MOMENTUM
structural engineers

Meadows Hall, Richmond

Drainage strategy and SuDS assessment for the management of surface water runoff and foul water discharge

July 2022 . 4821
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Purpose

This document has been prepared for the sole benefit, use and information for the development at Meadows Hall, Richmond and for the purposes set out in the following pages.

The liability of Momentum Consulting Engineers Ltd in respect of the information contained in the document will not extend to any third party.

Document Control

Author
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Checker
Richard Heath

Issue History

Rev.	Date	Comments
P01	8 July 2022	Planning

Contents

London Borough Proforma

As per London Borough of Richmond Upon Thames

1. Project & Site Details			
Project / Site Name (including sub-catchment / stage / phase where appropriate)	Meadows Hall, Richmond		
Address & post code	Land adjacent to 40 Church Road Richmond Surrey TW10 6LN		
OS Grid ref. (Easting, Northing)	E	518392	
	N	174934	
LPA reference (if applicable)	TBC		
Brief description of proposed work	Construction of two residential blocks		
Total site Area	1000		m^2
Total existing impervious area	750		m^2
Total proposed impervious area	430		m^2
Is the site in a surface water flood risk catchment (ref. local Surface Water Management Plan)?	Refer to Flood Risk Assessment by STM Environmental		
Existing drainage connection type and location	Currently assumed to be separate surface and foul public sewers within Church Road. To be confirmed by CCTV survey during detail design phase.		
Designer Name	David Perkins		
Designer Position	Associate		
Designer Company	Momentum		

2. Proposed Discharge Arrangements			
2a. Infiltration Feasibility			
Superficial geology classification	No records		
Bedrock geology classification	London Clay formation		
Site infiltration rate	$7.3x10^{-5}$ and $3.7x10^{-5}$	m/s	
Depth to groundwater level	No free groundwater was encountered during the advancement of the boreholes	to a maximum depth of 20.45m below ground level	
Is infiltration feasible?	No for soakaways to large buildings Possible for permeable paving		

2b. Drainage Hierarchy	Feasible (Y/N)	Proposed (Y/N)
1 store rainwater for later use	Y	N
2 use infiltration techniques, such as porous surfaces in non-clay areas	Y	Y
3 attenuate rainwater in ponds or open water features for gradual release	N	N
4 attenuate rainwater by storing in tanks or sealed water features for gradual release	Y	Y
5 discharge rainwater direct to a watercourse	N	N
6 discharge rainwater to a surface water sewer/drain	Y	Y
7 discharge rainwater to the combined sewer.	N	N

2c. Proposed Discharge Details	
Proposed discharge location	Controlled discharge to public storm sewer within Church Road
Has the owner/ regulator of the discharge location been consulted?	No

3. Drainage Strategy				
3a. Discharge Rates & Required Storage				
	Greenfield (GF) runoff rate (l/s)	Existing discharge rate (l/s) (5 minute duration)	Required storage for GF rate (m^3) (6 hour duration)	Proposed discharge rate (l/s)
Qbar	0.15	N/A	N/A	N/A
1 in 1	0.13	11.48	4.5	2
1 in 30	0.35	27.24	10.8	2
1 in 100	0.48	34.52	15.4	2
1 in 100 + CC	N/A	N/A	N/A	2
Climate change allowance used		40%		
3b. Principal Method of Flow Control		Pump		
3c. Proposed SuDS Measures				
		Catchment area (m^2)	Plan area (m^2)	Storage vol. (m^3)
Rainwater harvesting		0	0	0
Infiltration systems		670	670	50
Green roofs		0	0	0
Blue roofs		0	0	0
Filter strips		0	0	0
Filter drains		0	0	0
Bioretention / tree pits		0	0	0
Pervious pavements		0	0	0
Swales		0	0	0
Basins/ponds		0	0	0
Attenuation tanks		430	22.5	17.1

4. Supporting Information	
4a. Discharge & Drainage Strategy	Page/section of drainage report
Infiltration feasibility (2a) – geotechnical factual and interpretive reports, including infiltration results	12 - ‘Site Infiltration Testing’
Drainage hierarchy (2b)	11 - ‘Drainage Hierachy’
Proposed discharge details (2c) – utility plans, correspondence / approval from owner/regulator of discharge location	Refer to Appendix B
Discharge rates & storage (3a) – detailed hydrologic and hydraulic calculations	Refer to Appendix E
Proposed SuDS measures & specifications (3b)	10 - ‘SuDS Assessment’
4b. Other Supporting Details	Page/section of drainage report
Detailed Development Layout	Appendix D
Detailed drainage design drawings, including exceedance flow routes	Appendix D
Detailed landscaping plans	Appendix D
Maintenance strategy	Refer to separate document entitled ‘Management and Maintenance Plan for Sustainable Urban Drainage Systems (SuDS)
Demonstration of how the proposed SuDS measures improve:	
a) water quality of the runoff?	Filtration through granular material below permeable paving
b) biodiversity?	Refer to landscape statement by Outerspace
c) amenity?	Refer to landscape statement by Outerspace

Background information

Existing site / surface water discharge
This report refers to the development at the following address :

Meadows Hall
Land adjacent to 40 Church Road
Richmond
Surrey
TW10 6LN

Site Location

OS X (Eastings)	518392
OS Y (Northings)	174934
National Grid Reference	TQ 18392 74934

The existing site is classified as a brownfield site.

The existing site currently consists of tarmac surfacing, a previous building concrete slab from a former demolished day centre and areas of dense vegetation.

The image below has been taken from internet aerial mapping of the existing site.

The total site area within the redline boundary is approximately 1000m² (0.1ha).

A topographical survey / Underground service trace GPR survey drawing is included within Appendix A of this document.

The site topography varies from 14.5m AOD to 16m AOD.

The existing site is currently covered by 75% of impermeable surfaces. The total impermeable area assumed to be positively drained to the existing sewer network is approximately 750m².

Runoff rate and volume
The following table is a summary of the peak rainfall in l/s for various rainfall events and storm durations. No allowance for climate change is used to calculate existing peak rates. Refer to calculation sheet numbers 6004 to 6006.

Existing Peak Rainfall	1 year l/s	30 yrs l/s	100 yrs l/s
5 min	11.48	27.34	34.52
1 hour	2.67	6.42	8.46
6 hour	0.76	1.67	2.18

The following table is a summary of the volume runoff in m³ for various rainfall events and storm durations. No allowance for climate change is used to calculate existing volume runoff. Refer to calculation sheet numbers 6004 to 6006.

Existing Volume Runoff	1 year m³	30 yrs m³	100 yrs m³
5 min	3.44	8.20	10.36
1 hour	9.60	23.10	30.45
6 hour	16.45	36.07	46.98

A local water authority asset location search has been carried out and this is included within Appendix B this document.

Public storm and foul water sewers exist within Church Road which bounds the site to the west.

Currently no CCTV investigations have been carried out, however with the presence of an existing ground slab and existing manholes it is likely that a private drainage exists.

It is assumed the surface water runoff from the existing impermeable area is positively drained and discharged at an un-controlled rate to the existing public storm sewer in Church Road.

It is assumed the surface water from the existing green infrastructure infiltrates into the ground naturally.

A public lateral drain enters the site via crossing the southern site boundary and exits the site to the west.. The location of this sewer is below the footprint of the proposed Mews block. A diversion is therefore proposed as part of the development.

A ground investigation has been carried out by “Your Environment” in February 2022.

Site characteristics
The following is a summary of the design criteria used in the design for appraising the surface water management requirements for the proposed development. This information is based on site location from HR Wallingford mapping.

Soil characteristics

Soil type	2
Standard Percentage Runoff (SPR)	0.3

Hydrological characteristics

SAAR (mm)	598
M5-60 rainfall depth (mm)	20
r’ Ratio M5-60/M5-2 day	0.4
Hydrological region	6

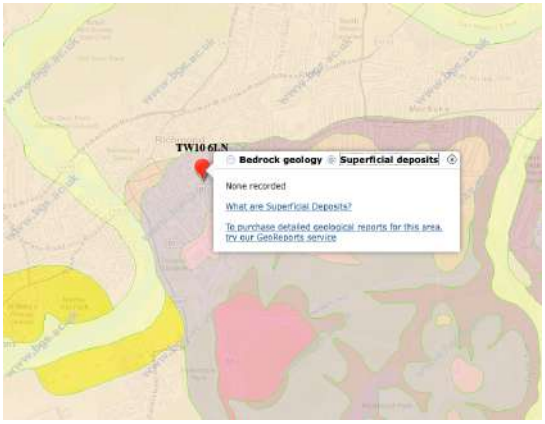
Greenfield runoff rates
The following has been calculated for the site. This relates to runoff rates prior to development from a greenfield situation to a brownfield status. Refer to calculation sheet number 6000.

QBar l/s	1 year l/s	30 yrs l/s	100 yrs l/s
0.15	0.13	0.35	0.48

Local rivers
The River Thames is located approximately 750m west of the site running from south to north.

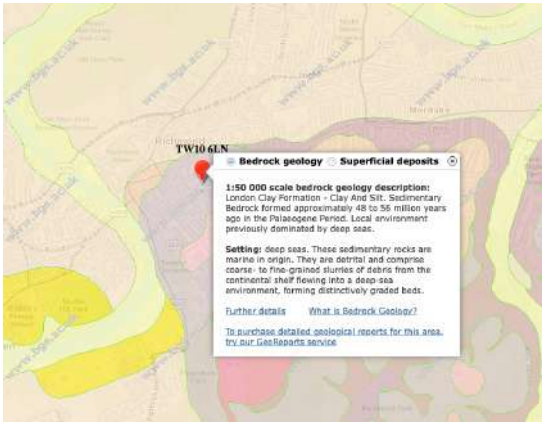
Site geology
The British Geological Society maps indicate the following :

No superficial deposits. The image below has been taken from the BGS website.



Bedrock geology. London Clay Formation - Clay And Silt. Sedimentary Bedrock formed approximately 48 to 56 million years ago in the Palaeogene Period. Local environment previously dominated by deep seas. The image below has been taken from the BGS website.

There are no records of BGS boreholes on the site.



Soils close to the surface
Soilscapes by Cranfield Soil and Agrifood Institute classifies the soil as Soilscape 18 : Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils.

Flood risk
A Flood map for planning report is included within Appendix C this document. This states 'your selected location is in flood zone 1, an area with a low probability of flooding'.

The site is located in an area designated as a 'critical drainage area', therefore a formal flood risk assessment is required.

A formal flood risk assessment has been carried out by STM environmental.

The flood risk assessment determined the following :

- There is low risk of flooding from fluvial, tidal, pluvial, reservoirs and canals, and groundwater.
- The site will remain dry during both the 1 in 30 year and the 1 in 100 year event. No significant surface water flooding incidents had been identified.
- The development will not significantly increase the site impermeable area. As such it is unlikely to have an adverse impact on local flood risk.

The FRA concluded that it is considered that overall flood risk to the proposed development is low. With the implementation of SuDS strategy, the proposal is unlikely to have an adverse impact on local flood rick.

Proposed drainage strategy

Requirements
London Borough of Richmond upon Thames Local Plan policy LP21 :

"The Council will require the use of Sustainable Drainage Systems (SuDS) in all development proposals. Applicants will have to demonstrate that their proposal complies with the following :

1. A reduction in surface water discharge to greenfield run-off rates wherever feasible.

2. Where greenfield run-off rates are not feasible, this will need to be demonstrated by the applicant, and in such instances, the minimum requirement is to achieve at least a 50% attenuation of the site's surface water runoff at peak times based on the levels existing prior to the development."

Non-statutory technical standards for sustainable drainage systems produced by Defra Clause S3 states the following :

"For developments which were previously developed, the peak runoff rate from the development to any drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event must be as close as reasonably practicable to the greenfield runoff rate from the development for the same rainfall event, but should never exceed the rate of discharge from the development prior to redevelopment for that event."

Non-statutory technical standards for sustainable drainage systems produced by Defra Clause S5 states the following :

"Where reasonably practicable, for developments which have been previously developed, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the greenfield runoff volume for the same event, but should never exceed the runoff volume from the development site prior to redevelopment for that event."

Proposed strategy
The proposed drainage strategy is shown on drawing 4821-610 included within Appendix D this document.

It is proposed to limit the volume of surface water leaving the site and limit the flow of any surface water that does need to connect to the public sewer network.

Storage
The storage calculations given in this document assume that there will be 100% surface water runoff from the roof surfaces.

External hardworks are to be permeable surfaces overlying a granular bed to provide attenuation and filtration prior to percolation into the strata below or where impermeable surfaces are proposed these fall towards green infrastructure to allow for infiltration into the ground.

The area positively drained and discharged to the public storm water sewer network is a total of 430m^2.

Attenuation tanks will be the plastic crate type storing surface water runoff volume prior to a pumped flow controlled release into a brake chamber with a gravity connection to the public storm sewer network.

Runoff rate and volume
The following table is a summary of the un-controlled peak rainfall in litres/second for various rainfall events and storm durations. A climate change allowance of 40% has been used to calculate proposed surface water runoff rates. Refer to calculation sheet numbers 6007 to 6009 inc.

Proposed peak rainfall	1 year l/s	30 yrs l/s	100 yrs l/s
5 min	9.15	22.38	28.73
1 hour	2.25	5.08	6.64
6 hour	0.63	1.29	1.65

The following table is a summary of the volume surface water runoff in cubic metres for various rainfall events and storm durations. A climate change allowance of 40% has been used to calculate proposed volume runoff. Refer to calculation sheet numbers 6007 to 6009 inc.

Proposed volume runoff	1 year m^3	30 yrs m^3	100 yrs m^3
5 min	2.75	6.71	8.62
1 hour	8.09	18.28	23.91
6 hour	13.70	27.81	35.73

Peak flow control
The development decreases the impermeable area and even with the allowance for climate change unattenuated runoff rates are less than existing.

The proposals currently decrease demand on the public storm sewer network.

It is good practice to provide a betterment when connected to the public sewer by reducing rates to a practical figure based on type of flow control and allowable space available for storage.

The proposed development considers the effects of climate change with a maximum flow controlled site discharge rate of 2 l/s.

Given site constraints this is as close to as reasonably practical to the greenfield runoff rate for the 1 in 100 year rainfall event (0.48 l/s) and therefore complies with the Clause S3.

The following table is a summary of the comparison of existing peak runoff, proposed un-attenuated peak runoff with the proposed flow controlled attenuated discharge rates for the 1 in 100 year rainfall event.

Comparison	5 min	1 hour	6 hour
Existing un-attenuated	34.52 l/s	8.46 l/s	2.18 l/s
Proposed **IF** un-attenuated	28.73 l/s	6.64 l/s	1.65 l/s
Proposed flow controlled and attenuated	2.0 l/s	2.0 l/s	2.0 l/s

Volume control
The development decreases the impermeable area and even with the allowance for climate change unattenuated runoff volumes are less than existing.

The proposals currently decrease demand on the public storm sewer network.

An attenuation volume in the region of 17m^3 is required to store surface water runoff and release at the proposed discharge rate.

The volume is provided in a single volume located centrally on the site.

Refer to calculation 6010 for further information.

Discharge point
Surface water will discharge into the public storm sewer located in Church Road via a new connection.

Asset records do not provide an invert for this sewer at the point of connection so at present it is conservatively assumed that it is 1.5m below ground level.

A GPR survey would be required to determine the depth of the sewer together with a Section 106 application for consent to connect submitted to the local water authority.

SuDS assessment

We have evaluated the use of SuDS techniques in relation to the development site:

SuDS technique	Flood reduction	Water quality improvement	Landscape and wildlife benefit	Comment
Living roofs Green roofs	Yes	Yes	Yes	Not possible due to the proposed pitched profile of the roof surfaces. Not appropriate for this site.
Basins and ponds Constructed wetlands Balancing ponds Detention basins Retention ponds	Yes	Yes	Yes	Not suitable for the use within the landscaped areas. Not appropriate for this site.
Filter strips and swales	Yes	Yes	Yes	Not suitable for the use within the landscaped areas. Not appropriate for this site.
Infiltration devices Soakaways Infiltration trenches and basins	Yes	Yes	Yes	Site investigation work to date has confirmed the ground may be suitable for use of surface water soakaways to discharge large volumes of runoff in concentrated areas. It is not possible to use soakaways to drain surface water runoff from building roofs due to constraints on location adjacent to building foundations.
Permeable surfaces and filter drains Gravelled areas Solid paving blocks Porous paving	Yes	Yes	No	Permeable paving is proposed within hard landscaped areas to drain and store runoff prior to infiltration.
Tanked and piped systems Over-sized pipes / tanks Storm cells	Yes	No	No	Proposed to attenuate roof runoff prior to a flow controlled discharge to public storm sewer. Appropriate for this site.

Discharge hierarchy

The following have been considered :

London Plan - Policy SI13

Criteria	Project specific comments
Rainwater harvesting (including a combination of green and blue roofs)	There are no requirements for rainwater harvesting as the proposed landscaping is designed around a minimum maintenance approach with plants that do not require irrigation. The architectural proposals are not suitable for use of blue roofs.
Infiltration techniques and green roofs	Infiltration testing has been carried out. It is not possible to use soakaways to drain surface water runoff from building roofs due to constraints on location adjacent to building foundations. Areas of green landscaping and permeable hard surfaces will infiltrate via natural processes into the soils overlying the natural geology.
Rainwater attenuation in open water features for gradual release	Not practical for this site as there is no room for open water features
Rainwater discharge direct to a watercourse (unless not appropriate)	No watercourses present therefore not applicable
Rainwater attenuation above ground (including blue roofs)	Not possible due to the proposed pitched profile of the roof surfaces.
Rainwater attenuation below ground	Below ground, large void ratio, plastic crate type storage is proposed to attenuate surface water runoff from the roofs
Rainwater discharge to a surface water sewer or drain	Impermeable roof surfaces to be flow controlled and discharged to the public storm sewer
Rainwater discharge to a combined sewer	None present therefore not applicable

Site infiltration testing

The following has been taken from the 'Land Contamination Phase 2 & Geotechnical Investigation' by Your environment. Document reference : YEX2487 – Meadows Hall, Richmond February 2022.

Site investigation results

Falling head permeability tests were undertaken at depths of 4.0mbgl in BH01, 2.2mbgl in BH02 during the advancement of the boreholes and 0.9mbgl in HTP01. All tests were completed within the natural granular strata. The soakage rates were good within 2 of the tests (BH02 and HTP01) recording soil infiltration rates of between $7.3x10^{-5}$ and $3.7x10^{-5}$ m/s. Within BH01 it was not possible to calculate an infiltration rate due to the water level not attaining 25% effective depth.

The natural granular strata generally demonstrated good infiltration rates with 2 of the 3 permeability tests demonstrating good soakage rates.

Therefore, it is considered that the natural granular strata beneath the site demonstrate good permeability and would promote the use of soakaways as an effective means of surface water disposal.

Free groundwater was not encountered during the investigation to a maximum depth of 20.45mbgl. However, groundwater levels are subject to seasonal variation or changes in local drainage conditions.

Exceedance

Overland flow routes

Designing for Exceedance in Urban Drainage - Good Practice (CIRIA C635) states the following :

'that the flooding of property should not occur in the event of a drainage system failure (caused either by extreme rainfall or a lack of maintenance)'

A drawing appended to this document indicates overland flow routes should the surface water system surcharge due to the capacity of the system being exceeded by flash floods or In the event of the drainage system fails or becomes blocked. Refer to drawing number 4821-611 included within Appendix D of this document.

External surfaces will fall away from the buildings and drain towards permeable external surfaces.

As infiltration is a suitable as the main method of controlling surface water for this site the green infrastructure will be used to control exceedance with paving laid to fall towards these areas.

Overland flow will not cause flooding to any buildings either within the development or adjacent to the site.

Foul water discharge

Proposals
There will be an increase in foul flow discharge from the site due to the proposed redevelopment.

A pre-planning enquiry has yet to be assessed by the local water authority for the proposed development. The assessment would be able to confirm if there will be sufficient sewerage capacity in the adjacent foul water sewer network to serve the development.

A conventional gravity foul drainage system is proposed.

Discharge point
Foul water will discharge into the public foul sewer located in Church Road via a new connection.

Asset records do not provide an invert for this sewer at the point of connection so at present it is conservatively assumed that it is 2.5m below ground level.

A GPR survey would be required to determine the depth of the sewer together with a Section 106 application for consent to connect submitted to the local water authority.

Conclusion

All drainage works shall be completed prior to first occupation.

We believe the Sustainable Urban Drainage System hierarchy has been considered fully, with as much of the surface water runoff as possible treated at source and attenuated and restricted to a lower discharge rate when connected to the public sewer.

The design has been prepared based on the principle that the building structures are treated as impermeable surfaces draining to attenuation with a flow controlled discharge and the green infrastructure and hard landscaping as permeable surfaces draining to ground.

SuDS components have been considered and utilised where possible for the proposed development and thus will reduce the peak rate of runoff of the surface water leaving the site, and therefore reduce flood risk at the site and elsewhere, as well as providing biodiversity and amenity value.

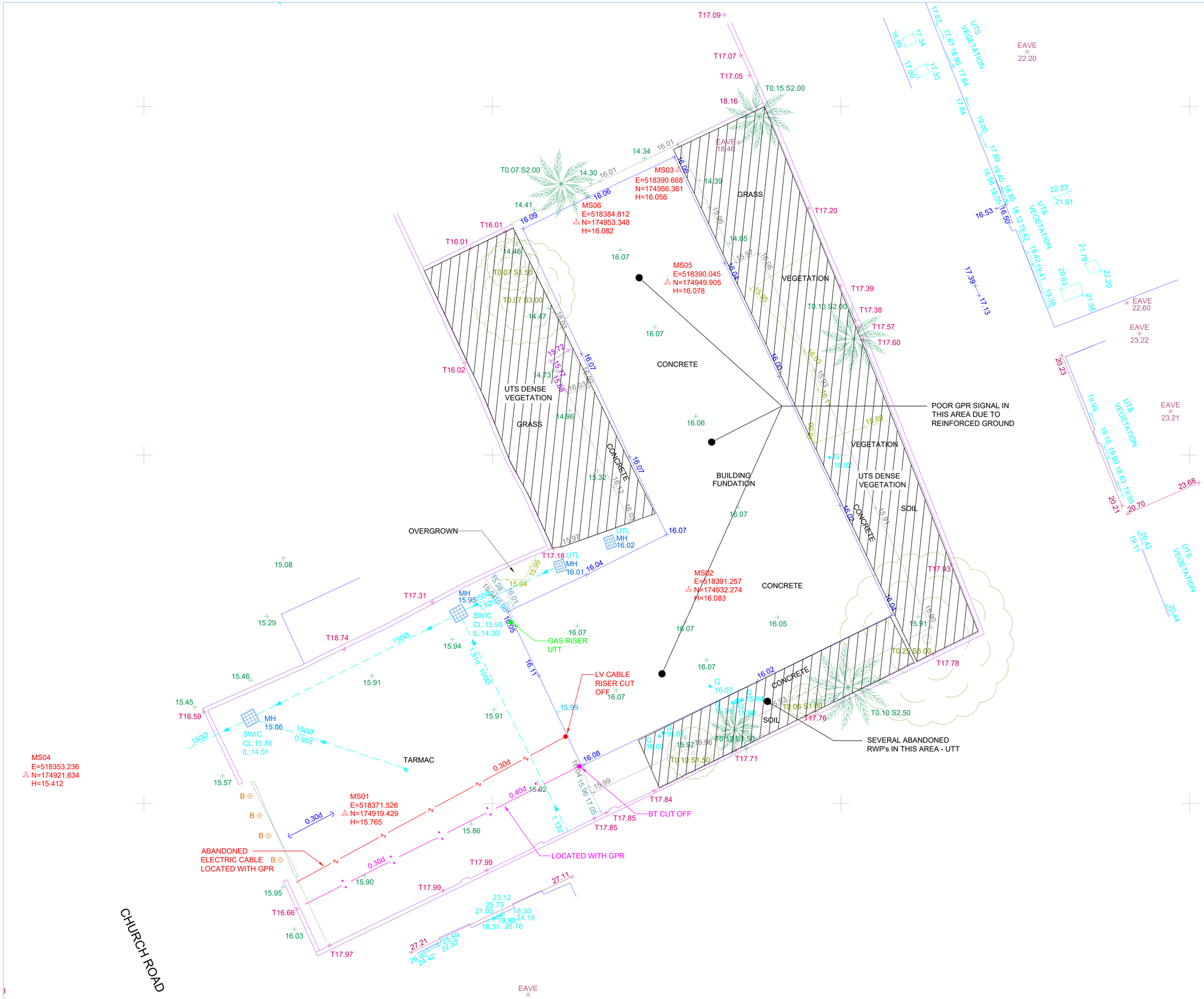
Surface water runoff from building roofs will be attenuated and restricted to a maximum discharge rate of 2 l/s discharging to the existing public storm sewer for all events up to the 1 in 100 year event with climate change allowance.

Landscape softworks will provide biodiversity and amenity value.

The risk of flooding at the proposed development site has been assessed from all sources, and it can be concluded that there is no risk of flooding to the proposed development site or adjacent properties.

All surface water calculations are appended to this document.

Appendix A - Topo survey and utility mapping



Electromagnetic and/or Ground Penetrating Radar techniques have been used to locate/map underground utilities and features on this drawing. Intersect Surveys Ltd has made every endeavour to make sure that the information contained within this drawing is accurate and of the highest quality. Intersect Surveys Ltd has used any record drawings provided by the client or by the Statutory Utility Providers, at the client's request, at the time of the survey. Any information taken from these drawings (e.g. pipe sizes and position) is not guaranteed. Historic record information is often incomplete and inaccurate and cannot be relied upon. Intersect Surveys Ltd is not liable for any topographical survey that has not been undertaken by us. Any inaccuracies relating to topographical plans/development plans/Ordnance Survey data that we have no control over is the liability of the customer. Where quoted, depth information of underground services/features is stated. Depths are generally within +/10% accurate, but cannot be guaranteed. Any depths shown on drains are usually to invert (base of drainage channel) unless otherwise stated. At Intersect Surveys Ltd we use skilled staff and modern, calibrated equipment to perform our surveys. However, the completeness of any underground survey cannot be 100% guaranteed and the results from these types of surveys are not infallible. If the location or depth of services/features is of particular importance to a project then it is strongly recommended that discussions are held with Intersect Surveys Ltd regarding any possible limitations or anomalies. It is also strongly advised that trial excavations should be undertaken to confirm survey results. We cannot be held responsible for any inaccuracies beyond those that could be reasonably expected by a competent company.

ABBREVIATIONS (Land & Utilities)

AR	ASSUMED ROUTE	KO	KERB OUTLET	SIL	SIGNAL LOST
AV	AIR VALVE	Lby	LIFEBUOY	SP	SIGN POST
BB	BELISHA BEACON	Lck	LOCK GATE	SPil	SHEET PILING
BO	BACKDROP	Ldr	LADDER	Spr	SPRING
BS	BOLLARD	LP	LAMP POST	SPT	SETTLING POINT
BH	BOREHOLE	LP	LAMP POST	ST	STOP TAP
BMsh	BASEMENT HATCH COVER	LV	LOW VOLTAGE	Stc	STILE
Bin	LITTER / GRIT SALT BIN	MgP	MOORING POST	Stl	STRUCTURE TOP LEVEL
BL	BASEMENT LIGHT	mH	METERS HIGH	Stp	STUMP (TREE)
Bol	BOLLARD	Mchy	MACHINERY	StP	STAND PIPE
BP	BOUNDARY POST	MH	MANHOLE	StPo	STAY POST
BR	BUS SHELTER	MkP	MARKER POST	Sw	SWITCH
BTIC	BRITISH TELECOM CHAMBER	MkE	MARKER POST (ELECTRIC)	SV	STOP VALVE
Cat\.	CATENARY LEVEL	MkG	MARKER POST (GAS)	SVP	SOIL VENT PIPE
CATV	CABLE TV COVER	MkR	MARKER POST (RAILWAY)	TBM	TEMPORARY BENCH MARK
CB	CONTROL BOX	MkT	MARKER POST (TELECOM)	TCB	TELEPHONE CALL BOX
CBt	CONVEYOR BELT	MkW	MARKER POST (WATER)	TCL	TELECOM CHAMBER COVER
CH	CHIMNEY	MP	MILE POST	TFR	TAKEN FROM RECORDS
CGrd	CATTLE GRID	MP	MOORING PILE	TL	TRAFFIC LIGHT
CHL	CHANNEL LEVEL	NL	NOT LOCATED	TL	TRAFFIC LIGHT
Chy	CHIMNEY	NP	NAME PLATE	TP	TELEGRAPH POLE
CI	CAST IRON	OSA	OUTSIDE SURVEY AREA	Tpl	TRIAL PIT
CL	COVER LEVEL	OSBM	O.S BENCH MARK	Tr	TROUGH
CO	CLEANING EYE	OGE	OVERGROWN EDGE	TS	TOTAL STATION
CP	CABLE PIT	OHC	OVERHEAD CABLE (UNSPECIFIED)	UTA	UNABLE TO GAIN ACCESS
CpL	COPING LEVEL	OHCE	OVERHEAD CABLE (ELECTRIC)	UTL	UNABLE TO LIFT
Cpwr	CAPSTAN	OHG	OVERHEAD GANTRY	UTR	UNABLE TO ROD
Cpst	CAMERA POST	OHP	OVERHEAD PIPE	UTS	UNABLE TO SURVEY
CR	CABLE RISER	OHT	OVERHEAD CABLE (TELECOM)	UTT	UNABLE TO TRACE
CrL	CROWN LEVEL	OP	OUTLET PIPE	VC	VITREOUS CLAY
CTV	CCTV CAMERA	P	PIPE	VP	VENT PIPE
CWM	CABLE WINDING MACHINERY	Pb	PARK BENCH	VR	VAPOUR RECOVERY
d	DEPTH	PB	POST BOX	VS	VENTILATION SHAFT
Dia	DIAMETER	PCrg	PEDESTRIAN CROSSING	VW	VALVE / SLUICE WHEEL
DS	DIRECTION SIGN	PE	POLYETHALINE	WB	WEIGHBRIDGE
EIC	ELECTRIC INSPECTION COVER	PF	PITCH FIBER	WL	WATER LEVEL
EoC	EDGE OF CANOPY	PI	PILE	WM	WATER METER
EOB	EDGE OF BUILDINGS	PI	PAVEMENT DETECTOR	WO	WASH OUT VALVE
EOT	END OF TRACE	Pmd	PLANT MOTOR DRIVE	Wr	WEIR
EP	ELECTRICITY POLE	PP	PETROL / DIESEL PUMP	WrL	WEIR LEVEL
ER	EARTH ROD	PR	PIPE RISER	WrPl	WEIR PLATE (TOP)
EShwr	EMERGENCY SHOWER	Psk	PENSTOCK	WWP	WASTE WATER PIPE
ESP	ELECTRICITY SUPPLY POINT	PU	PUMP		
Esw	ELECTRICAL SWITCH	PV	PIPE (VERTICAL)		FENCE TYPES:
FC	FIRE CLAY	PVC	POLYVINYL CHLORIDE	AMF	ARMCO
FH	FIRE HYDRANT	Pyl	PYLON	BWF	BARBED WIRE
FL	FLOOR LEVEL	Pz	PIEZOMETER	CBF	CLOSE BOARDED
FS	FLAG STAFF / POLE	RE	RODDING EYE	CIF	CORRUGATED IRON
G	GULLY	RG	RAIN GAUGE	CLF	CHAIN LINK
Gn	GRITH	RMP	RESERVOIR MONITORING PNT	CPF	CHESTNUT PALING
GP	GAS GUARD POST	RP	REFLECTOR POST	IRF	IRON RAILING
GPR	GPR TRACED	RP	RAIL POST	PBF	POST & BOARD
GPR	TRACED BY G.P.R	RSP	RAILWAY SIGNAL POST	PCF	POST & CHAIN
Gr/	GRILLE	RWP	RAIN WATER PIPE	PIF	POST & IRON RAIL
GV	GAS VALVE	S	SPREAD	PRF	POST & RAIL
Hgt	HEIGHT	SA	SURVEY ABANDONED	PWF	POST & WIRE
Hr/	HANDRAIL	SB	SIGN BOARD	SPF	STEEL PALLISADE
HV	HIGH VOLTAGE	Shlt	SHELTER (BUS / TRAM)	WMF	WIRE MESH
IC	INSPECTION CHAMBER	SL	SOFFIT LEVEL		
IL	INVERT LEVEL	SL	SOFFIT LEVEL		
IP	INLET PIPE	SIL	SILT LEVEL (TOP)		
JN	JUNCTION	SMP	SETTLEMENT MONITORING PNT		

KEY

- CCTV / CABLE TELEVISION
- COMBINED DRAINAGE
- COMMUNICATIONS CABLE
- COMPRESSED AIR
- DUCTING
- EARTH CABLE
- ELECTRIC CABLE
- END OF TRACE
- FOUL DRAINAGE
- FUEL PIPE
- GAS PIPE
- GAUGE LINE
- HEATING
- OFFSET FILL PIPE
- PUMPING MAIN
- RADAR AREA ANOMALY
- RADAR UTILITY TRACE
- SURFACE DRAINAGE
- SURVEY BOUNDARY
- TELECOM CABLE
- TRAFFIC LIGHTS
- UNIDENTIFIED
- VAPOUR RECOVERY
- VENT PIPE
- WATER PIPE
- O.S BENCH MARK
- SURVEY CONTROL STATION

Revision	Description	Date

Drawing Status: INFORMATION

INTERSECT SURVEYS
T: 0208 399 3851 M: 07535 236 812
www.intersectsurveys.co.uk

Client: YOUR ENVIRONMENT

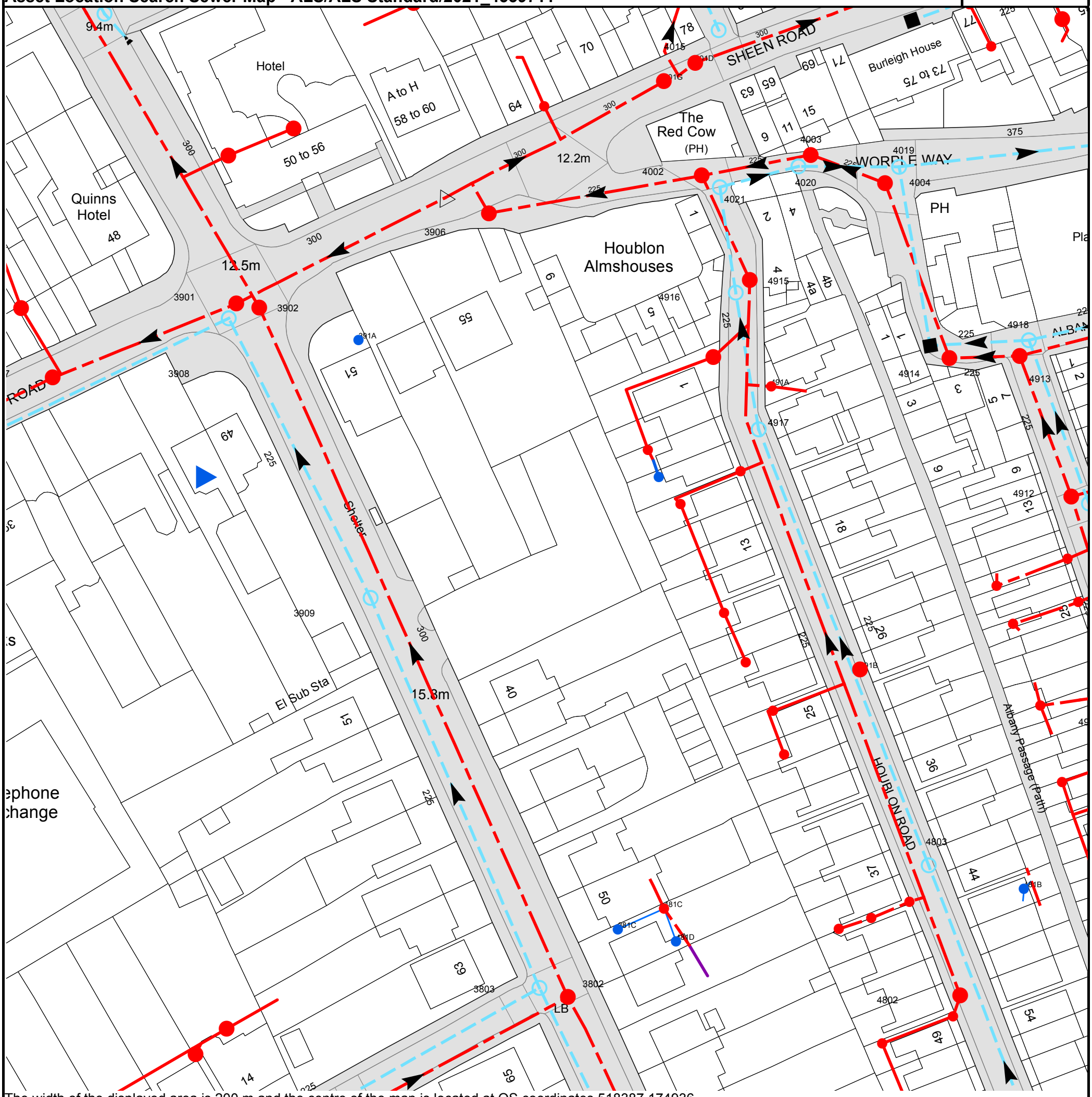
Project: MEADOWS HALL RICHMOND

Title: UNDERGROUND UTILITY SERVICES LAYOUT

Drawn	Surveyed:	Date
A.J.O.	A.S.	SEPT'20
Cad File: 115171-001		Scale 1:100@A1
Drawing Number 115171-001		Revision

Appendix B - Public asset search

Asset Location Search Sewer Map - ALS/ALS Standard/2021_4539711



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 518387,174936

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

NB. Levels quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates that no survey information is available

Manhole Reference	Manhole Cover Level	Manhole Invert Level
40XR	n/a	n/a
40XV	n/a	n/a
49YZ	n/a	n/a
4919	15.59	13.75
4912	15.55	12.92
4917	14.31	12.99
491A	n/a	n/a
4914	14.51	11.77
4913	14.78	13.15
4918	14.77	13.15
4915	15.31	11.81
4004	13.45	10.35
4019	13.28	11.15
4020	12.87	11.34
4003	12.93	9.88
481B	n/a	n/a
4803	17.72	16.3
48ZT	n/a	n/a
48XW	n/a	n/a
49WQ	n/a	n/a
49YR	n/a	n/a
49WY	n/a	n/a
49YW	n/a	n/a
49WX	n/a	n/a
49YV	n/a	n/a
49ZP	n/a	n/a
3009	9.41	7.69
30XY	n/a	n/a
491B	n/a	n/a
49WW	n/a	n/a
49XT	n/a	n/a
49WT	n/a	n/a
49XR	n/a	n/a
49XP	n/a	n/a
4916	13.3	11.92
3906	12.77	9.85
4021	12.77	11.38
4002	13.29	n/a
30XR	n/a	n/a
401G	n/a	n/a
401D	n/a	n/a
4015	11.51	9.63
40XQ	n/a	n/a
30ZW	n/a	n/a
29YS	n/a	n/a
2907	12.68	9.24
30XX	n/a	n/a
3908	12.53	11.16
3901	n/a	n/a
3902	12.54	n/a
391A	n/a	n/a
3909	14.97	13.75
3803	18.7	17.23
3802	18.85	15.94
381C	n/a	n/a
481C	n/a	n/a
481D	n/a	n/a
48WX	n/a	n/a
48WW	n/a	n/a
48XR	n/a	n/a
48TT	n/a	n/a
48XQ	n/a	n/a
4802	18.33	17.36
38ZQ	n/a	n/a
3806	n/a	n/a

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

ALS Sewer Map Key

Public Sewer Types (Operated & Maintained by Thames Water)

Foul: A sewer designed to convey waste water from domestic and industrial sources to a treatment works.

Surface Water: A sewer designed to convey surface water (e.g. rain water from roofs, yards and car parks) to rivers or watercourses.

Combined: A sewer designed to convey both waste water and surface water from domestic and industrial sources to a treatment works.

Trunk Surface Water

Trunk Foul

Storm Relief

Trunk Combined

Vent Pipe

Bio-solids (Sludge)

Proposed Thames Surface Water Sewer

Proposed Thames Water Foul Sewer

Gallery

Foul Rising Main

Surface Water Rising Main

Combined Rising Main

Sludge Rising Main

Proposed Thames Water Rising Main

Vacuum

Sewer Fittings

A feature in a sewer that does not affect the flow in the pipe. Example: a vent is a fitting as the function of a vent is to release excess gas.

Air Valve

Dam Chase

Fitting

Meter

Vent Column

Operational Controls

A feature in a sewer that changes or diverts the flow in the sewer. Example: A hydrobrake limits the flow passing downstream.

Control Valve

Drop Pipe

Ancillary

Weir

End Items

End symbols appear at the start or end of a sewer pipe. Examples: an Undefined End at the start of a sewer indicates that Thames Water has no knowledge of the position of the sewer upstream of that symbol, Outfall on a surface water sewer indicates that the pipe discharges into a stream or river.

Outfall

Undefined End

Inlet

Other Symbols

Symbols used on maps which do not fall under other general categories

Public/Private Pumping Station

Change of characteristic indicator (C.O.C.I.)

Invert Level

Summit

Areas

Lines denoting areas of underground surveys, etc.

Agreement

Operational Site

Chamber

Tunnel

Conduit Bridge

Other Sewer Types (Not Operated or Maintained by Thames Water)

Foul Sewer

Surface Water Sewer

Combined Sewer

Gulley

Culverted Watercourse

Proposed

Abandoned Sewer

Notes:

1) All levels associated with the plans are to Ordnance Datum Newlyn.

2) All measurements on the plans are metric.

3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate direction of flow.

4) Most private pipes are not shown on our plans, as in the past, this information has not been recorded.

5) 'na' or '0' on a manhole level indicates that data is unavailable.

6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in milimetres. Text next to a manhole indicates the manhole reference number and should not be taken as a measurement. If you are unsure about any text or symbology present on the plan, please contact a member of Property Searches on 0800 009 4540.

Appendix C - Flood map for planning

Flood map for planning

Your reference	Location (easting/northing)	Created
4821	**518384/174931**	**26 Dec 2021 20:09**

Your selected location is in flood zone 1, an area with a low probability of flooding.

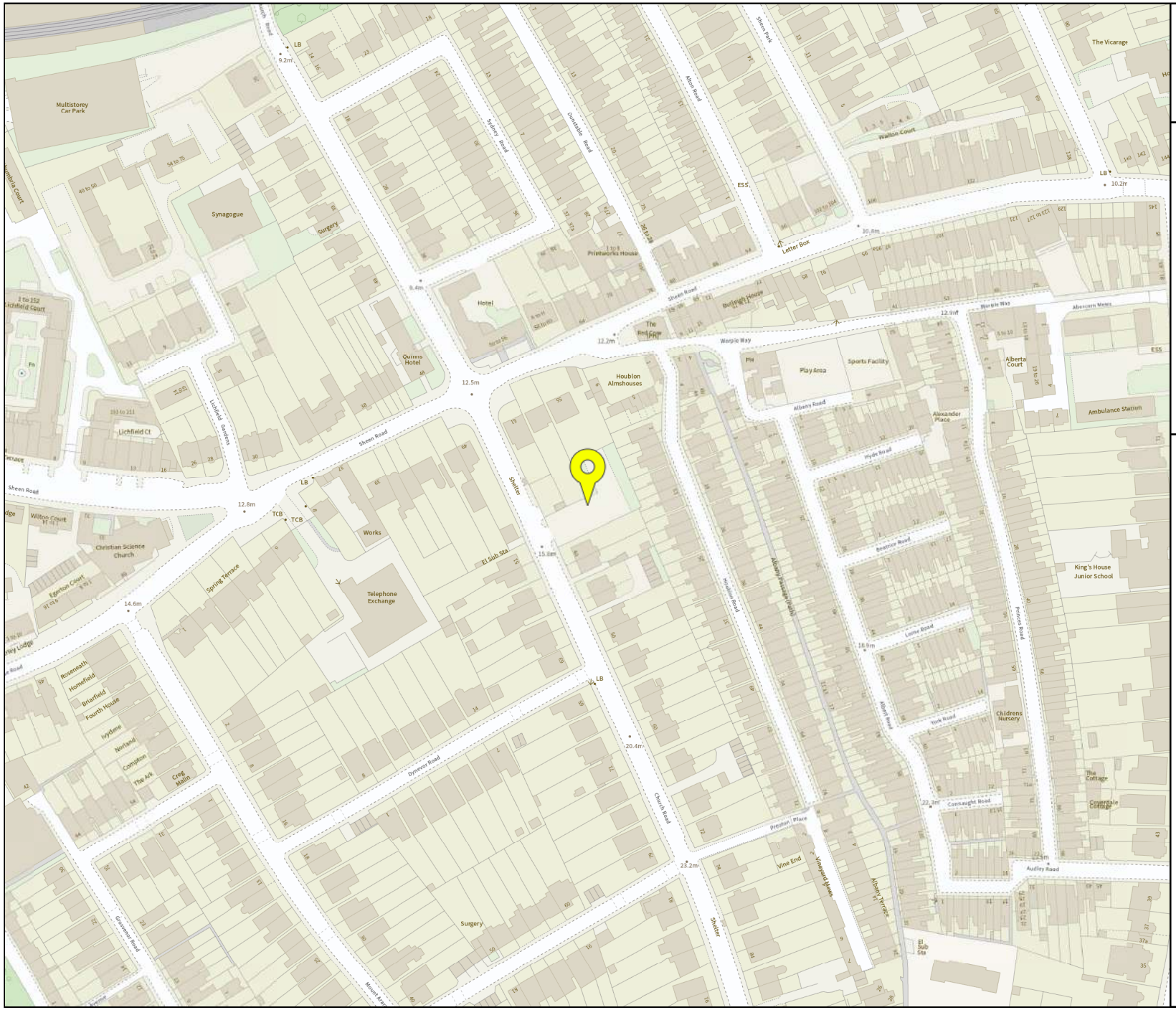
This means:

- you don't need to do a flood risk assessment if your development is smaller than 1 hectare and not affected by other sources of flooding
- you may need to do a flood risk assessment if your development is larger than 1 hectare or affected by other sources of flooding or in an area with critical drainage problems

Notes

The flood map for planning shows river and sea flooding data only. It doesn't include other sources of flooding. It is for use in development planning and flood risk assessments.

This information relates to the selected location and is not specific to any property within it. The map is updated regularly and is correct at the time of printing.



Environment Agency

Flood map for planning

Your reference
4821

Location (easting/northing)
518384/174931

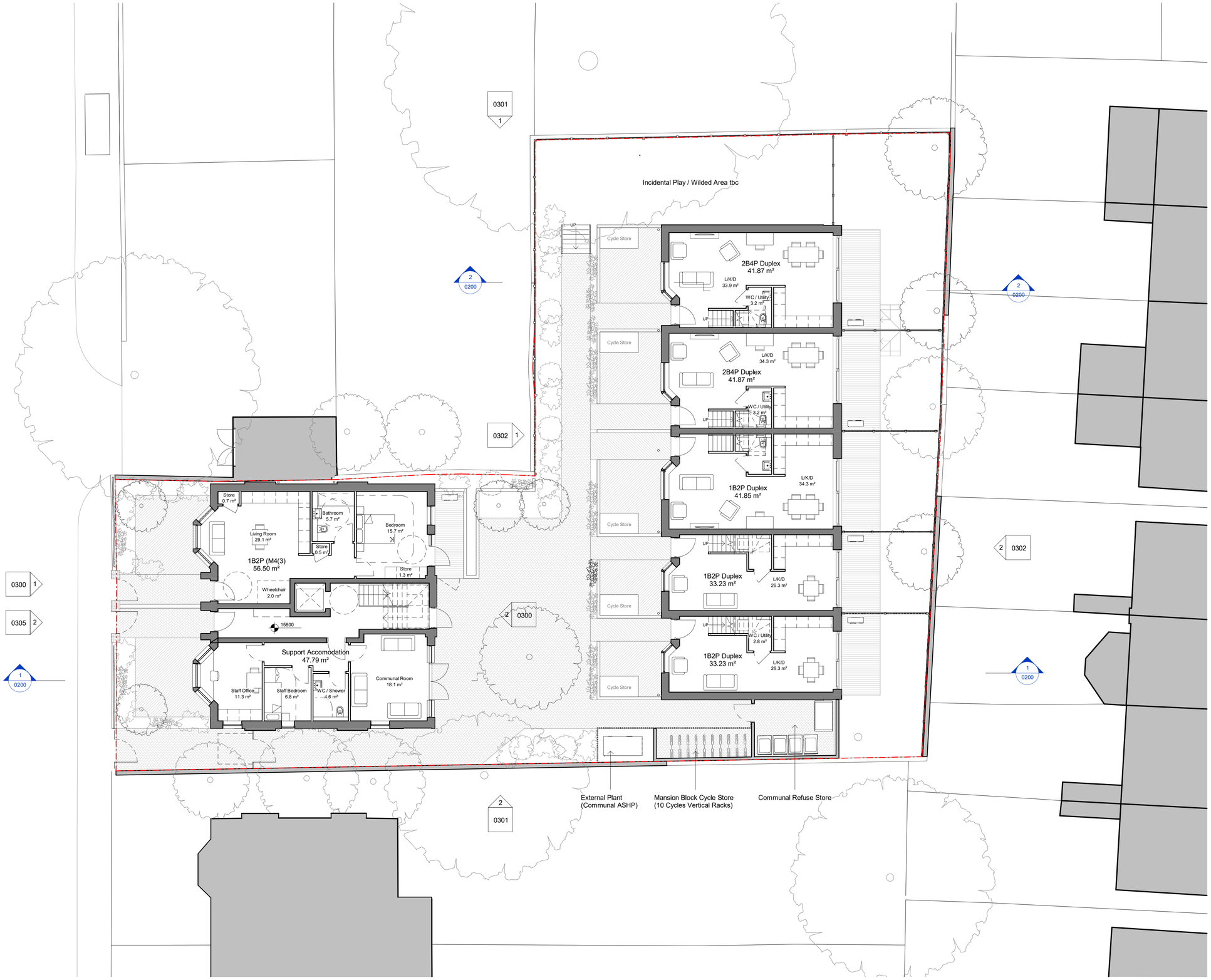
Scale
1:2500

Created
26 Dec 2021 20:09

- Selected point
- Flood zone 3
- Flood zone 3: areas benefitting from flood defences
- Flood zone 2
- Flood zone 1
- Flood defence
- Main river
- Flood storage area

0 20 40 60m

Appendix D - Drawings



Tree Canopy Zone
(translated from Tree Survey)

Root Protection Zone
(translated from Tree Survey)

DRAFT

Date

Revision	Date	Description

project
Meadows Hall

drawing title
Proposed Ground Floor Plan

drawing number WP-0733-A-0110

revision

scale @ A1 1 : 100

First Issue 10/12/2021

drawing purpose
DRAFT

WIMSHURST PELLERITI

The Mews,
6 Putney Common, SW15 1HL

0208 780 2206

info@wp.uk.com
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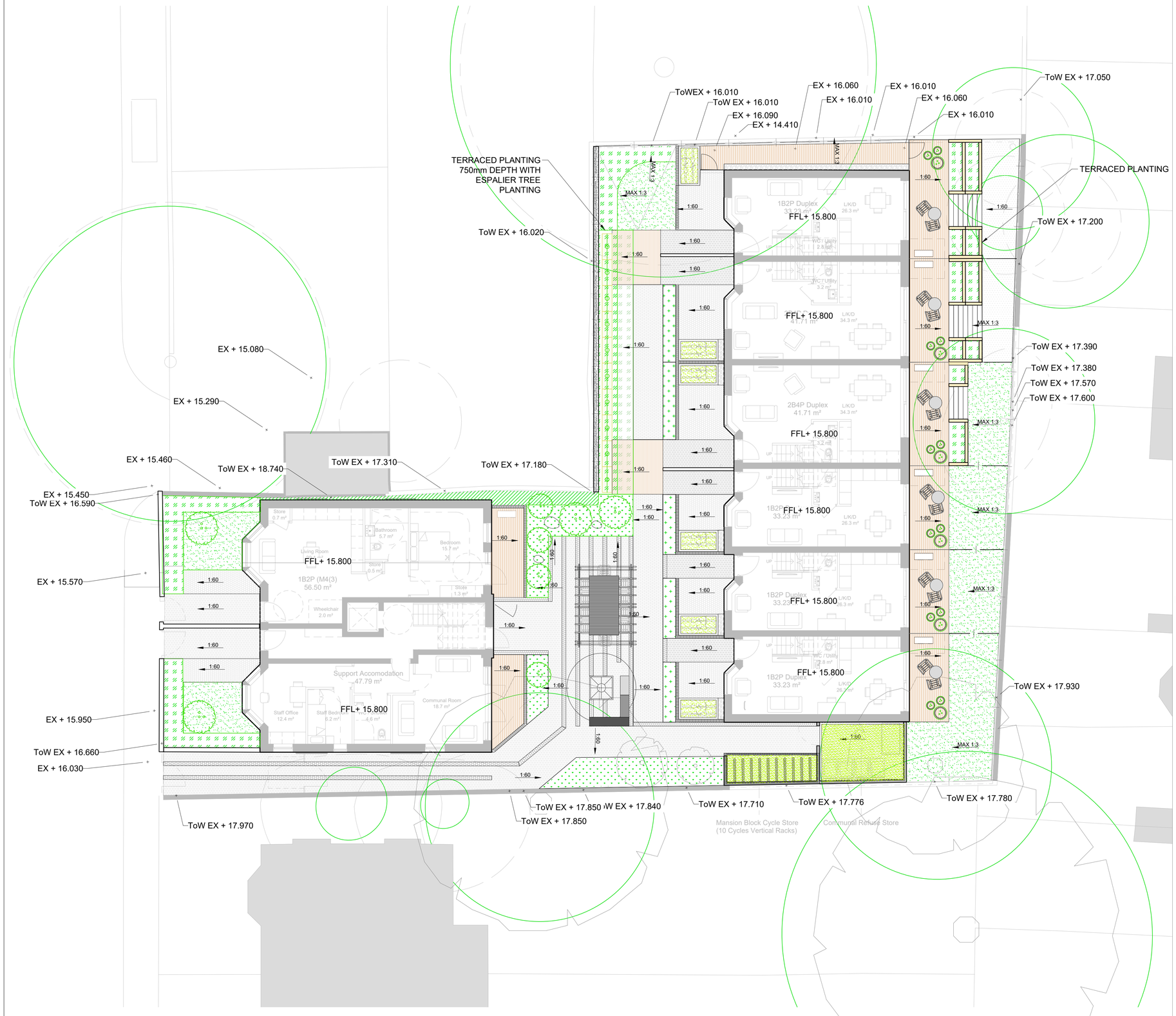


NOTE:
The proposals are based on:

- Topo survey MSL38026-T dated June 2021.
- Limited Existing levels information indicated therefore assumed ground level in some locations.
- Proposed levels and surfaces finishes to be coordinated with Engineers.
- All proposals within RPA to be coordinated with Arb Consultant.

KEY

- EXISTING TREE TO BE RETAINED WITH ASSOCIATED RPA
- BOUNDARY LINE
- PROPOSED MULTISTEM TREE
- TERRACED PLANTING APPROX. 750mm DEPTH W ESPALIER TREE PLANTIN
- PROPOSED SINGLE STEM FOCAL TREE
- EXISTING PERIMETER FENCE TO BE RETAINED
- EXISTING WALL TO BE RETAINED
- ToW EX + 16.010 — TOP OF THE WALL EXISTING LEVELS
- EX + 16.060 — EXISTING LEVELS
- 1:60 — PROPOSED LEVEL GRADIENT

PAVING

- HIGH QUALITY PAVING CONCRETE SETT
- HIGH QUALITY PAVING CONCRETE BLOCKS
- COMPOSITE DECKING
- HIGH QUALITY LOOSE GRAVEL
- MAINTENANCE GRAVEL STRIP

EDGES & WALLS

- EDGING
- RETAINING WALL FOR LEVEL CHANGE TO BE CONFIRMED BY STRUCTURAL ENG'S
- RETAINING CONCRETE WALL WITH TRELLIS ON TOP TO BE CONFIRMED BY STRUCTURAL ENG'S
- WALL BETWEEN APARTMENTS & MEWS

PLAY EQUIPMENT & FURNITURE

- BOULDERS (INFORMAL PLAY)
- SCULPTURAL BENCH (INFORMAL PLAY)
- TREE GRILL
- RAISED PLANTERS
- INDICATIVE TABLES & CHAIRS ON TERRACES
- INDICATIVE POTS
- PERGOLA WITH TABLE & CHAIRS FOR 10 PEOPLE
- CYCLE STORE WITH GREEN ROOF (MEWS BLOCK)
- CYCLE STORE WITH GREEN ROOF (MANSION BLOCK)
- REFUSE STORE WITH GREEN ROOF
- PRIVATE SCREENS
- TIMBER FENCE
- METAL FENCE
- PROPOSED GATE & RAILING
- STARS RESPONDING TO LEVELS CHANGE WITH ASSOCIATED HANDRAILS

PLANTING

- LAWN
- ORNAMENTAL PLANTING
- TERRACED PLANTING APPROX. 750mm DEPTH
- EXTENSIVE GREEN ROOF
- BOUNDARY HEDGE
- DEFENSIBLE PLANTING

Revisions:
(see rev clouds and notes for additional explanation of change)

Rev.	Description	Dwn.	Chk.	Date
WIP01		SS	BT	01.12.2021
WIP02		SS	BT	08.12.2021

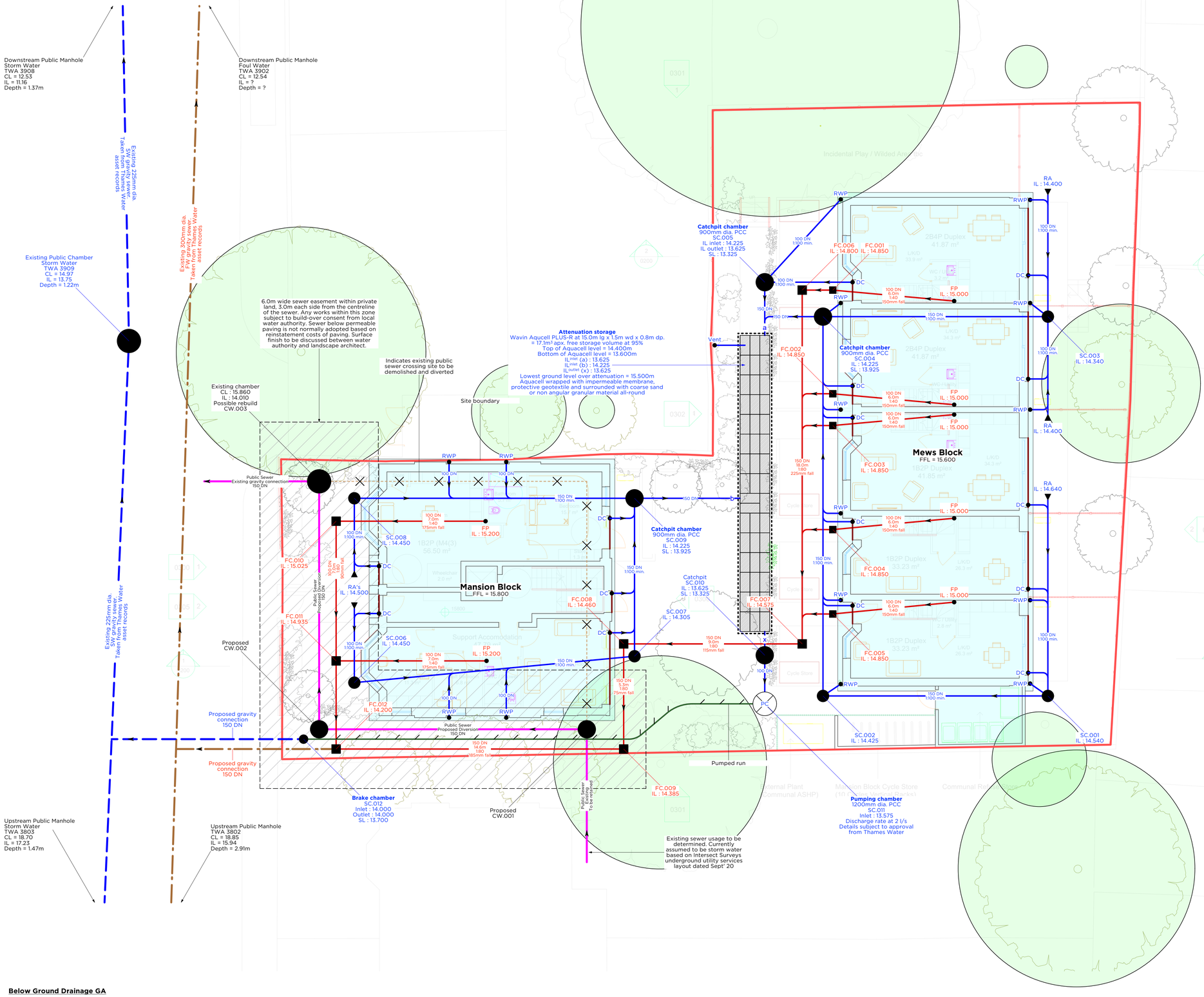
outerspace
urban + landscape design
the boathouse 27 ferry road
teddington middlesex tw11 9nn
t. 00 44 (0)20 8973 0070 e. info@outerspaceuk.com

Client: RHP	Project No: LN00651
Project: MEADOWS HALL	Dwg No: **L-100**
Drawing Title: **GENERAL ARRANGEMENT PLAN**	Status: **WIP**

Date	Scale	Rev	Dwn by:	Chk by:
01.12.2021	**1:100@ A1**	**WIP02**	SS	BT

Important note

ALL information subject to detailed design. This is a strategy **ONLY.**



Below Ground Drainage GA

Scale - 1:100

0 10 20 30m

Discharge strategy, general principles

General
For full details of discharge strategy refer to the following documents :

4821-MOM-MED-RPT-BGDstrategy-P01
4821-MOM-MED-RPT-MMplan-P01

Surface Water

Infiltration
Falling head permeability tests have been undertaken. All tests were completed within the natural granular strata. The soakage rates had been calculated as 7.3×10^{-5} and 5.7×10^{-5} m/s. Results from these tests provide suitable rates for dealing with surface water run-off from hard landscape surfaces. All soft landscaping will naturally infiltrate.

Hard permeable surfaces
Water landing on hard permeable surfaces will percolate through the joints in the paving and get captured in a gravel bed below the surface build-up. The gravel bed will filtrate and treat the run-off prior to infiltration into the natural soils. The gravel bed will act as long term attenuation.

Run-off from buildings
Surface water run-off from roofs will be taken to the attenuation storage located centrally on the site. The outflow from the storage will be restricted by a pumped flow control to an acceptable discharge rate. At present the site discharge rate has been set to 2 l/s. This rate is to be agreed with the LLFA and TWA. Storage requirement based on a 100 year plus 40% climate change rainfall event is acheivable on site. A brake chamber and new gravity connection to the public storm water sewer in Church Road will be required. This connection will be subject to a Section 106 application.

Foul Water

Foul water from buildings
Foul water will connect into the public foul water sewer in Church Road. This connection will be subject to a Section 106 application.

Public Sewer Diversion

A diversion of a public sewer is required due to its current location within the development proposals. The proposed route will run parallel to the south and to the west of the proposed mansion block with a connection onto the existing run that connects to the one of the public sewers within Church Road. The diversion, building close-to and abandonment of the existing sewer will all be subject to an agreement with TWA. All sewer works to be built to adoptable standards and under a section 185 agreement.

Specification

Surface Water General
All surface water drainage to be 100mm DN unless where indicated
Pumping chamber to be 1200mm dia.
Catchpit chambers to be 900mm dia. PCC
Brake chamber to be 900mm dia. PCC
All chambers other than the above to be 450/600 dia PPIC

Foul Water General
All foul water drainage to be 100mm DN unless where indicated
All chambers other than the above to be 450/600 dia PPIC
Soffits level where chambers accept and receive different pipe DN's

Sewer Diversion General
Diversion set to constant gradient to suit existing level information
Sewer chambers to be 1200mm dia. PCC

Key

Private drainage - Existing
Combined waste gravity drain — CW
Foul waste gravity drain — FW
Surface water gravity drain — SW
Drain to be made redundant
Drain to be demolished

Private drainage - Proposed
Combined waste gravity drain — CW
Foul waste gravity drain — FW
Surface water gravity drain — SW
Surface water land drain — LD
Surface water linear channel — LC

Private drainage - Miscellenous
Pumped pipeline - Foul or Surface
Perforated drain - Foul or Surface

Public drainage
Combined waste sewer — CW
Foul waste sewer — FW
Surface water sewer — SW

Foul waste

FC.001	Chamber
FR.001	Drain run
SS	Stub stack
SVP	Soil vent pipe
AAV	Air admittence valve
FP	Generic foul point
TG	Trapped gully

Surface water

SC.001	Chamber
1.000	Drain run
RWP	Rain water pipe
BIG	Back inlet gully
YG	Yard gully

Miscellenous

IL	Invert level
CL	Cover level
PPIC	Polypropylene inspection chamber
PCC	Precast concrete chamber
BWK	Brick chamber
MAC	Mini Access Chamber
SD	Slot drain
DC	Drainage channel
LC	Linear channel
VC	Vitrified clay
PP	Plastic pipe
RP	Rocker pipe
SL	Sump level
BD	Backdrop connection
IT	Interseptor trap
DN	Diameter

Tree root protection zone

Impermeable roof area

Rev	Date	By	Description
00	10.12.21	dp	Issued for information only
P01	17.06.22	dp	Issued for information only
P02	08.07.22	dp	Planning issue

NOT FOR CONSTRUCTION

Date	Scale	Format
Dec '21	1:100	A1
Drawn	Reviewed	Approved
dp		

Work Stage & Reason For Issue
Outline Design
Planning

Architect
Wimshurst Pelleriti

Client
-

Project Number & Title
4821
Meadows Hall
Richmond

Sheet Number & Title
00610
GA Plan
Drainage Strategy

MOMENTUM
structural engineers

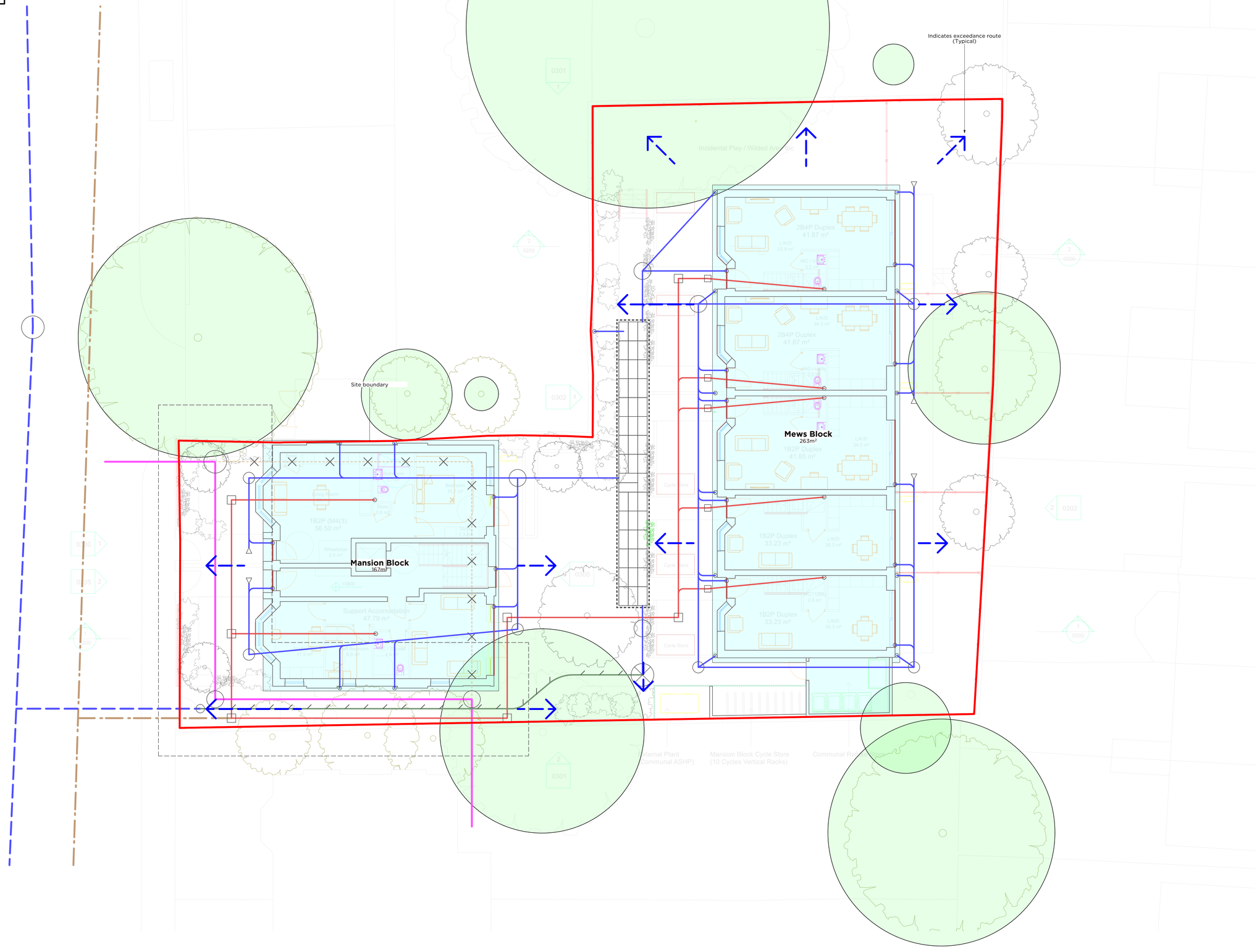
Bath 01225 444194 | London 020 7739 6939

www.momentumengineering.com

Document Reference
4821-MOM-XX-XX-DR-C-00610
P02

Important note

For further confirmation of finish floor levels and external levels including levels at dwelling entrance thresholds refer to drawings by the Architect and Landscape Architect.



0 | 10 | 20 | 30m

This drawing is to be read in conjunction with all other relevant contract documents and other consultants information.

Do not scale from this drawing or digital data contained within. Dimensional accuracy may not be a true representation of actual setting out.

Work only to figured dimensions. If in doubt, ask.

Unless noted otherwise, all dimensions in millimeters, all levels in meters.

All levels and dimensions to be checked on site by persons carrying out the work. Please report any discrepencies to Momentum.

Rev	Date	By	Description
P01	08.07.22	dp	Planning issue

NOT FOR CONSTRUCTION

Date	Scale	Format
Jul '22	1:100	A1
Drawn	Reviewed	Approved
dp		

Work Stage & Reason For Issue
Outline Design
Planning

Architect
Wimshurst Pelleriti

Client
-

Project Number & Title
4821
Meadows Hall
Richmond

Sheet Number & Title
00610
GA Plan
Exceedance

MOMENTUM
structural engineers

Bath 01225 444194 | London 020 7739 6939

www.momentumengineering.com

Document Reference
4821-MOM-XX-XX-DR-C-00611
P01

Appendix E - Calculations

Project

Meadows Hall, Richmond

Title	Date	By	Reference
Greenfield Runoff Rate	05/07/2022	dp	4821-MOM-XX-XX-CA-C- **6000**

Area (m²)	1000
Area (km²)	0.001
Area (ha)	0.1
SAAR (mm)	598
SPR	0.3
Hydrological	Region 6

Soil Indices	SPR
1 = sandy highly permeable	0.1
2	0.3
3	0.37
4 = heavy clay	0.47
5 = rock	0.53

For SAAR readings refer to http://www.uksuds.com/drainage-tools-members/greenfield-runoff-rate-tool.html

Hydrological Regions

For sites greater than 50 ha (500,000m²)

MEAN ANNUAL GREENFIELD PEAK FLOW

The method of calculating the rate of greenfield runoff in this tool is based on Flood Estimation for Small Catchments, Report no. 124 (Institute of Hydrology, 1994) which is based on the investigation of 71 small rural catchments (<25 km²). A regression equation was produced to calculate $Qbar_{rural}$, the mean annual flood:

- $Qbar_{rural} = 0.00108 \cdot (0.01 \cdot AREA)^{0.89} \cdot SAAR^{1.17} \cdot SPR^{2.17} \cdot 1000$, l/s

where:

- $Qbar_{rural}$ is the mean annual flood flow from a rural catchment in l/s (approximately 2.3 year return period).
- AREA is the area of the catchment in ha.
- SAAR is the standard average annual rainfall for the period 1941 to 1970 in mm.
- SPR is Standard Percentage Runoff coefficient for the SOIL category.

	1 in 2.3 Yrs	1 in 1 Yr	1 in 30 Yrs	1 in 100 Yrs
Growth Factor	1.00	0.85	2.30	3.19
QBAR (l/s)	0.30	0.26	0.69	0.96

For sites less than 50 ha (500,000m²)

$Qbar_{rural} = (0.583 \cdot SAAR^{3.17} \cdot SPR^{2.17}) \cdot (AREA/50)$, l/s

	1 in 2.3 Yrs	1 in 1 Yr	1 in 30 Yrs	1 in 100 Yrs
Growth Factor	1.00	0.85	2.30	3.19
QBARRURAL (l/s)	0.15	0.13	0.35	0.48

Project

Meadows Hall, Richmond

Title	Date	By	Reference
Greenfield Runoff Volume (1in1)	05/07/2022	dp	4821-MOM-XX-XX-CA-C- **6001**

Design Parameters

Return Period (Yrs)	1
r =	0.4
M5_60 (mm)	20
P Climate (%)	0
CWI	90
DPRCWI	-9.45

Area (m^2)	1000
Area (km^2)	0.001
Area (ha)	0.1
SAAR (mm)	598
SPR	0.3
Hydrological	Region 6

Design Rainfall

Duration min	Growth Factor Z1	M5 Rainfall mm	Growth Factor Z2	Return Period Rainfall mm	Rainfall Intensity mm/hr
5	0.37	7.47	0.62	4.59	55.11
10	0.52	10.47	0.61	6.39	38.37
15	0.63	12.67	0.62	7.79	31.18
30	0.80	16.07	0.62	10.03	20.06
60	1.00	20.00	0.64	12.80	12.80
120	1.21	24.13	0.66	15.84	7.92
240	1.45	28.93	0.68	19.55	4.89
360	1.60	32.07	0.68	21.94	3.66
600	1.79	35.87	0.69	24.81	2.48
1,440	2.24	44.80	0.71	31.79	1.32

Pre-development Greenfield Runoff Volume

Duration min	DPR,rain	PR (%)	Runoff Volume (m^3)
5.0	0.0	20.6	0.9
15.0	0.0	20.6	1.6
60.0	0.0	20.6	2.6
360.0	0.0	20.6	4.5

Currently set up for England and Wales Only using FSR data

Project

Meadows Hall, Richmond

Title	Date	By	Reference
Greenfield Runoff Volume (1in30)	05/07/2022	dp	4821-MOM-XX-XX-CA-C- **6002**

Design Parameters

Return Period (Yrs)	30
r =	0.4
M5_60 (mm)	20
P Climate (%)	0
CWI	90
DPRCWI	-9.45

Area (m^2)	1000
Area (km^2)	0.001
Area (ha)	0.1
SAAR (mm)	598
SPR	0.3
Hydrological	Region 6

Design Rainfall

Duration min	Growth Factor Z1	M5 Rainfall mm	Growth Factor Z2	Return Period Rainfall mm	Rainfall Intensity mm/hr
5	0.37	7.47	1.46	10.94	131.23
10	0.52	10.47	1.49	15.63	93.81
15	0.63	12.67	1.51	19.14	76.57
30	0.80	16.07	1.53	24.62	49.23
60	1.00	20.00	1.54	30.80	30.80
120	1.21	24.13	1.53	36.97	18.48
240	1.45	28.93	1.51	43.81	10.95
360	1.60	32.07	1.50	48.09	8.01
600	1.79	35.87	1.48	53.11	5.31
1,440	2.24	44.80	1.44	64.55	2.69

Pre-development Greenfield Runoff Volume

Duration min	DPR,rain	PR (%)	Runoff Volume (m^3)
5.0	0.0	20.6	2.2
15.0	0.0	20.6	3.9
60.0	0.0	20.6	6.3
360.0	1.9	22.5	10.8

Currently set up for England and Wales Only using FSR data

Project

Meadows Hall, Richmond

Title	Date	By	Reference
Greenfield Runoff Volume (1in100)	05/07/2022	dp	4821-MOM-XX-XX-CA-C- **6003**

Design Parameters

Return Period (Yrs)	100
r =	0.4
M5_60 (mm)	20
P Climate (%)	0
CWI	90
DPRCWI	-9.45

Area (m^2)	1000
Area (km^2)	0.001
Area (ha)	0.1
SAAR (mm)	598
SPR	0.3
Hydrological	Region 6

Design Rainfall

Duration min	Growth Factor Z1	M5 Rainfall mm	Growth Factor Z2	Return Period Rainfall mm	Rainfall Intensity mm/hr
5	0.37	7.47	1.85	13.81	165.69
10	0.52	10.47	1.92	20.07	120.42
15	0.63	12.67	1.95	24.73	98.94
30	0.80	16.07	2.00	32.11	64.22
60	1.00	20.00	2.03	40.60	40.60
120	1.21	24.13	2.01	48.59	24.30
240	1.45	28.93	1.98	57.25	14.31
360	1.60	32.07	1.95	62.64	10.44
600	1.79	35.87	1.92	68.97	6.90
1,440	2.24	44.80	1.85	82.95	3.46

Pre-development Greenfield Runoff Volume

Duration min	DPR,rain	PR (%)	Runoff Volume (m^3)
5.0	0.0	20.6	2.8
15.0	0.0	20.6	5.1
60.0	0.3	20.9	8.5
360.0	4.0	24.5	15.4

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Project

Meadows Hall, Richmond

MOMENTUM structural engineers

Title	Date	By	Reference
Existing Runoff - 1 Year return period	05/07/2022	dp	4821-MOM-XX-XX-CA-C- **6004**

Duration min	Duration sec	Rainfall Intensity mm/hr	Impermeable Area m^2	Peak Discharge l/s	Volume Runoff m^3
5	300	55.11	750	11.48	3.44
10	600	38.37	750	7.99	4.80
15	900	31.18	750	6.50	5.85
30	1,800	20.06	750	4.18	7.52
60	3,600	12.80	750	2.67	9.60
120	7,200	7.92	750	1.65	11.88
240	14,400	4.89	750	1.02	14.66
360	21,600	3.66	750	0.76	16.45
600	36,000	2.48	750	0.52	18.61
1,440	86,400	1.32	750	0.28	23.84

Rainfall Intensity l/s per m^2	Return Period Rainfall mm
0.015	4.59
0.011	6.39
0.009	7.79
0.006	10.03
0.004	12.80
0.002	15.84
0.001	19.55
0.001	21.94
0.001	24.81
0.000	31.79

User Input

IMP Area	750	.....	m^2
r =	0.40	.....	Ratio of 60 min to 2 day rainfalls of 5 yr return period
P Climate (%)	0	.....	Increase of rainfall intensity due to global warming (%)

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Project

Meadows Hall, Richmond

MOMENTUM structural engineers

Title	Date	By	Reference
Existing Runoff - 30 Year return period	05/07/2022	dp	4821-MOM-XX-XX-CA-C- **6005**

Duration min	Duration sec	Rainfall Intensity mm/hr	Impermeable Area m^2	Peak Discharge l/s	Volume Runoff m^3
5	300	131.23	750	27.34	8.20
10	600	93.81	750	19.54	11.73
15	900	76.57	750	15.95	14.36
30	1,800	49.23	750	10.26	18.46
60	3,600	30.80	750	6.42	23.10
120	7,200	18.48	750	3.85	27.72
240	14,400	10.95	750	2.28	32.86
360	21,600	8.01	750	1.67	36.07
600	36,000	5.31	750	1.11	39.83
1,440	86,400	2.69	750	0.56	48.41

Rainfall Intensity l/s per m^2	Return Period Rainfall mm
0.036	10.94
0.026	15.63
0.021	19.14
0.014	24.62
0.009	30.80
0.005	36.97
0.003	43.81
0.002	48.09
0.001	53.11
0.001	64.55

User Input

IMP Area	750	.....	m^2
r =	0.40	.....	Ratio of 60 min to 2 day rainfalls of 5 yr return period
P Climate (%)	0	.....	Increase of rainfall intensity due to global warming (%)

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Project

Meadows Hall, Richmond

MOMENTUM structural engineers

Title	Date	By	Reference
Existing Runoff - 100 Year return period	05/07/2022	dp	4821-MOM-XX-XX-CA-C- **6006**

Duration min	Duration sec	Rainfall Intensity mm/hr	Impermeable Area m^2	Peak Discharge l/s	Volume Runoff m^3
5	300	165.69	750	34.52	10.36
10	600	120.42	750	25.09	15.05
15	900	98.94	750	20.61	18.55
30	1,800	64.22	750	13.38	24.08
60	3,600	40.60	750	8.46	30.45
120	7,200	24.30	750	5.06	36.44
240	14,400	14.31	750	2.98	42.93
360	21,600	10.44	750	2.18	46.98
600	36,000	6.90	750	1.44	51.73
1,440	86,400	3.46	750	0.72	62.21

Rainfall Intensity l/s per m^2	Return Period Rainfall mm
0.046	13.81
0.033	20.07
0.027	24.73
0.018	32.11
0.011	40.60
0.007	48.59
0.004	57.25
0.003	62.64
0.002	68.97
0.001	82.95

User Input

IMP Area	750	.....	m^2
r =	0.40	.....	Ratio of 60 min to 2 day rainfalls of 5 yr return period
P Climate (%)	0	.....	Increase of rainfall intensity due to global warming (%)

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Project

Meadows Hall, Richmond

MOMENTUM structural engineers

Title	Date	By	Reference
Proposed Runoff - 1 Year return period (c/w CC)	05/07/2022	dp	4821-MOM-XX-XX-CA-C- **6007**

Duration min	Duration sec	Rainfall Intensity mm/hr	Impermeable Area m^2	Peak Discharge l/s	Volume Runoff m^3
5	300	76.63	430	9.15	2.75
10	600	54.45	430	6.50	3.90
15	900	44.75	430	5.35	4.81
30	1,800	29.24	430	3.49	6.29
60	3,600	18.82	430	2.25	8.09
120	7,200	11.62	430	1.39	9.99
240	14,400	7.10	430	0.85	12.21
360	21,600	5.31	430	0.63	13.70
600	36,000	3.62	430	0.43	15.55
1,440	86,400	1.93	430	0.23	19.97

Rainfall Intensity l/s per m^2	Return Period Rainfall mm
0.021	6.39
0.015	9.07
0.012	11.19
0.008	14.62
0.005	18.82
0.003	23.23
0.002	28.40
0.001	31.86
0.001	36.17
0.001	46.43

User Input

IMP Area	430	.....	m^2
r =	0.40	.....	Ratio of 60 min to 2 day rainfalls of 5 yr return period
P Climate (%)	40	.....	Increase of rainfall intensity due to global warming (%)

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Project

Meadows Hall, Richmond

MOMENTUM structural engineers

Title	Date	By	Reference
Proposed Runoff - 30 Year return period (c/w CC)	05/07/2022	dp	4821-MOM-XX-XX-CA-C- **6008**

Duration min	Duration sec	Rainfall Intensity mm/hr	Impermeable Area m^2	Peak Discharge l/s	Volume Runoff m^3
5	300	187.36	430	22.38	6.71
10	600	134.27	430	16.04	9.62
15	900	108.92	430	13.01	11.71
30	1,800	69.06	430	8.25	14.85
60	3,600	42.50	430	5.08	18.28
120	7,200	25.19	430	3.01	21.66
240	14,400	14.76	430	1.76	25.39
360	21,600	10.78	430	1.29	27.81
600	36,000	7.13	430	0.85	30.65
1,440	86,400	3.62	430	0.43	37.34

Rainfall Intensity l/s per m^2	Return Period Rainfall mm
0.052	15.61
0.037	22.38
0.030	27.23
0.019	34.53
0.012	42.50
0.007	50.38
0.004	59.06
0.003	64.67
0.002	71.27
0.001	86.83

User Input

IMP Area	430	.....	m^2
r =	0.40	.....	Ratio of 60 min to 2 day rainfalls of 5 yr return period
P Climate (%)	40	.....	Increase of rainfall intensity due to global warming (%)

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Title	Date	By	Reference
Proposed Runoff - 100 Year return period (c/w CC)	05/07/2022	dp	4821-MOM-XX-XX-CA-C- **6009**

Duration min	Duration sec	Rainfall Intensity mm/hr	Impermeable Area m^2	Peak Discharge l/s	Volume Runoff m^3
5	300	240.50	430	28.73	8.62
10	600	174.47	430	20.84	12.50
15	900	142.71	430	17.05	15.34
30	1,800	90.87	430	10.85	19.54
60	3,600	55.61	430	6.64	23.91
120	7,200	32.77	430	3.91	28.18
240	14,400	19.10	430	2.28	32.85
360	21,600	13.85	430	1.65	35.73
600	36,000	9.08	430	1.08	39.05
1,440	86,400	4.50	430	0.54	46.48

Rainfall Intensity l/s per m^2	Return Period Rainfall mm
0.067	20.04
0.048	29.08
0.040	35.68
0.025	45.44
0.015	55.61
0.009	65.54
0.005	76.39
0.004	83.09
0.003	90.81
0.001	108.10

User Input

IMP Area	430	.....	m^2
r =	0.40	.....	Ratio of 60 min to 2 day rainfalls of 5 yr return period
P Climate (%)	40	.....	Increase of rainfall intensity due to global warming (%)

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Project

Meadows Hall, Richmond

MOMENTUM structural engineers

Title	Date	By	Reference
Attenuation Storage - 100 Year return period (40% CC)	05/07/2022	dp	4821-MOM-XX-XX-CA-C- **6010**

Duration min	Duration sec	Rainfall Intensity mm/hr	Impermeable Area m^2	Peak Discharge l/s	Volume Runoff m^3	Storage Inflow l/s	Storage Flow l/s	Free Volume Required m^3	Rainfall Intensity l/s per m^2	Return Period Rainfall mm
5	300	240.50	430	28.73	8.62	28.73	26.73	8.02	0.067	20.04
10	600	174.47	430	20.84	12.50	20.84	18.84	11.30	0.048	29.08
15	900	142.71	430	17.05	15.34	17.05	15.05	13.54	0.040	35.68
30	1,800	90.87	430	10.85	19.54	10.85	8.85	15.94	0.025	45.44
60	3,600	55.61	430	6.64	23.91	6.64	4.64	16.71	0.015	55.61
120	7,200	32.77	430	3.91	28.18	3.91	1.91	13.78	0.009	65.54
240	14,400	19.10	430	2.28	32.85	2.28	0.28	4.05	0.005	76.39
360	21,600	13.85	430	1.65	35.73	1.65	-0.35	-7.47	0.004	83.09
600	36,000	9.08	430	1.08	39.05	1.08	-0.92	-32.95	0.003	90.81
1,440	86,400	4.50	430	0.54	46.48	0.54	-1.46	-126.32	0.001	108.10

User Input

IMP Area	430	.....	m^2
Storage Outflow	2.00	.....	Allowable discharge rate (l/s)
Free Volume	0.95	.....	Free volume of storage chamber
Urban Creep	1.00	.....	Allowance for future urban creep
r =	0.40	.....	Ratio of 60 min to 2 day rainfalls of 5 yr return period
P Climate (%)	40	.....	Increase of rainfall intensity due to global warming (%)
Return Period	100	.....	Return period for rainfall (Yrs)

Design Summary

Largest Free Volume (m^3)	16.71
with Urban Creep Allowance (m^3)	16.71
Total Storage To Be Provided (m^3)	17.6

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Project

Meadows Hall, Richmond

Title	Date	By	Reference
Greenfield Runoff Volume (1in1)	05/07/2022	dp	4821-MOM-XX-XX-CA-C- **6001**

Design Parameters

Return Period (Yrs)	1
r =	0.4
M5_60 (mm)	20
P Climate (%)	0
CWI	90
DPRCWI	-9.45

Area (m^2)	1000
Area (km^2)	0.001
Area (ha)	0.1
SAAR (mm)	598
SPR	0.3
Hydrological	Region 6

Design Rainfall

Duration min	Growth Factor Z1	M5 Rainfall mm	Growth Factor Z2	Return Period Rainfall mm	Rainfall Intensity mm/hr
5	0.37	7.47	0.62	4.59	55.11
10	0.52	10.47	0.61	6.39	38.37
15	0.63	12.67	0.62	7.79	31.18
30	0.80	16.07	0.62	10.03	20.06
60	1.00	20.00	0.64	12.80	12.80
120	1.21	24.13	0.66	15.84	7.92
240	1.45	28.93	0.68	19.55	4.89
360	1.60	32.07	0.68	21.94	3.66
600	1.79	35.87	0.69	24.81	2.48
1,440	2.24	44.80	0.71	31.79	1.32

Pre-development Greenfield Runoff Volume

Duration min	DPR,rain	PR (%)	Runoff Volume (m^3)
5.0	0.0	20.6	0.9
15.0	0.0	20.6	1.6
60.0	0.0	20.6	2.6
360.0	0.0	20.6	4.5

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Project

Meadows Hall, Richmond

Title	Date	By	Reference
Greenfield Runoff Volume (1in30)	05/07/2022	dp	4821-MOM-XX-XX-CA-C- **6002**

Design Parameters

Return Period (Yrs)	30
r =	0.4
M5_60 (mm)	20
P Climate (%)	0
CWI	90
DPRCWI	-9.45

Area (m^2)	1000
Area (km^2)	0.001
Area (ha)	0.1
SAAR (mm)	598
SPR	0.3
Hydrological	Region 6

Design Rainfall

Duration min	Growth Factor Z1	M5 Rainfall mm	Growth Factor Z2	Return Period Rainfall mm	Rainfall Intensity mm/hr
5	0.37	7.47	1.46	10.94	131.23
10	0.52	10.47	1.49	15.63	93.81
15	0.63	12.67	1.51	19.14	76.57
30	0.80	16.07	1.53	24.62	49.23
60	1.00	20.00	1.54	30.80	30.80
120	1.21	24.13	1.53	36.97	18.48
240	1.45	28.93	1.51	43.81	10.95
360	1.60	32.07	1.50	48.09	8.01
600	1.79	35.87	1.48	53.11	5.31
1,440	2.24	44.80	1.44	64.55	2.69

Pre-development Greenfield Runoff Volume

Duration min	DPR,rain	PR (%)	Runoff Volume (m^3)
5.0	0.0	20.6	2.2
15.0	0.0	20.6	3.9
60.0	0.0	20.6	6.3
360.0	1.9	22.5	10.8

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Project

Meadows Hall, Richmond

Title	Date	By	Reference
Greenfield Runoff Volume (1in100)	05/07/2022	dp	4821-MOM-XX-XX-CA-C- **6003**

Design Parameters

Return Period (Yrs)	100
r =	0.4
M5_60 (mm)	20
P Climate (%)	0
CWI	90
DPRCWI	-9.45

Area (m^2)	1000
Area (km^2)	0.001
Area (ha)	0.1
SAAR (mm)	598
SPR	0.3
Hydrological	Region 6

Design Rainfall

Duration min	Growth Factor Z1	M5 Rainfall mm	Growth Factor Z2	Return Period Rainfall mm	Rainfall Intensity mm/hr
5	0.37	7.47	1.85	13.81	165.69
10	0.52	10.47	1.92	20.07	120.42
15	0.63	12.67	1.95	24.73	98.94
30	0.80	16.07	2.00	32.11	64.22
60	1.00	20.00	2.03	40.60	40.60
120	1.21	24.13	2.01	48.59	24.30
240	1.45	28.93	1.98	57.25	14.31
360	1.60	32.07	1.95	62.64	10.44
600	1.79	35.87	1.92	68.97	6.90
1,440	2.24	44.80	1.85	82.95	3.46

Pre-development Greenfield Runoff Volume

Duration min	DPR,rain	PR (%)	Runoff Volume (m^3)
5.0	0.0	20.6	2.8
15.0	0.0	20.6	5.1
60.0	0.3	20.9	8.5
360.0	4.0	24.5	15.4

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Project

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MOMENTUM structural engineers

Title	Date	By	Reference
Existing Runoff - 1 Year return period	05/07/2022	dp	4821-MOM-XX-XX-CA-C- **6004**

Duration min	Duration sec	Rainfall Intensity mm/hr	Impermeable Area m^2	Peak Discharge l/s	Volume Runoff m^3
5	300	55.11	750	11.48	3.44
10	600	38.37	750	7.99	4.80
15	900	31.18	750	6.50	5.85
30	1,800	20.06	750	4.18	7.52
60	3,600	12.80	750	2.67	9.60
120	7,200	7.92	750	1.65	11.88
240	14,400	4.89	750	1.02	14.66
360	21,600	3.66	750	0.76	16.45
600	36,000	2.48	750	0.52	18.61
1,440	86,400	1.32	750	0.28	23.84

Rainfall Intensity l/s per m^2	Return Period Rainfall mm
0.015	4.59
0.011	6.39
0.009	7.79
0.006	10.03
0.004	12.80
0.002	15.84
0.001	19.55
0.001	21.94
0.001	24.81
0.000	31.79

User Input

IMP Area	750	.....	m^2
r =	0.40	.....	Ratio of 60 min to 2 day rainfalls of 5 yr return period
P Climate (%)	0	.....	Increase of rainfall intensity due to global warming (%)

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Title	Date	By	Reference
Existing Runoff - 30 Year return period	05/07/2022	dp	4821-MOM-XX-XX-CA-C- **6005**

Duration min	Duration sec	Rainfall Intensity mm/hr	Impermeable Area m^2	Peak Discharge l/s	Volume Runoff m^3
5	300	131.23	750	27.34	8.20
10	600	93.81	750	19.54	11.73
15	900	76.57	750	15.95	14.36
30	1,800	49.23	750	10.26	18.46
60	3,600	30.80	750	6.42	23.10
120	7,200	18.48	750	3.85	27.72
240	14,400	10.95	750	2.28	32.86
360	21,600	8.01	750	1.67	36.07
600	36,000	5.31	750	1.11	39.83
1,440	86,400	2.69	750	0.56	48.41

Rainfall Intensity l/s per m^2	Return Period Rainfall mm
0.036	10.94
0.026	15.63
0.021	19.14
0.014	24.62
0.009	30.80
0.005	36.97
0.003	43.81
0.002	48.09
0.001	53.11
0.001	64.55

User Input

IMP Area	750	.....	m^2
r =	0.40	.....	Ratio of 60 min to 2 day rainfalls of 5 yr return period
P Climate (%)	0	.....	Increase of rainfall intensity due to global warming (%)

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Title	Date	By	Reference
Existing Runoff - 100 Year return period	05/07/2022	dp	4821-MOM-XX-XX-CA-C- **6006**

Duration min	Duration sec	Rainfall Intensity mm/hr	Impermeable Area m^2	Peak Discharge l/s	Volume Runoff m^3
5	300	165.69	750	34.52	10.36
10	600	120.42	750	25.09	15.05
15	900	98.94	750	20.61	18.55
30	1,800	64.22	750	13.38	24.08
60	3,600	40.60	750	8.46	30.45
120	7,200	24.30	750	5.06	36.44
240	14,400	14.31	750	2.98	42.93
360	21,600	10.44	750	2.18	46.98
600	36,000	6.90	750	1.44	51.73
1,440	86,400	3.46	750	0.72	62.21

Rainfall Intensity l/s per m^2	Return Period Rainfall mm
0.046	13.81
0.033	20.07
0.027	24.73
0.018	32.11
0.011	40.60
0.007	48.59
0.004	57.25
0.003	62.64
0.002	68.97
0.001	82.95

User Input

IMP Area	750	.....	m^2
r =	0.40	.....	Ratio of 60 min to 2 day rainfalls of 5 yr return period
P Climate (%)	0	.....	Increase of rainfall intensity due to global warming (%)

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Project

Meadows Hall, Richmond

MOMENTUM structural engineers

Title	Date	By	Reference
Proposed Runoff - 1 Year return period (c/w CC)	05/07/2022	dp	4821-MOM-XX-XX-CA-C- **6007**

Duration min	Duration sec	Rainfall Intensity mm/hr	Impermeable Area m^2	Peak Discharge l/s	Volume Runoff m^3
5	300	76.63	430	9.15	2.75
10	600	54.45	430	6.50	3.90
15	900	44.75	430	5.35	4.81
30	1,800	29.24	430	3.49	6.29
60	3,600	18.82	430	2.25	8.09
120	7,200	11.62	430	1.39	9.99
240	14,400	7.10	430	0.85	12.21
360	21,600	5.31	430	0.63	13.70
600	36,000	3.62	430	0.43	15.55
1,440	86,400	1.93	430	0.23	19.97

Rainfall Intensity l/s per m^2	Return Period Rainfall mm
0.021	6.39
0.015	9.07
0.012	11.19
0.008	14.62
0.005	18.82
0.003	23.23
0.002	28.40
0.001	31.86
0.001	36.17
0.001	46.43

User Input

IMP Area	430	.....	m^2
r =	0.40	.....	Ratio of 60 min to 2 day rainfalls of 5 yr return period
P Climate (%)	40	.....	Increase of rainfall intensity due to global warming (%)

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Title	Date	By	Reference
Proposed Runoff - 30 Year return period (c/w CC)	05/07/2022	dp	4821-MOM-XX-XX-CA-C- **6008**

Duration min	Duration sec	Rainfall Intensity mm/hr	Impermeable Area m^2	Peak Discharge l/s	Volume Runoff m^3
5	300	187.36	430	22.38	6.71
10	600	134.27	430	16.04	9.62
15	900	108.92	430	13.01	11.71
30	1,800	69.06	430	8.25	14.85
60	3,600	42.50	430	5.08	18.28
120	7,200	25.19	430	3.01	21.66
240	14,400	14.76	430	1.76	25.39
360	21,600	10.78	430	1.29	27.81
600	36,000	7.13	430	0.85	30.65
1,440	86,400	3.62	430	0.43	37.34

Rainfall Intensity l/s per m^2	Return Period Rainfall mm
0.052	15.61
0.037	22.38
0.030	27.23
0.019	34.53
0.012	42.50
0.007	50.38
0.004	59.06
0.003	64.67
0.002	71.27
0.001	86.83

User Input

IMP Area	430	.....	m^2
r =	0.40	.....	Ratio of 60 min to 2 day rainfalls of 5 yr return period
P Climate (%)	40	.....	Increase of rainfall intensity due to global warming (%)

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Project

Meadows Hall, Richmond

MOMENTUM structural engineers

Title	Date	By	Reference
Proposed Runoff - 100 Year return period (c/w CC)	05/07/2022	dp	4821-MOM-XX-XX-CA-C- **6009**

Duration min	Duration sec	Rainfall Intensity mm/hr	Impermeable Area m^2	Peak Discharge l/s	Volume Runoff m^3
5	300	240.50	430	28.73	8.62
10	600	174.47	430	20.84	12.50
15	900	142.71	430	17.05	15.34
30	1,800	90.87	430	10.85	19.54
60	3,600	55.61	430	6.64	23.91
120	7,200	32.77	430	3.91	28.18
240	14,400	19.10	430	2.28	32.85
360	21,600	13.85	430	1.65	35.73
600	36,000	9.08	430	1.08	39.05
1,440	86,400	4.50	430	0.54	46.48

Rainfall Intensity l/s per m^2	Return Period Rainfall mm
0.067	20.04
0.048	29.08
0.040	35.68
0.025	45.44
0.015	55.61
0.009	65.54
0.005	76.39
0.004	83.09
0.003	90.81
0.001	108.10

User Input

IMP Area	430	.....	m^2
r =	0.40	.....	Ratio of 60 min to 2 day rainfalls of 5 yr return period
P Climate (%)	40	.....	Increase of rainfall intensity due to global warming (%)

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Project

Meadows Hall, Richmond

MOMENTUM structural engineers

Title	Date	By	Reference
Attenuation Storage - 100 Year return period (40% CC)	05/07/2022	dp	4821-MOM-XX-XX-CA-C- **6010**

Duration min	Duration sec	Rainfall Intensity mm/hr	Impermeable Area m^2	Peak Discharge l/s	Volume Runoff m^3	Storage Inflow l/s	Storage Flow l/s	Free Volume Required m^3	Rainfall Intensity l/s per m^2	Return Period Rainfall mm
5	300	240.50	430	28.73	8.62	28.73	26.73	8.02	0.067	20.04
10	600	174.47	430	20.84	12.50	20.84	18.84	11.30	0.048	29.08
15	900	142.71	430	17.05	15.34	17.05	15.05	13.54	0.040	35.68
30	1,800	90.87	430	10.85	19.54	10.85	8.85	15.94	0.025	45.44
60	3,600	55.61	430	6.64	23.91	6.64	4.64	16.71	0.015	55.61
120	7,200	32.77	430	3.91	28.18	3.91	1.91	13.78	0.009	65.54
240	14,400	19.10	430	2.28	32.85	2.28	0.28	4.05	0.005	76.39
360	21,600	13.85	430	1.65	35.73	1.65	-0.35	-7.47	0.004	83.09
600	36,000	9.08	430	1.08	39.05	1.08	-0.92	-32.95	0.003	90.81
1,440	86,400	4.50	430	0.54	46.48	0.54	-1.46	-126.32	0.001	108.10

User Input

IMP Area	430	.....	m^2
Storage Outflow	2.00	.....	Allowable discharge rate (l/s)
Free Volume	0.95	.....	Free volume of storage chamber
Urban Creep	1.00	.....	Allowance for future urban creep
r =	0.40	.....	Ratio of 60 min to 2 day rainfalls of 5 yr return period
P Climate (%)	40	.....	Increase of rainfall intensity due to global warming (%)
Return Period	100	.....	Return period for rainfall (Yrs)

Design Summary

Largest Free Volume (m^3)	16.71
with Urban Creep Allowance (m^3)	16.71
Total Storage To Be Provided (m^3)	17.6

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