	+0%					5.100
1.002	Outfall	120 Winter	30	+0%	30/15 Summer				5.063

PN	US/MH Name	Surcharged	Flooded	Flow / Cap.	Overflow (l/s)	Pipe	Status	Level
		Depth (m)	Volume (m³)			Flow (l/s)		Exceeded
1.000	Saltings	-0.235	0.000	0.00		8.5	FLOOD RISK*	
1.001	North Court	-0.236	0.000	0.00		9.4	FLOOD RISK*	
2.000	south court	-0.141	0.000	0.03		72.4	FLOOD RISK*	
2.001	bridge	-0.200	0.000	0.02		54.2	FLOOD RISK*	
1.002	Outfall	0.065	0.000	2.36		40.0	FLOOD RISK	

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

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
 Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
 Hot Start Level (mm) 0 Inlet Coefficient 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 0 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.000 Cv (Summer) 0.750
 Region England and Wales Ratio R 0.350 Cv (Winter) 0.840

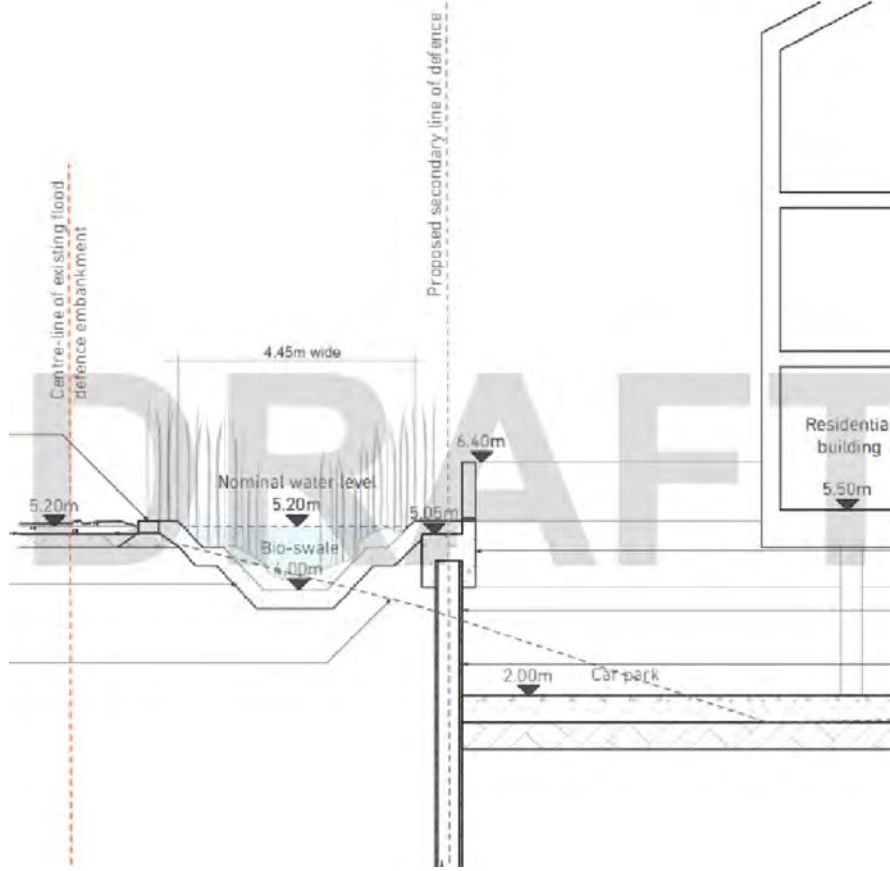
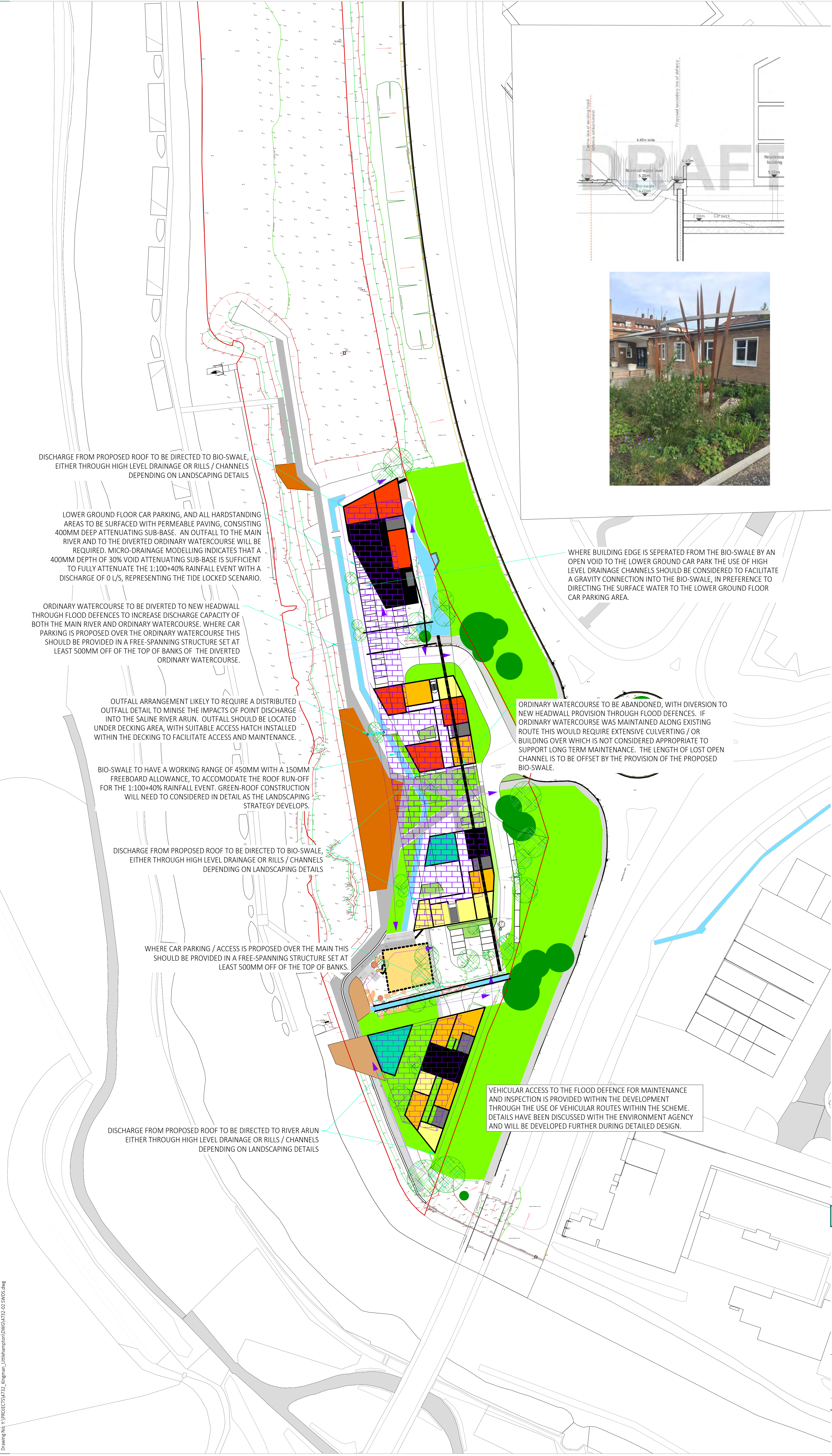
Margin for Flood Risk Warning (mm) 300.0
 Analysis Timestep 2.5 Second Increment (Extended)
 DTS Status ON
 DVD Status ON
 Inertia Status ON

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, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level
									(m)
1.000	Saltings	120 Winter	100	+40%					5.204
1.001	North Court	120 Winter	100	+40%					5.200
2.000	south court	60 Winter	100	+40%		100/120 Summer			5.300
2.001	bridge	120 Winter	100	+40%					5.273
1.002	Outfall	120 Winter	100	+40%	30/15 Summer				5.193

PN	US/MH Name	Surcharged Flooded		Pipe		Status	Level Exceeded
		Depth (m)	Volume (m³)	Flow / Cap.	Flow / (l/s)		
1.000	Saltings	-0.096	0.000	0.01	15.8	FLOOD RISK*	
1.001	North Court	-0.100	0.000	0.01	19.5	FLOOD RISK*	
2.000	south court	0.000	0.000	0.07	209.3	FLOOD RISK*	
2.001	bridge	-0.027	0.000	0.04	98.3	FLOOD RISK*	
1.002	Outfall	0.195	0.000	3.94	66.8	FLOOD RISK	

Part D: Drainage Strategy Overview



1. GENERAL
- a. THIS DRAWING IS NOT TO BE SCALED, WORK TO FIGURED DIMENSIONS ONLY, CONFIRMED ON SITE.
- b. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTURAL DRAWINGS, DETAILED SPECIFICATIONS WHERE APPLICABLE AND ALL ASSOCIATED DRAWINGS IN THIS SERIES.
- c. ANY DISCREPANCY ON THIS DRAWING IS TO BE REPORTED IMMEDIATELY TO THE PARTNERSHIP FOR CLARIFICATION.
- d. THE CONTRACTOR IS RESPONSIBLE FOR ALL TEMPORARY WORKS AND FOR THE STABILITY OF THE WORKS IN PROGRESS.
- e. CDM REGULATIONS 2015. ALL CURRENT DRAWINGS AND SPECIFICATIONS MUST BE READ IN CONJUNCTION WITH THE DESIGNER'S HAZARD RISK AND ENVIRONMENT ASSESSMENT RECORD. DESIGN HAS BEEN PRODUCED BASED ON INFORMATION PROVIDED BY THE CLIENT/PRINCIPLE DESIGNER AVAILABLE AT TIME OF ISSUE. CONTRACTOR TO REVIEW DRAWING AND SPECIFICATION IN CONTEXT WITH THE WIDER SITE AND SPECIFIC SITE INVESTIGATION, CONTAMINATION ASSESSMENT, ASBESTOS SURVEY, ENVIRONMENTAL SURVEY, UXO SURVEY AND ANY OTHER RELEVANT INFORMATION AND MANAGE RISKS RELATING TO THE WORKS OUTLINED IN THE DRAWINGS AND SPECIFICATION. PRINCIPLE CONTRACTOR TO MAKE DESIGNER AND CLIENT AWARE OF SITE SPECIFIC RISKS THAT MAY AFFECT THE DRAWING AND SPECIFICATION.
- f. CDM REGULATIONS 2015. FOR GENERIC MAINTENANCE AND MANAGEMENT RISKS REFER TO CHAPTER 36 OF CIRIA 752 SUDS MANUAL. FOR PROPRIETARY SYSTEMS SEE MANUFACTURER'S MANAGEMENT AND MAINTENANCE DETAILS AND RISK ASSESSMENT WITH REGARDS TO MAINTENANCE OF PROPRIETARY SYSTEMS.

LEGEND	
	PRIVATE SURFACE WATER DRAIN
	ABANDONED ORDINARY WATERCOURSE
	INSPECTION CHAMBER
	PERMEABLE PAVING (LOWER GROUND FLOOR)

REV	DATE	CKD	APPD	BY	DESCRIPTION
PRELIMINARY DRAWING FOR INFORMATION ONLY. NOT FOR CONSTRUCTION.					
Client THE LITTLEHAMPTON YACHT CLUB					
AMBIENTAL ENVIRONMENTAL ASSESSMENT a company of Royal HaskoningDHV					
Project HAMPTON QUAY PLANNING APPLICATION					
Drawing SURFACE WATER DRAINAGE STRATEGY OUTLINE STRATEGY					
Drawn by: SJB					Date: JAN-2018
Drawing No. 4732 - DR02					Revision -
Drawing Scale:					

Part E: Stakeholder Comment Response

Comment Response Sheet

Project Number	4732	Document	4732_Kingman_Littlehampton_FRA_Final_v2 Consultation Response 11 November 2019
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Document Purpose

The purpose of this document is to provide a systematic record of the comments received related to the above documents, and Ambiental's proposed approach to dealing with the comments.

Overarching Comments & Responses

We welcome the Arun Council's Drainage Engineer's Comments, and have set out below our clarifications to the points raised, including proposed amendments to the FRA text. The key themes identified from the response are:

1. Infiltration Testing, based on BGS data now available, we believe that infiltration testing is unnecessary and unreasonable. However, to avoid delays, onsite geo-technical testing should include a BRE365 soakage test over the winter period.
2. The points raised are generally related to Land Drainage and Surface Water Drainage can be addressed through minor modifications to the FRA.
3. With Arun's support the team are looking to provide an exemplar scheme in relation for SuDS and Flood Management. To this end we would welcome a workshop meeting with Arun to discuss the matters raised, and work with them to further develop the scheme.

Comment Source: Arun District Council, Drainage Engineer Karl McLaughlin, General Comments.

Reference	Comment	Response	Accepted?
1. Para 5.13	Point 5.13 – The information from the SMP has been misconstrued. The SMP states that a Hold The Line policy is recommended provided funding is available. Additionally, the SMP acknowledges that the policy may need revision during future reviews which is something that the FRA has failed to mention.	To satisfy Arun DC, we suggest amending the end of the paragraph 5.13 to state: <i>"The Hold the Line Policy is contingent on future funding becoming available."</i>	
2. -	I raise the above point as the current funding mechanism, Flood and Coastal Erosion Risk Management - Grant in Aid (FCERM GIA), does not provide public funding for properties constructed after 2012.	As set out in paragraph 7.7 and 8.3, the scheme is designed with habitable finished floor levels above the 1:1,000 year tidal flood level, including an allowance for climate change. The proposals are therefore not reliant on flood defence upgrades to be made safe based on the current tidal flood level predictions for 2115.	
3. -	Furthermore, the FRA identifies that the defences are privately owned and that an upgradeable approach will be taken when designing the development. However, the FRA has failed to mention how funding of future works will be made available, should the development require it.	The adaptive approach has been included in the FRA, should future updates to the climate change predictions exceed those currently being considered. For clarity at the end of paragraph 5.13:	

Reference	Comment	Response	Accepted?
		<i>"The proposals have been designed to be safe for the 1:1,000 year tidal in 2115, see Section 8 for more details, and based on current predictions, no further improvements, beyond those outlined for the development proposals to the flood defences are necessary. Furthermore this design approach exceeds the standards required by the Environment Agency."</i>	
4. -	Safe access and egress to all of the habitable spaces will need to be maintained at all times. This is so that a) the occupants can escape to higher / safe areas and b) the emergency services can reasonably access the site in all conditions	Additional text to be inserted in Section 8.12: <i>"The access and egress route across the podium will be designed to accommodate emergency vehicles"</i> .	

Comment Source: Arun District Council, Drainage Engineer Karl McLaughlin, Surface Water Drainage.

Reference	Comment	Response	Accepted?
5.	It would appear that the development proposes to culvert a significant length of Ordinary watercourse. Further information on culverting a watercourse can be found at https://www.arun.gov.uk/surfacewater/ . In terms of the 'ordinary watercourse' passing through the site, no buildings or structures will be permitted over or within 3 metres of it. Culverting will only be permitted where necessary to facilitate vehicular access across it. The layout at present conflicts with our requirements and would be objected to. Any alterations to the watercourse, including discharging too, culverting, etc will also require Land Drainage Consent.	The guidance provided from the link states: <i><u>"Culverting (piping) a watercourse is not advised unless there is no alternative. The resulting reduction in storage volume, flow capacity and habitat potential would be unacceptable. Culverted watercourses are also more difficult to maintain due to the limited accessibility."</u></i> The published policy contradicts the advice provided in the response, which implies that culverting can only be for vehicular access. The upstream sections of the watercourse are restricted by culverts, and therefore providing a culvert of greater flow capacity would offset the perceived risk, as outlined in the FRA. The proposed swale could be used to provide compensatory habitat, for the loss of open watercourse. Section 23, 3¹, of the Land Drainage Act states that with regards to culverting or other structures on watercourses "consent is not to be unreasonably withheld". An alternative could be to divert the Ordinary Watercourse to a new outfall on the Tidal River Arun, to minimise the amount of culverting. It should be noted that the upstream sections of watercourse are heavily urbanised, with little evidence of open watercourses visible from aerial photography.	

¹ <http://www.legislation.gov.uk/ukpga/1991/59/section/23>

Reference	Comment	Response	Accepted?
6.	Point 5.42/43 – The FRA would appear to have misinterpreted information from the Non-statutory technical standards for sustainable drainage systems. The document does not supersede the drainage hierarchy referenced in Policy W DM3 of the Local Plan, see point (f.)² Or other local policies. The hierarchy for sustainable drainage must be followed with infiltration fully investigated before the option of potentially discharging to watercourses such as the River Arun. Winter infiltration testing and winter groundwater monitoring must be undertaken, and it is advised that the applicant discusses the extent of this monitoring/testing with us at the earliest opportunity. Infiltration tests must be carried out in accordance with BRE365, CIRIA R156 or a similar approved method and cater for the 1 in 10 year storm between the invert of the entry pipe to the soakaway, and the base of the structure. It must also have provision to ensure that there is capacity in the system to contain below ground level the 1 in 100 year event plus 40% on stored volumes, as an allowance for climate change. Adequate freeboard must be provided between the base of the soakaway structure and the highest recorded annual groundwater level identified in that location. Furthermore, the FRA references borehole testing (point 5.34) that indicates a low ground water table. As such, we would expect that further investigations are likely to support the successful application of infiltration.	On the contrary the Non Statutory technical standard S1 states that where a discharge to a tidal system is proposed an unrestricted discharge is allowed. The full extract of Standard S1 is included at 5.42. The British geological survey indicates that the site is located on Raised Marine Deposits – Clay, Silt, Sand and Gravel. Since completing the report further borehole records are now available on the BGS website. A summary of a few of which are provided below. A BGS historic record for the site from June 1968, indicates that groundwater was struck at 10 feet (approximately 3m) below ground level. Trial pits undertaken in 2012, to support the Environment Agency flood defence scheme (available from the BGS), indicates that under the topsoil the site is underlain by a shallow layer of Dense Sand, underlain by Clay, underlain by Sand. Groundwater was encountered within the lower sand layer (below the clay) the records indicate that groundwater rose to 2.2m below ground level, to within the Clay layer. Indicating that the Clay layer acts to confine groundwater.³ A 5.5m deep borehole⁴, from 2012, encountered groundwater at 1.2m below ground level (October 2012) On the basis of the available BGS borehole logs undertaken at the site, and the elevated groundwater level infiltration forms of drainage are not considered appropriate. We trust that including this information in the Flood Risk Assessment will satisfy Arun District Council. Based on the information now available further investigation is considered both unnecessary and unreasonable.	
7.	Point 5.45 – The FRA states that “Drainage of the under-croft parking areas should be directed to a foul network, as these are unlikely to receive significant rainfall ... These pumps should be isolatable should the under-croft parking area become flooded due to discharges from the culverts entering the site.” It is my understanding that the proposed floor level is below the 1:1 year storm threshold and therefore should the defences become compromised the carpark would be	The under-croft car park area would not be subject to significant amounts of rainfall. Normal design of basement and multi-storey car park drainage (for covered areas) is to direct this to the foul drainage network. Should Arun insist on a deviation from this normal design practice, then a full retention petrol interceptor could be provided upstream of the outfall to the Ordinary Watercourse.	

² <https://www.arun.gov.uk/download.cfm?doc=docm93ijim4n12861.pdf&ver=13001>

³ BGS ID: 19952417

⁴ BGS ID: 1995242

Reference	Comment	Response	Accepted?
	regularly flooded at high water. In addition, surface water should not be discharged into the foul drainage system and any potential pollutants will need to be dealt with via other methods of treatment/disposal. Therefore, the proposed drainage layout of the undercroft parking should be revised.	In order for the under-croft area to be flooded, a failure of the flood defences would need to occur. As the risk of a breach is a residual risk designing the car park drainage to accommodate this is considered disproportionate to the likelihood of occurring. Furthermore, as the flood waters would recede through the breach in the flood defence, as the tidal level reduces, therefore negating the need for a positive drainage outfall.	
8.	If on-site infiltration is not possible, then drainage via a restricted discharge to a suitable local watercourse would be considered. Any discharge to the watercourses behind the River Arun flood defence bank/wall should be restricted to 1 year greenfield run-off rates, with a minimum rate of 2l/s. It is quite likely on this site, that the surface water drainage system will comprise of a hybrid arrangement, where infiltration will be utilised where ever possible, but in combination with a restricted discharge to watercourses. Any design, will also need to take account of tide locking associated with any outfall to the River Arun.	As the River Arun is 'local watercourse' an unrestricted discharge, as per the current design, will be pursued. The reasoning for this is that it will reduce the amount of surface water being discharge to the Ordinary Watercourse which is tide locked, which will overall reduce the risk of flooding. The above ground drainage would discharge into the swale, which would provide suitable water quality improvements before allowing a discharge into the River Arun, in accordance with the Non-Statutory Guidance. The ground level hardstanding areas not forming part of the under-croft, will be provided with lined permeable paving, constructed to a suitable depth to attenuate the 1:100 +40% flow (we note that the Adopted Local Plan refers to 30%, contrary to current Environment Agency guidance), and this would be restricted to the 1:1 greenfield rate subject to a minimum outflow of 2 l/s. The drainage strategy can be updated to reflect the above detail	
9.	We suggest that, at the earliest stage, the developer gives due consideration to the appropriate location and design of surface water drainage features to achieve the necessary capacity, water quality (via the SuDS management/treatment train), as well as ease of on-going maintenance. Surface water drainage features should also be designed in a manner that positively affects the amenity of the site. We would like to remind the developer that, open features, such as swales (which have already been proposed), basins and ponds, when designed correctly, can satisfy all the above aspirations in addition to; being easier to maintain, having longer lifespans and offering ecological advantages over subterranean features such as "plastic crate systems".	As noted by Arun DC swales have been included in the design. We will update the report to include the CIRIA SuDS Selection Matrix and provide a discussion on the various opportunities and constraints for the main SuDS devices.	

Reference	Comment	Response	Accepted?
10.	It should also be noted that attenuation features should not be counted within useable public open space provision.	This constraint will be considered as part of the SuDS Selection Matrix, and weighed against the open space requirements for the site.	
11.	The surface water drainage system will need to be designed to ensure that it is not compromised by the undefended flood zone 2/3 extents.	If Arun District Council require SuDS to be outside of the Flood Zone 2/3 extent, then these could only be provided at the higher (podium level). This contradicts their previous advice.	
12.	Supplementary guidance notes regarding surface water drainage are located here https://www.arun.gov.uk/surfacewater on Arun District Councils website, which also includes a link to the West Sussex County Council policy for the management of surface water, which needs to be adhered too. A surface water drainage checklist is available here https://www.arun.gov.uk/drainagechecklist on Arun District Councils website, this should be submitted with a Discharge of Conditions Application.	Noted.	
13.	As noted, a watercourse designated 'main river' crosses the site and therefore the Environment Agency should be consulted in this respect. This includes any proposals for making connections to it or indeed the 'River Arun' which is also classified as 'main river'. The proposal for a pumped 'main river' outfall will also need to be discussed with them, although it should be noted that pumping is not a sustainable option.	Noted.	
14.	The Environment Agency Will need to provide detailed comments in respect to the development being located within flood zone 3, also taking into account the present flood defences and also the proposal for moorings within the main channel of the 'River Arun'.	Noted.	
15.	As mentioned in the report, areas of the site are within areas subject to surface water flood risk, which are directly linked to the fluvial network. The design will need to give due consideration to any impact on upstream property/land should these areas of land be raised and may therefore warrant compensation measures. West Sussex County Council (the lead local flood authority) should also be consulted.	Noted.	

Reference	Comment	Response	Accepted?
16.	Southern Water should be consulted in respect to the connection of foul drainage to the public foul sewer network.	Noted.	

Signed:

Steven Brown, Associate

B.Eng., M.Sc., MCIWEM C.WEM, AMICE

Appendix IV - Arun District Council SuDS Pro-Forma



Surface Water Drainage Proposal Checklist

This 'Surface Water Drainage Proposals Checklist' has been designed to clearly define Arun District Council's and Chichester District Council's expectations and requirements for any surface water drainage proposals, submitted for appraisal by the council's Engineers, during the planning process.

Please be aware that it is in your interest to provide all of the requested information, as this will allow the council's Engineers to quickly and efficiently review your proposals. The omission of any requested information may lead to delays in the planning process.

This document will be of help to any applicant, or drainage consultant, preparing to submit a 'Discharge of Conditions Application' relating to surface water drainage conditions. Alternatively, it can also be used earlier in the planning process, if the applicant wishes to avoid pre-commencement conditions relating to surface water drainage. The Town and Country Planning Regulations now require pre-commencement conditions to have the prior agreement of the applicant regarding their wording and use. Therefore, if you wish to avoid pre-commencement conditions, in relation to surface water drainage, you will need to submit proposals that provide the information requested in this checklist and also align with the requirements of the following documents:

[West Sussex Policy for the Management of Surface Water](#) (WSSC)

['Supplementary Requirements for Surface Water Drainage Proposals'](#). (Arun DC)

['Supplementary Requirements for Surface Water Drainage Proposals'](#). (Chichester DC)

By submitting all of the information requested by this checklist you will enable the council's Engineers to determine whether your proposals follow the hierarchy for sustainable drainage and will adequately drain the site.

Please be aware that it will be difficult for the council's Engineers to undertake a timely assessment of your application if you fail to provide any of the information requested.

Surface Water Drainage Proposal Checklist

Ground Investigation Results			
Results Required	Results Provided?		
Winter groundwater monitoring results (Please refer to guidance note 1 below)	Yes		No ☒
Period of winter groundwater monitoring Note 1	From	☒ MM/YYYY	
	To	☒ MM/YYYY	
Maximum recorded groundwater level	Groundwater level taken from historic borholes indicating groundwater at 1m BGL, therefore infiltration not practicable.		
Winter infiltration test results Note 2	Yes		No ☒
Date of winter infiltration testing		☒ MM/YYYY	
Details of the location and depth of the infiltration testing Note 3	Yes		No ☒
Minimum infiltration rate Note 4	Not appropriate due to high groundwater m/s		

Guidance Notes

1. A full winters groundwater monitoring should be undertaken, (October to March inclusive) to enable the peak annual groundwater levels to be established. The extent of winter monitoring for developments of less than 5 properties should be discussed with the council's Engineers.
2. Infiltration testing should be undertaken during the wet winter months (typically January) and in line with BRE365, or a similar approved method. Tests should be repeated 3x, to replicate saturated ground conditions. Please note that infiltration testing is to be carried out at a time and depth agreed with the Councils engineers.
3. Infiltration testing should be undertaken at the location and depth of any proposed infiltration structures. This must be above the maximum recorded groundwater level in that vicinity.
4. The minimum infiltration rate obtained at the location and depth of the proposed infiltration structures should be used to inform the design of the structures.

Proposed Method of Surface Water Disposal			
Infiltration On-site, via soak-away structures	Yes		No ☒
If on-site infiltration is not to be used, has justification for this been provided? Note 5	Yes	☒	No
Attenuation (on-site) with a restricted discharge to a watercourse on, or adjacent to, the site	Yes		No ☒
Attenuation (on-site) with a restricted discharge to a surface water sewer on, or adjacent to, the site	Yes		No ☒
Attenuation (on-site) with a restricted discharge to a foul water sewer on, or adjacent to, the site	Yes		No ☒

Guidance Notes

5. If on-site infiltration is not being used to drain the site you will need to provide evidence that demonstrates on-site infiltration is unviable.

It is proposed to provide a new tidal discharge into the River Arun. The Environment Agency have stated that they are comfortable with an unrestricted discharge into the tidal River Arun, provided water quality requirements are achieved.

Drainage Design: Supporting Calculations					
Calculations Required			Calculations Provided?		
Infiltration Structures	Half-drain time for 10 year event (plus climate change allowance)	Infiltration methods of drainage are not appropriate due to high groundwater level.			
	Half-drain time for 100 year event (plus climate change allowance)				
	Calculations demonstrating that the 1 in 100 year event, plus climate change allowance can be accommodated on-site. Note 7				
	Lowest base level of infiltration structure				
	Has the design sought to provide treatment of potential contaminants? E.g. hydrocarbons.				
Attenuation and Subsequent Restricted Discharge	Pre-development run-off rate calculations	Yes	☒	No	
	Proposed discharge rate Note 6	Unrestricted discharge to the tidal River Arun. With checks for a submerged outfall			
	Calculations demonstrating that the 1 in 100 year event, plus climate change allowance can be accommodated on-site. Note 7	Yes	☒	No	
	Has the design sought to provide treatment of potential contaminants? E.g. hydrocarbons.	Yes	☒	No	
	If your proposed scheme incorporates any impermeable lined attenuation features we require calculations to demonstrate that appropriate resistance to floatation (due to groundwater levels) is catered for in the design	Yes	☒	No	
	If you propose discharging into or altering an ordinary watercourse; have you sought Ordinary Watercourse/Land Drainage Consent? Note 8	Yes		No	To be addressed post planning
	If discharging to a watercourse, piped system or the sea, has the proposed drainage network been modelled against predicted top water levels for the 1 in 100 year storm event plus climate change allowance, within the existing system? Note 9	Yes	☒	No	

Guidance Notes

- Any proposed discharge rate must be less than, or equal to, the pre-development rate. Greenfield sites must use the mean flow rate (Q_{bar}) and be based upon the area occupied by the development, ignoring significant open spaces. Please note that the minimum acceptable discharge rate is 2l/s when using formal flow control devices, unless otherwise agreed. Additionally, if you are developing a brownfield site, we expect you to provide fully detailed plans of the existing surface water drainage arrangements on site, including impermeable areas, gullies, outfalls, pipes & diameters, manholes, etc. We generally seek 50% betterment in terms of run off from brownfield sites.
- The appropriate factor of safety from the table below must be applied to your calculations to ensure your design is fully in accordance with CIRIA R156/ CIRIA C753.

Factor of Safety Table						
Size of Area to be Drained	Consequences of failure					
	No damage or inconvenience		Minor inconvenience, e.g. surface water on car park		Damage to buildings or structures or roads.	
	Cv=1.0	Cv=0.75	Cv=1.0	Cv=0.75	Cv=1.0	Cv=0.75
<100 m ²	1.5	2	2	3	10	13
100m ² to 1000m ²	1.5	2	3	4	10	13
>1000m ²	1.5	2	5	6.5	10	13

8. [Ordinary Watercourse/Land Drainage Consent](#) will need to be sought, ideally in parallel with planning permission, if you propose discharging into, culverting or altering a watercourse.
9. Modelling is required to ensure that problems, such as surcharged outfalls, are addressed.

Plans/Drawings/Diagrams				
Required	Provided?			
Plan detailing the location of groundwater monitoring and infiltration testing	Yes	☐	No	☒
Detailed drainage layout plan ^{Note 10}	Yes	☒	No	☐
Construction detail plans ^{Note 11}	Yes	☒	No	☐
Exceedance flow route plans ^{Note 12}	Yes	☒	No	☐
Impermeable area plan	Yes	☒	No	☐
If ground levels are being raised $\geq 300\text{mm}$ above existing levels and is unavoidable, have fully detailed plans been provided, together with drainage proposals, to address any potential drainage related issues.	Yes	☒	No	☐
		☐		☐

Guidance Notes

10. Drainage layout plans should include:
 - All surface water drainage pipes labelled with; diameters, pipe materials, falls and invert levels.
 - All infiltrating and attenuating structures (including permeable paving) labelled with; dimensions, invert and cover levels.
 - All manholes labelled with; cover levels, invert levels, cover types detailed.
 - All silt traps clearly labelled with sump depths.
 - Control structures with outflow rates and invert levels.
 - Proposed/existing levels of any areas subject to ground raising, together with suitable measures/detailed drawings for the associated management of surface water runoff. Please note that ground raising should be avoided unless there are exceptional circumstances.
11. Site specific construction detail plans should be supplied if your proposed drainage scheme includes any of the following elements: pipe bed and surround; infiltrating structures; attenuating structures; manholes; catch-pits/silt traps; control devices; permeable paving; headwalls.
12. Unless specifically requested by the council's drainage engineers 'Exceedance Flow Route Plans' are only required for developments of more than 5 residential properties or more than 0.5ha of commercial development .