Appendix 12B

Drainage Strategy

Drainage Strategy

Revision 3

Liverpool Waters
Plot CO2
East Waterloo Dock

26th October 2019

Ref: 4/6679

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DRAINAGE STRATEGY
Liverpool Waters Plot CO2

Report Reference: 4/6679/DS

Revision 3

Date originated: 19th November 2018

Prepared for: Romal Capital Group Ltd

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1.0 INTRODUCTION

1.1 General

1.1.1 This report has been prepared on instructions received from Romal Capital Group Ltd and relates to the proposed development works at West Waterloo Dock as part of Liverpool Waters Project. The development is currently referred to as Plot CO2.

1.1.2 The proposed works at the site include the construction of a new dock wall and infilling behind this wall to provide the platform to erect four new mixed-use blocks (A-D) of 10 storeys and provide a total of 538 apartments (one – three bedrooms), along with associated commercial space, car parking, landscaping, servicing and access.

1.1.1 This report outlines the initial drainage design philosophy in relation to the proposed development.

1.1.3 This report is prepared solely for the benefit of the Client. This report may not be assigned without prior written permission from Clancy Consulting (CC).

1.1.4 This report is based upon existing and proposed plans for the development as well as data obtained from the Environment Agency, Liverpool City Council, United Utilities and site investigations undertaken by CC Geotechnical.

1.2 Report Structure

1.2.1 The report has been structured to follow the general principles set out in the Liverpool City Council's Greenfield/ Brownfield Site Surface Water Management Guidance (May 2016).

1.2.2 The methodology for this report has comprised of a desktop study including liaison with Liverpool City Council and United Utilities. Reference has also been made to all available and relevant plans, CCTV survey, Site / Ground Investigation and topographical survey information. Design calculations have been undertaken to establish existing discharge rates for the various storm events with attenuation sized accordingly.

1.2.3 The drainage strategy will provide justification of the discharge method considering the following (in order of preference);

1. Discharge by Infiltration
2. Discharge to Watercourse
3. Discharge to Surface Water Sewer
4. Discharge to Combined Sewer

1.2.4 The drainage strategy will discuss proposed SUDs techniques and comply with the 'Non-Statutory Technical Standards for Sustainable Drainage Systems'.

1.2.5 Sources of information:

- Environment Agency (EA)
- Clancy Consulting Ltd Flood Risk Assessment (FRA)
- Liverpool City Council Greenfield/ Brownfield Site Surface Water Management Guidance (May 2016).
- Flood Risk Resilience Strategy (Condition 21): Neighbourhood C by Curtins (May 2019) – referred to as Condition 21 Report within this document.
- United Utilities Public Sewer Records

- Ground Investigation Report by CC Geotechnical (October 2018).
- Non-statutory technical standards for sustainable drainage systems.
- Merseyside Environmental Advisory Service Discretionary Advice
- Natural England Discretionary Advice
- Canal & River Trust

1.3 Background Information

1.3.1 Following recent consultation, planning guidance was issued which came into force on 6 April 2015 and concerns all "major" housing developments (developments of 10 dwellings or more). This guidance sets out the following main points;

1.3.2 LPAs will be required to consider SuDS in connection with planning applications, rather than a separate local government body.

1.3.3 Lead Local Flood Authorities (LLFAs) will become statutory consultees on surface water management regarding planning applications. LPAs must satisfy themselves that operational standards and maintenance are provided for the lifespan of the development using for example planning conditions or Section 106 agreements.

1.3.4 The operation and on-going maintenance of SuDS must also be economical.

1.3.5 A clear set of non-statutory technical standards for SuDS has been produced by the Government working closely with the Environment Agency, local authorities and developers to reduce the risk of surface water flooding, improve water quality and the environment and to ensure that SuDS are robust, safe and affordable.

1.3.6 They should be read in conjunction with a Planning Practice Guide which is now available online.

1.3.7 The Technical Guidance previously published has now been replaced with a Web based Practice Guide – Flood Risk and Coastal Change.

http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/reducing-the-causes-and-impacts-of-flooding/why-are-sustainable-drainage-systems-important/

2.0 LOCAL POLICY

LCC GREENFIELD / BROWNFIELD SITES SURFACE WATER MANAGEMENT GUIDANCE

If the site has previously been developed it should be demonstrated that the drainage system is still operational for it to be classed as brownfield. Information should be obtained on the system, e.g. pipe diameters, levels, gradients, lengths, hydraulic controls, etc. These details should be used, along with the contributing area characteristics of the site, to set up a drainage model (or to inform another assessment method) in order to evaluate the peak flow rates at the outfalls from the existing site for the design return period events. The maximum allowed flow from the site should then be derived using the 1:2yr critical rainfall event with a 30% reduction applied to offer improvement.

The limiting discharge figure for the proposed development should be used in the design of the drainage system for the minimum requirement that flows for up to the 1:30yr critical rainfall event are retained within the system and that for the 1:100yr+30% climate change allowance, critical rainfall event there will be no flooding to any buildings and any excess volumes of water will be retained on site.

Notwithstanding the above, the existing site drainage constraints will also be taken into account when agreeing any discharge limits and the proposed flow should not exceed existing pipe capacity. For example, if the existing site outfall was a 150mm dia pipe, irrespective of the area being drained, it would have a maximum flow capacity which may be lower than any proposed flows calculated using the above criteria, assuming a free discharge. Therefore, discharge to the existing drainage system from the development would be effectively increased from the existing situation which is contrary to Environment Agency and National Planning Policy Framework guidance for flood risk and surface water management.

Where records of the previously developed system are not available and system characteristics cannot otherwise be determined, or if the drainage system is broken or blocked (or no longer operational), then the run-off characteristics should be defined as greenfield.

If a site is classed as greenfield the flow rates from the development will be limited to the equivalent greenfield run off rates. For example, the flow rate from the development for the 1:30yr critical rainfall event should not exceed the greenfield run off rate for the site for the 1:30 year rainfall event, likewise for the 1:2 & 1:100 year scenarios. A minimum flow of 5 l/s can be used when the greenfield run off rate falls below 5 l/s.

It should be noted that this discharge figure will satisfy planning requirements but the applicant should consult United Utilities to determine if they have any discharge restrictions, which could be more restrictive.

For all developments over 1ha a FRA (Flood Risk Assessment) will be required which should be based on the requirements as detailed in Environment Agency (Greater Manchester, Merseyside & Cheshire) Local Planning Standing Advice and NPPF guidance. The detail and technical complexity of a FRA will reflect the scale, nature and location of the development. Where available, reference should be made to the Strategic Flood Risk Assessment (SFRA) for locally specific guidance and information.

The following list sets out key information that should be submitted within a FRA for developments

- A location plan that includes geographical features, street names and identifies the catchment, watercourses or other bodies of water in the vicinity.

- A plan of the site showing existing site; development proposals; and identification of any structures (e.g. embankments), which may influence local flood flow overland or in any watercourses (e.g. culverts) present on the site.

- Site levels of both existing and proposed. Reference to Ordnance Datum, may be required where details of context of the site to its surroundings is needed.

- Details of the existing surface water drainage arrangements on site (if any) and the receptor e.g. soakaway, sewer, canal, watercourse etc.

- Proposals for surface water management that aims to not increase, and where practicable reduce the rate of runoff from the site as a result of the development

- Information about the surface water disposal measures already in place and estimates of the rates of run-off generated by the surfaces drained.

- An assessment of the volume of surface water run-off likely to be generated from the proposed development and confirmation of how any excess volumes would be retained within the development.

- Information regarding how the proposed drainage design will perform under the increased frequency and intensity of rainfall that is predicted as a result of climate change (30% for residential development & 20% for non- residential).

- Information about other potential sources of flooding, if any, that may affect the site e.g. streams, surface water run-off, sewers, groundwater, reservoirs, canals and other artificial sources or any combination of these; including details on how these sources of flooding will be managed safely within the development proposal.

It should be noted that the above list is not exhaustive but provides a framework for the FRA to be prepared.

For developments less than 1 ha a FRA will not be required but a drainage design statement should be provided proportional to the scale of the development and follow the same design principles with regards to calculating the maximum design flow rates for the site.

In line with NPPF (National Planning Policy Framework) the development of a site should look towards the use of SUDS techniques as a method of reducing the run off from the site, as a result of the development. Government policy strongly encourages a hierarchical approach to the use of sustainable drainage systems in new developments and infiltration methods for private drainage should be used where possible.

For residential developments greater than 0.5 ha and where the floor space of any building is greater than 1000m² Ground Investigations should be carried out to BRE 365 to determine if infiltration drainage methods are practicable and suitable for the sites. A soils report including ground percolation test results and recommendations will need to be submitted within the drainage design statement or FRA, for approval, although any detailed soakaway design information is not required at this stage. If this proves that infiltration drainage is not a viable option, then a positive piped system of surface water run off disposal will need to be provided.

Any soakaway design and the sub ground strata of the sloping site areas shall be considered so as not to cause flooding to any adjoining third party land.

For developments containing prospectively adoptable surface water sewers the following document published by United Utilities should be referred to for guidance related to SUDS

http://www.unitedutilities.com/documents/7010b_S104_Guide_adoption_sewers_2016_WEB_ACC.pdf

3.0 SITE CHARACTERISTICS

3.1 Existing Site Characteristics

3.1.1 The site is located as detailed as below in Table 1 & Figure 6.

Table 1 - Site Location References (streetmap.co.uk)

OS X (Eastings)	333455
OS Y (Northings)	391242
Nearest Post Code	L3 0BT
Lat (WGS84)	N53:24:50 (53.413770)
Long (WGS84)	W3:00:09 (-3.002624)
LR	SJ334912
mX	-334250
mY	7025569

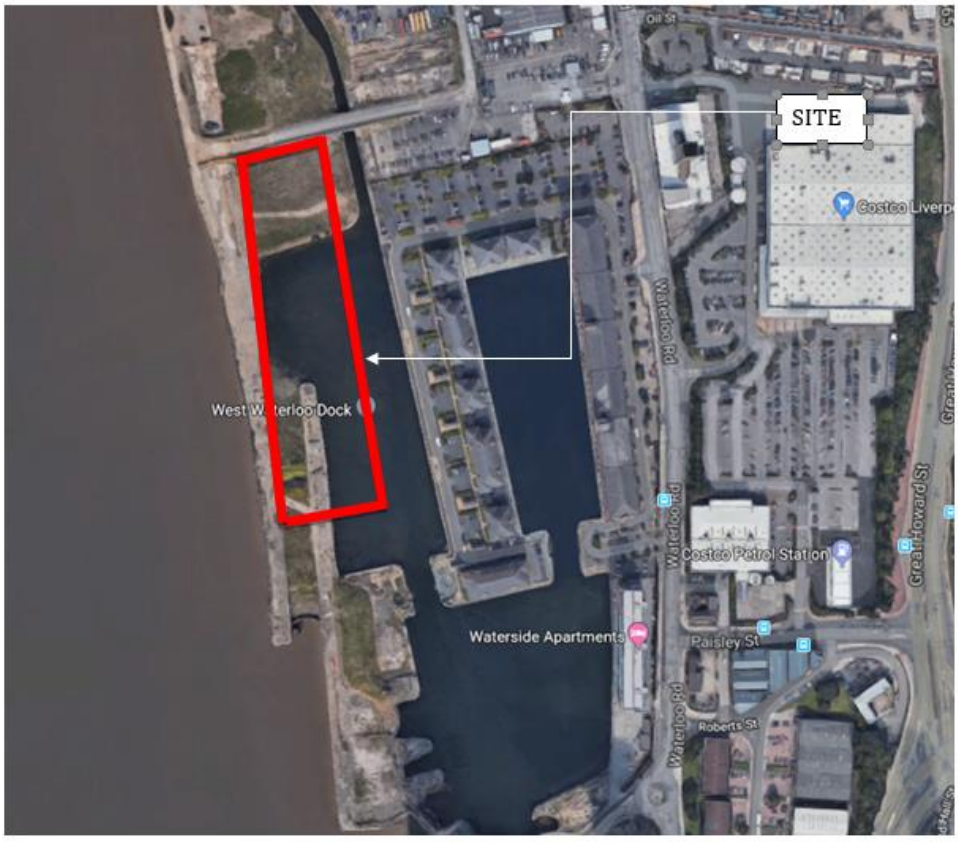

Figure 1 - Site Location Map (Google Maps)

3.1.2 The development is located North of Liverpool City Centre within West Waterloo Dock on the waterfront. The development is bordered by the Liverpool Canal Link to the West, Princes Half Tide Dock to the South, The River Mersey (and river wall) to the East and undeveloped land to the North.

3.1.3 The area proposed for development was historically West Waterloo Docks and warehouses. Over time, the warehouses have been demolished and the dock itself has been partially infilled along with Waterloo Lock system, whilst other areas remain as the dock.

3.1.4 The development falls within the wider Liverpool Waters masterplan – covering the re-development of up to 60 hectares of former dock land along Liverpool Waterfront providing mixed use developments and an extension from Liverpool City Centre northwards.

3.1.5 Outline planning was granted by Liverpool City Council in June 2013 (Application no. 10O/2424) for a mixed-use development across 60 hectares of derelict dockland.

3.1.6 The overall area proposed for development is approximately 1.12 hectares

3.1.7 Site ground levels along the dock sides are generally flat at a level of approximately 8.000m AOD. The canal level is generally kept at approximately 4.770m AOD.

3.1.8 The site is approximately 20m away from the River Mersey.

3.2 Existing Drainage

3.2.1 Asset drawings provided by United Utilities have shown no existing sewer infrastructure on or in the vicinity of the development.

3.2.2 It is likely that the vast majority – if not all - of the existing surface water drains freely into West Waterloo dock.

3.2.3 However, the future development of the area will see a new road constructed to service the Isle of Man Ferry Terminal and Plot C02.

3.2.4 The Flood Risk Assessment for the Northern Link Road indicates the storm sewerage for the site has been designed in accordance with DMRB Volume 4 (HD 33/16 and HA 102/00) for a 1 in 100 year storm event with checks against 1 a in 30 year storm event. The drainage system has also been assessed for the consequences of exceedance for return periods in excess of 1 in 100 years to ensure any surcharge levels do not exceed the levels of chamber covers.

3.2.5 The South to North link road which runs parallel to the West boundary of the development has a lowest proposed level of 6.849m AOD – lifting, on average, the existing ground level by approximately 300mm.and similar to this development.

3.2.6 The Flood Risk Assessment for the Northern Link Road states that the lowest level remains higher than the minimum ground level of 6.70m AOD as set out within Liverpool Waters Environmental Statement.

3.2.7 Review of the Northern Link Road levels against proposed site ground floor levels generally shows the development has been set to remain above the road level – further reducing the risk of flooding from the Northern Link Road.

3.2.8 The Flood Risk Assessment for the Northern Link Road indicates that stormwater run-off will be adequately managed by inclusion of road gullies and designated carrier networks, with discharge into the canal and locks – as existing drainage is believed to do.

3.2.9 No calculations or mitigations measures have been presented within the Flood Risk Assessment for review of the proposals and flood risk management.

3.2.10 Figures 5 and 6 show the proposed drainage below this road which borders the development. A surface water sewer is proposed ranging in diameter from 150mm up to 300mm but this appears to be solely for the road drainage as there are numerous gullies connected to it with no provisions for a connection for the development.

3.2.11 There is also a foul water sewer proposed below the road with a number of branches along the length coming onto the development for connection of the foul water system.

3.2.12 The impermeable areas on the existing site are the dockside wharf, with the rest either being dock (open, partial infill or full infill).

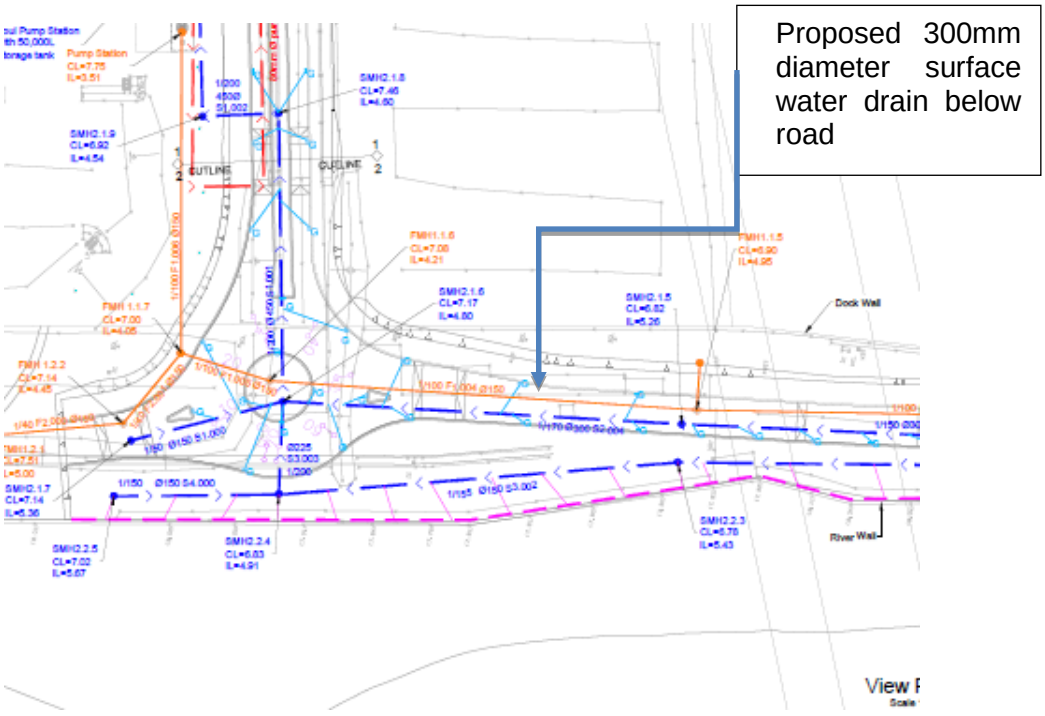

Figure 2 – Road Drainage Extract One (Amey Consulting Drawing CO00205341-H-D-NLR-500)

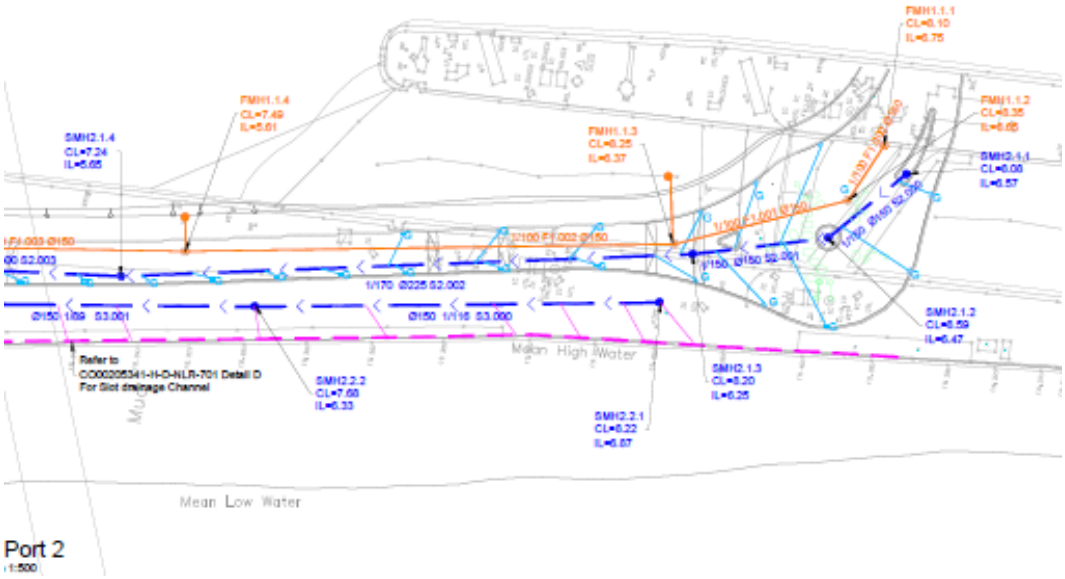

Figure 3 – Road Drainage Extract Two (Amey Consulting Drawing CO00205341-H-D-NLR-500)

3.3 Development Proposals

3.3.1 The proposed works at the site include the construction of a new dock wall and infilling behind this wall to provide the platform to erect four new mixed-use blocks (A-D). These blocks range in height between 10 and 11 storeys and provide a total of 542 apartments (one – three bedrooms), along with associated commercial space, car parking, landscaping, servicing and access.

3.3.2 Blocks A and B are to be constructed facing along and projecting into the dock with Blocks C and D built facing the River Mersey. Across the blocks, the ground floors contain commercial units, reception areas, plant rooms and storage for bicycles with Blocks C and D only containing residential apartments.

3.3.3 A canal side walkway/ boardwalk will be provided at canal level (6.600m AOD) with the buildings projecting over into the canal to create a colonnade.

3.3.4 The proposed ground floor levels of the buildings range from 8.050m AOD at the North end of the development up to 8.400m AOD at the South end of the development. The lowest accessible level is set at 6.600m AOD (lower ground floor) to provide a transition and access point between the blocks and the canal side.

4.0 SURFACE WATER DRAINAGE STRATEGY

4.1 Surface Water Disposal Hierarchy

The disposal of surface water should be considered in the following order of priority;

1. Infiltration into the subsoil via soakaways or permeable paving.

2. Discharge to a water course or the sea.

3. Discharge to a surface water sewer.

4. Discharge to a combined sewer.

If it is not possible to discharge to a soakaway, then surface water should be controlled with the use of Sustainable Drainage Systems (SuDS) and considered using the SuDS Hierarchy.

4.2 SuDS Hierarchy

	SUDS technique	*Flood Reduction*	*Pollution Reduction*	*Landscape & Wildlife Benefit*
Most Sustainable	Living roofs	✔	✔	✔
	Basins and ponds - Constructed wetlands - Balancing ponds - Detention basins - Retention ponds	✔	✔	✔
	Filter strips and swales	✔	✔	✔
	Infiltration devices - soakaways - infiltration trenches and basins	✔	✔	✔
	Permeable surfaces and filter drains - gravelled areas - solid paving blocks - porous paviors	✔	✔	
Least Sustainable	Tanked systems - over-sized pipes/tanks - storms cells	✔		

Table 2 – SUDS Hierachy

4.3 Disposal Strategy for Plot CO2

4.3.1 Infiltration

All soakaways must be situated at least 5m away from the building footprint as per building regulations which may limit the location of such soakaways.

In addition, although there are areas on this development subject to dock infill and this is likely to be by imported aggregates, the permeability at the base of the fill is likely to be minimal with its previous history as a water retaining dock.

4.3.2 Water Course

The nearest water course is the River Mersey located approximately 20m to the west of the site. While this would be a potential discharge point for the surface water, it is unlikely that this would be acceptable to Environment Agency and would also mean crossing third party land to do so.

A feasible option is to discharge directly into West Waterloo Dock. From initial discussions with both The Canal and Rivers Trust and Peel Land and Property Group Management Limited (Dock Operators), there have been no objections to this proposal. The only consideration Peel have advised is with regard to achieving a flow velocity into the dock of 0.5m/s. However, this is outside the limit advised for best practice construction and within Sewers for Adoption in order to achieve self-cleansing within the surface water drainage network.

To achieve this, the energy generated within the flow of water along the surface water network must be disrupted to dissipate the energy and subsequently its velocity. This can be achieved in a number of ways such as including orifice plates or flow controls with the effective volume of water behind this stored in storage in order to remain within the design requirements. This will require conversations with all relevant parties to achieve an amicable solution.

The outfall of the drainage into the dock should be located at a level above the maximum canal level to ensure surface water can discharge from the development but not too high to minimise any potential for turbulence in the water.

4.3.3 Surface Water Sewer

The nearest surface water drainage system will be below the new access road to the Isle of Man Ferry Terminal. The proposed drawings show no branches onto this development and it appears it may have been designed for the road drainage only. This drainage run does ultimately discharge into West Waterloo Dock.

The nearest surface water drainage system will be below the new access road to the Isle of Man Ferry Terminal. The proposed drawings show no branches onto this development and it appears it may have been designed for the road drainage only. This drainage run does ultimately discharge into West Waterloo Dock.

4.3.4 Combined Sewer

The nearest surface water drainage system will be below the new access road to the Isle of Man Ferry Terminal. The proposed drawings show no branches onto this development and it appears it may have been designed for the road drainage only. This drainage run does ultimately discharge into West Waterloo Dock.

4.4 SuDS Strategy for Plot CO2

4.4.1 Landscaped Areas

The most sustainable solution to control run-off at its source would be to utilise areas of landscaping (grass and planting). These areas will not be suitable for direct filtration but can retain part of the rainwater, slow down the speed of run-off and also reduce water pollution.

4.4.2 Ponds/ Basins and Swales

There are no areas large enough on the development to accommodate ponds/ basins and/or swales.

4.4.3 Living Roof

A significant area of the site receiving surface water is roof area. The most sustainable solution to control run-off at its source would be to provide living or green roof areas. The current proposals do not allow for this an option.

4.4.4 Tanked System

A tanked system would provide additional attenuation storage to control rainfall up to 1 in 100 year change events with an allowance for climate change.

5.0 PROPOSED FOUL WATER DRAINAGE

5.1 Peak Flow Requirements

5.1.1 The foul drainage from each block will have separate foul drainage systems. These systems will combine on the development before entering a pumping station located in the North West corner of the development. See Appendix F.

5.1.2 This then rising main which runs below the North Link Road before turning East, across the canal bridge and into the gravity fed foul drainage system which ultimately connects into the existing United Utilities infrastructure.

5.1.3 The proposed foul water for the upper residential floors will be collected via soil vent pipes which will be hidden within the risers for the apartments along corridor lines.

5.1.4 Floor gullies from Plant rooms and cycle stores will be collected into the wider site foul drainage network.

5.1.5 The drainage for the ground floor commercial units will be routed via stub stacks and will be collected into the wide development foul drainage network. These will connect with the residential drainage runs before discharging off site.

5.1.6 The proposed floor layouts for Plot CO2 has been assessed and based on the discharge unit method. A total peak flow rate of approximately 43.6 l/s will be achieved from Plot C02. This will be split further to avoid the discharge flowing through one pipe.

SUMMARY	Discharge Unit	Totals	Total DU
Shower	0.6	1405	843
Washbasin	0.6	1415	849
WCs (4l - 9l cistern)	2.5	1415	3537.5
Kitchen Sink	1.3	656	852.8
Dishwasher	0.8	542	516.8
Floor drains (50mm - 100mm)	2	15	30
Washing Machine (House)	1.5	542	969
			7598.1
Peak Flow Discharge	43.6	l/s	

Table 3 – Preliminary Foul Discharge Flow Rate (Total)

5.1.7 It is currently understood that Section 106 agreements will not be required for the connections onto the new sewer in the link road. This will be covered by the Section 104 agreement that will be undertaken by others for the sewer under the link road. However, this should be confirmed at detailed design stage.

6.0 PROPOSED SURFACE WATER DRAINAGE

6.1 Peak Flow and Attenuation Requirements

6.1.1 The site currently has an impermeable area of 800m^2. Based upon a 15 minute storm event, the 1 in 2 year storm event has a peak flow of 8l/s. It is likely that this currently drains straight into West Waterloo Dock.

6.1.2 In accordance with the SUDS hierarchy, the FRA has established that filtration via a soakaway is not practical on site but connection to West Waterloo Dock is practical and feasible.

6.1.3 Following discussions with Liverpool City Council, no betterment on the current flow is required and an unrestricted flow into the dock is permissible along with ensuring the requirements for the peak storms is achieved.

6.1.4 Following discussions with The Canal and River Trust, they have not imposed any further restrictions on the discharge into West Waterloo Dock.

6.1.5 Following discussions with Peel Land and Property Group Management Limited, the only restriction imposed is that discharge from the site into West Waterloo Dock should be at 0.5 m/s. This is outside the limit advised for best practice construction and within Sewers for Adoption in order to achieve self cleansing within the surface water drainage network.

6.1.6 To achieve this, the energy generated within the flow of water along the surface water network must be disrupted to dissipate the energy and subsequently its velocity. This can be achieved in a number of ways such as including orifice plates or flow controls with the effective volume of water behind this stored in storage in order to remain within the design requirements. Conversations are currently ongoing.

6.1.7 The FRA has established that the attenuation requirements for the 30 year and 100 year (including 30% climate change) rainfall events can be accommodated by allowing the water level in the dock to raise temporarily.

6.1.8 This is subject to agreement from the Canal and Rivers Trust and the dock operators and is detailed below.

6.1.9 Any new development's drainage must be designed in accordance with current best practice to provide adequate capacity not to flood for the critical 1 in 30 year storm event and flood water generated for the 1 in 100 year plus climate change storm event shall be controlled with the area of the development so as not to cause damage to buildings, essential services or adjoining developments and services.

6.1.10 The FRA has confirmed the 1 in 2 year storm event will also be analysed to ensure no access chambers/ manholes surcharge during this event.

6.1.11 A surface water drainage model has been designed using MicroDrainage design software by WinDes for the following storm events;

1. The 1 in 2 year storm event with a free outfall.
2. The 1 in 30 year storm event with a surcharged outfall set to 6.000m AOD.

3. The 1 in 100 year storm event, including an allowance of 30% for climate change, with a surcharged outfall set at 6.000m AOD.
4. The 1 in 100 year storm event, including an allowance of 40% for climate change with a surcharged outfall set at 7.150m AOD.

6.1.12 The surcharged outfall level of 6.000m AOD corresponds to the estimated flood level for the 1 in 100 year storm event as noted within the FRA.

6.1.13 The surcharged outfall level of 7.15m AOD corresponds to the estimated flood level for the 1 in 200 year River Mersey Level for the year 2115. This is the level on which floor levels have been set against.

6.1.14 The results from the initial drainage models are as follows;

Event	Maximum Discharge Rate (l/s)	Design Requirement	Result
1: 2 Year	124	No Surcharge	Pass
1 in 30 Year Event (Surcharged Outfall 6.00m AOD)	64.4	No Flooding	Pass
1 in 100 Year Event + 30% Climate Change (Surcharged Outfall 6.00m AOD)	111.6	Flooding Contained on Site	Pass – Total Flood Volume 300m^3 – to be contained and kept away from buildings with level management during detailed design.
1 in 100 Year Event + 40% Climate Change (Surcharged Outfall 7.150m AOD)	92.2	Flooding Contained on Site	Pass – Total Flood Volume 369m^3 – to be contained and kept away from buildings with level management during detailed design.

Table 4 – Surface Water Model Summary

6.1.15 The finished habitable floor levels of the buildings are set at a minimum of 8.050m AOD, as specified in the FRA – giving in excess of the 600mm freeboard above the 1 in 200 year River Mersey level up to the tear 2115.

6.1.16 Correspondence with all relevant parties with vested interest is ongoing.

6.1.17 In accordance with the FRA, West Waterloo dock will provide the attenuation storage for the 30 year storm event, by allowing the water level to temporarily rise in storm events and will be controlled outside of the scope of this development.

6.1.18 A brief estimation has been undertaken to assess the additional volume of water entering the dock, assuming a 30% betterment has been applied to the 1 in 2 year storm event on the current site (8l/s x 0.7 = 5.6l/s).

6.1.19 Using a figure of 5600m^2 as the revised area of West Waterloo Dock (post CO2 development), the volume entering the dock and estimated rise in water level is as follows;

1. The 1 in 30 year storm event: 490m^3 giving a 88mm raise in water level.
2. The 1 in 100 year storm event, including 30% climate change allowance: 820m^3 giving a 146mm raise in water level.

6.1.20 These estimates give no consideration to any other developments discharging into West Waterloo Dock, no consideration to the larger area of the docks as in reality the docks are not seldom closed along the Leeds-Liverpool Canal route, no consideration to evaporation.

6.1.21 These level changes would not cause a significant issue; even when applied to the 1 in 200 Mersey level for 2115 (7.15m AOD), this would not cause flooding to the surrounding area.

6.1.22 The proposed drainage strategy drawing 001 is enclosed in Appendix B along with areas susceptible to flooding under the initial drainage arrangement (Drawing 002).

6.1.23 A minimum of one stage of water quality treatment is provided for all areas within the site and a two-stage treatment has been proposed for all areas subject to vehicles.

6.1.24 The measures to implement this, include for vehicular areas subject to surface water runoff are to pass through a Class 1, Full Retention Petrol Interceptor prior to connecting to the drainage picked up from roofs.

6.1.25 Further measures to be assessed during detailed design include silt traps located within the drainage system to prevent silt passing to the dock waters, green roofs, permeable paving and tree pits to reduce the volume of water leaving the development.

6.1.26 The surface water drainage system will remain separate from the foul water drainage system whilst on the development.

6.1.27 All proposed flow rates and connection points will be subject to agreement and approval from relevant and interested parties.

6.1.28 The surface water drainage strategy is summarised as follows:

- Building rooftops – to be drained under gravity before entering the onsite public surface water system discharging directly into West Waterloo Dock.
- Areas of external hardstanding– to be drained via gravity using falls within the external works and collected in gullies and linear drainage before entering the onsite public surface water system and discharging directly into West Waterloo Dock.
- Areas of external car parking – to be drained via gravity using falls within the external works and collected in gullies and linear drainage before entering the onsite public surface water system via a petrol interceptor and discharged directly into West Waterloo Dock.
- No surcharging of access chambers/ manholes during the 1 in 2 year storm event.
- No surface flooding will occur for all storm events up to and including the 1 in 30 year storm event.
- Under the 1 in 100 year storm event plus 30% climate change allowance, on site flooding is acceptable. Site levels will be designed to ensure flood water remains on site whilst also not effecting the residents.
- The FRA has established that the attenuation requirements for the 30 year and 100 year (including 30% climate change) rainfall events can be accommodated by allowing the water level in the dock to raise temporarily.

- The volume range for the 30 year and 100 year storm events entering West Waterloo Dock ranges between 490m^3 and 820m^3. This gives a theoretical water level increase in West Waterloo Dock from this development of 88mm and 146mm respectively.
- Consideration of the 1 in 100 year storm event plus 40% climate change allowance.
- Detailed design will look at using green roofs, permeable paving and tree pits to reduce the volume entering West Waterloo Dock where possible.
- Approval of flows entering the drainage system by relevant and interest parties will be required to proceed with detailed design.

6.2 Flood Risk within the Development

6.2.1 Reference should be made to the Flood Risk Assessment report which supports the application.

6.2.2 The drainage system must be designed so that, surcharging of access chambers/ manholes does not occur on any part of the site for a 1 in 2 year rainfall event.

6.2.3 The drainage system must be designed so that, flooding does not occur on any part of the site for a 1 in 30 year rainfall event.

6.2.4 The drainage system must be designed so that, unless an area is designated to hold and/or convey water as part of the design, flooding does not occur during a 1 in 100 year rainfall event (with 30% climate change allowance) in any part of: a building (including a basement); or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development.

6.2.5 The design of the site must ensure that, so far as is reasonably practicable, flows resulting from rainfall in excess of a 1 in 100 year rainfall event are managed in exceedance routes that minimise the risks to people and property.

6.2.6 Consideration must be given to the implications of flooding on site during the 1 in 100 year rainfall event plus 40% climate change.

6.2.7 Levels will be designed such that in the event of a more extreme rainfall event water will discharge away from buildings.

7.0 MAINTENANCE & CONSTRUCTION

7.1 Maintenance Considerations

7.1.1 This section is intended to give an overview of the operation and maintenance for the drainage features included with the drainage strategy and in relation to typical details.

7.1.2 Where proprietary products are specified, the manufacturer's instructions and recommendations should be followed in priority to this document unless specifically noted otherwise due to project constraints.

7.1.3 The surface water network has been designed to accommodate the 1 in 100 year storm rainfall event plus an allowance for climate change particular to the requirements of the development.

7.1.4 It may be that the exceedance flows above the 1 in 30 year storm rainfall event are stored within the site partially above ground, on non-habitable external landscaping, parking or other space.

7.1.5 As the flows are generally being attenuated on site and within SuDS features there will be a period after storm events where the network is still partially or fully surcharged and is draining down.

7.1.6 Where this surcharging is still present after 48hrs appropriate action should be taken.

7.1.7 A suitable maintenance strategy should be adopted to ensure the drainage network is cleaned regularly and the routine maintenance and cleansing regime should be documented.

7.1.8 It is assumed that the maintenance of the drainage network will be the responsibility of an on-site facilities management team.

7.1.9 A copy of the final construction drainage layout should be provided in the final Operations and Maintenance Manual.

7.1.10 It is recommended that the drainage system is inspected as a minimum twice a year, with the system also being inspected after any major storm event.

7.1.11 Significant sediment deposition is likely in areas used for storage, so a post clean-up operation may be required including the removal of litter, vegetation, sewerage debris and larger objects.

7.1.12 Long-term management practices include monthly sweeping of external paved areas. The sweeping program will remove sand and contaminants directly from paved surfaces before they become mobilised during storm events and transported to the drainage system.

7.1.13 During the winter months, drainage features such as gullies and channels should be cleared of ice, snow, debris or litter

7.1.14 Sediment/material removal should be undertaken in consultation with the environmental regulator to confirm appropriate protocols; especially where run-off is taken from potentially contaminated areas such as the filter drains and the upstream/downstream chambers.

7.1.15 Pumping should only be used to facilitate drainage for those parts of the site where it is not reasonably practicable to drain water by gravity.

7.2 Construction

7.2.1 Components must be designed to ensure structural integrity of the drainage system and any adjacent structures or infrastructure under anticipated loading conditions over the design life of the development taking into account the requirement for reasonable levels of maintenance.

7.2.2 Damage to the drainage system resulting from associated construction activities must be minimised and must be rectified before the drainage system is considered to be completed.

7.2.3 The materials, including products, components, fittings or naturally occurring materials, which are specified by the designer, must be of a suitable nature and quality for their intended use.

7.2.4 The detailed design of the system and product selection for the storage and pipe solution will be made at the detailed design stage when all the site constraints can be considered. There are numerous products available for storage of water below ground and care will be needed to ensure that the right product is chosen for the final loading conditions.

7.2.5 A Section 106 application will be required for the connection to the public sewer. United Utilities will provide details of how the connection be allowed to be made to their assets.

8.0 CONCLUSIONS AND RECOMMENDATIONS

8.1.1 This report outlines the design philosophy for the drainage system proposed for Plot CO2 development at Liverpool Waters in accordance with Lead Local Authority (Liverpool City Council) requirements for surface water management on and in accordance with the findings from the FRA.

8.1.2 The site is part of the historic dock network on Liverpool's waterfront and had remained derelict and unused for some time. As such, surface water runoff is believed to drain directly into West Waterloo Dock, as there are no existing public sewers to connect to.

8.1.3 The proposed development will collect rainfall from roofs, hardstanding and car parking and discharge this volume directly into West Waterloo Dock. Following discussions with the LLFA, no betterment is required and the FRA has established that the volume of surface water from the peak storms can be accommodated within the dock itself.

8.1.4 The development will be designed to avoid surcharging access chambers/ manholes during the 1 in 2 year storm event, avoid flooding on the development during the 1 in 30 year storm event and ensure flooding within the 1 in 100 year storm event (plus climate change) is managed on site away from people and property.

8.1.5 As the flow will discharge directly into West Waterloo Dock, consideration has been given in the event flood water levels as noted in the FRA are above the outfall and prevent flow from the development.

8.1.6 Although not used for filtration, other SUDs options may be viable to store peak flow volume on site. These include green roofs, permeable paving and tree pits.

8.1.7 Foul water will be collected from the buildings in a separate foul drainage network before discharging into the main Liverpool Waters drainage network to be constructed as part of the Link Road.

8.1.8 Approval of flows entering the drainage system by relevant and interest parties will be required to proceed with detailed design.

APPENDIX A

PROPOSED SITE PLAN

Ollier Smurthwaite Architects A476_P_101

Cont. edge of batter

2248mm

A

B

C

D

Terrace for outdoor seating

Extent of 'Cultural Square'

COMMERCIAL | GYM | CYCLE STORE | FFL + 8.650 | BIN STORE | PLANT | SUB STATION

UNDERCROFT

PLANT | BIN STORE | FFL + 8.400 | CYCLE STORE | COMMERCIAL

SUB STATION | CLN | PLANT | FFL + 8.050 | RECEPTION | CYCLE STORE | BIN STORE

SUB STATION | PLANT | BIN STORE | FFL + 8.400 | RECEPTION | CYCLE STORE | COMMUNAL SPACE

1863mm

RIVER MERSEY

Mean High Water

Mud

BUS STOP

- cores/ reception/ circulation
- one bed - 38sqm
- two bed - 57sqm
- three bed - 97sqm
- penthouse - varies
- duplex - 79sqm
- ancillary

C02 SITE
GROUND FLOOR PLAN

scale 1:250 0 10m

rev.	date	drn	aud
-	00.00.00 -	-	-

drawing status: DRAFT

Second Floor
40 King Street
Manchester
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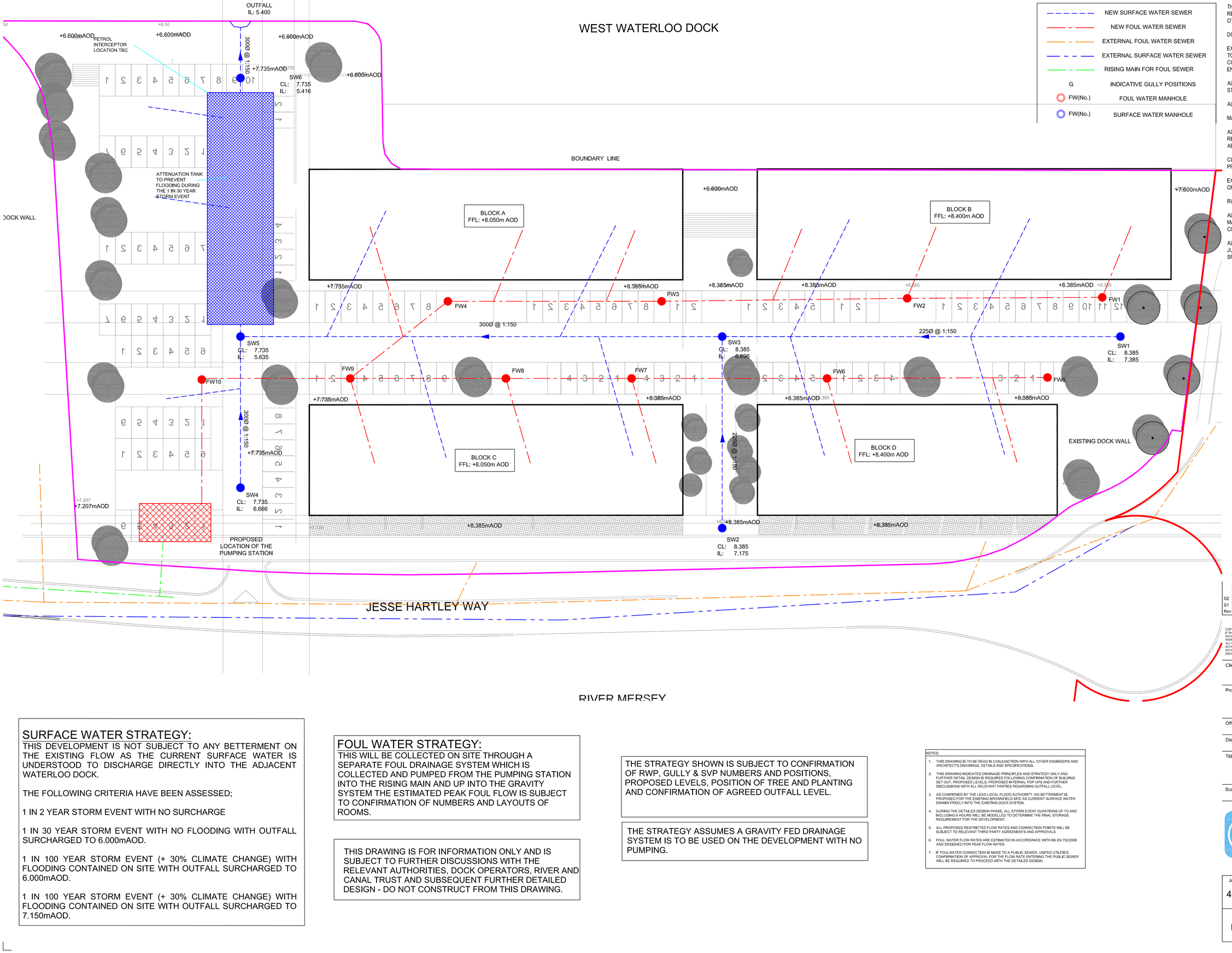
OLLIER SMURTHWAITE ARCHITECTS

Client	ROMAL CAPITAL	Scale	Drawn	Checked	Date	Issue
Job title	PLOTS C02 CENTRAL DOCKS, LIVERPOOL	1:500@A3	YM	YM	20.09.19	-
Drawing title	PROPOSED GROUND FLOOR PLAN	Job number	Drawing number			
		A476	A476_P_101			

APPENDIX B

DRAINAGE STRATEGY DRAWING 001
& FLOOD AREA DRAWING 002

WEST WATERLOO DOCK



GENERAL NOTES

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT CLANCY CONSULTING, ARCHITECTURAL AND OTHER ENGINEERS DRAWINGS AND SPECIFICATIONS.

DO NOT SCALE THIS DRAWING.

EXISTING DRAINAGE AND LEVELS SHOWN ON THIS DRAWING TO BE CONFIRMED BY THE CONTRACTOR ON SITE PRIOR TO COMMENCEMENT OF THE DRAINAGE WORKS. THE ENGINEER IS TO BE NOTIFIED OF ANY DISCREPANCIES.

ALL NEW PIPES UP TO BE V.C. TO BSEN 295-1.1991 EXTRA STRENGTH GRADE

ALL PIPES TO BE 150 DIA. MIN FALL 1 : 150 (UNO)

MANHOLES, RODDING EYES ETC. TO BE ENCASED IN S.R.C.

ALL INTERNAL CONNECTIONS TO CONSIST OF STANDARD REST BEND WITH APPROPRIATE ADAPTOR TO CONNECT TO ABOVE GROUND DRAINAGE.

COVER LEVELS TO BE CHECKED AGAINST ARCHITECTS PROPOSED EXTERNAL WORKS LEVEL / DETAIL DRAWINGS

EXISTING MANHOLES, LEVELS & PIPE SIZES TO BE CHECKED ON SITE

RWP POSITIONS ARE TO BE CONFIRMED BY ARCHITECT

ALL CONNECTIONS INTO EXISTING SEWERS ARE VIA MANHOLES, ANY SADDLE CONNECTION IS SUBJECT TO CONFIRMATION FROM LOCAL WATER AUTHORITY.

ALL OUTGOING AND INCOMING PIPES AT MANHOLE JUNCTIONS TO BE CONNECTED SOFFIT TO SOFFIT UNLESS SPECIFIED OTHERWISE.

- NEW SURFACE WATER SEWER
- NEW FOUL WATER SEWER
- EXTERNAL FOUL WATER SEWER
- EXTERNAL SURFACE WATER SEWER
- RISING MAIN FOR FOUL SEWER
- G — INDICATIVE GULLY POSITIONS
- FW(No.) — FOUL WATER MANHOLE
- FW(No.) — SURFACE WATER MANHOLE

SURFACE WATER STRATEGY:

THIS DEVELOPMENT IS NOT SUBJECT TO ANY BETTERMENT ON THE EXISTING FLOW AS THE CURRENT SURFACE WATER IS UNDERSTOOD TO DISCHARGE DIRECTLY INTO THE ADJACENT WATERLOO DOCK.

THE FOLLOWING CRITERIA HAVE BEEN ASSESSED;

1 IN 2 YEAR STORM EVENT WITH NO SURCHARGE

1 IN 30 YEAR STORM EVENT WITH NO FLOODING WITH OUTFALL SURCHARGED TO 6.000mAOD.

1 IN 100 YEAR STORM EVENT (+ 30% CLIMATE CHANGE) WITH FLOODING CONTAINED ON SITE WITH OUTFALL SURCHARGED TO 6.000mAOD.

1 IN 100 YEAR STORM EVENT (+ 30% CLIMATE CHANGE) WITH FLOODING CONTAINED ON SITE WITH OUTFALL SURCHARGED TO 7.150mAOD.

FOUL WATER STRATEGY:

THIS WILL BE COLLECTED ON SITE THROUGH A SEPARATE FOUL DRAINAGE SYSTEM WHICH IS COLLECTED AND PUMPED FROM THE PUMPING STATION INTO THE RISING MAIN AND UP INTO THE GRAVITY SYSTEM THE ESTIMATED PEAK FOUL FLOW IS SUBJECT TO CONFIRMATION OF NUMBERS AND LAYOUTS OF ROOMS.

THIS DRAWING IS FOR INFORMATION ONLY AND IS SUBJECT TO FURTHER DISCUSSIONS WITH THE RELEVANT AUTHORITIES, DOCK OPERATORS, RIVER AND CANAL TRUST AND SUBSEQUENT FURTHER DETAILED DESIGN - DO NOT CONSTRUCT FROM THIS DRAWING.

THE STRATEGY SHOWN IS SUBJECT TO CONFIRMATION OF RWP, GULLY & SVP NUMBERS AND POSITIONS, PROPOSED LEVELS, POSITION OF TREE AND PLANTING AND CONFIRMATION OF AGREED OUTFALL LEVEL.

THE STRATEGY ASSUMES A GRAVITY FED DRAINAGE SYSTEM IS TO BE USED ON THE DEVELOPMENT WITH NO PUMPING.

NOTES:

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER ENGINEER'S AND ARCHITECT'S DRAWINGS, DETAILS AND SPECIFICATIONS.
2. THIS DRAWING INDICATES DRAINAGE PRINCIPLES AND STRATEGY ONLY AND FURTHER DETAIL DESIGN IS REQUIRED FOLLOWING CONFIRMATION OF BUILDING SET OUT, PROPOSED LEVELS, PROPOSED INTERNAL POP UPS AND FURTHER DISCUSSIONS WITH ALL RELEVANT PARTIES REGARDING OUTFALL LEVEL.
3. AS CONFIRMED BY THE LEAD LOCAL FLOOD AUTHORITY, NO BETTERMENT IS PROPOSED FOR THE EXISTING BROWNFIELD SITE AS CURRENT SURFACE WATER DRAIBN FREELY INTO THE EXISTING DOCK SYSTEM.
4. DURING THE DETAILED DESIGN PHASE, ALL STORM EVENT DURATIONS UP TO AND INCLUDING 6 HOURS WILL BE MODELLED TO DETERMINE THE FINAL STORAGE REQUIREMENT FOR THE DEVELOPMENT.
5. ALL PROPOSED RESTRICTED FLOW RATES AND CONNECTION POINTS WILL BE SUBJECT TO RELEVANT THIRD PARTY AGREEMENTS AND APPROVALS
6. FOUL WATER FLOW RATES ARE ESTIMATED IN ACCORDANCE WITH BS EN 752:2008 AND DESIGNED FOR PEAK FLOW RATES.
7. IF FOUL WATER CONNECTION IS MADE TO A PUBLIC SEWER, UNITED UTILITIES CONFIRMATION OF APPROVAL FOR THE FLOW RATE ENTERING THE PUBLIC SEWER WILL BE REQUIRED TO PROCEED WITH THE DETAILED DESIGN.

Rev	Date	Description	By	Check	App.
02	25/10/19	ISSUED FOR INORMATION	MD	JG	BRH
01	30/11/18	ISSUED FOR INORMATION	MD	JG	BRH

Client: ROMAL CAPITAL GROUP LTD

Project: PLOT CO2
LIVERPOOL WATERS

Office: LIVERPOOL

Discipline: CIVIL

Title: PROPOSED DRAINAGE

Scale @ A1: 1:250

Status: INFORMATION

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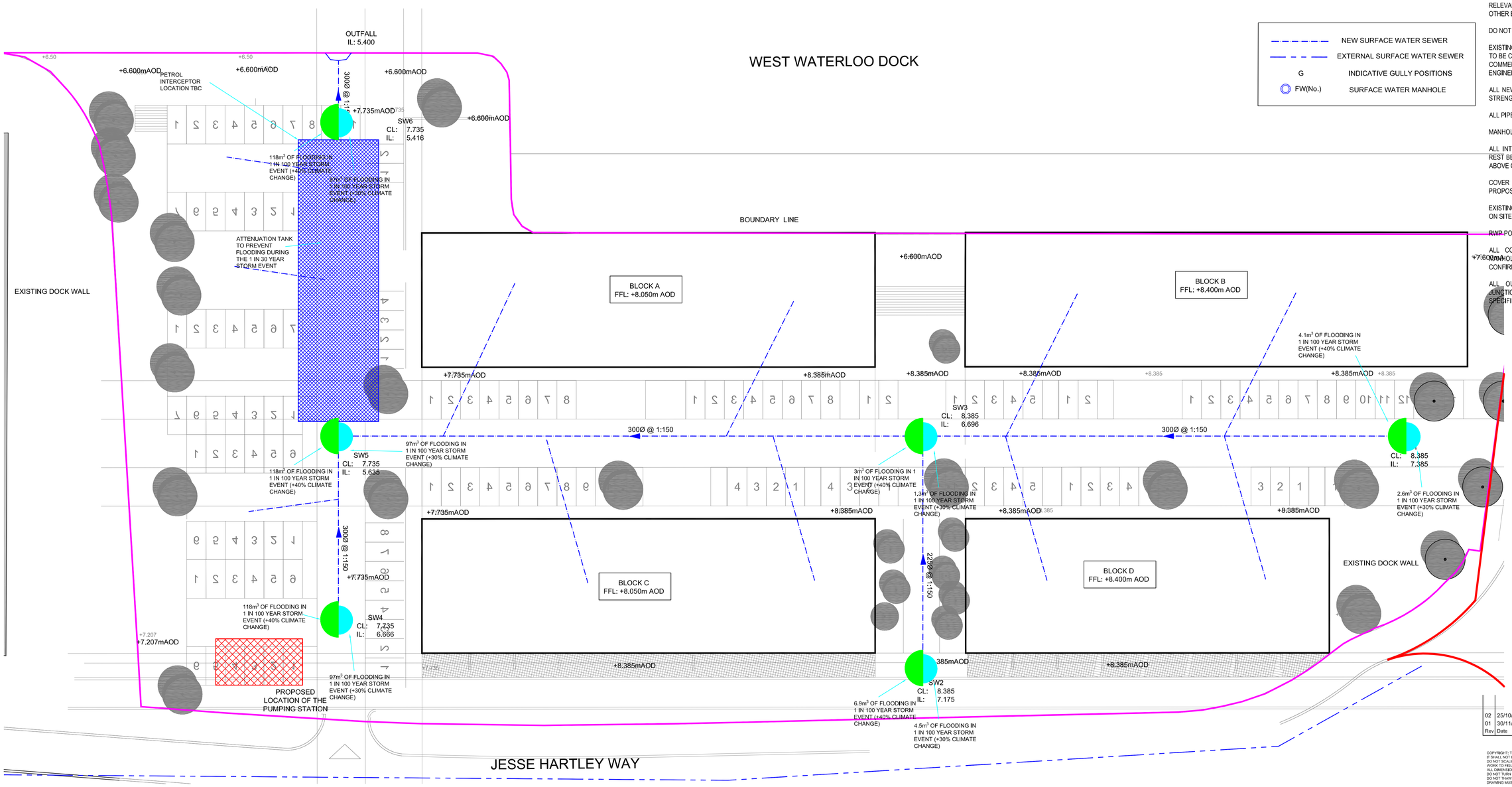
Birmingham 0121 200 3500 , Glasgow 0141 222 7120 , Liverpool 0151 227 5300 , London 020 3277 0970 , Manchester 0161 613 6000 , Newcastle 0191 221 0702 , Norwich 01603 308190 , Prestwich 01292 475251 , Reading 0118 941 7888

Job Number	Originator	Building/Zone	Level
4/6679	CCL	CO2	EXT
Type	Discipline	Drawing No.	Revision
DRN	C	001	02

WEST WATERLOO DOCK



NEW SURFACE WATER SEWER
EXTERNAL SURFACE WATER SEWER
G INDICATIVE GULLY POSITIONS
FW(No.) SURFACE WATER MANHOLE

GENERAL NOTES

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ALL NEW PIPES UP TO BE V.C. TO BSEN 295-1.1991 EXTRA STRENGTH GRADE

ALL PIPES TO BE 150 DIA. MIN FALL 1 : 150 (UNO)

MANHOLES, RODDING EYES ETC. TO BE ENCASED IN S.R.C.

ALL INTERNAL CONNECTIONS TO CONSIST OF STANDARD REST BEND WITH APPROPRIATE ADAPTOR TO CONNECT TO ABOVE GROUND DRAINAGE.

COVER LEVELS TO BE CHECKED AGAINST ARCHITECTS PROPOSED EXTERNAL WORKS LEVEL / DETAIL DRAWINGS

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1 IN 100 YEAR STORM EVENT (+ 30% CLIMATE CHANGE) WITH FLOODING CONTAINED ON SITE WITH OUTFALL SURCHARGED TO 7.150mAOD.

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THE FLOOD VOLUMES SHOWN IS IS BASED ON THE DRAINAGE STRATEGY WHICH IS SUBJECT TO CONFIRMATION OF RWP, GULLY & SVP NUMBERS AND POSITIONS, PROPOSED LEVELS, POSITION OF TREE AND PLANTING AND CONFIRMATION OF AGREED OUTFALL LEVEL.

THE STRATEGY ASSUMES A GRAVITY FED DRAINAGE SYSTEM IS TO BE USED ON THE DEVELOPMENT WITH NO PUMPING.

Rev	Date	Description	By	Check	App.
02	25/10/19	ISSUED FOR INORMATION	MD	JG	BRH
01	30/11/18	ISSUED FOR INORMATION	MD	JG	BRH

Client: ROMAL CAPITAL GROUP LTD

Project: PLOT CO2
LIVERPOOL WATERS

Office: LIVERPOOL

Discipline: CIVIL

Title: INDICATIVE FLOOD VOLUMES & LOCATIONS OF FLOODING IN 1 IN 100 YEAR STORM EVENTS

Scale @ A1: 1:250

Status: INFORMATION

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Job Number	Originator	Building/Zone	Level
4/6679	CCL	CO2	EXT
Type	**Discipline**	**Drawing No.**	**Revision**
DRN	C	002	02

APPENDIX C

INITIAL DRAINAGE CALCULATIONS

Existing Network Details for Storm

* - Indicates pipe has been modified outside of System 1

	PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	k (mm)	HYD SECT	DIA (mm)	Section Type
*	1.000	58.400	0.389	150.1	0.038	5.00	0.600	o	225	Pipe/Conduit
*	2.000	26.900	0.179	150.3	0.064	5.00	0.600	o	225	Pipe/Conduit
*	1.001	71.500	0.477	149.9	0.300	0.00	0.600	o	300	Pipe/Conduit
*	3.000	22.000	0.147	149.7	0.074	5.00	0.600	o	225	Pipe/Conduit
*	1.002	33.000	0.220	150.0	0.362	0.00	0.600	o	450	Pipe/Conduit
*	1.003	15.400	0.077	200.0	0.108	0.00	0.600	o	450	Pipe/Conduit

	PN	US/MH Name	US/CL (m)	US/IL (m)	US C.Depth (m)	DS/CL (m)	DS/IL (m)	DS C.Depth (m)	Ctrl	US/MH (mm)
*	1.000	mhs 1	8.385	7.385	0.775	8.385	6.996	1.164		1200
*	2.000	mhs 2	8.385	7.175	0.985	8.385	6.996	1.164		1200
*	1.001	mhs 3	8.385	6.996	1.089	7.735	6.519	0.916		1200
*	3.000	mhs 4	7.735	6.666	0.844	7.735	6.519	0.991		1200
*	1.002	mhs 5	7.735	6.519	0.766	7.735	6.299	0.986		1500
*	1.003	mhs 6	7.735	5.477	1.808	6.600	5.400	0.750		1500

Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
mhs 1	8.385	1.000	Open Manhole	1200	1.000	7.385	225				
mhs 2	8.385	1.210	Open Manhole	1200	2.000	7.175	225				
mhs 3	8.385	1.389	Open Manhole	1200	1.001	6.996	300	1.000	6.996	225	
								2.000	6.996	225	
mhs 4	7.735	1.069	Open Manhole	1200	3.000	6.666	225				
mhs 5	7.735	1.216	Open Manhole	1500	1.002	6.519	450	1.001	6.519	300	
								3.000	6.519	225	
mhs 6	7.735	2.258	Open Manhole	1500	1.003	5.477	450	1.002	6.299	450	822
	6.600	1.200	Open Manhole	0		OUTFALL		1.003	5.400	450	

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	o	225	mhs 1	8.385	7.385	0.775	Open Manhole	1200
2.000	o	225	mhs 2	8.385	7.175	0.985	Open Manhole	1200
1.001	o	300	mhs 3	8.385	6.996	1.089	Open Manhole	1200
3.000	o	225	mhs 4	7.735	6.666	0.844	Open Manhole	1200
1.002	o	450	mhs 5	7.735	6.519	0.766	Open Manhole	1500
1.003	o	450	mhs 6	7.735	5.477	1.808	Open Manhole	1500

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	58.400	150.1	mhs 3	8.385	6.996	1.164	Open Manhole	1200
2.000	26.900	150.3	mhs 3	8.385	6.996	1.164	Open Manhole	1200
1.001	71.500	149.9	mhs 5	7.735	6.519	0.916	Open Manhole	1500
3.000	22.000	149.7	mhs 5	7.735	6.519	0.991	Open Manhole	1500
1.002	33.000	150.0	mhs 6	7.735	6.299	0.986	Open Manhole	1500
1.003	15.400	200.0		6.600	5.400	0.750	Open Manhole	0

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)
1.003		6.600	5.400	0.000	0	0

Volume Summary (Static)

Length Calculations based on Centre-Centre

Pipe Number	USMH Name	Manhole Volume (m³)	Pipe Volume (m³)	Storage Structure Volume (m³)	Total Volume (m³)
1.000	mhs 1	1.131	2.322	0.000	3.453
2.000	mhs 2	1.368	1.070	0.000	2.438
1.001	mhs 3	1.571	5.054	0.000	6.625
3.000	mhs 4	1.209	0.875	0.000	2.084
1.002	mhs 5	2.149	5.248	0.000	7.397
1.003	mhs 6	3.990	2.449	0.000	6.439
Total		11.418	17.018	0.000	28.437

Volume Summary (Static)

Length Calculations based on True Length

Pipe Number	USMH Name	Manhole Volume (m³)	Pipe Volume (m³)	Storage Structure Volume (m³)	Total Volume (m³)
1.000	mhs 1	1.131	2.274	0.000	3.405
2.000	mhs 2	1.368	1.022	0.000	2.390
1.001	mhs 3	1.571	4.959	0.000	6.530
3.000	mhs 4	1.209	0.821	0.000	2.030
1.002	mhs 5	2.149	5.010	0.000	7.159
1.003	mhs 6	3.990	2.330	0.000	6.320
Total		11.418	16.416	0.000	27.834

2 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 Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

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

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm)	19.100
Region	England and Wales	Ratio R	0.400
Cv (Summer)	0.750		
Cv (Winter)	0.840		

Margin for Flood Risk Warning (mm) 150.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	2
Climate Change (%)	0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
1.000	mhs 1	15 Winter	2	+0%					7.445	-0.165	0.000
2.000	mhs 2	15 Winter	2	+0%					7.256	-0.144	0.000
1.001	mhs 3	15 Winter	2	+0%					7.180	-0.116	0.000
3.000	mhs 4	15 Winter	2	+0%					6.776	-0.115	0.000
1.002	mhs 5	15 Winter	2	+0%					6.751	-0.218	0.000
1.003	mhs 6	15 Winter	2	+0%					5.782	-0.145	0.000

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	mhs 1	0.15		6.3	OK	
2.000	mhs 2	0.27		10.8	OK	
1.001	mhs 3	0.67		58.1	OK	
3.000	mhs 4	0.31		12.0	OK	
1.002	mhs 5	0.52		118.9	OK	
1.003	mhs 6	0.79		133.5	OK	

Existing Network Details for Storm

* - Indicates pipe has been modified outside of System 1

	PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	k (mm)	HYD SECT	DIA (mm)	Section Type
*	1.000	58.400	0.389	150.1	0.038	5.00	0.600	o	225	Pipe/Conduit
*	2.000	26.900	0.179	150.3	0.064	5.00	0.600	o	225	Pipe/Conduit
*	1.001	71.500	0.477	149.9	0.300	0.00	0.600	o	300	Pipe/Conduit
*	3.000	22.000	0.147	149.7	0.074	5.00	0.600	o	300	Pipe/Conduit
*	1.002	33.000	0.220	150.0	0.362	0.00	0.600	o	225	Pipe/Conduit
*	1.003	15.400	0.015	1026.7	0.108	0.00	0.600	o	225	Pipe/Conduit

	PN	US/MH Name	US/CL (m)	US/IL (m)	US C.Depth (m)	DS/CL (m)	DS/IL (m)	DS C.Depth (m)	Ctrl	US/MH (mm)
*	1.000	mhs 1	8.385	7.385	0.775	8.385	6.996	1.164		1200
*	2.000	mhs 2	8.385	7.175	0.985	8.385	6.996	1.164		1200
*	1.001	mhs 3	8.385	6.996	1.089	7.735	6.519	0.916		1200
*	3.000	mhs 4	7.735	6.666	0.769	7.735	6.519	0.916		1200
*	1.002	mhs 5	7.735	5.635	1.875	7.735	5.415	2.095		300
*	1.003	mhs 6	7.735	5.415	2.095	6.600	5.400	0.975		1500

Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
mhs 1	8.385	1.000	Open Manhole	1200	1.000	7.385	225				
mhs 2	8.385	1.210	Open Manhole	1200	2.000	7.175	225				
mhs 3	8.385	1.389	Open Manhole	1200	1.001	6.996	300	1.000	6.996	225	
								2.000	6.996	225	
mhs 4	7.735	1.069	Open Manhole	1200	3.000	6.666	300				
mhs 5	7.735	2.100	Open Manhole	300	1.002	5.635	225	1.001	6.519	300	959
								3.000	6.519	300	959
mhs 6	7.735	2.320	Open Manhole	1500	1.003	5.415	225	1.002	5.415	225	
	6.600	1.200	Open Manhole	0		OUTFALL		1.003	5.400	225	

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	o	225	mhs 1	8.385	7.385	0.775	Open Manhole	1200
2.000	o	225	mhs 2	8.385	7.175	0.985	Open Manhole	1200
1.001	o	300	mhs 3	8.385	6.996	1.089	Open Manhole	1200
3.000	o	300	mhs 4	7.735	6.666	0.769	Open Manhole	1200
1.002	o	225	mhs 5	7.735	5.635	1.875	Open Manhole	300
1.003	o	225	mhs 6	7.735	5.415	2.095	Open Manhole	1500

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	58.400	150.1	mhs 3	8.385	6.996	1.164	Open Manhole	1200
2.000	26.900	150.3	mhs 3	8.385	6.996	1.164	Open Manhole	1200
1.001	71.500	149.9	mhs 5	7.735	6.519	0.916	Open Manhole	300
3.000	22.000	149.7	mhs 5	7.735	6.519	0.916	Open Manhole	300
1.002	33.000	150.0	mhs 6	7.735	5.415	2.095	Open Manhole	1500
1.003	15.400	1026.7		6.600	5.400	0.975	Open Manhole	0

Surcharged Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.003		6.600	5.400	0.000	0	0

Datum (m) 6.000 Offset (mins) 0

Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)
1	6.000	16	6.000	31	6.000	46	6.000	61	6.000	76	6.000	91	6.000	106	6.000
2	6.000	17	6.000	32	6.000	47	6.000	62	6.000	77	6.000	92	6.000	107	6.000
3	6.000	18	6.000	33	6.000	48	6.000	63	6.000	78	6.000	93	6.000	108	6.000
4	6.000	19	6.000	34	6.000	49	6.000	64	6.000	79	6.000	94	6.000	109	6.000
5	6.000	20	6.000	35	6.000	50	6.000	65	6.000	80	6.000	95	6.000	110	6.000
6	6.000	21	6.000	36	6.000	51	6.000	66	6.000	81	6.000	96	6.000	111	6.000
7	6.000	22	6.000	37	6.000	52	6.000	67	6.000	82	6.000	97	6.000	112	6.000
8	6.000	23	6.000	38	6.000	53	6.000	68	6.000	83	6.000	98	6.000	113	6.000
9	6.000	24	6.000	39	6.000	54	6.000	69	6.000	84	6.000	99	6.000	114	6.000
10	6.000	25	6.000	40	6.000	55	6.000	70	6.000	85	6.000	100	6.000	115	6.000
11	6.000	26	6.000	41	6.000	56	6.000	71	6.000	86	6.000	101	6.000	116	6.000
12	6.000	27	6.000	42	6.000	57	6.000	72	6.000	87	6.000	102	6.000	117	6.000
13	6.000	28	6.000	43	6.000	58	6.000	73	6.000	88	6.000	103	6.000	118	6.000
14	6.000	29	6.000	44	6.000	59	6.000	74	6.000	89	6.000	104	6.000	119	6.000
15	6.000	30	6.000	45	6.000	60	6.000	75	6.000	90	6.000	105	6.000	120	6.000

Surcharged Outfall Details for Storm

Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)
121	6.000	183	6.000	245	6.000	307	6.000	369	6.000	431	6.000	493	6.000	555	6.000
122	6.000	184	6.000	246	6.000	308	6.000	370	6.000	432	6.000	494	6.000	556	6.000
123	6.000	185	6.000	247	6.000	309	6.000	371	6.000	433	6.000	495	6.000	557	6.000
124	6.000	186	6.000	248	6.000	310	6.000	372	6.000	434	6.000	496	6.000	558	6.000
125	6.000	187	6.000	249	6.000	311	6.000	373	6.000	435	6.000	497	6.000	559	6.000
126	6.000	188	6.000	250	6.000	312	6.000	374	6.000	436	6.000	498	6.000	560	6.000
127	6.000	189	6.000	251	6.000	313	6.000	375	6.000	437	6.000	499	6.000	561	6.000
128	6.000	190	6.000	252	6.000	314	6.000	376	6.000	438	6.000	500	6.000	562	6.000
129	6.000	191	6.000	253	6.000	315	6.000	377	6.000	439	6.000	501	6.000	563	6.000
130	6.000	192	6.000	254	6.000	316	6.000	378	6.000	440	6.000	502	6.000	564	6.000
131	6.000	193	6.000	255	6.000	317	6.000	379	6.000	441	6.000	503	6.000	565	6.000
132	6.000	194	6.000	256	6.000	318	6.000	380	6.000	442	6.000	504	6.000	566	6.000
133	6.000	195	6.000	257	6.000	319	6.000	381	6.000	443	6.000	505	6.000	567	6.000
134	6.000	196	6.000	258	6.000	320	6.000	382	6.000	444	6.000	506	6.000	568	6.000
135	6.000	197	6.000	259	6.000	321	6.000	383	6.000	445	6.000	507	6.000	569	6.000
136	6.000	198	6.000	260	6.000	322	6.000	384	6.000	446	6.000	508	6.000	570	6.000
137	6.000	199	6.000	261	6.000	323	6.000	385	6.000	447	6.000	509	6.000	571	6.000
138	6.000	200	6.000	262	6.000	324	6.000	386	6.000	448	6.000	510	6.000	572	6.000
139	6.000	201	6.000	263	6.000	325	6.000	387	6.000	449	6.000	511	6.000	573	6.000
140	6.000	202	6.000	264	6.000	326	6.000	388	6.000	450	6.000	512	6.000	574	6.000
141	6.000	203	6.000	265	6.000	327	6.000	389	6.000	451	6.000	513	6.000	575	6.000
142	6.000	204	6.000	266	6.000	328	6.000	390	6.000	452	6.000	514	6.000	576	6.000
143	6.000	205	6.000	267	6.000	329	6.000	391	6.000	453	6.000	515	6.000	577	6.000
144	6.000	206	6.000	268	6.000	330	6.000	392	6.000	454	6.000	516	6.000	578	6.000
145	6.000	207	6.000	269	6.000	331	6.000	393	6.000	455	6.000	517	6.000	579	6.000
146	6.000	208	6.000	270	6.000	332	6.000	394	6.000	456	6.000	518	6.000	580	6.000
147	6.000	209	6.000	271	6.000	333	6.000	395	6.000	457	6.000	519	6.000	581	6.000
148	6.000	210	6.000	272	6.000	334	6.000	396	6.000	458	6.000	520	6.000	582	6.000
149	6.000	211	6.000	273	6.000	335	6.000	397	6.000	459	6.000	521	6.000	583	6.000
150	6.000	212	6.000	274	6.000	336	6.000	398	6.000	460	6.000	522	6.000	584	6.000
151	6.000	213	6.000	275	6.000	337	6.000	399	6.000	461	6.000	523	6.000	585	6.000
152	6.000	214	6.000	276	6.000	338	6.000	400	6.000	462	6.000	524	6.000	586	6.000
153	6.000	215	6.000	277	6.000	339	6.000	401	6.000	463	6.000	525	6.000	587	6.000
154	6.000	216	6.000	278	6.000	340	6.000	402	6.000	464	6.000	526	6.000	588	6.000
155	6.000	217	6.000	279	6.000	341	6.000	403	6.000	465	6.000	527	6.000	589	6.000
156	6.000	218	6.000	280	6.000	342	6.000	404	6.000	466	6.000	528	6.000	590	6.000
157	6.000	219	6.000	281	6.000	343	6.000	405	6.000	467	6.000	529	6.000	591	6.000
158	6.000	220	6.000	282	6.000	344	6.000	406	6.000	468	6.000	530	6.000	592	6.000
159	6.000	221	6.000	283	6.000	345	6.000	407	6.000	469	6.000	531	6.000	593	6.000
160	6.000	222	6.000	284	6.000	346	6.000	408	6.000	470	6.000	532	6.000	594	6.000
161	6.000	223	6.000	285	6.000	347	6.000	409	6.000	471	6.000	533	6.000	595	6.000
162	6.000	224	6.000	286	6.000	348	6.000	410	6.000	472	6.000	534	6.000	596	6.000
163	6.000	225	6.000	287	6.000	349	6.000	411	6.000	473	6.000	535	6.000	597	6.000
164	6.000	226	6.000	288	6.000	350	6.000	412	6.000	474	6.000	536	6.000	598	6.000
165	6.000	227	6.000	289	6.000	351	6.000	413	6.000	475	6.000	537	6.000	599	6.000
166	6.000	228	6.000	290	6.000	352	6.000	414	6.000	476	6.000	538	6.000	600	6.000
167	6.000	229	6.000	291	6.000	353	6.000	415	6.000	477	6.000	539	6.000	601	6.000
168	6.000	230	6.000	292	6.000	354	6.000	416	6.000	478	6.000	540	6.000	602	6.000
169	6.000	231	6.000	293	6.000	355	6.000	417	6.000	479	6.000	541	6.000	603	6.000
170	6.000	232	6.000	294	6.000	356	6.000	418	6.000	480	6.000	542	6.000	604	6.000
171	6.000	233	6.000	295	6.000	357	6.000	419	6.000	481	6.000	543	6.000	605	6.000
172	6.000	234	6.000	296	6.000	358	6.000	420	6.000	482	6.000	544	6.000	606	6.000
173	6.000	235	6.000	297	6.000	359	6.000	421	6.000	483	6.000	545	6.000	607	6.000
174	6.000	236	6.000	298	6.000	360	6.000	422	6.000	484	6.000	546	6.000	608	6.000
175	6.000	237	6.000	299	6.000	361	6.000	423	6.000	485	6.000	547	6.000	609	6.000
176	6.000	238	6.000	300	6.000	362	6.000	424	6.000	486	6.000	548	6.000	610	6.000
177	6.000	239	6.000	301	6.000	363	6.000	425	6.000	487	6.000	549	6.000	611	6.000
178	6.000	240	6.000	302	6.000	364	6.000	426	6.000	488	6.000	550	6.000	612	6.000
179	6.000	241	6.000	303	6.000	365	6.000	427	6.000	489	6.000	551	6.000	613	6.000
180	6.000	242	6.000	304	6.000	366	6.000	428	6.000	490	6.000	552	6.000	614	6.000
181	6.000	243	6.000	305	6.000	367	6.000	429	6.000	491	6.000	553	6.000	615	6.000
182	6.000	244	6.000	306	6.000	368	6.000	430	6.000	492	6.000	554	6.000	616	6.000

Surcharged Outfall Details for Storm

Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)
617	6.000	679	6.000	741	6.000	803	6.000	865	6.000	927	6.000	989	6.000	1051	6.000
618	6.000	680	6.000	742	6.000	804	6.000	866	6.000	928	6.000	990	6.000	1052	6.000
619	6.000	681	6.000	743	6.000	805	6.000	867	6.000	929	6.000	991	6.000	1053	6.000
620	6.000	682	6.000	744	6.000	806	6.000	868	6.000	930	6.000	992	6.000	1054	6.000
621	6.000	683	6.000	745	6.000	807	6.000	869	6.000	931	6.000	993	6.000	1055	6.000
622	6.000	684	6.000	746	6.000	808	6.000	870	6.000	932	6.000	994	6.000	1056	6.000
623	6.000	685	6.000	747	6.000	809	6.000	871	6.000	933	6.000	995	6.000	1057	6.000
624	6.000	686	6.000	748	6.000	810	6.000	872	6.000	934	6.000	996	6.000	1058	6.000
625	6.000	687	6.000	749	6.000	811	6.000	873	6.000	935	6.000	997	6.000	1059	6.000
626	6.000	688	6.000	750	6.000	812	6.000	874	6.000	936	6.000	998	6.000	1060	6.000
627	6.000	689	6.000	751	6.000	813	6.000	875	6.000	937	6.000	999	6.000	1061	6.000
628	6.000	690	6.000	752	6.000	814	6.000	876	6.000	938	6.000	1000	6.000	1062	6.000
629	6.000	691	6.000	753	6.000	815	6.000	877	6.000	939	6.000	1001	6.000	1063	6.000
630	6.000	692	6.000	754	6.000	816	6.000	878	6.000	940	6.000	1002	6.000	1064	6.000
631	6.000	693	6.000	755	6.000	817	6.000	879	6.000	941	6.000	1003	6.000	1065	6.000
632	6.000	694	6.000	756	6.000	818	6.000	880	6.000	942	6.000	1004	6.000	1066	6.000
633	6.000	695	6.000	757	6.000	819	6.000	881	6.000	943	6.000	1005	6.000	1067	6.000
634	6.000	696	6.000	758	6.000	820	6.000	882	6.000	944	6.000	1006	6.000	1068	6.000
635	6.000	697	6.000	759	6.000	821	6.000	883	6.000	945	6.000	1007	6.000	1069	6.000
636	6.000	698	6.000	760	6.000	822	6.000	884	6.000	946	6.000	1008	6.000	1070	6.000
637	6.000	699	6.000	761	6.000	823	6.000	885	6.000	947	6.000	1009	6.000	1071	6.000
638	6.000	700	6.000	762	6.000	824	6.000	886	6.000	948	6.000	1010	6.000	1072	6.000
639	6.000	701	6.000	763	6.000	825	6.000	887	6.000	949	6.000	1011	6.000	1073	6.000
640	6.000	702	6.000	764	6.000	826	6.000	888	6.000	950	6.000	1012	6.000	1074	6.000
641	6.000	703	6.000	765	6.000	827	6.000	889	6.000	951	6.000	1013	6.000	1075	6.000
642	6.000	704	6.000	766	6.000	828	6.000	890	6.000	952	6.000	1014	6.000	1076	6.000
643	6.000	705	6.000	767	6.000	829	6.000	891	6.000	953	6.000	1015	6.000	1077	6.000
644	6.000	706	6.000	768	6.000	830	6.000	892	6.000	954	6.000	1016	6.000	1078	6.000
645	6.000	707	6.000	769	6.000	831	6.000	893	6.000	955	6.000	1017	6.000	1079	6.000
646	6.000	708	6.000	770	6.000	832	6.000	894	6.000	956	6.000	1018	6.000	1080	6.000
647	6.000	709	6.000	771	6.000	833	6.000	895	6.000	957	6.000	1019	6.000	1081	6.000
648	6.000	710	6.000	772	6.000	834	6.000	896	6.000	958	6.000	1020	6.000	1082	6.000
649	6.000	711	6.000	773	6.000	835	6.000	897	6.000	959	6.000	1021	6.000	1083	6.000
650	6.000	712	6.000	774	6.000	836	6.000	898	6.000	960	6.000	1022	6.000	1084	6.000
651	6.000	713	6.000	775	6.000	837	6.000	899	6.000	961	6.000	1023	6.000	1085	6.000
652	6.000	714	6.000	776	6.000	838	6.000	900	6.000	962	6.000	1024	6.000	1086	6.000
653	6.000	715	6.000	777	6.000	839	6.000	901	6.000	963	6.000	1025	6.000	1087	6.000
654	6.000	716	6.000	778	6.000	840	6.000	902	6.000	964	6.000	1026	6.000	1088	6.000
655	6.000	717	6.000	779	6.000	841	6.000	903	6.000	965	6.000	1027	6.000	1089	6.000
656	6.000	718	6.000	780	6.000	842	6.000	904	6.000	966	6.000	1028	6.000	1090	6.000
657	6.000	719	6.000	781	6.000	843	6.000	905	6.000	967	6.000	1029	6.000	1091	6.000
658	6.000	720	6.000	782	6.000	844	6.000	906	6.000	968	6.000	1030	6.000	1092	6.000
659	6.000	721	6.000	783	6.000	845	6.000	907	6.000	969	6.000	1031	6.000	1093	6.000
660	6.000	722	6.000	784	6.000	846	6.000	908	6.000	970	6.000	1032	6.000	1094	6.000
661	6.000	723	6.000	785	6.000	847	6.000	909	6.000	971	6.000	1033	6.000	1095	6.000
662	6.000	724	6.000	786	6.000	848	6.000	910	6.000	972	6.000	1034	6.000	1096	6.000
663	6.000	725	6.000	787	6.000	849	6.000	911	6.000	973	6.000	1035	6.000	1097	6.000
664	6.000	726	6.000	788	6.000	850	6.000	912	6.000	974	6.000	1036	6.000	1098	6.000
665	6.000	727	6.000	789	6.000	851	6.000	913	6.000	975	6.000	1037	6.000	1099	6.000
666	6.000	728	6.000	790	6.000	852	6.000	914	6.000	976	6.000	1038	6.000	1100	6.000
667	6.000	729	6.000	791	6.000	853	6.000	915	6.000	977	6.000	1039	6.000	1101	6.000
668	6.000	730	6.000	792	6.000	854	6.000	916	6.000	978	6.000	1040	6.000	1102	6.000
669	6.000	731	6.000	793	6.000	855	6.000	917	6.000	979	6.000	1041	6.000	1103	6.000
670	6.000	732	6.000	794	6.000	856	6.000	918	6.000	980	6.000	1042	6.000	1104	6.000
671	6.000	733	6.000	795	6.000	857	6.000	919	6.000	981	6.000	1043	6.000	1105	6.000
672	6.000	734	6.000	796	6.000	858	6.000	920	6.000	982	6.000	1044	6.000	1106	6.000
673	6.000	735	6.000	797	6.000	859	6.000	921	6.000	983	6.000	1045	6.000	1107	6.000
674	6.000	736	6.000	798	6.000	860	6.000	922	6.000	984	6.000	1046	6.000	1108	6.000
675	6.000	737	6.000	799	6.000	861	6.000	923	6.000	985	6.000	1047	6.000	1109	6.000
676	6.000	738	6.000	800	6.000	862	6.000	924	6.000	986	6.000	1048	6.000	1110	6.000
677	6.000	739	6.000	801	6.000	863	6.000	925	6.000	987	6.000	1049	6.000	1111	6.000
678	6.000	740	6.000	802	6.000	864	6.000	926	6.000	988	6.000	1050	6.000	1112	6.000

Surcharged Outfall Details for Storm

Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)
1113	6.000	1154	6.000	1195	6.000	1236	6.000	1277	6.000	1318	6.000	1359	6.000	1400	6.000
1114	6.000	1155	6.000	1196	6.000	1237	6.000	1278	6.000	1319	6.000	1360	6.000	1401	6.000
1115	6.000	1156	6.000	1197	6.000	1238	6.000	1279	6.000	1320	6.000	1361	6.000	1402	6.000
1116	6.000	1157	6.000	1198	6.000	1239	6.000	1280	6.000	1321	6.000	1362	6.000	1403	6.000
1117	6.000	1158	6.000	1199	6.000	1240	6.000	1281	6.000	1322	6.000	1363	6.000	1404	6.000
1118	6.000	1159	6.000	1200	6.000	1241	6.000	1282	6.000	1323	6.000	1364	6.000	1405	6.000
1119	6.000	1160	6.000	1201	6.000	1242	6.000	1283	6.000	1324	6.000	1365	6.000	1406	6.000
1120	6.000	1161	6.000	1202	6.000	1243	6.000	1284	6.000	1325	6.000	1366	6.000	1407	6.000
1121	6.000	1162	6.000	1203	6.000	1244	6.000	1285	6.000	1326	6.000	1367	6.000	1408	6.000
1122	6.000	1163	6.000	1204	6.000	1245	6.000	1286	6.000	1327	6.000	1368	6.000	1409	6.000
1123	6.000	1164	6.000	1205	6.000	1246	6.000	1287	6.000	1328	6.000	1369	6.000	1410	6.000
1124	6.000	1165	6.000	1206	6.000	1247	6.000	1288	6.000	1329	6.000	1370	6.000	1411	6.000
1125	6.000	1166	6.000	1207	6.000	1248	6.000	1289	6.000	1330	6.000	1371	6.000	1412	6.000
1126	6.000	1167	6.000	1208	6.000	1249	6.000	1290	6.000	1331	6.000	1372	6.000	1413	6.000
1127	6.000	1168	6.000	1209	6.000	1250	6.000	1291	6.000	1332	6.000	1373	6.000	1414	6.000
1128	6.000	1169	6.000	1210	6.000	1251	6.000	1292	6.000	1333	6.000	1374	6.000	1415	6.000
1129	6.000	1170	6.000	1211	6.000	1252	6.000	1293	6.000	1334	6.000	1375	6.000	1416	6.000
1130	6.000	1171	6.000	1212	6.000	1253	6.000	1294	6.000	1335	6.000	1376	6.000	1417	6.000
1131	6.000	1172	6.000	1213	6.000	1254	6.000	1295	6.000	1336	6.000	1377	6.000	1418	6.000
1132	6.000	1173	6.000	1214	6.000	1255	6.000	1296	6.000	1337	6.000	1378	6.000	1419	6.000
1133	6.000	1174	6.000	1215	6.000	1256	6.000	1297	6.000	1338	6.000	1379	6.000	1420	6.000
1134	6.000	1175	6.000	1216	6.000	1257	6.000	1298	6.000	1339	6.000	1380	6.000	1421	6.000
1135	6.000	1176	6.000	1217	6.000	1258	6.000	1299	6.000	1340	6.000	1381	6.000	1422	6.000
1136	6.000	1177	6.000	1218	6.000	1259	6.000	1300	6.000	1341	6.000	1382	6.000	1423	6.000
1137	6.000	1178	6.000	1219	6.000	1260	6.000	1301	6.000	1342	6.000	1383	6.000	1424	6.000
1138	6.000	1179	6.000	1220	6.000	1261	6.000	1302	6.000	1343	6.000	1384	6.000	1425	6.000
1139	6.000	1180	6.000	1221	6.000	1262	6.000	1303	6.000	1344	6.000	1385	6.000	1426	6.000
1140	6.000	1181	6.000	1222	6.000	1263	6.000	1304	6.000	1345	6.000	1386	6.000	1427	6.000
1141	6.000	1182	6.000	1223	6.000	1264	6.000	1305	6.000	1346	6.000	1387	6.000	1428	6.000
1142	6.000	1183	6.000	1224	6.000	1265	6.000	1306	6.000	1347	6.000	1388	6.000	1429	6.000
1143	6.000	1184	6.000	1225	6.000	1266	6.000	1307	6.000	1348	6.000	1389	6.000	1430	6.000
1144	6.000	1185	6.000	1226	6.000	1267	6.000	1308	6.000	1349	6.000	1390	6.000	1431	6.000
1145	6.000	1186	6.000	1227	6.000	1268	6.000	1309	6.000	1350	6.000	1391	6.000	1432	6.000
1146	6.000	1187	6.000	1228	6.000	1269	6.000	1310	6.000	1351	6.000	1392	6.000	1433	6.000
1147	6.000	1188	6.000	1229	6.000	1270	6.000	1311	6.000	1352	6.000	1393	6.000	1434	6.000
1148	6.000	1189	6.000	1230	6.000	1271	6.000	1312	6.000	1353	6.000	1394	6.000	1435	6.000
1149	6.000	1190	6.000	1231	6.000	1272	6.000	1313	6.000	1354	6.000	1395	6.000	1436	6.000
1150	6.000	1191	6.000	1232	6.000	1273	6.000	1314	6.000	1355	6.000	1396	6.000	1437	6.000
1151	6.000	1192	6.000	1233	6.000	1274	6.000	1315	6.000	1356	6.000	1397	6.000	1438	6.000
1152	6.000	1193	6.000	1234	6.000	1275	6.000	1316	6.000	1357	6.000	1398	6.000	1439	6.000
1153	6.000	1194	6.000	1235	6.000	1276	6.000	1317	6.000	1358	6.000	1399	6.000	1440	6.000

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 Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

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

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.400
Return Period (years)	30	Profile Type	Summer
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.100	Cv (Winter)	0.840

Synthetic Rainfall Details

Storm Duration (mins) 30

Storage Structures for Storm

Cellular Storage Manhole: mhs 5, DS/PN: 1.002

Invert Level (m) 5.635 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	350.0	350.0	1.499	350.0	485.0	1.500	0.0	485.0

Volume Summary (Static)

Length Calculations based on Centre-Centre

Pipe Number	USMH Name	Manhole Volume (m³)	Pipe Volume (m³)	Storage Structure Volume (m³)	Total Volume (m³)
1.000	mhs 1	1.131	2.322	0.000	3.453
2.000	mhs 2	1.368	1.070	0.000	2.438
1.001	mhs 3	1.571	5.054	0.000	6.625
3.000	mhs 4	1.209	1.555	0.000	2.764
1.002	mhs 5	0.148	1.312	498.528	499.989
1.003	mhs 6	4.100	0.612	0.000	4.712
Total		9.528	11.925	498.528	519.981

Volume Summary (Static)

Length Calculations based on True Length

Pipe Number	USMH Name	Manhole Volume (m³)	Pipe Volume (m³)	Storage Structure Volume (m³)	Total Volume (m³)
1.000	mhs 1	1.131	2.274	0.000	3.405
2.000	mhs 2	1.368	1.022	0.000	2.390
1.001	mhs 3	1.571	5.001	0.000	6.572
3.000	mhs 4	1.209	1.502	0.000	2.711
1.002	mhs 5	0.148	1.276	498.528	499.953
1.003	mhs 6	4.100	0.582	0.000	4.682
Total		9.528	11.658	498.528	519.714

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 Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

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

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm)	19.100
Region	England and Wales	Ratio R	0.400
Cv (Summer)	0.750		
Cv (Winter)	0.840		

Margin for Flood Risk Warning (mm) 150.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	30, 100
Climate Change (%)	0, 30

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)
1.000	mhs 1	15 Winter	30	+0%	30/15 Summer	100/15 Summer			7.658	0.048
2.000	mhs 2	15 Winter	30	+0%	30/15 Summer	100/15 Summer			7.666	0.266
1.001	mhs 3	15 Winter	30	+0%	30/15 Summer	100/15 Summer			7.622	0.326
3.000	mhs 4	1440 Winter	30	+0%	30/1440 Winter	100/240 Winter			7.073	0.107
1.002	mhs 5	1440 Winter	30	+0%	30/15 Summer	100/240 Winter			7.073	1.213
1.003	mhs 6	1440 Winter	30	+0%	30/15 Summer	30/960 Winter			7.315	1.675

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	mhs 1	0.000	0.29		12.0	SURCHARGED	3
2.000	mhs 2	0.000	0.51		19.9	SURCHARGED	3
1.001	mhs 3	0.000	1.30		112.7	SURCHARGED	3
3.000	mhs 4	0.000	0.01		1.1	SURCHARGED	13
1.002	mhs 5	0.000	1.61		64.2	SURCHARGED	13
1.003	mhs 6	0.000	6.01		64.4	SURCHARGED	13

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 Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

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

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.100 Cv (Summer) 0.750
Region England and Wales Ratio R 0.400 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years) 30, 100
Climate Change (%) 0, 30

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)
1.000	mhs 1	15 Winter	100	+30%	30/15 Summer	100/15 Summer			8.387	0.777
2.000	mhs 2	15 Winter	100	+30%	30/15 Summer	100/15 Summer			8.389	0.989
1.001	mhs 3	15 Winter	100	+30%	30/15 Summer	100/15 Summer			8.386	1.090
3.000	mhs 4	1440 Winter	100	+30%	30/1440 Winter	100/240 Winter			7.832	0.866
1.002	mhs 5	1440 Winter	100	+30%	30/15 Summer	100/240 Winter			7.833	1.973
1.003	mhs 6	1440 Winter	100	+30%	30/15 Summer	30/960 Winter			7.832	2.192

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	mhs 1	2.644	0.75		30.5	FLOOD	3
2.000	mhs 2	4.495	1.30		51.2	FLOOD	3
1.001	mhs 3	1.321	1.82		158.2	FLOOD	3
3.000	mhs 4	97.358	0.62		49.6	FLOOD	13
1.002	mhs 5	97.939	2.07		82.4	FLOOD	13
1.003	mhs 6	97.296	10.42		111.6	FLOOD	13

Existing Network Details for Storm

* - Indicates pipe has been modified outside of System 1

	PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	k (mm)	HYD SECT	DIA (mm)	Section Type
*	1.000	58.400	0.389	150.1	0.038	5.00	0.600	o	225	Pipe/Conduit
*	2.000	26.900	0.179	150.3	0.064	5.00	0.600	o	225	Pipe/Conduit
*	1.001	71.500	0.477	149.9	0.300	0.00	0.600	o	300	Pipe/Conduit
*	3.000	22.000	0.147	149.7	0.074	5.00	0.600	o	300	Pipe/Conduit
*	1.002	33.000	0.220	150.0	0.362	0.00	0.600	o	225	Pipe/Conduit
*	1.003	15.400	0.015	1026.7	0.108	0.00	0.600	o	225	Pipe/Conduit

	PN	US/MH Name	US/CL (m)	US/IL (m)	US C.Depth (m)	DS/CL (m)	DS/IL (m)	DS C.Depth (m)	Ctrl	US/MH (mm)
*	1.000	mhs 1	8.385	7.385	0.775	8.385	6.996	1.164		1200
*	2.000	mhs 2	8.385	7.175	0.985	8.385	6.996	1.164		1200
*	1.001	mhs 3	8.385	6.996	1.089	7.735	6.519	0.916		1200
*	3.000	mhs 4	7.735	6.666	0.769	7.735	6.519	0.916		1200
*	1.002	mhs 5	7.735	5.635	1.875	7.735	5.415	2.095		300
*	1.003	mhs 6	7.735	5.415	2.095	6.600	5.400	0.975		1500

Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
mhs 1	8.385	1.000	Open Manhole	1200	1.000	7.385	225				
mhs 2	8.385	1.210	Open Manhole	1200	2.000	7.175	225				
mhs 3	8.385	1.389	Open Manhole	1200	1.001	6.996	300	1.000	6.996	225	
								2.000	6.996	225	
mhs 4	7.735	1.069	Open Manhole	1200	3.000	6.666	300				
mhs 5	7.735	2.100	Open Manhole	300	1.002	5.635	225	1.001	6.519	300	959
								3.000	6.519	300	959
mhs 6	7.735	2.320	Open Manhole	1500	1.003	5.415	225	1.002	5.415	225	
	6.600	1.200	Open Manhole	0		OUTFALL		1.003	5.400	225	

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	o	225	mhs 1	8.385	7.385	0.775	Open Manhole	1200
2.000	o	225	mhs 2	8.385	7.175	0.985	Open Manhole	1200
1.001	o	300	mhs 3	8.385	6.996	1.089	Open Manhole	1200
3.000	o	300	mhs 4	7.735	6.666	0.769	Open Manhole	1200
1.002	o	225	mhs 5	7.735	5.635	1.875	Open Manhole	300
1.003	o	225	mhs 6	7.735	5.415	2.095	Open Manhole	1500

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	58.400	150.1	mhs 3	8.385	6.996	1.164	Open Manhole	1200
2.000	26.900	150.3	mhs 3	8.385	6.996	1.164	Open Manhole	1200
1.001	71.500	149.9	mhs 5	7.735	6.519	0.916	Open Manhole	300
3.000	22.000	149.7	mhs 5	7.735	6.519	0.916	Open Manhole	300
1.002	33.000	150.0	mhs 6	7.735	5.415	2.095	Open Manhole	1500
1.003	15.400	1026.7		6.600	5.400	0.975	Open Manhole	0

Surcharged Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.003		6.600	5.400	0.000	0	0

Datum (m) 7.150 Offset (mins) 0

Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)
1	7.150	16	7.150	31	7.150	46	7.150	61	7.150	76	7.150	91	7.150	106	7.150
2	7.150	17	7.150	32	7.150	47	7.150	62	7.150	77	7.150	92	7.150	107	7.150
3	7.150	18	7.150	33	7.150	48	7.150	63	7.150	78	7.150	93	7.150	108	7.150
4	7.150	19	7.150	34	7.150	49	7.150	64	7.150	79	7.150	94	7.150	109	7.150
5	7.150	20	7.150	35	7.150	50	7.150	65	7.150	80	7.150	95	7.150	110	7.150
6	7.150	21	7.150	36	7.150	51	7.150	66	7.150	81	7.150	96	7.150	111	7.150
7	7.150	22	7.150	37	7.150	52	7.150	67	7.150	82	7.150	97	7.150	112	7.150
8	7.150	23	7.150	38	7.150	53	7.150	68	7.150	83	7.150	98	7.150	113	7.150
9	7.150	24	7.150	39	7.150	54	7.150	69	7.150	84	7.150	99	7.150	114	7.150
10	7.150	25	7.150	40	7.150	55	7.150	70	7.150	85	7.150	100	7.150	115	7.150
11	7.150	26	7.150	41	7.150	56	7.150	71	7.150	86	7.150	101	7.150	116	7.150
12	7.150	27	7.150	42	7.150	57	7.150	72	7.150	87	7.150	102	7.150	117	7.150
13	7.150	28	7.150	43	7.150	58	7.150	73	7.150	88	7.150	103	7.150	118	7.150
14	7.150	29	7.150	44	7.150	59	7.150	74	7.150	89	7.150	104	7.150	119	7.150
15	7.150	30	7.150	45	7.150	60	7.150	75	7.150	90	7.150	105	7.150	120	7.150

Surcharged Outfall Details for Storm

Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)
121	7.150	183	7.150	245	7.150	307	7.150	369	7.150	431	7.150	493	7.150	555	7.150
122	7.150	184	7.150	246	7.150	308	7.150	370	7.150	432	7.150	494	7.150	556	7.150
123	7.150	185	7.150	247	7.150	309	7.150	371	7.150	433	7.150	495	7.150	557	7.150
124	7.150	186	7.150	248	7.150	310	7.150	372	7.150	434	7.150	496	7.150	558	7.150
125	7.150	187	7.150	249	7.150	311	7.150	373	7.150	435	7.150	497	7.150	559	7.150
126	7.150	188	7.150	250	7.150	312	7.150	374	7.150	436	7.150	498	7.150	560	7.150
127	7.150	189	7.150	251	7.150	313	7.150	375	7.150	437	7.150	499	7.150	561	7.150
128	7.150	190	7.150	252	7.150	314	7.150	376	7.150	438	7.150	500	7.150	562	7.150
129	7.150	191	7.150	253	7.150	315	7.150	377	7.150	439	7.150	501	7.150	563	7.150
130	7.150	192	7.150	254	7.150	316	7.150	378	7.150	440	7.150	502	7.150	564	7.150
131	7.150	193	7.150	255	7.150	317	7.150	379	7.150	441	7.150	503	7.150	565	7.150
132	7.150	194	7.150	256	7.150	318	7.150	380	7.150	442	7.150	504	7.150	566	7.150
133	7.150	195	7.150	257	7.150	319	7.150	381	7.150	443	7.150	505	7.150	567	7.150
134	7.150	196	7.150	258	7.150	320	7.150	382	7.150	444	7.150	506	7.150	568	7.150
135	7.150	197	7.150	259	7.150	321	7.150	383	7.150	445	7.150	507	7.150	569	7.150
136	7.150	198	7.150	260	7.150	322	7.150	384	7.150	446	7.150	508	7.150	570	7.150
137	7.150	199	7.150	261	7.150	323	7.150	385	7.150	447	7.150	509	7.150	571	7.150
138	7.150	200	7.150	262	7.150	324	7.150	386	7.150	448	7.150	510	7.150	572	7.150
139	7.150	201	7.150	263	7.150	325	7.150	387	7.150	449	7.150	511	7.150	573	7.150
140	7.150	202	7.150	264	7.150	326	7.150	388	7.150	450	7.150	512	7.150	574	7.150
141	7.150	203	7.150	265	7.150	327	7.150	389	7.150	451	7.150	513	7.150	575	7.150
142	7.150	204	7.150	266	7.150	328	7.150	390	7.150	452	7.150	514	7.150	576	7.150
143	7.150	205	7.150	267	7.150	329	7.150	391	7.150	453	7.150	515	7.150	577	7.150
144	7.150	206	7.150	268	7.150	330	7.150	392	7.150	454	7.150	516	7.150	578	7.150
145	7.150	207	7.150	269	7.150	331	7.150	393	7.150	455	7.150	517	7.150	579	7.150
146	7.150	208	7.150	270	7.150	332	7.150	394	7.150	456	7.150	518	7.150	580	7.150
147	7.150	209	7.150	271	7.150	333	7.150	395	7.150	457	7.150	519	7.150	581	7.150
148	7.150	210	7.150	272	7.150	334	7.150	396	7.150	458	7.150	520	7.150	582	7.150
149	7.150	211	7.150	273	7.150	335	7.150	397	7.150	459	7.150	521	7.150	583	7.150
150	7.150	212	7.150	274	7.150	336	7.150	398	7.150	460	7.150	522	7.150	584	7.150
151	7.150	213	7.150	275	7.150	337	7.150	399	7.150	461	7.150	523	7.150	585	7.150
152	7.150	214	7.150	276	7.150	338	7.150	400	7.150	462	7.150	524	7.150	586	7.150
153	7.150	215	7.150	277	7.150	339	7.150	401	7.150	463	7.150	525	7.150	587	7.150
154	7.150	216	7.150	278	7.150	340	7.150	402	7.150	464	7.150	526	7.150	588	7.150
155	7.150	217	7.150	279	7.150	341	7.150	403	7.150	465	7.150	527	7.150	589	7.150
156	7.150	218	7.150	280	7.150	342	7.150	404	7.150	466	7.150	528	7.150	590	7.150
157	7.150	219	7.150	281	7.150	343	7.150	405	7.150	467	7.150	529	7.150	591	7.150
158	7.150	220	7.150	282	7.150	344	7.150	406	7.150	468	7.150	530	7.150	592	7.150
159	7.150	221	7.150	283	7.150	345	7.150	407	7.150	469	7.150	531	7.150	593	7.150
160	7.150	222	7.150	284	7.150	346	7.150	408	7.150	470	7.150	532	7.150	594	7.150
161	7.150	223	7.150	285	7.150	347	7.150	409	7.150	471	7.150	533	7.150	595	7.150
162	7.150	224	7.150	286	7.150	348	7.150	410	7.150	472	7.150	534	7.150	596	7.150
163	7.150	225	7.150	287	7.150	349	7.150	411	7.150	473	7.150	535	7.150	597	7.150
164	7.150	226	7.150	288	7.150	350	7.150	412	7.150	474	7.150	536	7.150	598	7.150
165	7.150	227	7.150	289	7.150	351	7.150	413	7.150	475	7.150	537	7.150	599	7.150
166	7.150	228	7.150	290	7.150	352	7.150	414	7.150	476	7.150	538	7.150	600	7.150
167	7.150	229	7.150	291	7.150	353	7.150	415	7.150	477	7.150	539	7.150	601	7.150
168	7.150	230	7.150	292	7.150	354	7.150	416	7.150	478	7.150	540	7.150	602	7.150
169	7.150	231	7.150	293	7.150	355	7.150	417	7.150	479	7.150	541	7.150	603	7.150
170	7.150	232	7.150	294	7.150	356	7.150	418	7.150	480	7.150	542	7.150	604	7.150
171	7.150	233	7.150	295	7.150	357	7.150	419	7.150	481	7.150	543	7.150	605	7.150
172	7.150	234	7.150	296	7.150	358	7.150	420	7.150	482	7.150	544	7.150	606	7.150
173	7.150	235	7.150	297	7.150	359	7.150	421	7.150	483	7.150	545	7.150	607	7.150
174	7.150	236	7.150	298	7.150	360	7.150	422	7.150	484	7.150	546	7.150	608	7.150
175	7.150	237	7.150	299	7.150	361	7.150	423	7.150	485	7.150	547	7.150	609	7.150
176	7.150	238	7.150	300	7.150	362	7.150	424	7.150	486	7.150	548	7.150	610	7.150
177	7.150	239	7.150	301	7.150	363	7.150	425	7.150	487	7.150	549	7.150	611	7.150
178	7.150	240	7.150	302	7.150	364	7.150	426	7.150	488	7.150	550	7.150	612	7.150
179	7.150	241	7.150	303	7.150	365	7.150	427	7.150	489	7.150	551	7.150	613	7.150
180	7.150	242	7.150	304	7.150	366	7.150	428	7.150	490	7.150	552	7.150	614	7.150
181	7.150	243	7.150	305	7.150	367	7.150	429	7.150	491	7.150	553	7.150	615	7.150
182	7.150	244	7.150	306	7.150	368	7.150	430	7.150	492	7.150	554	7.150	616	7.150

Surcharged Outfall Details for Storm

Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)
617	7.150	679	7.150	741	7.150	803	7.150	865	7.150	927	7.150	989	7.150	1051	7.150
618	7.150	680	7.150	742	7.150	804	7.150	866	7.150	928	7.150	990	7.150	1052	7.150
619	7.150	681	7.150	743	7.150	805	7.150	867	7.150	929	7.150	991	7.150	1053	7.150
620	7.150	682	7.150	744	7.150	806	7.150	868	7.150	930	7.150	992	7.150	1054	7.150
621	7.150	683	7.150	745	7.150	807	7.150	869	7.150	931	7.150	993	7.150	1055	7.150
622	7.150	684	7.150	746	7.150	808	7.150	870	7.150	932	7.150	994	7.150	1056	7.150
623	7.150	685	7.150	747	7.150	809	7.150	871	7.150	933	7.150	995	7.150	1057	7.150
624	7.150	686	7.150	748	7.150	810	7.150	872	7.150	934	7.150	996	7.150	1058	7.150
625	7.150	687	7.150	749	7.150	811	7.150	873	7.150	935	7.150	997	7.150	1059	7.150
626	7.150	688	7.150	750	7.150	812	7.150	874	7.150	936	7.150	998	7.150	1060	7.150
627	7.150	689	7.150	751	7.150	813	7.150	875	7.150	937	7.150	999	7.150	1061	7.150
628	7.150	690	7.150	752	7.150	814	7.150	876	7.150	938	7.150	1000	7.150	1062	7.150
629	7.150	691	7.150	753	7.150	815	7.150	877	7.150	939	7.150	1001	7.150	1063	7.150
630	7.150	692	7.150	754	7.150	816	7.150	878	7.150	940	7.150	1002	7.150	1064	7.150
631	7.150	693	7.150	755	7.150	817	7.150	879	7.150	941	7.150	1003	7.150	1065	7.150
632	7.150	694	7.150	756	7.150	818	7.150	880	7.150	942	7.150	1004	7.150	1066	7.150
633	7.150	695	7.150	757	7.150	819	7.150	881	7.150	943	7.150	1005	7.150	1067	7.150
634	7.150	696	7.150	758	7.150	820	7.150	882	7.150	944	7.150	1006	7.150	1068	7.150
635	7.150	697	7.150	759	7.150	821	7.150	883	7.150	945	7.150	1007	7.150	1069	7.150
636	7.150	698	7.150	760	7.150	822	7.150	884	7.150	946	7.150	1008	7.150	1070	7.150
637	7.150	699	7.150	761	7.150	823	7.150	885	7.150	947	7.150	1009	7.150	1071	7.150
638	7.150	700	7.150	762	7.150	824	7.150	886	7.150	948	7.150	1010	7.150	1072	7.150
639	7.150	701	7.150	763	7.150	825	7.150	887	7.150	949	7.150	1011	7.150	1073	7.150
640	7.150	702	7.150	764	7.150	826	7.150	888	7.150	950	7.150	1012	7.150	1074	7.150
641	7.150	703	7.150	765	7.150	827	7.150	889	7.150	951	7.150	1013	7.150	1075	7.150
642	7.150	704	7.150	766	7.150	828	7.150	890	7.150	952	7.150	1014	7.150	1076	7.150
643	7.150	705	7.150	767	7.150	829	7.150	891	7.150	953	7.150	1015	7.150	1077	7.150
644	7.150	706	7.150	768	7.150	830	7.150	892	7.150	954	7.150	1016	7.150	1078	7.150
645	7.150	707	7.150	769	7.150	831	7.150	893	7.150	955	7.150	1017	7.150	1079	7.150
646	7.150	708	7.150	770	7.150	832	7.150	894	7.150	956	7.150	1018	7.150	1080	7.150
647	7.150	709	7.150	771	7.150	833	7.150	895	7.150	957	7.150	1019	7.150	1081	7.150
648	7.150	710	7.150	772	7.150	834	7.150	896	7.150	958	7.150	1020	7.150	1082	7.150
649	7.150	711	7.150	773	7.150	835	7.150	897	7.150	959	7.150	1021	7.150	1083	7.150
650	7.150	712	7.150	774	7.150	836	7.150	898	7.150	960	7.150	1022	7.150	1084	7.150
651	7.150	713	7.150	775	7.150	837	7.150	899	7.150	961	7.150	1023	7.150	1085	7.150
652	7.150	714	7.150	776	7.150	838	7.150	900	7.150	962	7.150	1024	7.150	1086	7.150
653	7.150	715	7.150	777	7.150	839	7.150	901	7.150	963	7.150	1025	7.150	1087	7.150
654	7.150	716	7.150	778	7.150	840	7.150	902	7.150	964	7.150	1026	7.150	1088	7.150
655	7.150	717	7.150	779	7.150	841	7.150	903	7.150	965	7.150	1027	7.150	1089	7.150
656	7.150	718	7.150	780	7.150	842	7.150	904	7.150	966	7.150	1028	7.150	1090	7.150
657	7.150	719	7.150	781	7.150	843	7.150	905	7.150	967	7.150	1029	7.150	1091	7.150
658	7.150	720	7.150	782	7.150	844	7.150	906	7.150	968	7.150	1030	7.150	1092	7.150
659	7.150	721	7.150	783	7.150	845	7.150	907	7.150	969	7.150	1031	7.150	1093	7.150
660	7.150	722	7.150	784	7.150	846	7.150	908	7.150	970	7.150	1032	7.150	1094	7.150
661	7.150	723	7.150	785	7.150	847	7.150	909	7.150	971	7.150	1033	7.150	1095	7.150
662	7.150	724	7.150	786	7.150	848	7.150	910	7.150	972	7.150	1034	7.150	1096	7.150
663	7.150	725	7.150	787	7.150	849	7.150	911	7.150	973	7.150	1035	7.150	1097	7.150
664	7.150	726	7.150	788	7.150	850	7.150	912	7.150	974	7.150	1036	7.150	1098	7.150
665	7.150	727	7.150	789	7.150	851	7.150	913	7.150	975	7.150	1037	7.150	1099	7.150
666	7.150	728	7.150	790	7.150	852	7.150	914	7.150	976	7.150	1038	7.150	1100	7.150
667	7.150	729	7.150	791	7.150	853	7.150	915	7.150	977	7.150	1039	7.150	1101	7.150
668	7.150	730	7.150	792	7.150	854	7.150	916	7.150	978	7.150	1040	7.150	1102	7.150
669	7.150	731	7.150	793	7.150	855	7.150	917	7.150	979	7.150	1041	7.150	1103	7.150
670	7.150	732	7.150	794	7.150	856	7.150	918	7.150	980	7.150	1042	7.150	1104	7.150
671	7.150	733	7.150	795	7.150	857	7.150	919	7.150	981	7.150	1043	7.150	1105	7.150
672	7.150	734	7.150	796	7.150	858	7.150	920	7.150	982	7.150	1044	7.150	1106	7.150
673	7.150	735	7.150	797	7.150	859	7.150	921	7.150	983	7.150	1045	7.150	1107	7.150
674	7.150	736	7.150	798	7.150	860	7.150	922	7.150	984	7.150	1046	7.150	1108	7.150
675	7.150	737	7.150	799	7.150	861	7.150	923	7.150	985	7.150	1047	7.150	1109	7.150
676	7.150	738	7.150	800	7.150	862	7.150	924	7.150	986	7.150	1048	7.150	1110	7.150
677	7.150	739	7.150	801	7.150	863	7.150	925	7.150	987	7.150	1049	7.150	1111	7.150
678	7.150	740	7.150	802	7.150	864	7.150	926	7.150	988	7.150	1050	7.150	1112	7.150

Surcharged Outfall Details for Storm

Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)
1113	7.150	1154	7.150	1195	7.150	1236	7.150	1277	7.150	1318	7.150	1359	7.150	1400	7.150
1114	7.150	1155	7.150	1196	7.150	1237	7.150	1278	7.150	1319	7.150	1360	7.150	1401	7.150
1115	7.150	1156	7.150	1197	7.150	1238	7.150	1279	7.150	1320	7.150	1361	7.150	1402	7.150
1116	7.150	1157	7.150	1198	7.150	1239	7.150	1280	7.150	1321	7.150	1362	7.150	1403	7.150
1117	7.150	1158	7.150	1199	7.150	1240	7.150	1281	7.150	1322	7.150	1363	7.150	1404	7.150
1118	7.150	1159	7.150	1200	7.150	1241	7.150	1282	7.150	1323	7.150	1364	7.150	1405	7.150
1119	7.150	1160	7.150	1201	7.150	1242	7.150	1283	7.150	1324	7.150	1365	7.150	1406	7.150
1120	7.150	1161	7.150	1202	7.150	1243	7.150	1284	7.150	1325	7.150	1366	7.150	1407	7.150
1121	7.150	1162	7.150	1203	7.150	1244	7.150	1285	7.150	1326	7.150	1367	7.150	1408	7.150
1122	7.150	1163	7.150	1204	7.150	1245	7.150	1286	7.150	1327	7.150	1368	7.150	1409	7.150
1123	7.150	1164	7.150	1205	7.150	1246	7.150	1287	7.150	1328	7.150	1369	7.150	1410	7.150
1124	7.150	1165	7.150	1206	7.150	1247	7.150	1288	7.150	1329	7.150	1370	7.150	1411	7.150
1125	7.150	1166	7.150	1207	7.150	1248	7.150	1289	7.150	1330	7.150	1371	7.150	1412	7.150
1126	7.150	1167	7.150	1208	7.150	1249	7.150	1290	7.150	1331	7.150	1372	7.150	1413	7.150
1127	7.150	1168	7.150	1209	7.150	1250	7.150	1291	7.150	1332	7.150	1373	7.150	1414	7.150
1128	7.150	1169	7.150	1210	7.150	1251	7.150	1292	7.150	1333	7.150	1374	7.150	1415	7.150
1129	7.150	1170	7.150	1211	7.150	1252	7.150	1293	7.150	1334	7.150	1375	7.150	1416	7.150
1130	7.150	1171	7.150	1212	7.150	1253	7.150	1294	7.150	1335	7.150	1376	7.150	1417	7.150
1131	7.150	1172	7.150	1213	7.150	1254	7.150	1295	7.150	1336	7.150	1377	7.150	1418	7.150
1132	7.150	1173	7.150	1214	7.150	1255	7.150	1296	7.150	1337	7.150	1378	7.150	1419	7.150
1133	7.150	1174	7.150	1215	7.150	1256	7.150	1297	7.150	1338	7.150	1379	7.150	1420	7.150
1134	7.150	1175	7.150	1216	7.150	1257	7.150	1298	7.150	1339	7.150	1380	7.150	1421	7.150
1135	7.150	1176	7.150	1217	7.150	1258	7.150	1299	7.150	1340	7.150	1381	7.150	1422	7.150
1136	7.150	1177	7.150	1218	7.150	1259	7.150	1300	7.150	1341	7.150	1382	7.150	1423	7.150
1137	7.150	1178	7.150	1219	7.150	1260	7.150	1301	7.150	1342	7.150	1383	7.150	1424	7.150
1138	7.150	1179	7.150	1220	7.150	1261	7.150	1302	7.150	1343	7.150	1384	7.150	1425	7.150
1139	7.150	1180	7.150	1221	7.150	1262	7.150	1303	7.150	1344	7.150	1385	7.150	1426	7.150
1140	7.150	1181	7.150	1222	7.150	1263	7.150	1304	7.150	1345	7.150	1386	7.150	1427	7.150
1141	7.150	1182	7.150	1223	7.150	1264	7.150	1305	7.150	1346	7.150	1387	7.150	1428	7.150
1142	7.150	1183	7.150	1224	7.150	1265	7.150	1306	7.150	1347	7.150	1388	7.150	1429	7.150
1143	7.150	1184	7.150	1225	7.150	1266	7.150	1307	7.150	1348	7.150	1389	7.150	1430	7.150
1144	7.150	1185	7.150	1226	7.150	1267	7.150	1308	7.150	1349	7.150	1390	7.150	1431	7.150
1145	7.150	1186	7.150	1227	7.150	1268	7.150	1309	7.150	1350	7.150	1391	7.150	1432	7.150
1146	7.150	1187	7.150	1228	7.150	1269	7.150	1310	7.150	1351	7.150	1392	7.150	1433	7.150
1147	7.150	1188	7.150	1229	7.150	1270	7.150	1311	7.150	1352	7.150	1393	7.150	1434	7.150
1148	7.150	1189	7.150	1230	7.150	1271	7.150	1312	7.150	1353	7.150	1394	7.150	1435	7.150
1149	7.150	1190	7.150	1231	7.150	1272	7.150	1313	7.150	1354	7.150	1395	7.150	1436	7.150
1150	7.150	1191	7.150	1232	7.150	1273	7.150	1314	7.150	1355	7.150	1396	7.150	1437	7.150
1151	7.150	1192	7.150	1233	7.150	1274	7.150	1315	7.150	1356	7.150	1397	7.150	1438	7.150
1152	7.150	1193	7.150	1234	7.150	1275	7.150	1316	7.150	1357	7.150	1398	7.150	1439	7.150
1153	7.150	1194	7.150	1235	7.150	1276	7.150	1317	7.150	1358	7.150	1399	7.150	1440	7.150

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 Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

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

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.400
Return Period (years)	30	Profile Type	Summer
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.100	Cv (Winter)	0.840

Synthetic Rainfall Details

Storm Duration (mins) 30

Storage Structures for Storm

Cellular Storage Manhole: mhs 5, DS/PN: 1.002

Invert Level (m) 5.635 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	350.0	350.0	1.499	350.0	485.0	1.500	0.0	485.0

Volume Summary (Static)

Length Calculations based on Centre-Centre

Pipe Number	USMH Name	Manhole Volume (m³)	Pipe Volume (m³)	Storage Structure Volume (m³)	Total Volume (m³)
1.000	mhs 1	1.131	2.322	0.000	3.453
2.000	mhs 2	1.368	1.070	0.000	2.438
1.001	mhs 3	1.571	5.054	0.000	6.625
3.000	mhs 4	1.209	1.555	0.000	2.764
1.002	mhs 5	0.148	1.312	498.528	499.989
1.003	mhs 6	4.100	0.612	0.000	4.712
Total		9.528	11.925	498.528	519.981

Volume Summary (Static)

Length Calculations based on True Length

Pipe Number	USMH Name	Manhole Volume (m³)	Pipe Volume (m³)	Storage Structure Volume (m³)	Total Volume (m³)
1.000	mhs 1	1.131	2.274	0.000	3.405
2.000	mhs 2	1.368	1.022	0.000	2.390
1.001	mhs 3	1.571	5.001	0.000	6.572
3.000	mhs 4	1.209	1.502	0.000	2.711
1.002	mhs 5	0.148	1.276	498.528	499.953
1.003	mhs 6	4.100	0.582	0.000	4.682
Total		9.528	11.658	498.528	519.714

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 Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

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

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm)	19.100
Region	England and Wales	Ratio R	0.400
Cv (Summer)	0.750		
Cv (Winter)	0.840		

Margin for Flood Risk Warning (mm) 150.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	100
Climate Change (%)	40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)
1.000	mhs 1	15 Winter	100	+40%	100/15 Summer	100/15 Summer			8.389	0.779
2.000	mhs 2	15 Winter	100	+40%	100/15 Summer	100/15 Summer			8.392	0.992
1.001	mhs 3	15 Winter	100	+40%	100/15 Summer	100/15 Summer			8.388	1.092
3.000	mhs 4	1440 Winter	100	+40%	100/120 Summer	100/180 Winter			7.853	0.887
1.002	mhs 5	1440 Winter	100	+40%	100/15 Summer	100/180 Winter			7.854	1.994
1.003	mhs 6	1440 Winter	100	+40%	100/15 Summer	100/180 Winter			7.853	2.213

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	mhs 1	4.130	0.88		36.0	FLOOD	4
2.000	mhs 2	6.901	1.47		57.7	FLOOD	4
1.001	mhs 3	3.018	1.82		158.2	FLOOD	3
3.000	mhs 4	118.144	0.33		26.6	FLOOD	15
1.002	mhs 5	118.767	1.46		58.1	FLOOD	15
1.003	mhs 6	118.075	8.61		92.2	FLOOD	15

APPENDIX D

UNITED UTILITIES ASSET DRAWINGS

Refno	Cover	Func	Invert	Size.x	Size.y	Shape	Matl	Length	Grad
6001	7	CO							
6002	6.94	CO	4.06	450		CI	VC	8.98	
6003	7.63	CO	0	150		CI	VC	8.23	
6009		FO	0	2440		CI	CO	170.33	
6101	6.6	CO	2.77	1500	920	EG	CO	96.62	
6102		CO		900	570	EG	BR	6.04	
6103	6.67	CO	3.43	890	510	EG	BR	7.13	
6104	6.71	CO	3.39	930	580	EG	BR	3	2
6200		FO	0	2440		CI	CO	278.2	
6201	6.95	CO	2.35	1560	930	EG	CO	75.06	
6202	6.76	CO							
6203	6.95	CO							
6301		CO	0	1560	930	EG	CO	42.58	
6302		CO							
6401	7.03	CO	1.54	1400	930	EG	CO	29.58	269
6405		FO	0	2440		CI	CO	251.64	
7001	8.66	CO	4.35	450		CI	CO	13.04	93
7002	9.51	CO	5.22	950	550	EG	BR	12.21	28
7003	12.01	CO	7.97	930	520	EG	BR	50.22	19
7004	9.08	CO							
7101		CO		700	500	EG		7.21	
7102	10.84	CO	6.64	700		CI		10	3
7103	11.22	CO	7.4	675		CI	VC	13	
7104	11.26	CO	6.96	900	600	EG		6.32	
7105	10.65	CO							
7106	8.49	CO	4.43	960	560	EG	BR	6	
7108		CO		900	570	EG	BR	28.86	
7120		CO							
7201	7.02	CO	4.42	1500	1020	EG	CO	13.61	
7202	8.7	CO	0	1500	1020	EG	CO	49.03	
7203	11.57	CO	5.26	1500	1000	EG	BR	22.36	
7204	6.79	CO							
7205	8.44	CO	5.7	225		CI	VC	32.02	11
7206	11.76	CO	8.4	225		CI	VC	33.96	6
7301	8.86	CO	5.17	375		CI	VC	59.41	40
8001	15.42	CO	11.07	1200	740	EG	CO	42	67
8002	17.11	CO	12.72	600		SQ	VC	39.05	15
8004		CO	0	225		CI	VC	18.03	
8005	13.84	CO							
8008	16.71	CO							
8009	16.67	CO	13.94	300		CI	VC	9.9	76
8010	16.46	CO	14.05	300		CI	VC	12.21	122
8101	14.16	CO	9.59	100		CI	VC	6.32	
8102	13.68	CO	10.03	900	600	EG	VC	39.02	16
8103	14.6	SW	11.03	300		CI	VC	16.55	2
8104	13.5	CO	9.33	900	600	EG		45	8
8105	14.57	CO	9.81	1200	800	EG	BR	18.11	181
8108	13.78	CO	9.84	920			BR	53.78	9
8201	12.93	CO	5.46	1370	930	EG	BR	31.78	167
8202		CO		300		CI	VC	17.26	
8203	14.13	CO							
8205	13.79	CO	9.56	1150	970	EG	BR	41.22	
8210		CO	0	1219	762	EG	CO	26.31	
8211	13.99	CO	11.35	300		CI	VC	12.37	7
8302	13.99	CO	10.19	950	960	EG	BR	33.54	224
8304	14.03	CO							
8306	13.95	CO							
8401	12.25	CO	8.3	1130	750	EG	BR	22.2	22
8402		CO							
8403		CO	0	1090		CI	CO	32.06	
9005	16.1	CO	14.39	300		CI	VC	9.85	
9007	16.39	CO	14.18	300		CI	VC	12.08	93
9008		CO							
9009	15.96	SW							
9101	15.2	SW	11.69	300		CI	VC	82.38	10
9102	15.02	SW	11.89	300		CI	VC	24.74	2
9103	15.68	SW	13.95	300		CI	VC	39.62	3
9104	15.66	SW	12.21	450		CI	VC	73.35	159
9105	16.13	SW							
9401	16.15	CO	12.74	940	550	EG	BR	56.6	
9402	14.38	CO							
9403		CO	0	940		CI	CO	23.09	
9404		CO	0	375		CI	CO	14.1	
0401	16.14	CO	0	940	550	EG	BR	1	
9800		CO	0	1050		CI	VC	35.71	
6006		CO							
6110		CO							
6111		CO							
6305		CO							
6400		CO	0	450		CI	CO	34.54	
6403		CO							
6404		CO							
7000		CO	0	300		CI	VC	8.65	
7006		CO							
7007		CO							
7008		CO	0	300		CI	VC	21.56	
7107		CO							
7114		CO		900	600	EG		36.17	
7121		CO	0	920	530	EG	BR	6.71	
7122		CO							
7123		CO							
7124		CO							
7125		CO							
7207		CO							
7208		CO							
8000		CO	0	1150		CI	CO	8.29	
8006		CO	0	300		CI	VC	17.43	
8107		CO							
8109		CO	0	1549	940	EG	BR	16.28	
8110		CO							
8204		CO							
8209		CO							
8212		CO							
8300		CO	0	700	600	EG	CO	33.05	
8405		CO							
9010		CO							
9200		CO	0	1200		CI	CO	11.9	
9408		CO							
9411		CO	0	1010		CI	BR	13.89	
9412		CO							
9512		CO							
6004		CO							
6005		CO							
6007		CO							
6008		FO							
6105		CO							
6107		CO							
6109		CO							
6204		CO	0	1500	920	EG	CO	33.92	
6205		CO							
6303		CO							
6402		CO							
7011		CO	0	300		CI	VC	23.14	
7109		CO							
7111		CO							
7112		CO	0	800	550	EG	BR	8	
7113		CO							
7116		CO							
7117		CO							
8106		CO							
8207		CO							
8307		CO							
8404		CO							
9405		CO							
9407		CO							
9409		CO							
8003		CO							
8007		CO							
9001		CO							
9002		CO							
9003		CO							
9004		CO							
9006		CO							
9011		CO							
6207		FO	5.7			CI	DI	84.76	45

Refno	Cover	Func	Invert	Size.x	Size.y	Shape	Matl	Length	Grad

WASTE WATER SYMBOLOGY

Foul / Surface / Combined / Overflow

Manhole
Manhole, Side Entry
Mainsewer, Public
Mainsewer, Private
Mainsewer, S104
Rising Main, Public
Rising Main, Private
Rising Main, S104
Highway Drain, Private

Foul / Surface / Combined

WW Site Termination
Air Valve
Cascade
Non Return Valve
Extent of Survey
Flow Meter
Gulley
Hatch Box
Head of System
Hydrobrake / Vortex
Inlet
Inspection Chamber
Bifurcation
Catchpit
Contaminated Surface Water
WW Pumping Station
Sludge Pumping Station
Sewer Overflow
T Junction/Saddle
LampHole
OilInterceptor
PenStock
Pump
RoddingEye
Soakaway
Summit
Valve
Valve Chamber
Washout Chamber
DropShaft
WW Treatment Works
Septic Tank
Vent Column
Network Storage Tank
Orifice Plate
Vortex Chamber
Penstock Chamber
Blind Manhole

Sludge Main, Public
Sludge Main, Private
Sludge Main, S104

ABANDONED PIPE

MainSewer
Rising Main
Highway Drain
Sludge Main

Foul / Surface / Combined / Overflow

Screen Chamber
Discharge Point
Outfall

Control Kiosk
Unspecified

LEGEND

MANHOLE FUNCTION

FO Foul
SW Surface Water
CO Combined
OV Overflow

SEWER SHAPE

CI	Circular	TR	Trapezoidal
EG	Egg	AR	Arch
OV	Oval	BA	Barrel
FT	Flat Top	HO	HorseShoe
RE	Rectangular	UN	Unspecified
SQ	Square		

SEWER MATERIAL

AC	Asbestos Cement	DI	Ductile Iron
BR	Brick	PVC	Polyvinyl Chloride
PE	Polyethylene	CI	Cast Iron
RP	Reinforced Plastic Matrix	SI	Spun Iron
CO	Concrete	ST	Steel
CSB	Concrete Segment Bolted	VC	Vitrified Clay
CSU	Concrete Segment Unbolted	PP	Polypropylene
CC	Concrete Box Culverted	PF	Pitch Fibre
PSC	Plastic/Steel Composite	MAC	Masonry, Coursed
GRC	Glass Reinforced Concrete	MAR	Masonry, Random
GRP	Glass Reinforced Plastic	U	Unspecified

The position of underground apparatus shown on this plan is approximate only and is given in accordance with the best information currently available.
The actual positions may be different from those shown on the plan and private pipes, sewers or drains may not be recorded.
United Utilities will not accept any liability for any damage caused by the actual positions being different from those shown.

OS Sheet No: SJ3391SE
Scale: 1: 1250 Date: 20/07/2016
145 Nodes
Sheet 1 of 1

United Utilities
helping life flow smoothly

SEWER RECORDS

OS Sheet No: SJ3391SE

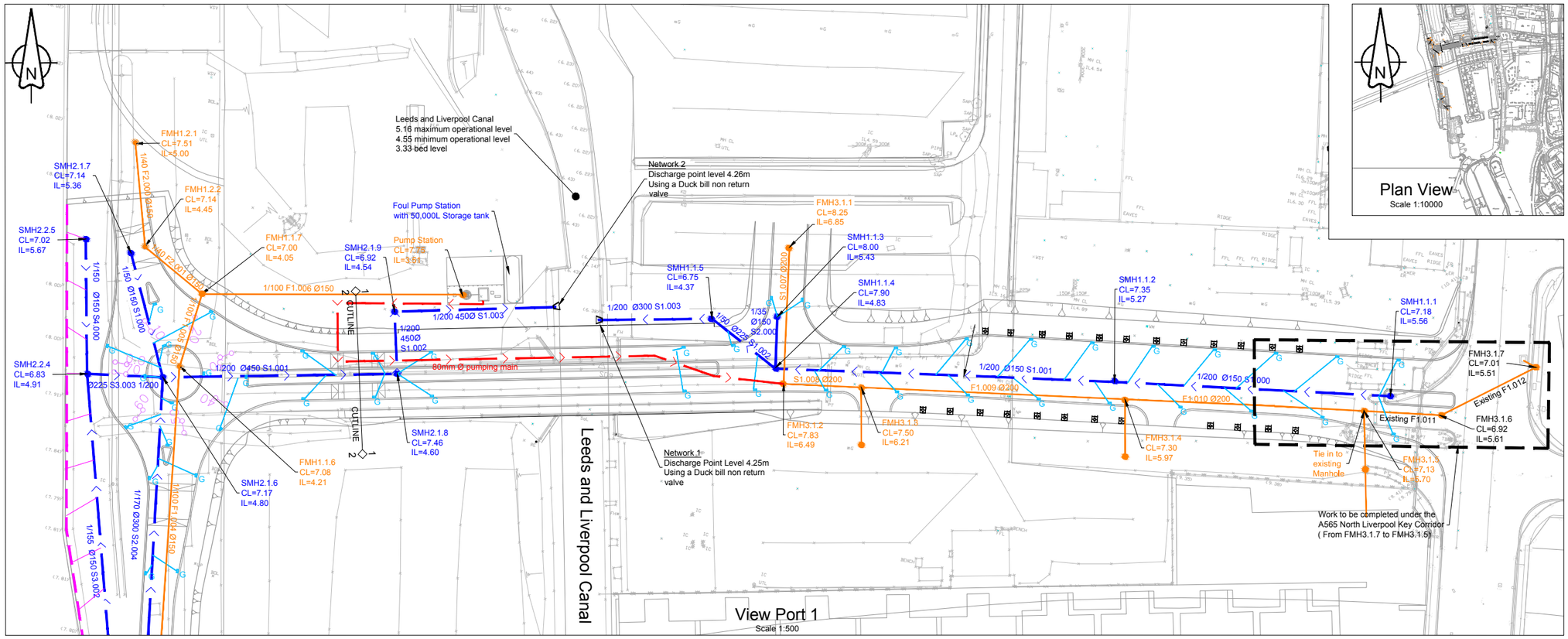
Printed By: Property Searches

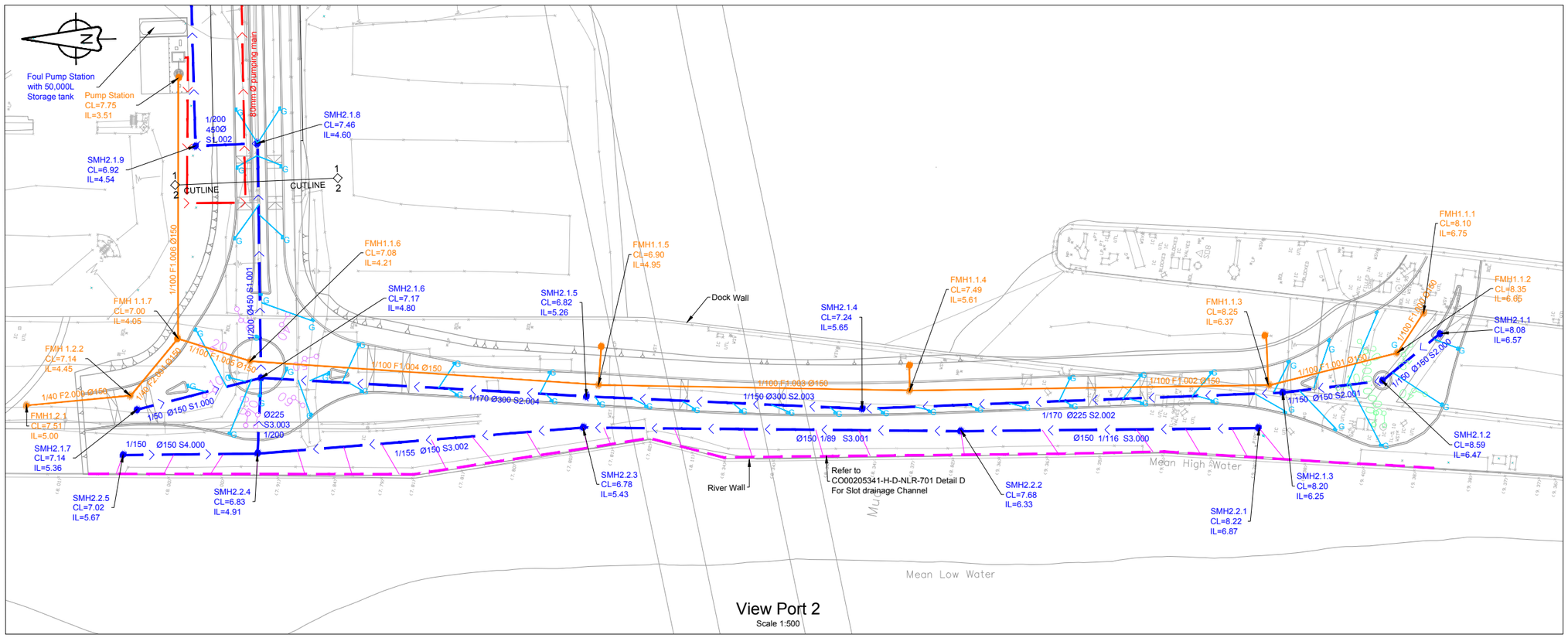
Scale: 1: 1250 Date: 20/07/2016

APPENDIX E

NORTHERN LINK ROAD GENERAL ARRANGEMENTDRAWING CO00205341-H-D-NLR-500 BY AMEY CONSULTING.

File ref - g:\1 active\gb schemes\liverpool\enterprise zone link road\07 cad\g. work area\1. live drgs\tender nlr\co00205341-h-d-nlr-500 proposed storm and foul drainage.dwg





RESIDUAL DESIGN HAZARDS

(The following information has been collected from Preconstruction Information and the Amey CDM Hazard Management Process.)

1. Asbestos
2. Working Near Water
3. Unexpected void shafts in existing ground
4. Working on unstable ground
5. Working at heights

NOTES

1. All levels are in metres above Ordnance Datum.
2. All Dimensions are in metres unless stated otherwise.
3. The Specification clauses referred to in this drawing, unless stated otherwise are from the Manual of Contract Documents for Highway Works (MCHW) - Volume 1 Specification for Highway Works.
4. Any discrepancies to be brought to the attention of Amey.
5. This drawing is to be read in conjunction with;

   -CO00205341-H-D-NLR-501-503 Proposed Drainage Long-Sections
   -CO00205341-H-D-NLR -700-701 Proposed Construction Details
6. FMH 3.15, 3.16 and 3.17 constructed under A565 Liverpool (NLKC). Refer to drawing CO0020216-PH3-DR-506 included in site information.
7. For gully and manhole detail please refer to LCC standard drainage detail SD-D-05 Type G1 gully and SD-D-16 Type 1 Manhole respectively.
8. Outfall pipes should be turned in the direction of flow
9. Precast concrete headwall to be constructed for road drainage outfalls shall be to spec. cl. 1710 and to comply with BS EN206-1:2000.
10. Adequate protection measures should be constructed at each outfall to prevent bank erosion or scouring of the channel bed.
11. Carrier drain to be solid wall pipe with Type S bedding.

KEY

Pumping Main
Foul Drainage
Storm Drainage
Gully & Connection
Slot Drainage Channel
Channel Drainage Connection
SMH = Storm Manhole (Network no. / Pipe Branch no. / Trunk no. — SMH1.1.1)
FMH = Foul Drainage Manhole (Network no. / Pipe Branch no. / Trunk no. — FMH1.1.1)

TENDER

Rev	Revision details	Drwn	Chkd	Appd	Date

Designed:	CM	Date:	June 18
Drawn:	CB	Date:	June 18
Checked:	GML	Date:	June 18
Approved:	GML	Date:	June 18

amey consulting
www.amey.co.uk

Client: Liverpool City Council

Project Name
Liverpool City Centre Connectivity Phase 2

Drawing Title
Northern Link
Proposed Storm and Foul Drainage

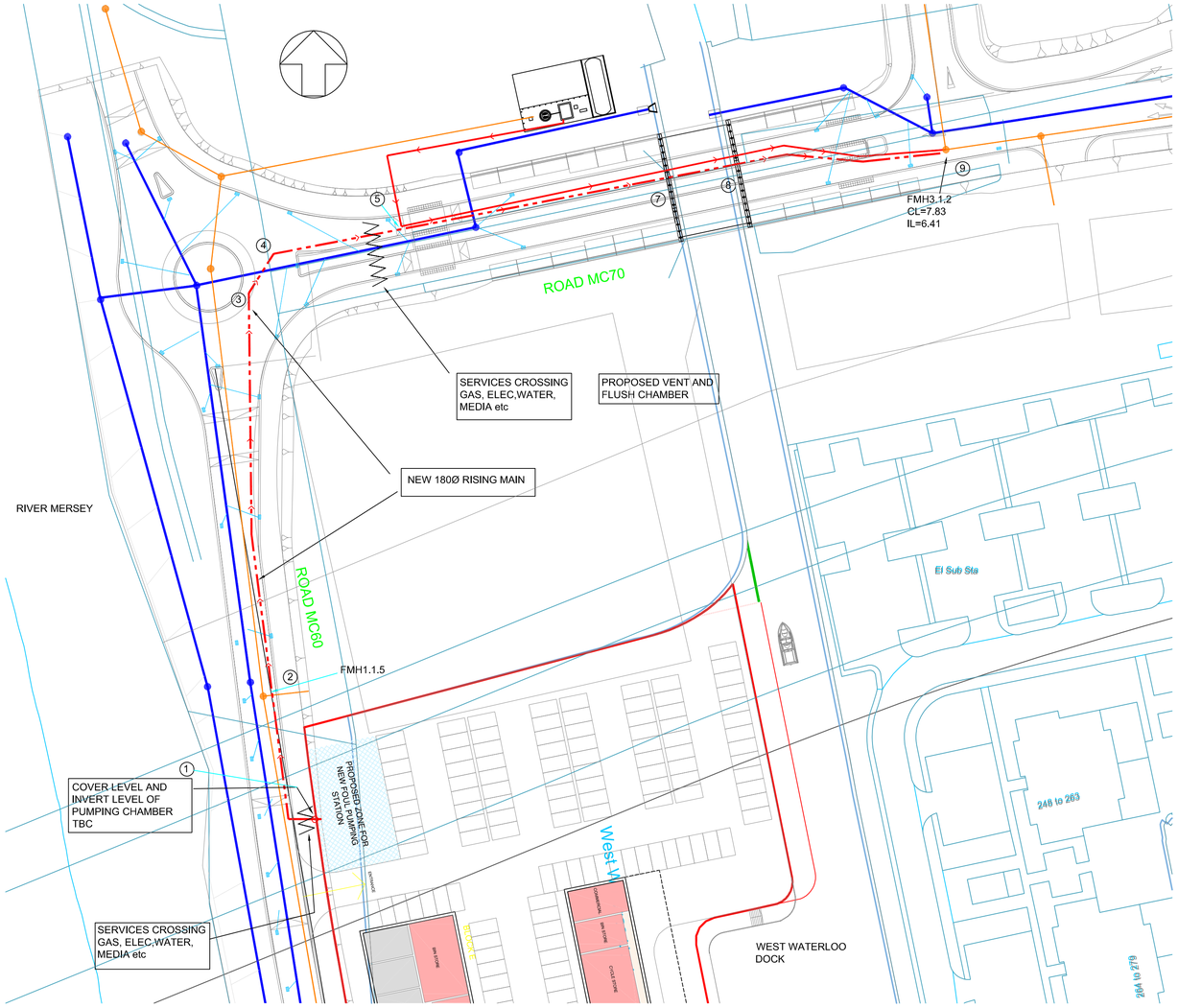
Original Drawing Size : A1	Scale : As Shown
Dimensions : m	

Drawing Status	Suitability
PUBLISHED	D2

Drawing No	Rev
CO00205341-H-D-NLR-500	-

APPENDIX F

PROPOSED RISING MAIN GENERAL ARRANGEMENT DRAWING 4/6679-CCL-CO2-DRN-GA-C-100-01 BY CLANCY CONSULTING.



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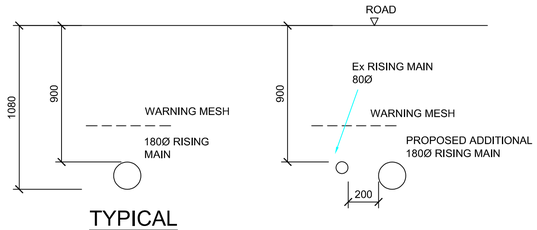

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COVER LEVELS TO BE CHECKED AGAINST ARCHITECTS PROPOSED EXTERNAL WORKS LEVEL / DETAIL DRAWINGS

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ALL OUTGOING AND INCOMING PIPES AT MANHOLE JUNCTIONS TO BE CONNECTED SOFFIT TO SOFFIT UNLESS SPECIFIED OTHERWISE.

PRELIMINARY COVER LEVEL AND INVERT LEVEL INTO THE PUMPING STATION ON CO2 SITE IS SUBJECT TO CONFIRMATION BY THE LANDSCAPE ARHCHITECT

PROPOSED NEW RISING MAIN - LOCATED ADJACENT TO EX/ NEW 80Ø RISING MAIN PIPE TO HAVE A min 200mm GAP TO PREVENT UNDERMINING PIPE.

180mm RISING MAIN FROM CO2 SITE SET 900mm BELOW ROAD LEVEL AND 2m OFF THE KERB LINE AS PER AMEY CONSULTING EMAIL DATED 23 AUG 2019.

THE NEW 180mm RISING MAIN FROM CO2 SITE IS TO FOLLOW THE LINE OF THE OTHER 80mm RISING MAIN AT THE POINT IT RUNS PARALLEL ACROSS THE BRIDGE AND CONNECTION INTO THE EXISTING COMBINED SEWER. DATED 23 AUG 2019.

POSITION, DEPTH, QUANTITY OF WASH OUT CHAMBERS AND AIR VALVES SUBJECT TO CONFIRMATION BY PUMP PROVIDERS

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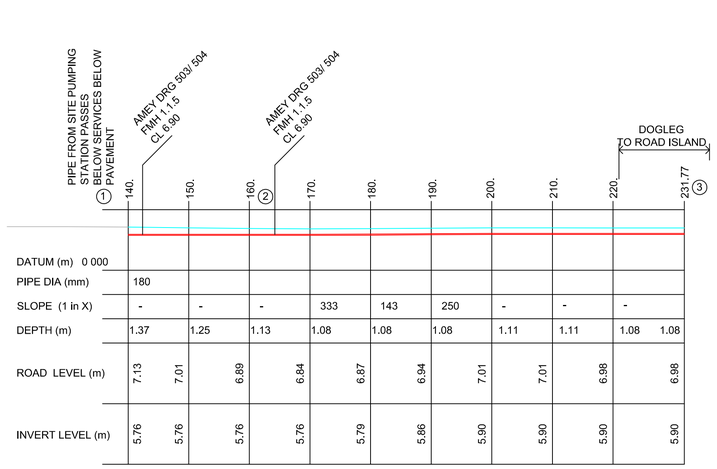
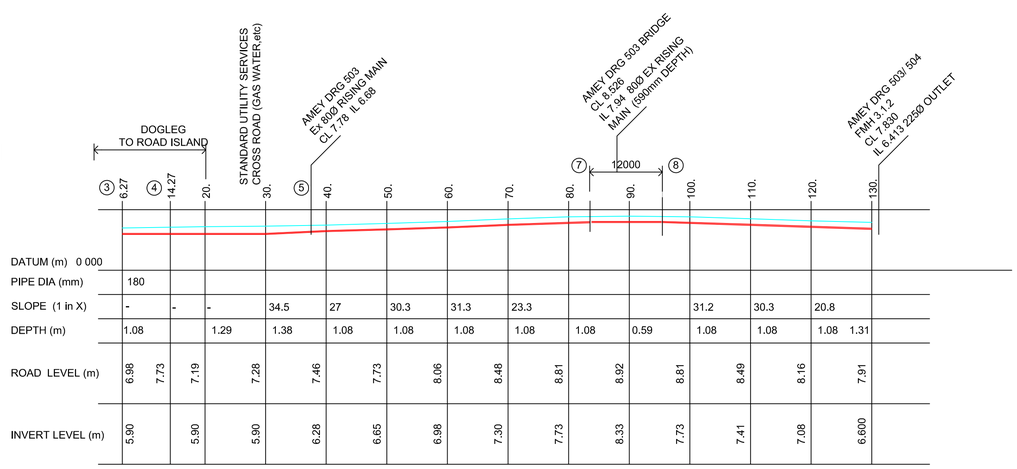


LONGITUDINAL ROAD SECTION

(USING AMEY CONSULTING DRG CO00205341-H-D-NLR-714 CO3 MC60 LONG SECTION AS REFERENCE)

SCALE 1-500



LONGITUDINAL ROAD SECTION

(USING AMEY CONSULTING DRG CO00205341-H-D-NLR-715 CO2 MC70 LONG SECTION AS REFERENCE)

SCALE 1-500

Rev	Date	Description	By	Check	App.
01	03/09/19	ISSUED FOR INFORMATION	RJM	MD	BRH

Client: ROMAL CAPITAL GROUP LTD

Project: PLOT CO2 LIVERPOOL WATERS

Office: LIVERPOOL

Discipline: CIVIL

Title: PROPOSED RISING MAIN

Scale @ A1: 1:500

Status: INFORMATION

clancy consulting
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Birmingham 0121 289 7600, Glasgow 0141 222 7720, Liverpool 0151 227 5500, London 020 3077 0970, Manchester 0161 613 6000, Newcastle 0191 221 2702, Norwich 01603 306100, Prestwich 01204 478375, Reading 0118 941 7888

Job Number	Originator	Building/Zone	Level
4/6679	CCL	CO2	DRN
Type	Discipline	Drawing No.	Revision
GA	C	100	01

Appendix 12C

Central Docks Flood Risk Strategy

MAY 2019

CENTRAL DOCKS

CONDITION

21

NEIGHBOURHOOD FLOOD RISK PROTECTION MEASURES

ARUP

LIVERPOOL WATERS

Peel Land & Property (Ports) Limited

Liverpool Waters

Flood Risk Resilience Strategy - Neighbourhood C

REP-259469-C002

Issue | 24 May 2019

Job number 259469-00

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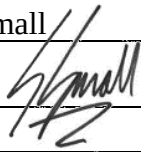
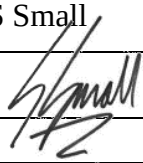
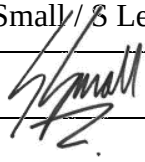
ARUP

Document verification

ARUP

Job title		Liverpool Waters			**Job number** 259469-00
Document title		Flood Risk Resilience Strategy - Neighbourhood C			**File reference** 4-05-02
Document ref		REP-259469-C002			
Revision	**Date**	**Filename**	REP-259469-C002 Issue.docx		
Issue	24 May 2019	**Description**	Formal Issue to LCC and EA		
			Prepared by	Checked by	Approved by
		Name	R Jenkinson / S Small	S Small	S Small / S Lesser
		Signature			
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				Issue Document verification with document	✓

Contents

Foreword

Background

This Strategy has been produced to discharge a planning condition under Part C of the Liverpool Waters (LW) scheme (Planning Application reference: 10O/2424). The LW scheme, which secured outline consent on the 19th of June 2013, covers an area of 60 hectares of former dockland located along Liverpool's Waterfront. The project will provide a mixed-use development of up to 1,691,100 sqm. The outline planning consent is split into multiple parts:

- Part A- Overall Development Quantum and Parameters
- Part B- Time Limits
- Part C- Information to be submitted prior to the submission of applications for reserved matters approval
- Part D- Details to be provided with Reserved Matters Applications
- Part E- Compliance Conditions

Across parts A to E there are a total of 76 conditions within the outline consent (originally 77, see s96a section for further details). 16 of these are pre-commencement conditions which therefore require discharging prior to any submission of detailed reserved matters applications (i.e. a specific development plot). These conditions are listed within Part C of the outline consent.

In June 2018, these 16 conditions were discharged for Princes Dock (Neighbourhood A) to allow for reserved matters applications to come forward for development in this neighbourhood alone. Each condition required a strategy to be produced which provided high level information on how specific requirements would be met.

To progress development within Central Docks (Neighbourhood C), Peel Land and Property are seeking to discharge these 16 pre-reserved matters conditions for this neighbourhood. The following strategy sets out the information required to discharge a pre-reserved matters condition for Central Docks, Liverpool Waters.

Consultees

Where relevant, advisory or statutory consultees have been engaged with during the production of the strategy. Additionally, liaison has taken place across all conditions between other sub-consultants to ensure each condition conforms to all other relevant conditions.

Standalone Applications

There have been several consents for developments within Central Docks. These developments have come forward as standalone applications and although measures have been considered to ensure general conformity with the outline consent, they have not directly followed the LW process. Due to the definition of

"committed development" only the standalone applications which have commenced on site can be considered and referenced within the condition strategy. For clarity these are:

- C04 – C06 (17F/1628)
- Northern Link Road (17F/2628)

Developments which have been determined but have not commenced:

- Isle of Man (18F/3231)

Developments which are currently being determined for planning are:

- C02 (18F/3247)
- District Heating Network, Phase 1 Part 2 (19F/0079)

As these applications have not been granted consent, they only hold limited weight and are not classed as committed development. Where relevant, these have been considered within the strategy but reference to the original outline consented plots for these emerging developments is still made where needed.

Part D Conditions

The following strategy has been produced to discharge Part C conditions, as such, it sets a high-level strategy for the Central Docks Neighbourhood. Further detail will be provided through the discharge of Part D conditions 'Details to be provided with Reserved Matters Applications'. Therefore, Part C conditions will establish the strategy, and Part D conditions will provide further details when reserved matters applications come forward.

S96a Amendment Application (18NM/2766)

In November 2018, a non-material amendment was consented for the Liverpool Waters Outline Consent. The amendments included:

1. **Liverpool Waters Parameter Plan Report (November 2011) to Liverpool Waters Parameter Plan Report (October 2018), where changes within the document include:**
    - PP003 Phasing Plan
    - PP004 Development Parcels
    - PP005 Development Plots
    - PP006 Building Heights
    - Illustrative Masterplan
2. **The wording of Condition 3:**

The development hereby approved shall only be implemented in general conformity with the following submitted application documents (The Principal Application Documents):

- Updated Planning Application form (November 2011);

- Statement of Key Development Principles (November 2011);
- LW Parameter Plan Report (incorporating Parameter Plans) (October 2018)
- Design and Access Statement (November 2011);
- Building Characterisation & Precedent Study (November 2011) ("BCPS");
- Public Realm Characterisation & Precedent Study (November 2011) "(PRCPS)";
- Conservation Management Plan for the Protection, Conservation and
- Preservation of Heritage Assets (November 2011);
- Liverpool Waters Indicative Masterplan (October 2011)

Received by the Local Planning Authority on the 8th & 16th December 2011 & October 2018.

3. The wording of condition 71:

No more than 27.24% (460,000sqm) of the entire total consented development floorspace set within the LWOPP shall be erected within Neighbourhoods A, B and C, and no development shall commence in Neighbourhoods D and E, until the Transport Assessment (November 2011) submitted and hereby approved with the application has been reviewed, updated and agreed by the Local Planning Authority in writing and identified measures have been secured to undertake the highway works and public transport enhancements identified as necessary within that updated Transport Assessment in a phased manner in relation to the development as a whole and in accordance with the Highway and Public Transport Enhancement Strategy referred to in Condition 19 and the monitoring and review and enhancement arrangements referred to in Schedule 3 of this permission.

4. The removal of condition 75 of the LW Outline Planning permission

5. The wording of Schedule 3:

The Highway & Public Transport Enhancement Strategy monitoring and review mechanisms referred to in Condition 10 and required in advance of any development in neighbourhoods D and E and anymore development floorspace greater than 27.2% (460,000sqm) of the entire total consented development floorspace within Neighbourhoods A, B and C (or 2021, whichever the earlier) shall identify the range, methodology, format and timetable of travel monitoring. The results of the monitoring shall be submitted annually to the Local Planning Authority commencing concurrently with submission to the Local Planning Authority of the first Detailed Neighbourhood Masterplan for neighbourhood B, C D or E required by Condition 11.

6. The wording of Schedule 5:

- The Pontoon and Princes Jetty shall be provided in conjunction with the development plots set out in the approved Princes Dock Neighbourhood Masterplan (May 2018).

- Central Park shall be commenced at the same time as the start of any construction work to provide buildings in any of development Parcels 3a, 3b, 3c, 3d and 3f.
- Bath Gate will be commenced and completed in conjunction with plot A05 (Plaza 1821).

Where relevant, the strategy will refer to the above amendments.

Section 96a Amendment Application (April 2019)

An additional non-material amendment has been submitted to Liverpool City Council (application currently pending decision). The amendments include:

1. Liverpool Waters Parameter Plan Report (October 2018) to Liverpool Waters Parameter Plan Report (April 2019), where changes within the document include:

- PP005 Development Plots
- PP006 Building Heights
- PP007 Access and Movement
- Illustrative Masterplan

2. The wording of Condition 3:

The development hereby approved shall only be implemented in general conformity with the following submitted application documents (The Principal Application Documents):

- Updated Planning Application form (November 2011);
- Statement of Key Development Principles (November 2011);
- LW Parameter Plan Report (incorporating Parameter Plans) (April 2019)
- Design and Access Statement (November 2011);
- Building Characterisation & Precedent Study (November 2011) ("BCPS");
- Public Realm Characterisation & Precedent Study (November 2011) "(PRCPS)";
- Conservation Management Plan for the Protection, Conservation and
- Preservation of Heritage Assets (November 2011);
- Liverpool Waters Indicative Masterplan (October 2011)

Received by the Local Planning Authority on the 8th & 16th December 2011, October 2018 and April 2019.

Purpose and Scope of the Strategy[RJ2][RJ3]

The purpose of this Flood Risk Resilience Strategy is to provide Liverpool City Council (LCC), as Local Planning Authority, with a written submission for LCC approval that enables Planning Consent (granted on 14 June 2013) No. 10 O/2424 Condition 21 to be discharged. Condition 21 requires a strategy for each neighbourhood.

A Flood Risk Resilience Strategy was produced for Neighbourhood A in January 2018; it gained the necessary regulator agreements and supported the successful discharge of conditions for Neighbourhood A. The strategy was principally for Neighbourhood A but provided an overview of flood risk resilience matters and approaches relating to Neighbourhoods B to E going forwards.

This Flood Risk Resilience Strategy principally focuses on Neighbourhood C, whilst also recognising that it relates to Neighbourhoods B, D & E.

The scope of this Flood Risk Resilience Strategy is to state how the applicant, for schemes covered by the 10 O/2424 outline consent, proposes to:

- deliver a Masterplan that incorporates the flood mitigation measures stated in the Environmental Statement and the 2011 Flood Risk Addendum (included in the Principal Application Documents);
- deliver/provide key Neighbourhood (or part of Neighbourhood) Plans/Strategies/Risk Assessments/Reports referred to in Condition 21 and Condition 33;
- manage, review and monitor technical matters (key criteria, technical submissions and construction) relating to development Infrastructure and Parcel/Plot proposals of the applicant in conjunction with Parcel/Plot Developer Partners;
- provide Parcel/Plot Developers with guidance to the relevant sections of the Principal Application Documents relating to flood risk resilience measures; and,
- provide Parcel/Plot Developers with a consistent set of flood risk mitigation technical requirements to be incorporated in proposals and submissions that should be produce to meet the requirements of the detailed Masterplan and Reserved Matters conditions.

Since the issue of the Neighbourhood A Princes Dock Flood Risk Resilience Strategy there have been some relevant revisions to studies and climate projections.

In agreement with the Environment Agency:

- the previous Flood Risk Resilience Strategy for Neighbourhood A defined FFL’s and EAR levels based on design flood levels using the River Mersey Extreme Sea Level Study 2008 and sea level rise data from Table 3 (based on UKCP09)(referred to in the 2011 FRA Addendum in the Liverpool Waters Principal Application Documents).

- this Neighbourhood C Strategy, and the subsequent Neighbourhoods B, D & E, the FFL's and EAR levels consider the updated Draft River Mersey Extreme Sea Level Study 2016 data and extracted sea level rise data from UKCP18.

This Strategy further looks to identify the wave overtopping requirements for public realm and plots adjacent to the River Mersey and examine the approaches to wave overtopping issues associated with these areas.

Wave overtopping flood risks in vulnerable areas of C to E will consider current data at the time of starting each Condition 33 Neighbourhood Flood Risk Resilience Plan (at present this includes the Draft River Mersey Estuary Study 2016 data). [RJ4]

The Flood Risk Resilience Strategies should be used throughout the design and construction period (2020 to 2036 for Neighbourhood C Central Docks) of the Liverpool Waters Development.

During the operational design life (limited to 2115) of the development, the Strategies should from time to time be revised in agreement with LCC and the Environment Agency in response to lessons learned, external events or enhancements that need capturing and recording.

A summary of the purpose and scope of this Flood Risk Resilience Strategy is given below.

Strategy Section and Title	Theme	Purpose and Content *(relevant Condition 21 Ref.)*
1 Introduction	Reflect back to LCC purpose of Strategy and orientate Parcel/Plot Developers to provide clarity and consistency in approach	Brief description of the Liverpool Waters (LW) Development. Confirmation the scope of this Strategy covers Neighbourhood C with reference to Neighbourhoods B, D & E and the 2018 the Flood Risk Resilience Strategy for Neighbourhood A Confirmation of Strategy Requirements. ***(21a,b,c)***
2 Liverpool Waters Outline Planning Consent – Condition 21		Confirm Part C Condition 21 of the 10O/2424 Outline Consent. Identify the main Principal Application Documents (PAD's) referred to in the Strategy. ***(21a)***
3 Overview of Flood Risk Legislative Context and the Consented Project Requirements		Identify: • Legislation and Guidance referred to in PAD's ***(21a)***; • Changes to legislation and guidance relevant to LW since 2011/2013 ***(21a)***; • New guidance relevant to LW flood risk resilience ***(21a)***; • Best practice to be adopted for LW going forward ***(21b)***.
4 Specific Flood Risk Resilience Promises and Mitigations in the Environmental Statement		Highlight the key LW flood risk resilience commitments and design criteria identified in PAD's (for example flood levels, freeboard, finished floor levels and external levels for safe egress) ***(21b, 21iii, 21iv)***. Reinforce the main PAD design criteria that the Neighbourhood Plans (Part D Condition 33) should be based upon. ***(21b, 21iii, 21iv)*** Confirm what further input data the applicant intends to obtain (surveys, inspections) to set more detailed design criteria for Neighbourhoods ***(21b, 21i)***.

Strategy Section and Title	Theme	Purpose and Content *(relevant Condition 21 Ref.)*
5 How the applicant intends to manage the delivery of Strategy Requirements	LW Project Delivery Proposals and Key Design Criteria to be passed to Parcel/Plot Developers	Confirmation of the: • The applicant Project Team assembled ***(21b)***; • Roles of the Team members and the Parcel/Plot Developers in the delivery of flood risk related Part C & Part D conditions ***(21b)***. • Project systems and Data Management the applicant intends to develop/use ***(21b)***; and, • LW project management review and monitoring processes to enable the applicant to deliver compliant Part D Reserved Matters submissions comprising Parcel/Plot Developer documents ***(21c)***.
6 Delivery of Flood Risk Resilience Measures within the Detailed Masterplan		Confirmation of how the applicant intends to provide the more detailed deliverables and key design values within the Masterplan ***(21c, 21i, 21ii, 21iii, 21iv)***: • Values/criteria to be used in the Condition 11 Masterplan; • Surface Water Management Strategies; • Flood Evacuation Strategies; • Neighbourhood Flood Risk Resilience Plans; • Parcel/Plot Flood Risk Assessments; • Summary of resilience measures by setting finished levels (and absolute values) for various site uses; and, • Summary of hierarchy of resilience measures to be used in exceptional circumstances.

Strategy Section and Title	Theme	Purpose and Content *(relevant Condition 21 Ref.)*
7 The Applicant Deliverables	The applicant and Parcel/Plot Developer Delivery Framework to provide guidance to Developers	Summary of the Neighbourhood Strategies and Plans that the Masterplan and Infrastructure proposals are expected to conform. Summary of the design/details/documents that are expected from the applicant ***(21b, 21i, 21ii, 21iii, 21iv)***. Flood Risk Resilience Measures to be specifically identified in the CDM Health & Safety Files.
8 Parcel/Plot Developer Deliverables		Flood Risk technical aspects and commitments that are intended to be bound into the Parcel/Plot development heads of terms and agreements. Summary of the Neighbourhood Strategies and Plans that the Parcel development proposals are expected to conform with. Summary of the design/details/documents that are expected from the Parcel/Plot Developers to conform to the Strategy ***(21i, 21iii, 21iv)***. Key criteria (like FFL, Plant & Equipment siting/levels, safe & inclusive evacuation routes) to be identified in the details ***(21iii, 21iv)***. Flood Risk Resilience Measures to be specifically identified in the CDM Health & Safety Files.
9 Review and Monitoring of Proposals		Summary of the applicant Review and Monitoring Processes for Infrastructure/Parcel proposals ***(21c)***. Flow Chart of interactions between Master Developer, Parcel/Plot Developer, LCC (as Planning Authority) and others ***(21b, 21c)***.
10 Periodic Review of the Strategy During Construction Phase	Life Cycles of the Strategy	Proposals for periodic or event triggered review of the Flood Risk Resilience Strategy throughout the 30 year design and construction life cycle of the LW Development ***(21c)***. Periodic reviews to capture emerging best practice and changing policies ***(21c)***. Event reviews in response to regional or national events related to Flood Risk ***(21c)***.
11 Operational Reviews of Flood Risk during Occupation/Use		Proposals for periodic review of LW Development flood risk resilience measures and resilience by Master Developer, Asset Owners and Occupiers. Proposals for periodic review of adopted Infrastructure flood risk resilience measures and resilience by Adopting Authority in conjunction with the Master Developer/Asset Owners.

1 Introduction

Arup has appointed by the applicant to prepare a Flood Risk Resilience Strategy document to support the Liverpool Waters Development (i.e. the Site) and associated Outline Planning Consent (reference: 10O/2323).

The Liverpool Waters development secured outline consent on the 19 June 2013. 77 conditions were attached to the outline planning consent. This document prepares a strategy to enable Condition 21: Neighbourhood Flood Risk Protection Measures to be discharged.

This document is titled Flood Risk Resilience Strategy as opposed to the Flood Risk Protection Strategy title used in Condition 21. We believe that 'resilience' better conveys the nature of flood risk in that 'protection' cannot be absolute, there is always the likelihood of a storm event that will exceed an economical level of protection in flood risk areas.

Condition 21 requires a strategy for each neighbourhood. This strategy is principally for Neighbourhood C (Central Docks) with an overview of flood risk resilience matters relating to Neighbourhoods B, D & E so that key Neighbourhood C constraints and methodologies can be identified and compared to the other neighbourhoods.

1.1 Proposed Development Description

The Development site is located on former dockland within central Liverpool, as indicated in Figure 1, and owned by the applicant.

The scheme secured outline planning consent for mixed-use developments of up to 1,691,100m2 on a 60 hectare site; which comprises residential developments, business & office spaces (including provision for financial and professional services), hotel and conference facilities, community and leisure land-uses, a cruise liner facility and energy centre, together with public realm and landscaping works.

The Development is to consist of five neighbourhoods, as outlined in Figure 1, which are intended to be developed by the applicant and various Infrastructure and Parcel/Plot developer partners.

Section 2 of the Environmental Statement (2011) contains a description of the outline masterplan proposals and more detailed information. The Indicative Masterplan is shown in Figure 2.

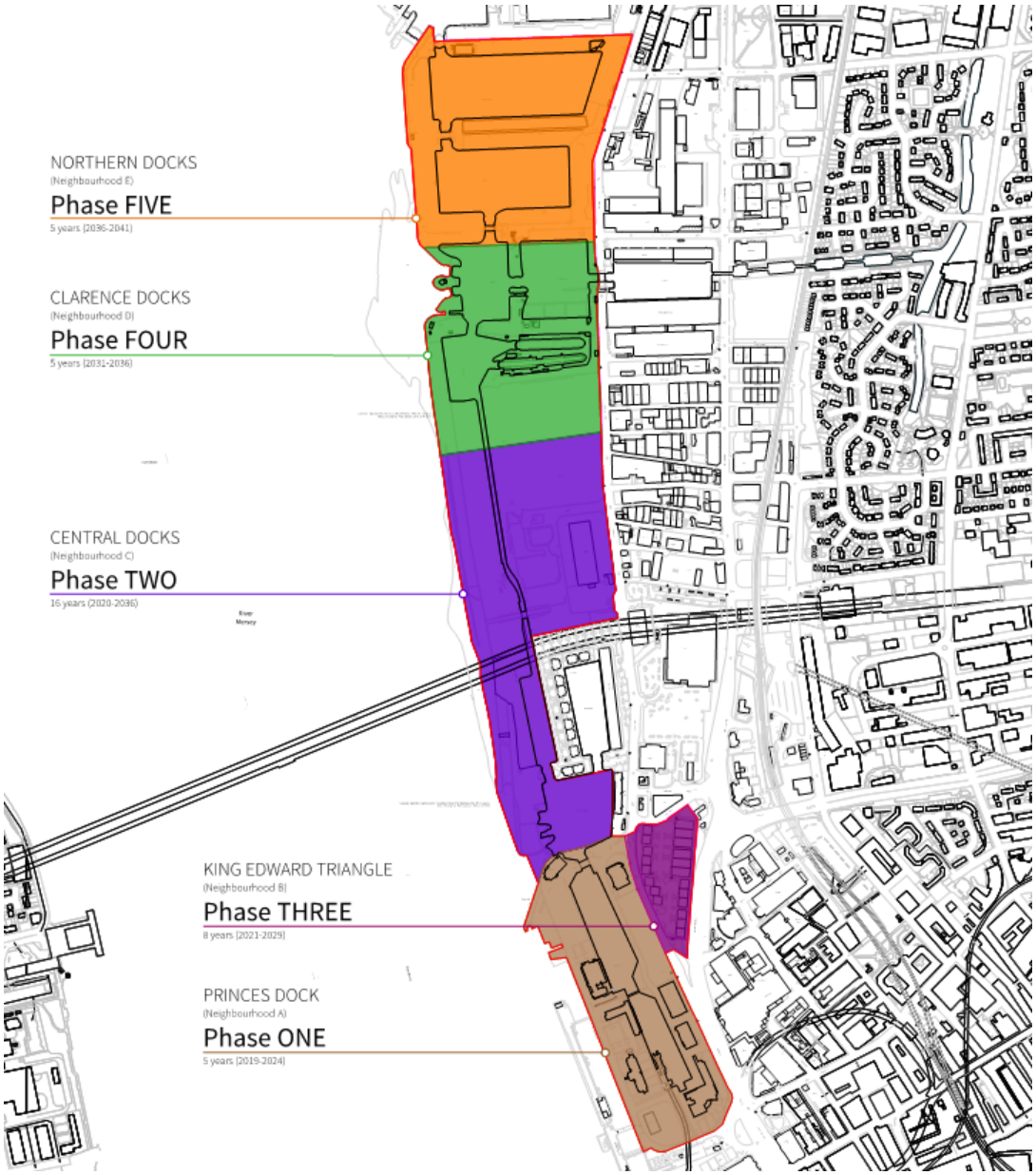

Figure 1 Extract from Parameter Plan – 003 Liverpool Waters Phasing Plan (2018)

Figure 2 Extract from Liverpool Water Illustrative Masterplan (2018)

1.2 Key Aims of the Strategy

The key aims of this Flood Risk Resilience Strategy are to:

- Meet the requirements set out in Planning Application 10O/2323 Outline Planning Consent Condition 21 (see Section 2);
- Confirm more detail of how the applicant intends to deliver the development flood risk resilience mitigation measures stated within the November 2011 Environmental Statement (ES) and October 2010 Flood Risk Assessment (FRA) and November 2011 Addendum submitted as part of the 10C/2323 Principal Application Documents (PAD);
- Identify and review any updates in policy/legislation and guidance since the preparation of the Principal Application Documents and confirm what best practice is intended to be adopted for the Liverpool Waters Development going forward;
- Provide consistency in approach to conforming to the Outline Planning Consent in relation to flood risk for the design of Neighbourhoods, Infrastructure and Parcel/Plot developments (which may happen over 20-30 years).
- Ensure developments are delivered safely and are resilient to both tidal and surface water flooding, including flooding as a result of climate change and sea level rise.

1.3 Role of the Liverpool Waters Coordination Panel

The role of the Liverpool Waters Coordination Panel referred to in the Outline Consent should be defined by the applicant and LCC.

2 Liverpool Waters Outline Planning Consent – Condition 21

The planning condition identifies the details LCC as LPA require from the applicant in respect of how the applicant intends to deliver and manage flood risk aspects. These details include: conformity with the ES; the specific development levels and resilience measures identified in the submitted FRA's; and, requirements of the conditions.

2.1 Neighbourhood Flood Risk Resilience Measures – Condition 21

Neighbourhood Flood Risk Protection Measures

21. ***(21a)*** Prior to the submission of the first application for reserved matters approval in each respective neighbourhood, a Flood Risk Protection Strategy based on the Principal Application Documents that relates to the detailed masterplan for that neighbourhood and which has regard to the wider application site shall be submitted to and approved in writing by the Local Planning Authority. ***(21b)*** The strategy shall include the means of delivering the development indicated in the Masterplan and the mitigation measures stated in the ES and the Strategic FRA Addendum submitted in support of the application. ***(21c)*** The approved strategy shall include provision for monitoring and review, and provide a strategic level framework to inform the determination of reserved matters applications in that particular neighbourhood. ***(21d)*** The Strategy shall include the following:

i. Provision for flood risk assessments to be submitted and agreed by the Local Planning Authority in writing for that neighbourhood;

ii. Provision for the submission of a Neighbourhood Surface Water Management strategy for the neighbourhood concerned to be submitted to and agreed in writing by the Local Planning Authority prior to any site remediation, preparation or demolition commencing;

iii. Provision for flood risk protection measures to be submitted and agreed in writing by the Local Planning Authority for all future ground, building and emergency access route levels and topography within that neighbourhood These shall adhere to the minimum finished floor levels (FFLs) of the Strategic FRA Addendum (November 2011) as a default position; and,

iv. Provision for a Flood Evacuation Strategy to be submitted and agreed in writing by the Local Planning Authority for the neighbourhood that ensures the safe and inclusive evacuation of all site users in the event of flooding.

Reason: To deliver a safe form of development which is resilient to both tidal and surface water flooding, including flooding as a result of climate change, in accordance with Policy GEN8, OE4, OE5, OE6 & EP13 of the adopted Liverpool UDP & the NPPF.

2.2 Detailed Neighbourhood Masterplans Condition 11

The strategy has been developed, where appropriate, with consideration given to the other Part C planning conditions to ensure a co-ordinated approach in the production of a Masterplan to meet the requirements of Condition 11.

The other strategies with close relationships and influence on Flood Risk Resilience Measures relate to:

- Masterplanning and access;
- Sustainability;
- Archaeology and Cultural Heritage; and,
- Ground conditions and earthworks.

2.3 Principal Application Documents

The Principal Application Documents (PAD) contain the following development proposals that are useful for orientation in respect of Flood Risk Resilience Measures:

- The Masterplan for each Neighbourhood A to E (NA to NE) (these should be developed further to meet the requirements of Condition 11)
    - NA to NE - Liverpool Waters Indicative Masterplan-October 2011
    - NA to NE - Liverpool Waters Indicative Masterplan Layout - Axonometric
    - NA - Liverpool Waters Indicative Masterplan-Princes Dock and King
    - NC - Liverpool Waters Indicative Masterplan-Central Docks Extract
    - ND - Liverpool Waters Indicative Masterplan-Clarence Docks Extract
    - NE - Liverpool Waters Indicative Masterplan-Northern Docks Extract
- Environmental Statement Section 2.0 The Proposals

The recent (2018) S96 Application updated the Illustrative Masterplan (Drawing 1868-VW-025 Issue 01) and Parameter Plans including 003 Phasing.

The PAD specifically relevant to Condition 21 and the Flood Risk Resilience Strategy are:

- Environmental Statement Section 2.0:
  - 2.5.6 Baseline studies
  - 2.12.10 to 2.12.16 Existing Drainage
  - 2.14 Flood Risk
  - 2.16.1 Construction Programme
  - 2.16.7 Temporary Drainage
  - 2.16.9 Surface Water discharge hierarchy
  - 2.17.9 Drainage to adoptable standards
- Environmental Statement Chapter 8 – Surface Water, Flood Risk, Drainage and Water Demand (November 2011) and Appendix 8 including:
  - Appendix 8.1 Peel Land and Property (Ports) Limited, Liverpool Waters, Flood Risk Assessment (January 2010)
  - Appendix 8.2 Peel Land and Property (Ports) Limited, Liverpool Waters, Outline Planning –Drainage Strategy Report (September 2010)
  - Appendix 8.3 Peel Land and Property (Ports) Limited, Liverpool Waters, Outline Planning –Utility Strategy Report (September 2010)
  - Appendix 8.4 Surface Water, Drainage, Flood Risk Scoping Responses & Action Table
  - Appendix 8.5 Peel Land and Property (Ports) Limited, Liverpool Waters, Surface Water, Flood Risk And Drainage Baseline Report (October 2011)
  - Appendix 8.6 Liverpool Waters Flood Risk Assessment Addendum (November 2011)

3 Overview of Flood Risk Policy Context and the Consented Project Requirements

The Liverpool Waters planning application was submitted in 2011 and Outline Consent was given in June 2013. Since these dates legislation, policy and guidance has been updated by the UK Government and associated authorities (e.g. Liverpool City Council, Environment Agency (EA), DEFRA, etc.).

Table 1 in this section of the Strategy confirms to LCC, the applicant and Parcel/Plot Developers:

- flood risk policy/legislation and guidance referred to in the Principal Application Documents;
- relevant updates to these references since 2011;
- new policy and guidance relevant to Flood Risk since 2011;
- a brief discussion of the relevant updates/changes; and,
- the best practice that is intended to be adopted for Liverpool Waters following a review of updated policy and guidance.

Table 1. Commentary on flood risk policy, guidance and references since 2011

Ref.	Flood Risk Policy, Guidance & References (In 2011 Principal Application Documents and later sources)	Relevant changes and updates since the 2011 FRA	Best practice to be adopted for Liverpool Waters
1a	Planning Policy Statements (PPS), including: • PPS 1. Supplement – Planning and Climate Change (Communities and Local Government, 2008) • PPS 23. Planning and Pollution Control (Communities and Local Government, 2004) • PPS 25. Development and Flood Risk (Communities and Local Government, 2006) – *identifies methodology and approach to undertaking an FRA*	PPS is withdrawn and now planning policy and guidance is detailed online within the National Planning Policy Framework (NPPF) and associated National Planning Policy Guidance (NPPG). The website is continually updated online and provides a source of the most up-to-date information. The guidance chapter on **Flood Risk and Coastal Change** provides the relevant information via https://www.gov.uk/guidance/flood-risk-and-coastal-change; including content on: • Planning and flood risk – including flood risk vulnerability, flood zone and flood risk tables • Site specific flood risk assessments and checklist • Flood warning and evacuation plans • Flood resilience and flood resistance measures - Refers to using EA Guidance and Standing Advice when developing FRA / proposals (refer to text below).	The methodology for determining Design Flood Levels and design criteria for flood risk resilience measures by control of levels should remain as the PAD. The design criteria and mitigation measures by control of Finished Floor Levels (see Section 6.2) should remain as defined/agreed within the PAD (Liverpool Waters Flood Risk Assessment and Addendum (2011), and Drainage Strategy (2011). The design criteria for Emergency Access Routes levels (see Section 6.3) should be as the Flood Risk Assessment Addendum (2011) and the minimum level in EA correspondence (which corresponds to the value in the Flood Risk Assessment (2010) and supported by Best Practice in Ref. 6b below). The design criteria for alternative emergency access to buildings should be as the Flood Risk Assessment Addendum (2011). Reference should be made to the updated NPPF and NPPG for the appropriate methodology and guidelines for aspects other than establishing the design flood levels.
1b		From the 6 April 2015 revised planning guidance requires that major developments (10+ dwellings, >1,000m2 or 0.5ha) are to ensure that SuDS are used, unless demonstrated inappropriate.	Incorporation of SuDS and criteria from the Neighbourhood Sustainability Strategies should be used throughout development proposals (unless demonstrated inappropriate), with the exception of storm water attenuation provisions. Storm water attenuation should be provided in accordance with the PAD Outline Planning Drainage Strategy and its drawing ARP-LAY-CD-004 (and successor documents).

Ref.	Flood Risk Policy, Guidance & References (In 2011 Principal Application Documents and later sources)	Relevant changes and updates since the 2011 FRA	Best practice to be adopted for Liverpool Waters
			Neighbourhood A, C, D and E should use the Dock Area freeboard as attenuation or discharge directly to the River Mersey. [RJ5] Neighbourhood B should use SuDS and Sustainability Strategy criteria for storm water attenuation (subject to consent of United Utilities and LCC).
1c		Information by the EA relating to **climate change allowances** in flood risk assessments is detailed within the NPPG via https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances There has been no revision to the sea level rise (mm/yr) allowances and no prediction of allowances beyond the year 2115. Please note, with the release of the latest climate change projections (UKCP18) in April 2019, there are likely to be updates to climate change guidance beyond this issue (February 2019).	In relation to climate change allowance: • The NPPG predicted sea level rise (mm/yr) due to climate change is as per the PSS 25. The NPPG should be consulted when considering sea-level rise due to climate change. • However, the guidance only provides information up to the year 2115. Conservatively, calculations for sea-level rise (and associated finished floor levels) are proposed to be based on the extrapolation of the 2115 increase in levels (mm/yr) when considering a building design life beyond this date. • Developers should consider periodic reviews of finished floor levels throughout the life-span of the development (prior to 2100) with any updated guidance for climate change and consider bringing forward the retrofitting of resilience measures as required. • Developers should consider a forward thinking 'managed adaptive approach' to afford capacity or space in the development to include additional resilience measures in the future.
1d	Extreme Sea Level Study 2008[RJ6] The 2008 Sea Levels used in the November 2011 FRA Addendum were: 0.5% AEP (previously referred to as 1 in 200 year) tidal flood event: 6.11m AOD	EA Draft Mersey Estuary 2016 Study has the following updated levels: 0.5% AEP: 6.13m AOD 0.1% AEP: 6.33m AOD	It is proposed to refer to the EA Draft Mersey Estuary 2016 Study for calculating the Design Flood Level that form part of the consented scheme for Neighbourhood C: • 0.5% AEP tidal flood event sea level of 6.13mOD

Ref.	Flood Risk Policy, Guidance & References (In 2011 Principal Application Documents and later sources)	Relevant changes and updates since the 2011 FRA	Best practice to be adopted for Liverpool Waters
	0.1% AEP (previously referred to as 1 in 1000 year) tidal flood event: 6.37m AOD (AEP – annual exceedance probability.)	*(Source: EA 2016 Draft River Mersey Extreme Sea Level Study and based on the Liverpool Gauge (node point: at node point ea013_90001_Liverpool_Gauge – at Gladstone River Entrance)*	• Sea level rise for a 30year design & construction period • Sea level rise for 60year/100year building design life (commercial/residential). This guidance above, is on the basis that the Development is still within the 30year design & construction timescale approved in the Outline Consent (i.e. commencing from 2011). It should also be noted that the best practice review of the Emergency Access Route proposals, see 6b below, has resulted in affording infrastructure a 0.1m freeboard resilience as the basis of design (this compares to 0.25m of flooding in the Nov 2011 FRA Addendum). The Neighbourhood B, D & E strategies should also consider the Draft Mersey Estuary 2016 Study data (or latest version available) for calculation of Design Flood Level.
1e	Rainfall intensity and climate change.	The guidance relating to peak rainfall intensity, for developing proposals to manage surface water run-off, has been updated since the production of the 2011 drainage strategy (i.e. developments should assess both the central and upper end allowances). Guidance now suggests examination of increased intensities between 20% and 40% should be examined. There is not specific LCC guidance to move away from the 30% figure in the Outline Planning Consent	Drainage infrastructure designs for Parcel/Plot and Infrastructure to be based on 1 in 100 year plus 30% increase in intensity. A design check to be undertaken for a 40% increase in intensity to understand any impacts.
2a 2b	Liverpool Unitary Development Plan (UDP) (2002) polices relevant to Condition 21 to deliver a safe form of development which is resilient to both tidal and surface water flooding, including flooding as a result of climate change. • **OE4** – The Mersey Coastal Zone	There have been no relevant changes to the policies listed. The UDP will be gradually replaced by the new **Local Plan for Liverpool**, which has been submitted for examination.	Until the release of the new Local Plan, the UDP will comprise the adopted statutory documents for making planning decisions in Liverpool. The applicant and partner developers should make themselves aware of potential changes/updates to these policies in the future incorporate results of reviews in

Ref.	Flood Risk Policy, Guidance & References (In 2011 Principal Application Documents and later sources)	Relevant changes and updates since the 2011 FRA	Best practice to be adopted for Liverpool Waters
2c 2d 2e 2f	• **OE5** - Protection of Nature Conservation Sites and Features. • **OE6** - Development and Nature Conservation • **EP13** – Flood prevention. • Local policy document **GEN8** which addresses the redevelopment of vacant land.	A 2018 Pre-Submission Draft of the Liverpool Local Plan is available online[1] at the Liverpool City Council website. Section 13 Environmental Resources indicates policies on Flood Risk and Water Management. The City Council has resolved that the **Core Strategy** will be at the heart of the Local Plan. The Core Strategy policies, which reached 'submission draft' stage in 2012 will be subject to alignment with the NPPF, and used as a material consideration in planning decisions. Please refer to the following link for further information: http://liverpool.gov.uk/council/strategies-plans-and-policies/environment-and-planning/plan-making-in-liverpool/current-local-plan-documents/local-plan/	revision to this Strategy and Neighbourhood Flood Risk Resilience Plans.
3a 3b 3c	Liverpool City Council Strategic Flood Risk Assessment (SFRA) (2008). Further sources of information and flood management plans include: • LCC Preliminary Flood Risk Assessment Report (2011) – *The Flood Risk Regulations (FRR) (2009) and Flood and Water Management Act (FWMA) (2010) required Lead Local Flood Authorities (LLFAs) to produce Flood Risk Management Plans by 2015. The first element of this programme is to produce a Preliminary FRA report.*	No revisions to this LCC guidance have been identified. Following the Preliminary Flood Risk Assessment report (PFRA), the draft (Nov 2017) LCC Local Flood Risk Management Strategy went out for consultation (January 2018)[2] and is now adopted as Liverpool's Local Flood Risk Management Strategy[3]. The strategy has no direct statements relating to the Liverpool Waters Development but messages in the strategy serves to reinforce general concerns of LCC (Highway Authority and LLFA) as owner and maintainer of highway and drainage infrastructure that are applicable to the Development.	The 2008 SFRA has served as the basis for assessing potential sources of flood risk and is reflected in the Environmental Statement and the Flood Risk Assessment 2011. The neighbourhood Flood Risk Resilience Plans should review any NPPF updated information and any updated information available from the EA/DEFRA; particularly in relation to: • Spatial development and flood risk (e.g. the updated EA Flood Maps for Planning) • Climate change allowances, sea level rise and building design life • Responsibilities (see Flood and Water Management Act 2010)

[1] https://liverpool.gov.uk/council/strategies-plans-and-policies/environment-and-planning/plan-making-in-liverpool/current-local-plan-documents/local-plan/

[2] http://liverpool.gov.uk/council/consultation/consultation-on-liverpool-city-council-s-draft-local-flood-risk-management-strategy/

[3] https://liverpool.gov.uk/council/strategies-plans-and-policies/roads-and-transport/local-flood-risk-management-and-drainage/local-flood-risk-management-strategy

Ref.	Flood Risk Policy, Guidance & References (In 2011 Principal Application Documents and later sources)	Relevant changes and updates since the 2011 FRA	Best practice to be adopted for Liverpool Waters
		The strategy does have an Appendix C Developer Guidance detailing design criteria for developments reflecting NPPF and the Liverpool SFRA.	These aspects would also be reviewed as part of periodic revisions to this Strategy during the 30 year design and construction life of the Liverpool Waters Development. A reminder of the facility for owners/occupiers to register for the Flood Warning Service should be included in Health & Safety File documentation.
3d	• Mersey Estuary Catchment Flood Management Plan (2009) – *Produced by the Environment Agency (EA), provides an overview of the catchment flood risk (incl. inland flooding from rivers, ground water surface water and tidal flooding, but not flooding directly from the sea (coastal flooding))*		
3e	• North West England and North Wales Shoreline Management Plan (SMP) (2010) – Cell 11.a - *provides a large-scale assessment of the risks associated with erosion and flooding at the coast.*		
3f	• Mersey Estuary Management Plan (MEMP) (2007) - provides a framework for co-ordinated action among the local authorities and interest groups of the Mersey Estuary		
3g	• New plan.	North West River Basin District Flood Risk Management Plan (FRMP), EA 2016	
4	EA Guidance for Flood Risk Assessments for Planning Applications – *referenced to by NPPG, provides the latest information on how to produce an FRA and extra flood resistance and resilience measures.*	Published in 2014 (updated 2017) and available online via. https://www.gov.uk/guidance/flood-risk-assessment-for-planning-applications Information includes details of extra flood resistance and resilient measures that developers should utilise, particularly within Flood Zone 2 and 3[4].	The criteria within the Liverpool Waters FRA and Addendum (2011) (and Drainage Strategy (2011)) should be used as the basis for the Neighbourhood C Flood Risk Plan produced by the applicant. The Neighbourhood B, D & E Flood Resilience Plans will use the same methodology as Neighbourhood C. Parcel/Plot Developers should be required to incorporate this latest flood resistance guidance when developing proposals.

[4] https://www.gov.uk/guidance/flood-risk-assessment-in-flood-zones-2-and-3#extra-flood-resistance-and-resilience-measures

Ref.	Flood Risk Policy, Guidance & References (In 2011 Principal Application Documents and later sources)	Relevant changes and updates since the 2011 FRA	Best practice to be adopted for Liverpool Waters
			In evidenced exceptions where flood resilience to Infrastructure cannot be afforded flood resilience by control of FFL and EAB/EAR levels; the applicant should be required to demonstrate adequate agreement with the emergency planning/Merseyside Resilience Forum (MRF). They should evidence that any additional MRF control measures are defined and referenced in H&S Files. In evidenced exceptions, where flood resilience to Buildings and external areas cannot be incorporated by control of FFL and EAB levels; the Parcel/Plot Developers should be required to demonstrate adequate space and enabling works for fitting (or retro-fitting) flood defence and resilience measures to the development. Temporary measures (e.g. temporary or manual flood gates) are less desirable due to the residual risk with any manual operations. If such measures are unavoidable, they should have an associated operational strategy developed and implemented with the appropriate stakeholders. Flood defence/resilience measure requirements are to be referenced in the H&S File.
5	EA Standing Advice - *Developers need to follow the Environment Agency's standing advice if you're carrying out a flood risk assessment for a development in Flood Zone 2 classed as 'more vulnerable', 'less vulnerable' and 'water compatible'.*	Published in 2012 (updated 2019), now titled 'Preparing a flood risk assessment: standing advice' and available online via. https://www.gov.uk/guidance/flood-risk-assessment-standing-advice No significant changes compared to PPS25 at the time. The Outline Consent gives permission to the inclusion of 'more vulnerable' uses (residential) within the Development (in line with the Liverpool SFRA 2008).	As PAD.

Ref.	Flood Risk Policy, Guidance & References (In 2011 Principal Application Documents and later sources)	Relevant changes and updates since the 2011 FRA	Best practice to be adopted for Liverpool Waters
6	DEFRA and EA guidance: Provides information regarding the management of flood risk and appropriate mitigation measures for developments.		
6a	• (R&DTR) FD2320/TR1 (2005) - Flood risk assessment guidance for new development: Phase 2 Framework and guidance for assessing and managing flood risk for new development - *the framework for assessing and managing flood risk for new development and provides all of the guidance produced by this project to support this.*	No major revisions to this guidance identified. All documents publicly available online.	Guidance to be utilised where the most recent EA/NPPG guidance (detailed above) does not provide the necessary guidance or information for a specific situation/aspect.
6b	• FD2320/TR2 (2005) – Framework and Guidance for Assessing and Managing Flood Risk for New Development – Flood Hazard Rating - *support guidance to enable effective use of this framework and decision guidance*	No major revisions to this guidance identified. All documents publicly available online. BS 8533:2011 (see below) has been developed since 2005 and has relevant and complimentary guidance.	This Strategy has been developed on the basis of the hierarchy of 'Safe Access and Exit' for people and vehicles in Section 13.3(below) with the guiding principle of Section 13.2 (below) that '*A route can only be completely safe in flood risk terms if it is dry at all times'*. *13.2 Introduction* *New developments are required to provide safe access and exit during a flood and the measures by which this will be achieved should be clear in the Flood Risk Assessment (FRA). Safe access and exit is required to enable the evacuation of people from the development, provide the emergency services with access to the development during a flood and enable flood defence authorities to carry out any necessary duties during the period of flood.* *A safe access or exit route is a route that is safe for use by occupiers without the intervention of the emergency services or others.* *Safe routes should be identified both inside and beyond the boundary of the new development. Even where a new development is above the floodplain and considered*

Ref.	Flood Risk Policy, Guidance & References (In 2011 Principal Application Documents and later sources)	Relevant changes and updates since the 2011 FRA	Best practice to be adopted for Liverpool Waters
			acceptable with regard to its impact on flood flows and flood storage, it should be demonstrated that the routes to and from the development are also safe to use. *A route can only be completely safe in flood risk terms if it is dry at all times.* *13.3 Requirements for Safe Access and Exit* *The requirements for safe access and exit from new developments in flood risk areas are as follows, in* *decreasing order of preference:* • *Safe dry route for people and vehicles* • *Safe dry route for people* • *If a dry route for people is not possible, a route for people where the flood hazard (in terms of depth* • *and velocity of flooding) is low and should not cause a risk to people.* • *If a dry route for vehicles is not possible, a route for vehicles where the flood hazard (in terms of depth and velocity of flooding) is low to permit access for emergency vehicles. However the public should not drive vehicles in floodwater.* *Where a dry route is not possible and a route with low flood hazard is identified, the route should not* *have any service covers that could be removed, or other underwater hazards. It is often difficult to see* *underwater hazards even in shallow water, particularly at night or if the water is silty. In addition, the* *route should be clearly marked, for example using painted posts.* A Neighbourhood Flood Evacuation Strategy showing Emergency Access Routes, that are dry at Design Flood Level, should be prepared by the applicant incorporating the principles of FD2320/TR2. The Design Flood Level

Ref.	Flood Risk Policy, Guidance & References (In 2011 Principal Application Documents and later sources)	Relevant changes and updates since the 2011 FRA	Best practice to be adopted for Liverpool Waters
			should be based on the most onerous development use, Residential Building, as flexibility of use within the Masterplan is required. Parcel/Plot Developers should prepare Parcel/Plot Flood Evacuation Strategies and details of safe evacuation routes for developments. Exceptions to a requirement for dry routes in a Neighbourhood Flood Evacuation Strategy should have to be demonstrated on a case by case basis. These should be limited to 0-250mm depth of flood water or 250-500mm depth of floodwater with a quantified risk assessment.
6c	• FD2321/PR (2005) – Flood Risks to People – *provides a methodology for assessing and mapping the risk of death or serious harm to people caused by flooding.*	No major revisions to this guidance identified. All documents publicly available online.	
7	The draft (Nov 2017) LCC Local Flood Risk Management Strategy is presently out for consultation (until 19th January 2018)[5]	The strategy does identify the facility for Mersey Estuary residents and businesses to register for the Flood Warning Service at: https://www.fws.environment-agency.gov.uk/app/olr/register	
8a	Informative Point 9. … all new highways and footways within the application site which are not be offered up for formal adoption, shall be implemented to adoption standards …. Therefore all the roads and footways within the Development should be designed and built to adoptable standards in respect of flood risk/resilience.		

[5] http://liverpool.gov.uk/council/consultation/consultation-on-liverpool-city-council-s-draft-local-flood-risk-management-strategy/

Ref.	Flood Risk Policy, Guidance & References (In 2011 Principal Application Documents and later sources)	Relevant changes and updates since the 2011 FRA	Best practice to be adopted for Liverpool Waters
8b	Informative 9 implies highway design standards such as DRMB Standards for Highways in absence of any specific LCC Highways design guides. Of relevance to flooding is: HD45/09 – Road Drainage and the Water Environment (2009) *Guidance on the assessment and management of the impacts that road projects may have on the water environment.*	No specific LCC Highways documentation or methodologies to supersede this DMRB standard. No further updates to this document are noted since the publication date.	
8c	3.30 – 'New roads or improvements should only be located within the functional floodplains if there is not acceptable alternative and should be restricted to the shortest practical crossing, avoiding extensive construction within the floodplain. Where this is unavailable, the level of the road should be above the level of the predicted flood event…. For major projects, a sensitivity check with the 0.1% annual event is advisable and should be discussed with the Overseeing Organisation. If a project is constructed in, or is likely to create, a passive floodplain, the consequences of overtopping or beach should be considered.'	While the Development Site is not within a Flood Zone 3B designation (as shown on the Liverpool SFRA 2008 Map 5 Estimated Flood \Risk Zone 3A and 3B) the principle of having the road level above the predicted flood level is noted.	Follow FD2320/TR2 (2005) – see 6b above.
9a	BS 8533:2011 – British Standard Code of Practice - Assessing and managing flood risk in development - *Offers recommendations and guidance for assessing flood risk and for selecting the appropriate flood risk measures for development in the UK.*	Document has been superseded by the version BS 8533:2017 published in December 2017.	Guidance to be utilised by Master Developer and Parcel/Plot Developer, for risk coverage in flood risk assessments where the most recent EA/NPPG guidance (above) does not provide the necessary guidance or information (with exception of fixed parameters already given for the Development in this Strategy). BS 8533: 2017 to be used for flood resilience design where relevant guidance is not given in EA/NPPG.
9b	4.4.2.3 Recommends examining the depth of flooding within the development for the 0.1%AEP flood event.		

Ref.	Flood Risk Policy, Guidance & References (In 2011 Principal Application Documents and later sources)	Relevant changes and updates since the 2011 FRA	Best practice to be adopted for Liverpool Waters
	The 0.1% AEP tidal flood event level in 2011 was 6.37mOD, which is 0.26m higher than the 0.5% AEP tidal flood event. As an observation the 0.26m figure is less than the 0.6m freeboard used for finished floor levels and 0.45m used for basement ramp thresholds. As an observation the 0.26m figure is 0.16m greater than the Emergency Access Rout minimum level. It is not possible at this stage to determine the depth of flood water for the Development as Masterplan levels have not all been finalised/designed.		It is proposed that the Neighbourhood Flood Resilience Plan includes a Neighbourhood Drawing/Plan showing the estimated depth of flood water for the 0.1% AEP tidal flood event and that this Drawing/Plan is updated when Parcel/Plot external levels are confirmed.
9c	5.5.3 recommends freeboard 'Mitigation within an area without raised flood risk management infrastructure' of 600mm and 300mm.	No change.	Retain the 600mm freeboard proposed in the PAD.
9d	5.7.2a flood evacuation routes – recommends routes be designed about the 0.5% AEP tidal flood event.	No change. Consistent with FD2320/TR2 (2005)	See 6b above.
10	Flood and Water Management Act (2010) – *details responsibilities for the management of water and flood risk to people, homes and businesses.* Further information available: https://www.gov.uk/guidance/flood-risk-management-information-for-flood-risk-management-authorities-asset-owners-and-local-authorities	Introduced in 2010 (similar time to the planning submission), and defines roles to further include: • EA – strategic overview of the management of all sources of flooding and coastal erosion and lead managing the risk from for main rivers. • Lead Local Flood Authorities (authorities or county councils) – responsible for local flood risk management in their areas and lead the management risk of flooding from surface water, groundwater and ordinary watercourses.	Master Developer to lead flood risk liaison and approval processes with the LPA, EA and LCC as LLFA.
11	Government Guidance for Flood and Coastal Change – *library of resources, information and guidance documents relating to flood risk*	Information provided online from 2012 onwards via. https://www.gov.uk/topic/environmental-management/flooding-coastal-change	Source of information/appropriate guidance for Master Developer and Parcel/Plot Developers.

Ref.	Flood Risk Policy, Guidance & References (In 2011 Principal Application Documents and later sources)	Relevant changes and updates since the 2011 FRA	Best practice to be adopted for Liverpool Waters
12	Department for Communities and Local Government / EA – Improving the flood performance of new buildings: flood resilient construction (2007) - *Provides guidance to developers and designers on how to improve the resilience of new properties in low or residual flood risk areas by the use of suitable materials and construction details.*	Available via. https://www.gov.uk/government/publications/flood-resilient-construction-of-new-buildings	Source of information/appropriate guidance for Master Developer and Parcel/Plot Developers.
13	EIS Appendix 8.2: Drainage Strategy Report (September 2010) The drainage strategy indicates some areas of the proposed development can discharge surface water direct to the River Mersey (as agreed with the EA). Tidal lock of drainage discharging direct to the Mersey has been identified as potentially giving rise to the need for development attenuation by the EA.		The Neighbourhood Flood Risk Resilience Plans should be progressed on the basis that direct surface water discharge to the River Mersey should be avoided to eliminate health and safety risk of construction and maintenance work adjacent to and in the tidal river. Surface Water discharge to the dock water space should enable the attenuation provided by the dock to be utilised.

4 Specific Flood Risk Resilience Measures in the Principal Application Documents

The ES (2011) and FRA Addendum (2011), as part of the PAD, provide information on the sources of flood risk and the proposed flood mitigation measures to be implemented across the Development as agreed within the Outline Planning Consent. The Liverpool Water Development should be designed and constructed over a 30 year period (approximately) by the applicant with multiple Parcel/Plot Developer partners (and associated design teams).

In respect of flood risk mitigation measures (which involve setting finished levels); to ensure consistency, integration (including inclusive access) and coordination between infrastructure, public realm and buildings across the Development, the PAD consider that all the development should be designed on the basis of flood risk mitigation criteria appropriate at the end of the construction period. So for example allowances for sea level rise have calculated with an additional 30 year period preceding the operational life of the development (a building or infrastructure).

It is proposed that the methodology and criteria in the PAD and the review in Section 3 be used to provide the required consistency, integration and coordination. This Section of the Strategy identifies the key criteria that Master Developer and Parcel/Plot Developers shall use.

4.1 Design Criteria

Table 2 highlights the criteria identified within the PADs, guidance and this Strategy that shall be adopted for future design and strategies associated with Liverpool Water Development going forwards.

It is noted that the main tidal flood event mitigation measures proposed for Liverpool Waters, beyond the sequential test with development steered towards the areas of the site with the lowest flood risk, are the raised finished levels for varying land-uses/proposed new developments across the site and the provision of safe access and egress routes.

It is expected that the applicant and Parcel/Plot Developers should repeat the design criteria as part of Plans, Strategies and Flood Risk Assessments.

Details of how these mitigation measures should be delivered across the Liverpool Waters Development are outlined in Section 6.

Table 2. Key Design Actions, Design Criteria and Flood Mitigation Measures to be used throughout Liverpool Waters

Aspect	Comments	Design Actions	Key Design Criteria to be used
Flood Zone Classification			
Flood Zone definitions are set out in the National Planning Policy Guidance: Flood Zone 1 - land assessed as having a less than 1 in 1,000 annual probability of river or sea flooding (<0.1%) Flood Zone 2 - land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% – 0.1%), or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% – 0.1%) in any year Flood Zone 3 - land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year	For the purposes of planning and Development design the 2008 tidal flood event levels identified in the 2013 Outline Planning Consent should be used. Current tidal flood event levels are not required to be used. A comparison with the FZ2 and FZ3 levels form the EA Mersey Extreme River Mersey Study 2016 Draft should be made.		Flood Zone Definitions for Liverpool Waters Development Neighbourhood A: FZ1 areas above 6.37mOD. FZ2 areas between 6.11mOD and 6.37mOD. FZ3 areas (including dock water space) below 6.11mOD. Flood Zone Definitions for Liverpool Waters Development Neighbourhoods B to E (subject to consideration of Draft Mersey Estuary Study 2016 data): FZ1 areas above TBC1 (min. 6.37mOD). FZ2 areas between TBC3 (min. 6.11mOD) and TBC1 (min. 6.37mOD). FZ3 areas (including dock water space) below TBC3 (min. 6.11mOD).
Additional topographical survey (FRA Addendum, 2011), for the area between Trafalgar Dock and West Waterloo Dock, indicates extents of the site within Flood Zone 2 and 3 – refer to Drawing No A062945-6/D100 for further details.	There are inaccuracies/errors in the areas shaded for represent FZ2 and FZ 3. The ground model does not appear to reflect the dock wall coping stone and the normal dock water surface hence the dock water space is not represented as FZ3 and the boundaries of FZ2 adjacent the dock space and infilling are not represented correctly. Activities have taken place in the Site since 2011 to change levels.	Topographic surveys of neighbourhoods to be undertaken and/or validation and coordination of recent surveys to be undertaken. FZ2 and FZ3 to be mapped for each Neighbourhood. (This exercise should be extended to map the extent of 0.5% AEP design flood levels for the 2115 design life end date based on the Masterplan, FFL's and EAR levels.)	

Aspect	Comments	Design Actions	Key Design Criteria to be used
The 2013 Outline Planning Consent accepts that the majority of the site is within FZ1 for planning purposes. FRA Addendum (2011) makes note that Flood Zone 2 is largely to be allocated for landscaped areas.		There are some existing site areas that are FZ2 & FZ3, these require detailed examination in Neighbourhood Flood Risk Resilience Plans. Proposed re-use/re-distribution of FZ2 areas to be shown in the Neighbourhood Flood Risk Resilience Plans.	
Vulnerability classification			
'Less vulnerable' – Commercial developments 'More vulnerable' – Residential developments *(Source: Table D2 and D3 of PPS25)* 'Less' and 'More vulnerable' development is acceptable within Flood Zone 1 and 2. (Source: LCC SFRA)	Essential Infrastructure (such as sub-stations, wind turbines, foul drainage pumping stations) and Highly Vulnerable (such as telecoms required during flooding and emergency access/ evacuation routes) have yet to be defined within the Development.	Resilience levels to be agreed for Essential Infrastructure and Highly Vulnerable uses. Locations and levels of Essential Infrastructure and Highly Vulnerable uses to be examined and shown in the Neighbourhood Flood Risk Resilience Plans.	Flexibility to locate Commercial and Residential development uses throughout the site subject to Design Flood Levels and Emergency Access Route requirements.
Sources of Flood Risk			
Main flooding mechanism is tidal flood events, i.e. water entering the site as a result of high tides, storm surges and wave action. The 2011 FRA Addendum (Section 5.1) discusses flooding mechanisms and existing features/elements adjacent the River Mersey. It concludes that current estimates for sea level rises should result in a 0.5% AEP tidal flood event level estimate greater than 6.52mOD (feature/boundary level at Salisbury Pier Head).	The PAD identify the low levels of features/elements (wave walls, lock gates) adjacent the River Mersey that tidal flood events would have to overtop to cause flooding. One boundary feature and potential mechanism not identified is the risk of Canning Half Tide Dock river entrance failing. This could cause tidal flooding of Canning Dock leading in turn to over topping of the flood gate at Mann Island Lock leading to flooding of the Liverpool Canal Link through Pier Head to Princes Dock.	Check feature/element levels and identify features/elements to be protected during Development construction. Make clear the ownership and maintenance responsibilities for features/elements affording flood resilience to Liverpool Waters. Highlight importance of the boundary feature levels to flood resilience in Neighbourhood Flood Risk Resilience Plans and H&S Files.	Design Flood Event to be the 2008 level for the 0.5% AEP tidal flood event plus allowances for sea level rise for Neighbourhood A. Design Flood Event to be the 2016 level for the 0.5% AEP tidal flood event plus allowances for sea level rise for Neighbourhoods B to E. Wave overtopping as a source of flood risk to infrastructure and buildings immediately adjacent the River Mersey to be considered using data current at the time of starting the Neighbourhood Flood Risk Resilience Plan for Neighbourhoods A and C to E.

Aspect	Comments	Design Actions	Key Design Criteria to be used
	A potential mechanism for increased exposure to risk from tidal flood events, that may otherwise be resisted by feature/elements adjacent the River Mersey, is failure of working Port/Dock infrastructure (river gate failure) or legacy dock/river infrastructure connections like sluicing and by-wash culverts.	Examine operational and legacy risks.	
No known historical flooding events; 2 no. public sewers flooding properties in the vicinity (as of 2011) *(Source: EA and UU Records).*		Updated searches to be undertaken to inform Neighbourhood Flood Risk Resilience Plans and Parcel/Plot FRA's.	
Ground water flooding considered to be low *(Source: Mersey Estuary Catchment Flood Management Plan)*			Ground water flooding low risk.
Risk of flooding due to canal infrastructure is considered low.	The Liverpool Canal Link connects to the Stanley Lock Flight at Stanley Dock/ Collingwood Dock. The risk of three sets of lock gates being vandalised or left open such that impounded water in the Eldonian area is rapidly drained to Liverpool Waters is considered low. Subject to the Dock Water space above normal operating levels not being flooded by a tidal flood event, the Dock Water space is judged to have sufficient freeboard to allow early warning of a flood event from the canal. The impounded water space in Liverpool Waters has two normal planned overflow routes – the overtopping of the lock gate in Princes Dock Lock and open connectivity to the operational Port of Liverpool by the Isolation Structure	Reflect a watching brief to users/occupiers of the Development Water Space in Construction Stage H&S Plans and H&S Files.	

Aspect	Comments	Design Actions	Key Design Criteria to be used
	between Bramley Moore Dock and Nelson Dock.		
Design Life			
The PAD proposes a 30 year construction period from 2011 to provide consistency in final design levels across the Liverpool Waters Development. *(2011 Flood Risk Assessment Addendum 3.2.3)*	Some portion of this construction period has elapsed but calculation of design life end dates remains valid.	The Central Docks Phase 3 has a Design & Construction period of 2020-2036. It is proposed to use this 2036 end of construction period in addition to the relevant design life (residential or commercial) to obviate the need to consider revised/re-worked levels for each plot at the time of its development planning submission within the neighbourhood.	Central Docks Design & Construction period will be 2020 – 2036.
Building Design Life values are: *(Section 5.80 LCC SFRA, 2008 and 2011 Flood Risk Assessment Addendum 3.2.3)*			
Residential buildings:100 years (design life end date: 2141)	In respect of the November 2011 FRA: Design life end date is not within the original 2008 EA data set for sea level rise estimates with horizon of 2115. Therefore only 107 years of a 130year residential design life has been assessed. If the 23 years had been included (in the 2011 Flood Risk Assessment Addendum Appendix B Section 2.0 calculation) at the 2085-2115 rate of 13mm/year this would have added an additional 299mm to the sea level rise allowance. The allowance of 13mm/year could be an over-estimate or under estimate. If a rate of 15mm/year for a period of 2115 to 2145 was assumed (following the linear increase in the EA published	Continue to propose the 2115 design life end date.	Residential Building design life end date 2115 (with a sea level rise review preceding this date).

Aspect	Comments	Design Actions	Key Design Criteria to be used
	estimates) was taken, then this would add an additional 345mm for the 23 years. The degree of uncertainty in the prediction of sea level rise reduces the meaningfulness and reliability of such estimates. It is not proposed to recalculate a higher increased Design Flood Level (equivalent to the 0.5% AEP tidal flood event for year 2141) to account for the Residential design life beyond 2115 on the basis that: • The future estimates beyond 2115 are increasingly not reliable; • The potential differences (above) are within the margin of the 0.6m freeboard (which in effect is a contingency for the uncertainty of the calculation methods and data); • Adding 0.3m or more to the FFL's and the Emergency Access Routes will exasperate heritage and inclusive access difficulties; • Future sea level rise estimates can be reviewed against the overall design flood level estimated now; • Future flood resilience can be examined with the potential of retrofitting resilience measures to the development as a whole, prior to 2115, at a time that should coincide with the end of the commercial developments (see below). The Neighbourhood C Central Docks design life end date will be 2136 (= 2036		

Aspect	Comments	Design Actions	Key Design Criteria to be used
	+ 100 years) which is 5 years shorter than the 2141 for the overall development.		
Commercial buildings: 60 years (design life end date: 2101)	Design life end date is within the original 2008 EA data set for sea level rise estimates with horizon of 2115. Therefore the full commercial development design life has been assessed.	Make strategy specific to Neighbourhood C Central Docks. Design Life End Date is 2096 (= 2036 + 60 years).	Commercial Building design life end date 2096.
Design Flood Level with Sea Level Rise Allowances (climate change)[SS7]			
The previous FRA (2011, WYG) was based on the EA's modelled 2008 flood levels of the Mersey (including tidal influences): 0.5% AEP: 6.11mOD 0.1% AEP: 6.37mOD *(Source: EA Extreme sea level study 2008, including surge and based on the Liverpool Gauge at grid reference 332480, 395240)*	The 2008 model has now been superseded by the EA Draft River Mersey Extreme Sea Level Study 2016. EA's modelled 2016 flood levels of the Mersey (including tidal influences): 0.5% AEP: 6.13mOD 0.1% AEP: 6.33mOD *(Source: Draft EA Mersey Estuary Study 2016 data, including surge and based on the Liverpool Gauge (ref ea013_9001_Liverpool_Guage)*	Adopt the 2016 study levels, noting that the levels relate to the lowest protection level provided by the river wall and the river entrances/locks to the working Port of Liverpool at the Gladstone River Entrance.	Use the EA Draft River Mersey Extreme Sea Level Study 2016 levels in flood risk assessment: 0.5% AEP: 6.13mOD 0.1% AEP: 6.33mOD
Climate change allowance for sea level rise based on UKCP09 data is calculated using: • 2008 – 2025: 2.5mm/year • 2025 – 2055: 7mm/year • 2055 – 2085: 10mm/year • 2085 – 2115: 13mm/year *(Source: LCC SFRA, 2008 and UK Gov, 2017)*	The Sea Level Rise allowance are expected to be revised in April 2019 based on the release of the UKCP18 Oct 2018 data (UK Climate Projection 2018).	Arup has extracted data from the UKCP18 data set and proposed the following sea level rise allowances be made. Based on Hillbre Island gauge location the following SLR rates have been determined: • 2016 – 2020: 2.5mm/year • 2020 – 2050: 7.3mm/year • 2050 – 2080: 11.7mm/year • 2080 – 2110: 15.5mm/year • 2110 – 2140: 15.5mm/year	Adopt the Arup proposed allowances based on UKCP18, in the place of an updated Table 3.

Aspect	Comments	Design Actions	Key Design Criteria to be used
	Using the Arup extracted UKCP18 SLR rates SLR can be calculated as: **Residential** Date / Years / Increase (mm/yr) / Total (mm) 2016 / / / 2020 / 4 / 2.5 / 10.0 2020 / / / 2050 / 30 / 7.3 / 219.0 2050 / / / 2080 / 30 / 11.7 / 352.0 2080 / / / 2110 / 30 / 15.5 / 464.0 2110 / / / 2115 / 5 / 15.5 / 77.3 / / Total / 1,122.3 0.5% AEP 6.13 mOD 0.5% AEP+SLR 7.25 mOD **Commerical** Date / Years / Increase (mm/yr) / Total (mm) 2016 / / / 2020 / 4 / 2.5 / 10.0 2020 / / / 2050 / 30 / 7.3 / 219.0 2050 / / / 2080 / 30 / 11.7 / 352.0 2080 / / / 2096 / 16 / 15.5 / 247.5 / / / / / / / Total / 828.5 0.5% AEP 6.13 mOD 0.5% AEP+SLR 6.96 mOD	Parcel/Plot Developers to demonstrate: • a Health & Safety File requirement to review sea level rise prior to 2115 in conjunction with the Master Developer. • Measures to consider the management of flood risk due to wave overtopping – see below.	Neighbourhood[RJ8] C Design Flood Levels, methodology as follows: • Residential unit of 100 years (end date 2136 limited to 2115), baseline year of 2016 = 1,122mm of sea-level rise due to climate change. Note, extrapolation of data beyond 2115 is an uncertainty within the proposals. • Commercial unit of 60 years (end date 2096), baseline year of 2016 = 828mm of sea-level rise due to climate change. The Design Flood Level is comprised of the 0.5% AEP event (2016, EA) plus Sea Level Rise allowance. This results in the following Design Flood Levels: Residential Buildings Design Flood Level (to 2115) 7.25mOD. Commercial Buildings Design Flood Level (to 2096) 6.96mOD. Emergency Access Routes Design Flood Level (to 2115) 7.25mOD.

Aspect	Comments	Design Actions	Key Design Criteria to be used
Extreme wave height sensitivity factor. The 2011 FRA has calculated a Residential Buildings sea level rise to 2115 of 0.942m plus extreme wave height allowance of 0.094m. The 2011 FRA has calculated a Commercial Buildings sea level rise to 2101 of 0.760m plus extreme wave height allowance of 0.076m (note error in Appendix B 3.0).	In the 2011 previous assessment, an additional 10% sensitivity factor for extreme wave height was added *(as per PPS25 Table B.2).* It is noted that this 10% allowance for extreme wave height has been applied to the increase in still sea level – this is an incorrect application of the 10% allowance, the allowance should relate to a wave height or rainfall or wind intensity. (The wave height in the Mersey can be in the range of 2.0m to 3.5m.) The modelling of a 0.5% AEP flood event that includes extreme sea level and extreme wave height is complex and has not been done in the 2011 FRA. The coincident combination of a 0.5% AEP extreme (still) sea level event and a 0.5% AEP extreme wave height will result in examination of an event with a much lower (and onerous) AEP event. It is not proposed to undertake such an analysis. We do not believe that the 10% precautionary allowance for extreme wave height overtopping (applied to say a 3.5m wave height) is appropriate to apply in calculating the 0.5% AEP design flood level for the development in combination-with and in addition-to the 6.11mOD 2008 0.5% AEP extreme sea level. The probability of such a coincidence of events would be much lower than 0.5% (and unreasonably onerous) for the project.	Do not repeat the 10% allowance.	

Aspect	Comments	Design Actions	Key Design Criteria to be used
Extreme wave height overtopping			
In relation to the FFLs *"…. as previously agreed with the EA, no specific inclusion has been included for the effects of extreme wave action, as this is to be considered as part of each detailed application for each site. However, the addition of 600mm freeboard is normally considered as a suitable allowance to cover the effects of extreme wave action, therefore, subject to the specific requirements of the EA, it may be acceptable to ignore these effects in setting minimum FFL's" (Section 5.2.2 FRA Addendum, 2011)*	The provision of 0.6m freeboard to design flood levels in the 2011 FRA Addendum (with FFL's at 7.75mOD & 7.55mOD) is much higher level of contingency than the 0.1m freeboard proposed in the 2010 FRA (with FFL's at 7.25mOD). The aspect of allowance for wave effects in freeboard referred to in 2010 and 2011 words are more appropriate to the effects of local waves/variations on an inland water surface, not the effect of waves at the River Mersey estuary (where wave heights are expected to be in the 2m+ range).	Neighbourhood Flood Resilience Plans to identify primary areas (mostly those areas immediately adjacent the River Mersey) where wave overtopping risk should be examined in more detail. Each should agree with the LPA and the EA how the nature of wave overtopping is required to be examined.	Wave height and overtopping data current at the time of starting the Neighbourhood Flood Risk Resilience Plans for Neighbourhoods C to E.
EA correspondence October 2011 recommends positioning the main entrances and ramps to basement car park away from sources of wave overtopping (i.e. on the dock side rather than river side).		Master Developer and Parcel/Plot Developers to consider the positioning of building entrances and basement car park ramps to face away from the River Mersey. External levels to be designed to direct flood water due to wave overtopping safely to the dock water space (or the River Mersey as appropriate). Neighbourhood Flood Resilience Plans to identify primary extreme event and wave overtopping corridors.	
Wave height	The 2010 and 2011 FRA's do not identify any wave height parameters or studies. Records for a buoy at New Brighton (now decommissioned) show that wave heights (for relatively low water levels) were between 1.57m to1.97m in 2015 to 2016. https://www.channelcoast.org/reports/	Further examination of the wave overtopping risk for Neighbourhoods C to E (Central Docks, Clarence Dock and Northern Docks) has been undertaken. This examination indicates that the predicted (at the year 2115 allowing for sea level rise) volumes of water overtopping the current wave wall crest	It is recommended that the Master Developer and Parcel/Plot Developers: • Understand the nature of direct wave impact and overtopping effects – in relation to damage to existing defences, direct hazards to the public adjacent to the river/sea

<table>
<tr><th>Aspect</th><th>Comments</th><th>Design Actions</th><th>Key Design Criteria to be used</th></tr>
<tr><td></td><td>The New Brighton side of the estuary is considered to be more protected than the Central Docks side of the estuary.</td><td>lowest levels are greater than those limits defined by EurOtop 2nd Edition.
Parameters considered relevant, from UCKP18 RCP8.5, for the 0.5% AEP for Hillbre Island (River Mersey levels to be confirmed likely to be 0.1-0.2m higher):
<table><tr><th>Year</th><th>50th Percentile</th><th>95th Percentile</th></tr><tr><td>2020</td><td>5.973mOD</td><td>6.035mOD</td></tr><tr><td>2100</td><td>6.545mOD</td><td>6.907mOD</td></tr><tr><td>2140</td><td>6.926mOD</td><td>7.555mOD</td></tr></table>An initial analysis of the current crest level (approx. 7.79mOD) for the existing Central Docks wave wall indicates that it will not be possible to provide the level of protection to pedestrians (less than 1litre/mrun/second) on the promenade for wave heights greater than 0.5m.</td><td>wall, damage to adjacent property and infrastructure, and associated inundation/flooding of infrastructure.
• Undertake specialist numerical modelling studies (where appropriate) to define local wave conditions and associated overtopping over the infrastructure design life.
• It is recommended at a Neighbourhood or site wide study is undertaken.</td></tr>
<tr><td>Buildings adjacent the River Mersey.</td><td>The design of buildings/property to resist (or be resilient to) wave overtopping impact is not specifically mentioned.
In respect of the rate/volumes of overtopped water an indication of relevant EurOtop guidance is shown below.
Table 3.2: General limits for overtopping for property behind the defence
<table><tr><th>Hazard type and reason</th><th>Mean discharge q (l/s per m)</th><th>Max volume V_{max} (l per m)</th></tr><tr><td>Significant damage or sinking of larger yachts; H_{m0} > 5 m</td><td>>10</td><td>>5,000 – 30,000</td></tr><tr><td>Significant damage or sinking of larger yachts; H_{m0} = 3-5 m</td><td>>20</td><td>>5,000 – 30,000</td></tr><tr><td>Sinking small boats set 5-10 m from wall; H_{m0} = 3-5 m
Damage to larger yachts</td><td>>5</td><td>>3,000-5,000</td></tr><tr><td>Safe for larger yachts; H_{m0} > 5 m</td><td><5</td><td><5,000</td></tr><tr><td>Safe for smaller boats set 5-10 m from wall; H_{m0} = 3-5 m</td><td><1</td><td><2,000</td></tr><tr><td>Building structure elements; H_{m0} = 1-3 m</td><td>≤1</td><td><1,000</td></tr><tr><td>Damage to equipment set back 5-10m</td><td>≤1</td><td><1,000</td></tr></table>Other criteria to be determined on a case by case basis.</td><td>Master Developer and Parcel/Plot Developers to examine the requirements of EurOtop 2nd Edition: *Manual on wave overtopping of sea defences and related structures*.
This should consider both infrastructure, landscaping and building design for areas affected by overtopping; referring to EurOtop Section 3.3.4 and 3.3.5 specifically.
Master Developer and Parcel/Plot Developers to:
• Develop the concept of a distance from the river wall beyond</td><td>Further Wave Overtopping Assessment required.
An allowable limited water volume due to wave overtopping should be considered in a more detailed wave overtopping assessment.
Assuming wave heights are less than 3m, wave overtopping allowance for buildings may be considered as 1l/s/m, but this should be examined to determine if it can be relaxed.
Building and Infrastructure to be designed to resist appropriate wave impacts.</td></tr>
</table>

<table>
<tr><th>Aspect</th><th>Comments</th><th>Design Actions</th><th>Key Design Criteria to be used</th></tr>
<tr><td>Infrastructure and Street Furniture adjacent the River Mersey</td><td>The design of infrastructure to resist (or be resilient to) wave overtopping impact is not specifically mentioned.
In respect of the rate/volumes of overtopped water an indication of relevant EurOtop guidance is shown below.
Table 3.3: Limits for overtopping for people and vehicles
<table><tr><th>Hazard type and reason</th><th>Mean discharge q (l/s per m)</th><th>Max volume V_{max} (l per m)</th></tr><tr><td>People at structures with possible violent overtopping, mostly vertical structures</td><td>No access for any predicted overtopping</td><td>No access for any predicted overtopping</td></tr><tr><td>People at seawall / dike crest. Clear view of the sea.
H_{m0} = 3 m
H_{m0} = 2 m
H_{m0} = 1 m
H_{m0} < 0.5 m</td><td>
0.3
1
10-20
No limit</td><td>
600
600
600
No limit</td></tr><tr><td>Cars on seawall / dike crest, or railway close behind crest
H_{m0} = 3 m
H_{m0} = 2 m
H_{m0} = 1 m</td><td>
<5
10-20
<75</td><td>
2000
2000
2000</td></tr><tr><td>Highways and roads, fast traffic</td><td>Close before debris in spray becomes dangerous</td><td>Close before debris in spray becomes dangerous</td></tr></table>
Other criteria to be determined on a case by case basis.</td><td>(eastwards) which wave overtopping does not need specific consideration/examination.
• Landscaping/public realm proposals are to be designed so that overland flows (as a result of overtopping) are diverted away from building structures and emergency access/escape routes and exits.
• Develop Neighbourhood Drainage Strategy proposals that consider overland flow pathways and the opportunities to divert overtopping flows into the existing docks for storage, when discharge to the River Mersey is unavailable.</td><td></td></tr>
<tr><td>Promenade adjacent the River Mersey
Emergency Access Routes adjacent the River Mersey</td><td>The level of protection required for safe use of the promenade and the EAR’s is not mentioned in the 2011 FRA.
In respect of the rate/volumes of overtopped water an indication of relevant EurOtop guidance is shown below.
Table 3.3: Limits for overtopping for people and vehicles
<table><tr><th>Hazard type and reason</th><th>Mean discharge q (l/s per m)</th><th>Max volume V_{max} (l per m)</th></tr><tr><td>People at structures with possible violent overtopping, mostly vertical structures</td><td>No access for any predicted overtopping</td><td>No access for any predicted overtopping</td></tr><tr><td>People at seawall / dike crest. Clear view of the sea.
H_{m0} = 3 m
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H_{m0} = 3 m
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10-20
<75</td><td>
2000
2000
2000</td></tr><tr><td>Highways and roads, fast traffic</td><td>Close before debris in spray becomes dangerous</td><td>Close before debris in spray becomes dangerous</td></tr></table></td><td>If the existing wave wall crest level does not afford a safe level of protection against wave overtopping rates/volumes, then the following hierarchy of measures should be examined.
• Locate vulnerable uses away from overtopping areas
• Increase the wave wall crest level
• Schemes for lines of secondary protection from wave overtopping
• Develop a scheme of provisions (which may include barriers, will include defining responsible organisations and will include an indication of trigger points for action) to prevent access to unsafe areas during overtopping events.</td><td>Further Wave Overtopping Assessment required.
An allowable limited water volume due to wave overtopping should be considered in flooding assessment.
Assuming wave heights are less than 3m, wave overtopping allowance for people and vehicles may be considered as 1l/s/m, but this should be examined to determine if it can be relaxed appropriately if wave heights are between 2m and 1m.</td></tr>
</table>

Aspect	Comments	Design Actions	Key Design Criteria to be used
Finished Floor Levels			
FFL's of any new buildings should be 600mm above the 1 in 200 year flood level (+ climate change) (Source: LCC SFRA, 2008):	The 600mm freeboard to finished floor levels is in line with: *Accounting for residual uncertainty: updating the freeboard guide.* *Report – SC120014* The 300mm freeboard to basement ramp levels is appropriate	As a primary measure of flood resilience, Developers are to utilise the minimum FFL's as detailed opposite as a default position; developers are to confirm these are appropriate in each application.	
(2011 Flood Risk Assessment Addendum gives) Residential Building FFL: 7.75mOD Commercial Building FFL: 7.55mOD Basement carpark threshold: 7.45mOD		Consideration towards flood resilient design and construction, and flood mitigation measures to be made – particularly to adaption in response to future predicted to sea-level rises beyond the current estimation horizon of 2115 over the full design life-span of the Liverpool Waters Development to 2141.	Minimum Finished Floor Levels: Neighbourhood C: Residential Building FFL: 7.85mOD Commercial Building FFL: 7.56mOD Basement carpark threshold: 7.55mOD
Retained historic buildings and dock walls: any historical buildings that are to be reused shall retain their existing FFL's and be adapted to include flood resilience measures.	The need to have an exception to the minimum FFL's shall be demonstrated and resilience measures and flood risk management provided.		
Public open spaces: proposals for Central Park and Prospect Park to be situated in Flood Zone 2 and to be at low level to retain the existing flood storage capacity of the flood zone.	See below regarding storage volumes.	See below	
External areas: finished levels around proposed buildings are to generally be 150mm below FFL of buildings. External levels to ensure overland surface water flow is directed away from buildings and into the dock basins.	The Emergency Access rote also need to be protected.	Consider and map out overland and exceedance flow paths to show that buildings and emergency access route are protected from overland flow.	Overland flows and exceedance flows to be directed away from Buildings and Emergency Access Routes.

Aspect	Comments	Design Actions	Key Design Criteria to be used
Floodplain Storage and Compensation			
"….parts of the new landscape areas are to be kept at low level to retain the existing flood storage capacity of the flood zone." *(FRA, 2011, Section 4.2.4)*	Existing flood storage capacity (in areas that are not dock water space) is related to existing ground levels, examination of areas at existing levels is required to understand current storage before potential impacts can be identified. Relates to hard and soft landscaping areas with potential to act as dry & wet basins.	Neighbourhood topographic survey required. Neighbourhood Flood Risk Resilience Plans to identify current flood storage areas (similar to the FZ2 & FZ3 mapping exercise).	Retain existing ground levels as much as possible in new landscape areas.
"Any loss of flood plain storage is compensated for by increasing the general level of the site around the perimeter of the existing docklands." *(FRA, 2011, Section 4.2.4)*	This statement is only correct when considering absolute volumes, by necessity flood storage has to be considered both in extent and level. Compensatory storage can only really be compensatory (with no adverse impact) if it provides capacity at the same level as the existing floodplain storage. The EA (in preparation of this Strategy) has confirmed that compensatory storage is not required for this tidal area.	Guidance in BS 8533:2017 notes that where a proposed development reduces the available storage, compensatory flood plain storage should be provided to prevent a net increase in the frequency or severity of flooding elsewhere. Neighbourhood Flood Risk Resilience Plans to identify current flood storage areas in FZ2.	The proposals will retain the sustainable aim of maintaining flood storage as much as possible as a constraint in the masterplan. Any FZ2 flood storage provisions to be between 2016 levels 6.13mOD (0.5% AEP) and 6.33mOD (0.1% AEP) to be of benefit to the development.
Safe Access and Evacuation Route Levels			
The 2011 FRA Addendum proposes a minimum level for emergency access infrastructure of 6.90mOD (to 2115) for residential access and 6.70mOD (to 2101) for commercial access.	See Table 1 Ref.6 discussion.	Exceptions to be evidenced and alternative arrangements agreed with Merseyside Resilience Forum and MFRS.	The minimum level for Emergency Access Routes shall be 7.35mOD for Neighbourhood A and TBCEAR (min. 7.35mOD) for Neighbourhoods B to E.
Transition to boundary levels and areas beyond the Liverpool Waters Development.	The applicant has no control over Emergency Access Routes outside the Development. A transition from 7.35mOD to existing road levels will be required in some areas.	Neighbourhood Flood Risk Resilience Plans to identify areas where EAR level may have to be below 7.35mOD.	

Aspect	Comments	Design Actions	Key Design Criteria to be used
Drainage Design and Discharge Limits			
Separate foul and surface water systems. SW drainage designed to accommodate: • No surcharge for a 1 in 2 year event • No flooding of network for a 1 in 30 year event and the drainage is modelled against a surcharged outfall, • No flooding off-site for a 1 in 100 year + % climate change event. Detailed design needs to account for the maximum water level that the docks would be allowed to raise without compromising the control features or canal traffic. SW Discharge to a sewer is only applicable in lieu of inability to drain to soakaways or to a watercourse.	Anticipated surface water volumes up to the 1 in 30 year would be attenuated on-site (potential to allow existing open docks to fill above the usual standing water level, in combination with tanks, if required). The proposals use the freeboard in Dock water space as attenuation but strictly speaking 'no flooding off-site' cannot be complied with. This Dock water space has unavoidable (and operationally necessary) connections off site such as through the Isolation Structure (to the Port of Liverpool) and through Princes Dock Lock and the Liverpool Canal Link (to Canning Dock.	Examination and use of sustainable urban drainage systems (SuDS) should be made to align with the Sustainability Strategy. Discharge limits to watercourses or UU sewers (where required) to be agreed with the appropriate authorities (i.e. UU, Environment Agency or LCC). Consent required from appropriate authority (i.e. United Utilised, Environment Agency or LCC) to discharge to sewers if needed. Regular maintenance is required to ensure networks work as proposed.	Criteria as opposite.
Rainfall Intensities (Climate Change)			
A 1 in 100 year + 30% climate change event is proposed. *(Source: Table B2 PPS 25, 2006. Condition 33 states 30%)*	This should be reviewed with the release of the UKCP18 Climate Change Projections to understand the implications on the original design basis.	A design check should be completed to understand the impact of 40% intensity increase. Consideration of adaptive measures if implications are significant.	1 in 100 year plus 30% increase in rainfall intensity subject to review.
Further considerations for developers			
During detailed design, consideration to ensure flood waters entering the non-tidal docks can be drained out to restore the dock levels to the operational range of 4.5mOD to 5.15mOD.		Master Developer to confirm dock water space drainage routes in the Neighbourhood Flood Risk Resilience Plans.	
Residual Risks			
Risk Registers	Some risks already identified, no registers developed to date.	Neighbourhood Flood Risk Resilience Plans to include risk registers.	

4.2 Exceptions

Potential exceptions to the design criteria and associated flood mitigation/resilience measures outlined above are detailed within Table 3 below.

For the avoidance of doubt, any exceptions are to be demonstrated to the Liverpool Waters Coordination Panel (see 1.3) and maybe subject to further coordination with LPA and the Environment Agency.

Table 3. Exceptions to mitigation measures

Potential exceptions to mitigation measures	**Description**
Neighbourhood C – Central Docks	Existing developments and those with independent planning consents within this neighbourhood are treated as exempt from measures within this report.
Links with existing infrastructure	Existing infrastructure with ground/floor levels below the minimum thresholds are to be identified, e.g. connection of proposed evacuation routes to existing highways at a lower level. These instances are to be discussed with the Liverpool City Council to co-ordinate the approach across the development and to raise awareness of potential flood risks.
Heritage features	Liverpool Waters is a heritage led regeneration project, and as such the proposals include provision for retaining archaeological and historic structures and artefacts in situ (particularly across sensitive parts of the World Heritage site). As noted previously, this involves minimising land raising, with heritage features to be adapted (where possible) with flood resilient measures.
Minimum finished floor levels unachievable	Where developers are able to provide evidence to indicate the minimum finished flood levels are unachievable, the EA guidance for Flood Zone 2 and 3 should be utilised which states extra flood resistance and resilience measures are required when: *"Areas at little or no risk of flooding from any source should always be developed in preference to areas at higher risk. You must make every effort to locate your development in an area that has little or no risk of flooding.* *When developments can't be located in a lower flood risk area, you need to consider flood resistance and resilience measures if you can't raise your development's ground floor levels above the estimated flood level for the site.* *Which flood resistance and resilience measures you need to take depends on the estimated depth in metres (m) that flood water will reach in your building."* Further information is available via the following link: https://www.gov.uk/guidance/flood-risk-assessment-in-flood-zones-2-and-3#extra-flood-resistance-and-resilience-measures Further guidance is available in BS 8533:2017 in relation to flood risk management and mitigation measures.

4.3 Flood Risk Resilience Strategy links

It is important to recognise the links between the Flood Risk Resilience Strategy and the further strategies and developments required as part of the outline planning condition consents. Table 4 provides a brief overview of where strategies may need to reference the criteria outlined within the Flood Risk Resilience Strategy, or where developers may have to adhere to information which supersedes that contained within this document.

Table 4. Links with further strategies and planning conditions

Conditions linking to Flood Risk Resilience	Comments
Planning Decision Notice Part C	
Condition 11: Detailed Neighbourhood Masterplans	Masterplans would need to be developed with adherence to the criteria outlined within this Flood Risk Resilience Strategy; particularly in relation to proposed site levels, finished floor levels and provision of emergency access routes and SuDS.
Condition 13: Neighbourhood Conservation Management Strategy	There is a need to ensure the resilience of features and structures of historical/heritage importance (particularly within sensitive parts of the World Heritage Site). Content within these strategies would need to be referred to and may superseded the design criteria within the Flood Risk Resilience Strategy.
Condition 15: Neighbourhood Water Environment Protection Strategy	Measures related to the control or water quality of flood waters and overland flow (e.g. discharge from surface water drainage systems) need to be developed in-line with the Neighbourhood Water Environment Protection strategy.
Condition 16: Neighbourhood Ecological & Biodiversity Strategy	Implications of potential flood waters and increases associated climate change may need to be considered within this strategy.
Condition 17: Neighbourhood Sustainability Strategy	As set out within the Outline Planning Consent (Condition 57) and Condition 17: Neighbourhood Sustainability Strategy; there is a requirement to achieve the following sustainability targets: • BREEAM Communities Excellent • BREEAM New Construction Excellent (non-domestic buildings) • Homes Quality Mark 5* (for all homes) (previously the Code for Sustainable Homes Level 6) Proposals for the site would need to look to achieve the required credits for each of the targets outlined. Please note, no building shall be occupied until a Final Certificate has been issued certifying that BREEAM rating excellent has been achieved for the building concerned.
Condition 24: Neighbourhood Car & Cycle Parking Management Strategy	These documents would need to be developed with adherence to the criteria outlined within this Flood Risk Resilience Strategy; particularly in relation to basement car-park threshold levels, locations and evacuation routes.
Planning Decision Notice Part D	All documents to be developed in line with the PAD and this Flood Risk Resilience Strategy.
Planning Decision Notice Part E	All documents to be developed in line with the PAD and this Flood Risk Resilience Strategy.

4.3.1 Sustainability strategy and measures

The Neighbourhood Flood Risk Resilience Plans, Infrastructure design and building designs should consider inclusion of the Sustainability Principles as summarised below.

Table 5. Sustainability Principles to be considered in Flood Risk Resilience design

Sustainability Principles	Targets	Compliance
• Maximise energy and water efficiency in design and construction of new development • Protect and enhance green infrastructure resource • Direct development to areas of the lowest risk of flooding • Maximise the use of Sustainable Urban Drainage Systems in new development		
Neighbourhood Scale: BREEAM Communities Credits (*denotes mandatory credit)	SE 03- Flood Risk Assessment* RE 03- Water Strategy* SE 13- Flood Risk Management LE 06- Rainwater Harvesting	
Non-domestic buildings: BREEAM Construction Credits	Wat 01- Water Consumption Wat 02- Water Monitoring Wat 03- Water Leak Detection Wat 04- Water Efficient Equipment	
Domestic buildings: Home Quality Mark	06 Flood Risk 07 Managing the Impact of Rainfall 25 Water Efficiency	

5 How the applicant intends to manage the delivery of the Strategy Requirements

The applicant intends to be the Master Developer for the Liverpool Waters Development.

The applicant and/or an Infrastructure Developer partner will be responsible for the design and construction of Infrastructure.

The Parcel/Plot Developer partners will be responsible for the design and construction of Parcel/Plot developments and this will be reviewed at various stages by the applicant.

5.1 The applicant Delivery Team

The applicant intends to assemble a Delivery Team. This team should include professionally qualified advisors and organisations that may change from time to time as project requirements dictate.

5.2 The applicant Delivery Processes

5.2.1 Project Delivery Processes

The processes and procedures the applicant intends to use (which may change and develop from time to time) in delivery of the Liverpool Waters Development are intended to be developed in other documents.

Infrastructure and Parcel/Plot developers should be required to adhere to the project delivery processes.

5.2.2 Flood Risk Resilience Measures Delivery Framework

The applicant, Infrastructure Developers and Parcel/Plot Developers should specifically be required to adhere to the following Flood Risk Resilience Measures Delivery Framework outlined in Figure 3 and Section 5.3.

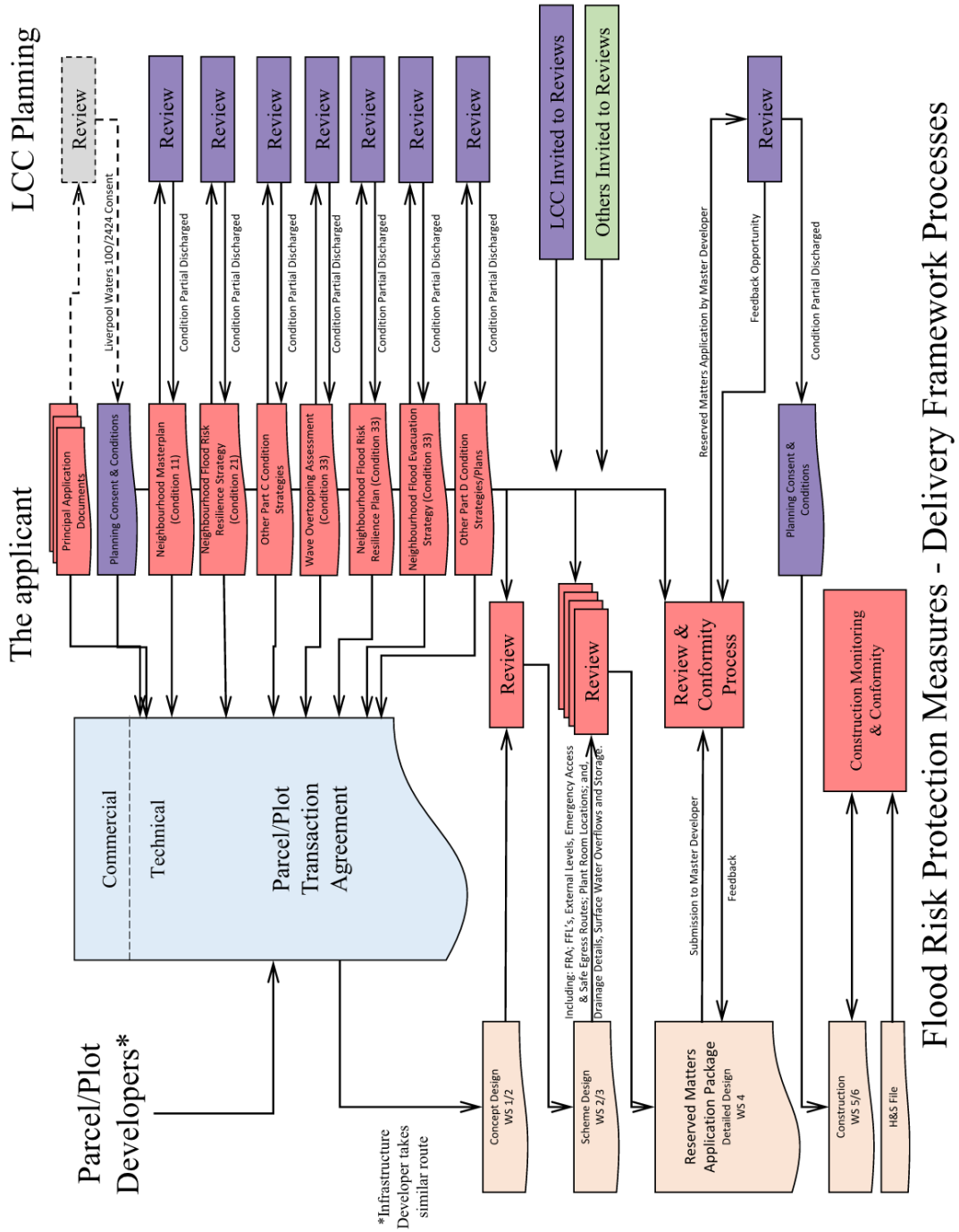

Figure 3 Flood Risk Resilience Measures - Delivery Framework Processes

5.3 Outline for managing the delivery of Flood Risk Resilience Strategy requirements

5.3.1 Responsibilities and interfaces

The applicant's role as Master Developer should involve managing technical matters (i.e. key criteria, technical submissions and strategies - including Part C and Part D conditions) relating to its own Master Developer development and infrastructure proposals and the proposals of the Parcel/Plot Developer partners.

The applicant intends to manage and peer review the Parcel/Plot Developers proposals and provide opportunities for review and input from the LCC Planning team throughout the development design phases.

To assist with the responsibilities outlined, the applicant intends to identify an Advisory Team comprising of suitably qualified professionals with particular on-going experience of the Liverpool Waters development proposals.

5.3.2 Outline Planning Consent Condition Requirements

The applicant and its Advisory Team intends to prepare submissions to enable partial discharge of Part C Conditions (information to submitted prior to the submission of applications for reserved matters approval, i.e. Conditions 9 to 24) on a Neighbourhood by Neighbourhood basis.

The applicant and its Advisory team intends to prepare submissions to enable partial discharge of Part D Condition Strategies and Plans (details to be provided with reserved matters applications) on a Neighbourhood by Neighbourhood basis.

The applicant and Parcel/Plot Developers intend to prepare submissions to enable partial discharge of Part D Condition Strategies and Plans on a Parcel/Plot by Parcel/Plot basis.

5.3.3 Parcel/Plot development design and construction

Parcel/Plot developers intend to undertake the Parcel/Plot development (from concept design through to construction) and provide the necessary information to obtain the appropriate reserved matters condition discharge for each Parcel/Plot.

The applicant intends to peer review the Parcel/Plot developer proposals at various design stages, as indicated on Figure 3, ensuring conformity across the design proposals, prior to Reserved Matters Applications for Parcel/Plots. LCC should be provided with the opportunity to input and review, where appropriate.

During construction the applicant intends to maintain involvement and undertake general monitoring of each Parcel/Plot to control conformity with the project requirements.

5.4 Systems underpinning delivery

To allow for the appropriate management and delivery of the required components of the Liverpool Waters Development, it is important that the appropriate tools and systems are developed to ensure conformity of design across multiple Neighbourhoods and Parcels/Plots.

The following systems and tools should be used to support efficient and consistent delivery of the Development:

- Development of a BIM common data environment (CDE) – allowing data to be shared between multiple sources and providing a single point of storage and access for documentation.
- Use of BIM document management/control.
- Coordinated topographic surveys.
- Sharing of data and lesson learnt between the applicant and the multiple Parcel/Plot Developers; for example:
    - Development of feedback loop between the applicant, Parcel/Plot Developers and stakeholders.
    - Development of watch-it's or best practice/guidance for the Project/Liverpool Waters.

This information should enable differing levels (security/confidentiality related) of access to Development information for various project stakeholders.

5.5 Considerations of wave overtopping

A preliminary examination of River Mersey levels (7.6mOD approximately at 2115), likely wave heights (in range of 0.5m to 2.0m) and the existing wave wall crest height (7.79mOD) has led to the conclusion that wave overtopping cannot be ignored for the Central Docks areas adjacent the River Mersey.

To allow an appropriate understanding of the risk to human safety and damage to property/infrastructure adjacent the River Mersey the applicant will commission a Wave Overtopping Assessment. This will include a numerical and wave overtopping modelling study appraised over the development design life.

The Wave Overtopping Assessment will be referenced in the Condition 33 Flood Risk Resilience Plan response.

This assessment will inform the detailed design of the development Masterplan in the promenade area and provide input data for building and infrastructure designers to design robust structures (or protection measures).

If the existing wave wall crest level does not afford a safe level of protection against wave overtopping rates/volumes, then the following hierarchy of measures should be examined.

- Increase the wave wall crest level;
- Schemes for lines of secondary protection from wave overtopping;

- Locate vulnerable uses away from overtopping areas; and,
- Develop a scheme of provisions (which may include barriers, will include defining responsible organisations and will include an indication of trigger points for action) to prevent access to unsafe areas during overtopping events.

At this stage the river wall and the wave wall of Central Docks are in the ownership of Peel Ports (Mersey Docks & Harbour Company). At present, no works to these assets are considered within the Liverpool Waters proposals. It is recommended that these assets are periodically reviewed over the development life-span to ensure their condition is appropriately maintained.

6 Delivery of Flood Risk Resilience Measures within the Detailed Masterplan

To ensure the delivery of the flood risk resilience measures across the site, as per detailed within this Flood Risk Resilience Strategy and in line with the Outline Planning Consent conditions, the plans, strategies and documentation summarised in Table 6 are intended to be delivered by the applicant in conjunction with Infrastructure and Parcel/Plot Developers.

Table 6. Delivery of the flood risk resilience measures

Document	Owner	
	The applicant	Parcel/Plot Developer
Masterplan Development (Condition 11) As per Part C: Condition 11, detailed masterplans are to be developed within each respective neighbourhood, based on the PADs. Masterplans should include provision for the flood resilience measures as per those outlined in Section 3, 4 and 6 – including external levels, FFLs, safe access and egress routes.		
Neighbourhood Surface Water Management Strategies (as per Condition 21) The Surface Water Management (SWM) Strategies should outline the preferred approach to managing surface water in each neighbourhood. In this context surface water flooding describes flooding from sewers, drains, groundwater, and runoff from land, small water courses and ditches that occurs as a result of heavy rainfall[6]. It should be developed in accordance with the guidance in Section 3, 4 and 6, and: • Ensure the new developments will not increase flood risk elsewhere (as per NPPG) and inform authorities of areas at risk of surface water flooding. • Co-ordinate and strategically plan the surface water drainage provision across the Liverpool Waters development. • Identify areas where sustainable urban drainage systems (SuDS) can be incorporated into the masterplan and discharge locations (and associated ownership and maintenance regimes). • Look to develop a framework for the management of water quality of surface waters. • Make reference to the further Liverpool Waters strategies and planning conditions outlined in Table 4 on page 46; ensuring compliance with the sustainability targets.		

[6] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69342/pb13546-swmp-guidance-100319.pdf

Document	Owner	
	The applicant	Parcel/Plot Developer

Wave Overtopping Assessment (Condition 33)
This study should confirm:
• Identification and agreement with the Environment Agency to:
  • the extent of the assessment along the Liverpool Waters boundary;
  • the assessment parameters and criteria;
  • input data;
  • the range of combined static/wave/storm event probabilities; and,
  • the sensitivities to be tested (including scenarios in support of any freeboard relaxation for plots C07, C08, C11 & C12) to be examined.
• Safe design criteria.
• Wave heights.
• Existing wave wall crest levels.
• Overtopping rates/volumes.
• Wave Overtopping mitigation inputs to the Masterplan		

Flood Risk Resilience Plan (Condition 33) Neighbourhood Flood Risk Assessments should comprise the Flood Risk Resilience Plan and should be provided by the applicant Advisor Team for each neighbourhood within input from Parcel/Plot Developers as appropriate. The FRAs are to be developed in line with guidance outlined in Section 3, 4 and 6. These documents should confirm the: • The design life of buildings, increased rainfall intensities %, sea level rise as a result of climate change and flooding due to extreme wave height overtopping river walls. • Means of surface water flood risk mitigation (incl. surface water overflows and entrapment measures). • Details of all future ground, building and emergency access routes levels and topography. • Extent and method of raising ground levels with Flood Zones 2 & 3, with areas of the site falling within Flood Risk Zone 2 following the raising of ground levels allocated for uses that are non-sensitive to flooding. • Details of flood resilience measures. • Make reference to the further Liverpool Waters strategies and planning conditions outlined in Table 4; ensuring compliance with the sustainability targets. As highlighted in Section 3, it is recommended that the applicant undertake a review of the extents of Flood Zone 2 and 3 for each neighbourhood and the impacts on any loss of floodplain storage as a result of the developments.		

Document	Owner	
	The applicant	Parcel/Plot Developer
Flood Evacuation Strategies (Condition 33) In association with the Flood Risk Resilience Plan, Flood Evacuation Strategies should be developed for each neighbourhood, which should include details of safe routes and evacuation options, for the development lifetime taking account of the vulnerability of its users. These should be developed in line in consultation with Merseyside Resilience Forum, MSFRS, Emergency Planners and the guidance outlined in Section 3, 4 and 6. The documents should include (as a minimum) details of: • The availability of flood warnings, and how these can be accessed; • The responsibility for monitoring and acting upon flood warnings; • The triggers for action in response to a flood warning; • The procedures required for safely evacuating people from the site; • The routes (and associated levels) by which people can be safely evacuated and provision for emergency vehicles to access the Development and Parcels/Plots; • The safe area to which evacuees should proceed; and, • The safe shut-down procedures for machinery or plant		
Parcel/Plot Flood Risk Assessment (Reserved Matters Applications) Developers should provide Parcel/Plot specific Flood Risk Assessments, in conformity with the Neighbourhood Flood Risk Resilience Plans and guidance outlined within this Strategy. These should be reviewed and monitored by the applicant/Advisor Team prior to Reserved Matters Applications for Parcels/Plots.		
Risk Register A Neighbourhood Risk Register should be developed to identify areas of residual flood risks for future developers and site users.		

6.1 Delivery of flood risk mitigation measures in practice

As outlined previously, beyond the sequential test with development steered towards the areas of the site with the lowest flood risk, the primary approach to the mitigation of flood risk across the Liverpool Waters Development is the control of minimum finished floor levels across all proposed buildings and the control of levels for safe/dry emergency access and egress. Where this is not possible it is expected that exceptions should be demonstrated and flood resistance and resilience measures would need to be implemented.

The following is a simple summary of how these flood risk resilience measures are anticipated to be delivered across the Liverpool Waters Development, in line with the design criteria outlined in Section 4, for a range of scenarios.

For illustrative purposes, potential examples of scenarios for setting finished floor levels (FFL) and Safe Emergency Access Routes (EAR) are outlined below.

6.2 Neighbourhood C Development Finished Floor Levels

6.2.1 Residential Building FFL

As per Table 2, Residential developments (16 year design/construction period (2020 to 2036) plus anticipated life-span of 100 (67 effective) years but with a design life end date set at 2115) are required to have a minimum finished floor level of 7.85mOD as Figure 4. General guidance includes:

- Evacuation routes

  Emergency egress for buildings with residential use must match the minimum finished floor level at the edge of the building (or ideally a landing/assembly area immediately outside the building) and be no lower than 7.35mOD to provide safe/dry egress to the Emergency Access Route. Emergency access to buildings for vehicles only can be set no lower than 7.00mOD.

- External ground levels

  Other external ground levels around buildings being set in line with inclusive access, heritage, flood exceedance route and drainage requirements.

- For developments of mixed commercial and residential use

  A commercial ground floor can be set at minimum of 7.85mOD as Figure 5 or at 7.56mOD provided there is provision for retrofitting resilience as Figure 6 (such as increased ground floor headroom to allow future floor and threshold levels to be raised to at least 7.85mOD, or installation of erectable flood defences that do not interfere with the safe residential emergency egress routes).

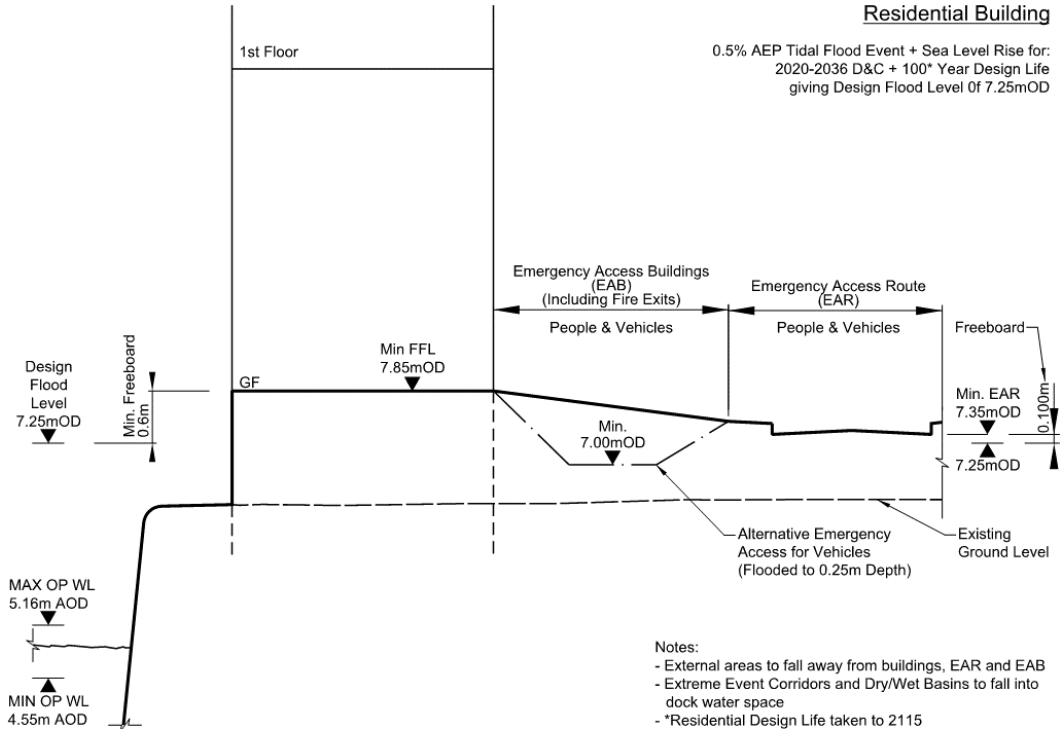

Figure 4 Residential Building Finished Floor Levels

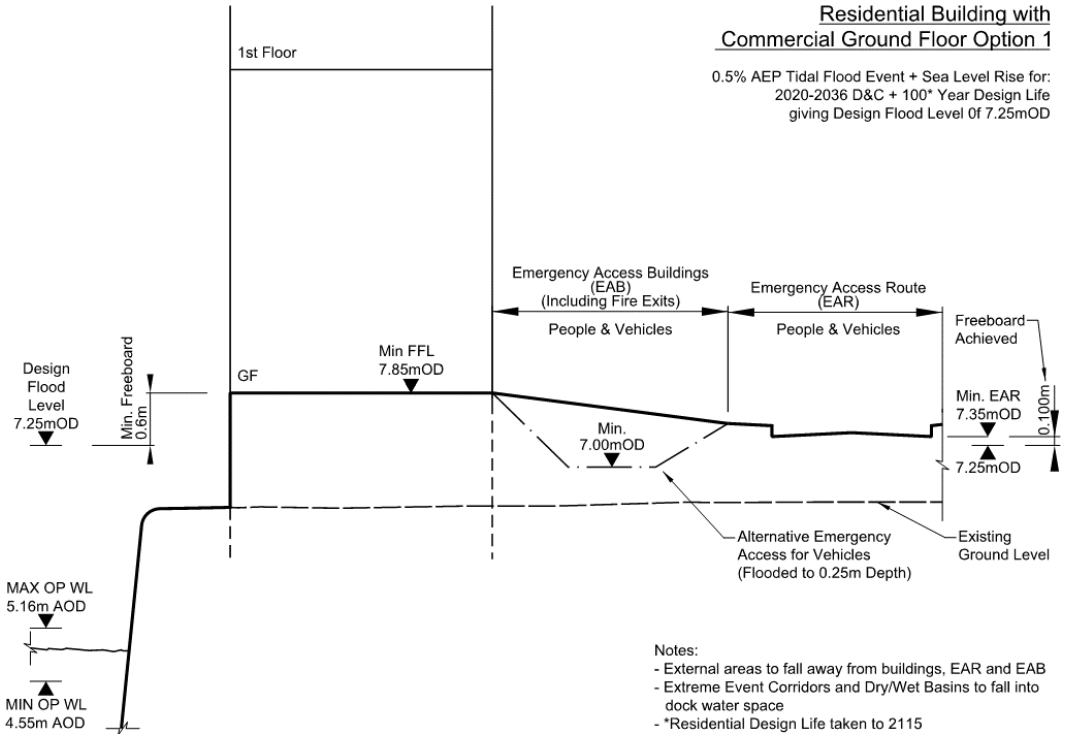

Figure 5 Residential Building with Commercial Ground Floor, Finished Floor Levels - Option 1

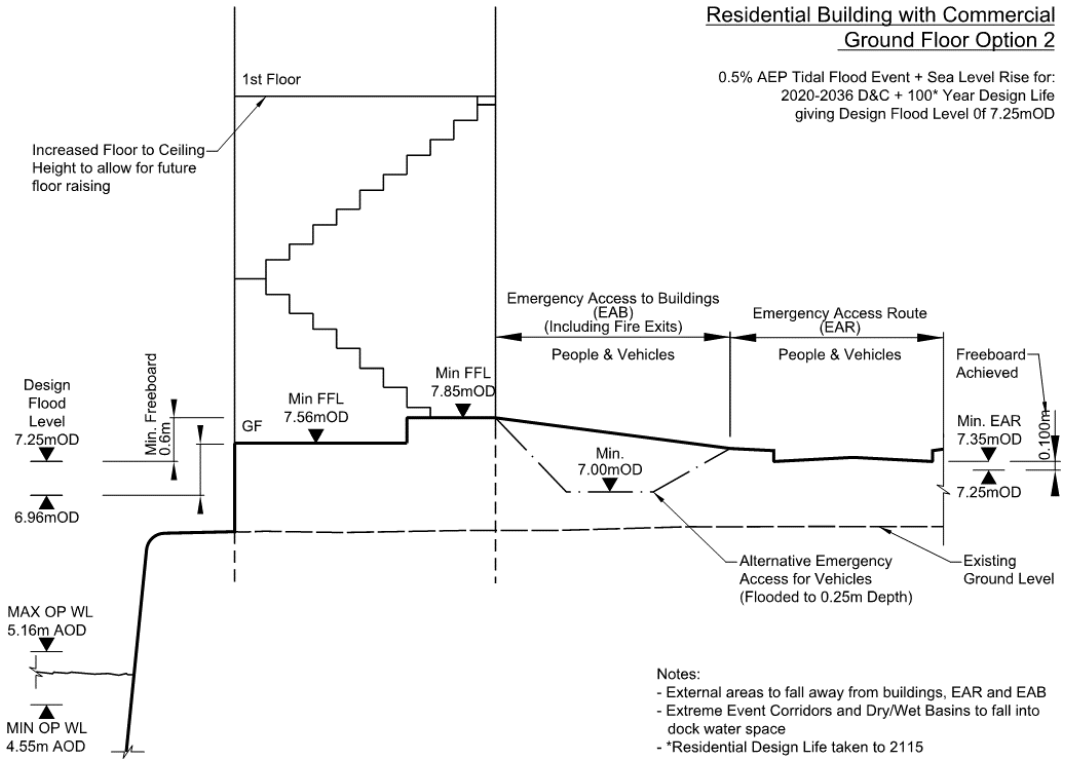

Figure 6 Residential Building with Commercial Ground Floor Finished Levels - Option 2

6.2.2 Commercial Building FFL

As per Table 2, commercial developments (anticipated life-span of 60 years plus 16 year construction period giving a design life end date set at 2101) are required to have a minimum finished flood level of 7.56mOD as Figure 7. General guidance includes:

- Evacuation routes

  Emergency egress for buildings with solely commercial use must match the minimum finished floor level at the edge of the building (or ideally a landing/assembly area immediately outside the building) and be no lower than 7.35mOD to provide safe/dry egress to the Emergency Access Route. Emergency access to commercial buildings for vehicles only can be set no lower than 6.71mOD.

- External ground levels

  Other external ground levels around buildings being set in line with inclusive access, heritage, flood exceedance route and drainage requirements.

- For developments of mixed commercial and residential use

  Refer to Section 6.2.1

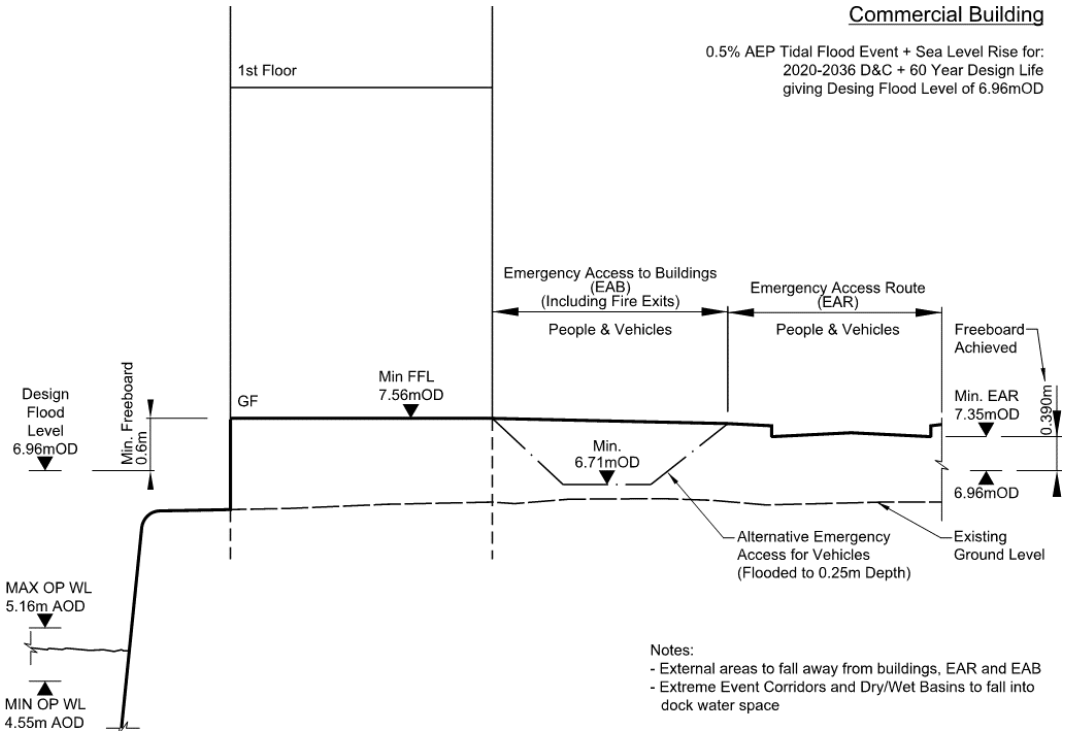

Figure 7 Commercial Building Finished Floor Level

6.2.3 Basement Car Park Access Threshold Level

As per the FRA Addendum (2011), basements are to be set at 0.3m above the 0.5% AEP tidal flood event level, plus the associated allowance for climate change, resulting in minimum thresholds of:

- Residential building basement car park threshold level of 7.25mOD + 0.3m giving 7.55mOD.
- Commercial building basement car park threshold level of 7.55mOD. It would be possible to set the threshold at 6.96mOD + 0.3m giving 7.26mOD but this is also the minimum level of the Emergency Access Route and it would be wise to give the basement car park threshold additional resilience above this level.

External levels should be designed such that run-off is directed away from the basement entrance.

Thresholds, ventilation shafts perimeter, sky-lights and access points to other basement types should be set at the same minimum level as FFL's in Section 6.2.1 & 6.2.2.

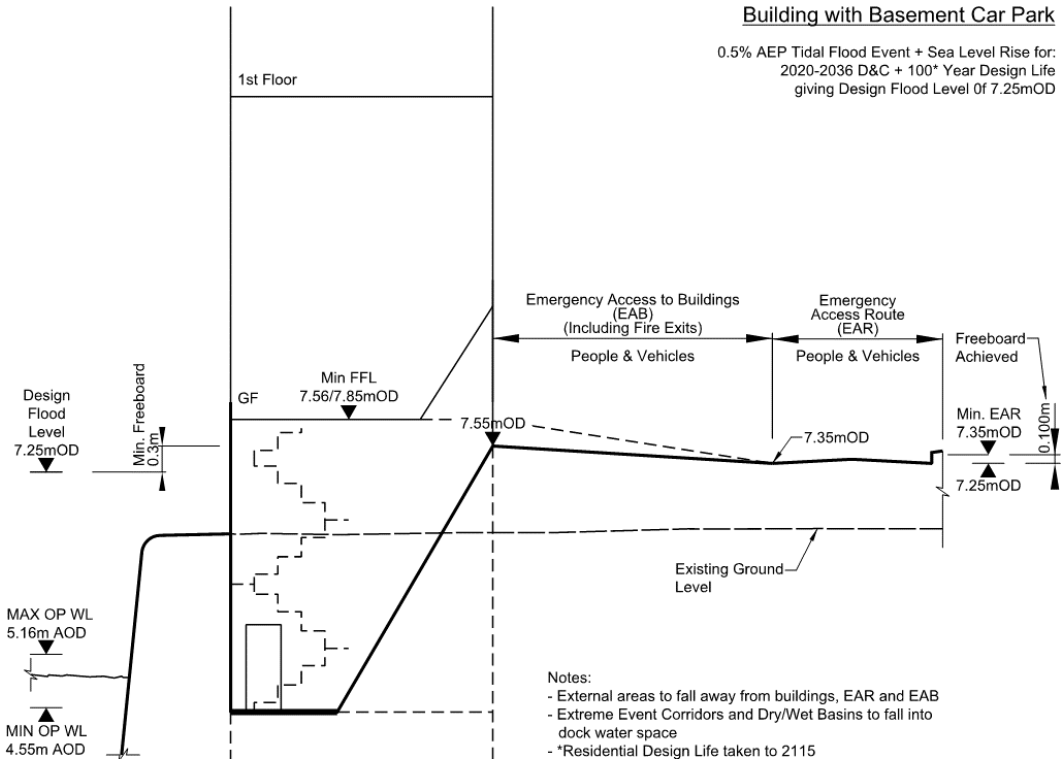

Figure 8 Basement Car Park Access Threshold Level

6.3 Infrastructure and External Levels

6.3.1.1 Emergency Access Routes for safe and inclusive evacuation

Public safety should be considered throughout all the aspects of managing flood risk across the Liverpool Waters Development; and as such, access considerations should include the movement of site inhabitants during a 'design flood' (i.e. 0.5% AEP tidal flood event plus climate change/sea level rise allowances) and be functional to changing circumstances over the developments life-span.

As per the guidance in the NPPG:

- *Access routes should allow occupants to safely access and exit their dwellings in design flood conditions. Vehicular access to allow the emergency services to safely reach the development during design flood conditions will also normally be required.*
- *Wherever possible, safe access routes should be provided that are located above design flood levels and avoiding flow paths. Where this is not possible, limited depths of flooding may be acceptable, provided that the proposed access is designed with appropriate signage etc to make it safe. Note, low levels of flooding can pose a risk to people in situ (because of, for example, the presence of unseen hazards and contaminants in floodwater, or the risk that people remaining may require medical attention).*

As per the FRA (2011), where the provision of dry access routes is not possible, a maximum flooded depth of 250mm (with a very low hazard rating) is appropriate to ensure adequate access people and emergency vehicles in areas not subject to wave overtopping. Areas subject to wave overtopping (adjacent the River Mersey) will be considered separately and will be examined in the Wave Overtopping Assessment.

As per FD2320-TR1[7] the route should not have any service covers that could be removed, or other underwater hazards and should be adequately signed to allow for emergency vehicles to pass safely across the site.

Proposals should consider safe access and egress routes beyond the boundary of Liverpool Waters – e.g. levels on Bath Street, Waterloo Road and Regent Road and areas to the east of the site. It is recommended that discussions with the Emergency Planners and LCC are undertaken to formulate a site-wide approach to the implementation and design of emergency access and egress routes across the development.

Figure 4 to Figure 8 illustrate the proposed minimum level for Emergency Access Routes for Neighbourhood C Central Docks where these can be achieved given that connections to Waterloo Road and Regent Road are fixed by LCC as Highway Authority.

[7] DEFRA – Framework & Guidance for Assessing and Managing Flood Risk for New Developments

6.3.1.2 Infrastructure Finished Levels

Infrastructure that is not part of the Emergency Access Routes is not constrained by minimum level requirements.

6.3.1.3 Infrastructure Equipment Levels

Emergency Access Routes should be above the 0.5% AEP Design Flood Level and therefore service covers should be permitted in these roads/accesses.

The siting of essential infrastructure above the 0.5% AEP Design Flood Level should be examined during the Detailed Master Plan production.

6.4 Potential flood mitigation and resilience measures

Where it is not possible to provide flood resilience by control of finished levels (subject to exception evidence as Section 4.2) the following main resilience measures should be examined for integration in proposals or future retrofitting.

- Erectable/Demountable defences/barriers (and means of safe egress).
- Watertight shutters (and means of safe egress).
- Raising floor and infrastructure levels.

6.5 Flood Risk Mitigation During Construction

During construction the applicant should require the Principle Designer and the Principle Contractor to examine the following aspects of flood risk within the Pre-construction and Construction Stage Health & Safety Plans:

- River Mersey extreme Wave over topping.
- Flood risk from the working Port and Liverpool Canal Link.
- Flood risk from legacy dock infrastructure (sluices, culverts etc).
- MEPAS sewer overflow failure/damage.
- Ground water (tidal effects and normal dock water level).
- Damage to United Utilities sewers at points of connection.
- Weather.
- Inundation of excavations.
- Dewatering pump failure.

6.6 Observations on committed schemes within the Neighbourhood C Central Docks boundary

There are two stand alone committed development schemes already within the southern areas of the Liverpool Waters Central Docks, these are:

- Plots C04 & C06 (Romal Capital) – 17F/1628; and,
- Northern Link Road (Liverpool City Council) – 17F/2628.

These schemes have only had the benefit of the Liverpool Water November 2011 FRA Addendum to refer to alongside the schemes own investigations and assessments. The following are observations made in the knowledge of the more recent assessments in this Strategy.

6.6.1 Plots C04 & C06

The Romal development scheme has an FRA and Sustainable Drainage System Strategy (Ref: 063213-CUR-00-XX-RP-D-001-00_FRA dated 02 June 2017).

The following observations are made:

a) The Residential Plots C04 & C06 have Finished Floor Levels on the ground floor of 7.75mOD, this is in line with the Liverpool Waters 2011 FRA Addendum and compares with the 7.85mOD proposed in this Flood Risk Resilience Strategy.

b) The FRA states that external levels are proposed at 7.40mOD.

c) The FRA and drainage drawings show area of flooding in extreme events but there is not enough proposed ground level information and detail to show the exceedance flow paths.

d) The Northern Link Road MC70 alignment long sections (approximate chainage 140m to 180m) shows proposed road levels higher than the proposed external works levels at the entrance to C04 & C06. It is not clear what measures are in place to deal with directing exceedance flows away from C04 & C06.

It is recommended that the C04 & C06 external ground levels are modelled in the Neighbourhood C Central Docks inputs to discharging Condition 33 and any exceptions to the wider Liverpool Waters Neighbourhood C Central Docks Flood Risk Resilience Strategy are shown graphically on drawings/plans.

6.6.2 Northern Link Road

The Northern Link Road (NLR) project had a Flood Risk Assessment prepared (Ref: CO00205341 /FRA01 00 August 2017). This FRA referred to the Liverpool Waters 2011 FRA Addendum and the Environment Agency Extreme Sea Level Study 2008. It also refers to the Draft 2016 River Mersey Extreme Sea Level Study.

The following observations are made:

a) The design life of the NLR is stated as being 60 years and 100 years depending on whether it is serving commercial or residential development. It is noted that these design life's do not take account of the Design & Construction periods included in the Liverpool Waters development.

b) The NLR is presumed to be Adopted by LCC Highways.

c) The NLR FRA sets a lowest level of 6.849mOD at Chainage 160m on the south to north link road, this is discussed as being in line with the 6.9mOD minimum level proposed in the Liverpool Waters 2011 FRA Addendum. It is noted that this 6.9mOD level assumed 0.25m depth of flooding. This 6.9mOD compares with the 7.35mOD in this Neighbourhood C Flood Risk Resilience Strategy.

d) It is proposed to map out the flooding extent on the NLR as part of the work to discharge Condition 33 for Neighbourhood C Masterplan as an observation. This will enable discussion with the Emergency Planners and Merseyside Fire & Rescue Services.

e) The aspect of wave overtopping (as prompted by the EA) is not considered for the south to north link road adjacent the River Mersey. (There appears to be some confusion regarding extreme wave action and freeboard allowances.)

f) There is some discussion regarding wave effects and freeboard but these are not really a response to the Environment Agency request to consider wave overtopping in the NLR FRA Appendix D correspondence.

g) An allowance for Sea Level Rise has been discussed

h) It may be that periodic reviews of the infrastructure levels during the deign life of the Liverpool Waters Development indicate that parts of the NLR would need to be modified to provide the same level of protection as the other Liverpool Waters infrastructure. It is presumed that LCC Highways would be responsible for amendment and associated costs.

It is recommended that the NLR proposals are modelled in the Neighbourhood C Central Docks inputs to discharging Condition 33 and exceptions to the wider Liverpool Waters Neighbourhood C Central Docks Flood Risk Resilience Strategy are shown graphically on drawings/plans.

7 The Applicant Deliverables

The applicant should provide the majority of the Neighbourhood Strategies, Plans, Reports, Studies and baseline information.

7.1 Summary of Deliverables

A summary of the details of the applicant Deliverables and associated conformity requirements related to this Flood Risk Resilience Strategy are outlined in Table 7.

Table 7. The applicant Flood Risk Resilience Related Deliverables

Documents	Content requirements	Conformity requirements
Documents to be provided for each Neighbourhoods A to E		
Masterplan Development	Masterplans should allow provision for flood alleviation measures within the proposals.	• Flood Risk Resilience Strategy • Outline Planning Conditions including: • Detailed Neighbourhood Masterplans • Neighbourhood Conservation Management Strategy • Neighbourhood Water Environment Protection Strategy • Neighbourhood Ecological & Biodiversity Strategy • Neighbourhood Sustainability Strategy • Guidance and regulations associated with NPPF and LCC. • Base information to support Merseyside Resilience Forum emergency planning.
Neighbourhood Flood Risk Resilience Plan	Should provide information in accordance with the information in Table 6. Documents should include: • Plans of surveys and topographical information defining the extents of the Flood Zones 2 & 3 (related to the 6.11mOD and 6.37mOD Flood Levels) for each neighbourhood. • Plans defining surface water management / drainage strategy proposals Details of compensatory storage requirements	
Neighbourhood Surface Water Management Strategy *	Should provide information in accordance with the information in Table 6. Documents should include: • Drawings/Plans identifying provision of surface water management strategies • Locations/provision for SuDS and attenuation; • Exceedance path routes.	
Neighbourhood 0.5% AEP and 0.1% AEP depth of flood water Drawing/Plan *	Extent of the 0.5% AEP design tidal flood event and the 0.1% AEP flood event given the final Development finished levels.	
Flood Evacuation Strategies *	Should provide information in accordance with the information in Table 6. Documents should include: Include plans outlining evacuation routes and associated thresholds for each plot.	

Documents	Content requirements	Conformity requirements
Documents to be provided for each Neighbourhoods A to E		
Neighbourhood Drainage Strategy *	Confirmation of the strategy for Surface Water (SW) and Foul Water (FW) drainage networks including: • Confirmation of ownership (the applicant private, Parcel/Plot Developer private, proposed for adoption by United Utilities (UU)); • Principle SW and FW network routes; • Confirmation of locations of any flood storage (i.e. dry/wet basins in parks); • Points of connection (to UU or docks); and, • Estimated flows (and in case of FW the likely demand curve based on construction and period to full occupation). Design of the primary SW and FW Drainage networks: • Plans and long sections; • Calculations; • Confirmation of the discharge constraints (including any limits at United Utilities points of connection); • Identification of Parcel/Plot Developer constraints (connections points, discharge flow rates); • Depths of surface water flooding in exceedance events; and, • Identification of foul drain/sewers flooding risk from blockages at all key nodes on the FW network (including point of connection).	
Health & Safety Files / Risk Registers	Details of residual risks to identified across each Neighbourhood and outlines for construction stage flood risk assessments. (Or information that would form the basis of the H&S File depending on the relative stage of the Infrastructure and Parcel/Plot developments)	

* Strategy or Plan that should need to be kept updated (with Infrastructure/Parcel/Plot details as they are finalised) after initial submission and approval.

7.2 Aspects flagged for inclusion in Neighbourhood Plans and Strategies

The following aspects are flagged in this Flood Risk Resilience Strategy for examination, by the applicant, during the Masterplan and Infrastructure designs supporting the delivery of the Neighbourhood Flood Risk Resilience Plans and Neighbourhood Flood Evacuation Strategies.

Some of these aspects represent the next level details for potential flood related risks for examination that have not been identified in the Principal Application Documents or the Outline Consent.

7.2.1 Neighbourhood A

1. Identification of existing Infrastructure that is not at finished levels in conformity with Emergency Access Route criteria in this Strategy.
2. Identification of existing development (previously developed plots) that are not at FFL's in conformity with flood resilience level criteria in this Strategy.
3. Identification of proposed Parcels/Plots heavily constrained such that conformity with level criteria in this Strategy is not practical such that resilience measures should be required.
4. The impact of existing Infrastructure levels on Flood Evacuation and the agreed approach with MFR
5. The flood risk resilience approach to be taken in the future when the redevelopment of existing development plots is undertaken (within the stated construction and operation life of the Liverpool Waters to 2115/2141).
6. Identification of the existing surface water drainage provisions and degree of conformity with this Strategy. The proposed approach for working within the original design capacity of the existing Princes Dock surface water drainage network so as to prevent surface water flooding when using current rainfall event data with climate change allowances.
7. Wave over topping impact.

7.2.2 Neighbourhood B

1. Approach to provision of SUDS attenuation prior to surface water disposal to UU sewers.
2. Detention of surface water within the Neighbourhood on steeply sloping site.
3. Exceedance flow routing on steeply sloping site.
4. Flood risk from higher ground to the east of the Neighbourhood.

7.2.3 Neighbourhood C

1. Identification of the existing dock areas to be infilled (i.e. in Flood Zones 2/3) and confirmation of the approach for provision of (compensatory) storage (in new parks, dry/wet basins and other areas proposed at levels between 6.37mOD and 6.11mOD or below 6.11mOD). (Compensatory storage for all Neighbourhoods being provided in Neighbourhood C.)
2. Use of landscape areas for flood storage.
3. Flood Risk Resilience measures related to old MDHC sluicing culverts that may create continuity between the River Mersey and existing dock water space.
4. Flood Risk Resilience measures related to old Clarence Dock Power Station cooling water intake/outlet culverts that may create continuity between the River Mersey and existing dock water space.
5. Emergency access route to new Cruise Terminal at West Waterloo.
6. Wave over topping impact.

7.2.4 Neighbourhood D

1. Identification of the existing dock areas to be infilled (i.e. in Flood Zones 2/3) and confirmation of the approach for provision of compensatory storage.
2. Protection of MEPAS Battery Lane CSO during construction.
3. Flood Risk Resilience measures related to old MDHC sluicing culverts that may create continuity between the River Mersey and existing dock water space.
4. Wave over topping impact.

7.2.5 Neighbourhood E

1. Identification of the existing Nelson Dock areas to be infilled (i.e. in Flood Zones 2/3) and confirmation of the approach for provision of compensatory storage.
2. Identification of the existing Bramley Moore Dock areas to be infilled (i.e. in Flood Zones 2/3) and confirmation of the approach for provision of compensatory storage north of the Isolation Structure.
3. Confirmation of the approach to providing Emergency Access Route continuity over the existing dock passages.
4. Flood Risk Resilience aspects related to Bramely Moor Dock continuity with the working Port of Liverpool and operation of the Isolation Structure.
5. Flood Risk Resilience measures related to old MDHC sluicing culverts that may create continuity between the River Mersey and existing dock water space.
6. Wave over topping impact.

8 Parcel/Plot Developer Deliverables

The Flood Risk technical aspects and commitments (represented by this Strategy and Table 7 documents) should be bound into the Parcel/Plot development heads of terms/land transaction agreements.

8.1 Summary of Deliverables

A summary of the design/documents expected of Parcel/Plot Development and the Neighbourhood Strategies and plans that these are expected to confirm to are outlined in Table 8.

Table 8. Parcel/Plot Developer deliverables

Documents	Content Requirements	Conformity Requirements
Documents to be provided for each plot		
Parcel/Plot Flood Risk Assessments (with input to the overall flood risk resilience plan)	Should provide information in accordance with the information in Table 6. Documents should include: • Details of the drainage strategy for each plot • Include plans or surveys and topographical information defining the extents of the Flood Zones. • Include plans surface water management / drainage strategy proposals • Make reference to the encompassing FRA and Surface Water Management plan for the Neighbourhood or site	Neighbourhood Flood Risk Assessment / Flood Risk Resilience Plan and associated documents / strategies (see Table 7).
Parcel/Plot Flood Evacuation Plan (or input to overall neighbourhood document)	Should provide information in accordance with the information in Table 6. Documents should include: • Include plans outlining evacuation routes and associated thresholds for each plot. • Make reference to the encompassing Flood Evacuation Strategy for the Neighbourhood and site	Flood Evacuation Strategy and associated documents/ strategies (see Table 7).
Health & Safety Files / Risk Registers	Details of residual risks to identified across each plot development.	

8.2 Aspects flagged for inclusion in Parcel/Plot Flood Risk Assessments and Strategies

The following aspects are flagged in this Flood Risk Resilience Strategy for examination, by Parcel/Plot Developers, in the designs supporting the delivery of the Parcel/Plot Flood Risk Assessments and Parcel/Plot Flood Evacuation Strategies.

8.2.1 Neighbourhood A

1. The proposed approach for working within the original design capacity of the existing Princes Dock surface water drainage network so as to prevent surface water flooding when using current rainfall event data with climate change allowances.
2. Safe access and egress route to buildings where existing infrastructure is below the minimum Emergency Access Route level of 7.25mOD.
3. Exceedance flow routing.
4. Wave over topping impact.

8.2.2 Neighbourhood B

1. UU combined sewer flooding.
2. Attenuation requirements (discharge to the dock water space not possible without new connections to the dock water space).
3. Detention of surface water within the Neighbourhood on steeply sloping site.
4. Exceedance flow routing on steeply sloping site.
5. Flood risk from higher ground to the east of the Neighbourhood.

8.2.3 Neighbourhood C

1. UU MEPAS overflow damage/leak.
2. Power Station cooling water inlet/outlet damage/failure.
3. Flood storage in landscape areas.
4. Wave over topping impact.

8.2.4 Neighbourhood D

1. Clarence Graving Dock
2. Wave over topping impact.

8.2.5 Neighbourhood E

1. Uses within the Bramley Moore Dock and Nelson Dock water spaces.
2. Wave over topping impact.

9 Review and Monitoring

The applicant is to undertake the role of reviewing and monitoring flood risk resilience measure proposals for development Infrastructure and Parcel/Plots.

The applicant should provide early opportunity in the design development stages for LCC (as LPA and technical departments) to attend reviews where current proposals should be explained.

These reviews should also have flexibility to create opportunities for liaison with regulators or undertakers.

The proposed framework for the applicant's management of the flood risk resilience measures delivery process is shown in Figure 3.

10 Periodic Review of the Strategy During Construction Phase

It is proposed that periodic (i.e. 5-10 year review cycles) or event triggered (e.g. regional or national events related to flood risk) reviews should be undertaken throughout the 16 year construction period for Neighbourhood C Central Docks. These reviews should:

- Identify whether the flood mitigation and resilience/resistance measures adopted within the present proposals are appropriate, in-light of the latest information associated with these events or changing guidance/policy.
- Capture emerging best practice and changing policies in relation to flood alleviation.

11 Operational Reviews of the Flood Risk during Occupation/Use

Depending on the residual flood risks identified by the developer (e.g. sea level rise / climate change allowance), it is proposed that periodic (i.e. 10-20 year cycles) reviews should be undertaken throughout the 60-100 year operational life-span for the Liverpool Waters Development.

In co-ordination with the applicant, Asset Owners (including the adoptive authorities) and Occupiers, these reviews should:

- Identify whether there is an increased risk of flooding to the development site wide and adopted infrastructure as a result of climate change, change in land-use/vulnerability or topographical levels; and as a result identify whether increased or enhanced flood resilience or resistance measures should be implemented within each neighbourhood. This includes adopted infrastructure flood risk resilience measures and resilience by Adopting Authority.
- Review the Emergency Evacuation Plan to ensure it is still relevant to the present usages of the site and update the plans where required.

12 Plots C07, C08, C11 & C12 Work in Progress

In the discussion between the applicant and the Environment Agency it has been agreed that the minimum freeboard to be applied to the Central Docks eastern plots can be reviewed on a plot by plot basis; such review providing clear evidence of an increased confidence in the predicted flood levels from the further work including the Wave Overtopping Assessment.

This Flood Risk Resilience Strategy for Central Docks continues the use of the 600mm freeboard identified in the earlier flood risk assessments and guidance.

In consideration of Plots C07, C08, C11 and C12 it has been agreed that the applicant can examine whether further studies increase the degree of confidence in flood levels such that the 600mm freeboard can be reduced to 300mm in the determination of minimum Finish Floor Levels. The aspects to be considered and agreed with the Environment Agency in the technical evaluation in the Plot Flood Risk Assessments will be:

- Flood Zone (all in Flood Zone 1 as shown by the additional topographic survey in the FRA Addendum of November 2011)
- Wave Overtopping Assessment considerations (proximity to the River Mersey, will wave overtopping have an impact on the plots).
- Examination of confidence levels (Accounting for residual uncertainty: updating the freeboard guide. Report – SC120014)

The Central Docks Masterplan will be presented on the basis of the following proposed levels for Plots C07, C08, C11 and C12:

- Commercial Minimum FFL of 7.26mOD to 7.56mOD
- Residential Minimum FFL of 7.55mOD to 7.85mOD
- (EAR's remain at a minimum level of 7.35mOD including 0.1m freeboard)

(It maybe that the applicant approaches the technical evaluation and liaison with the Environment Agency as an exercise preceding the Plot Flood Risk Assessments.)

At the conclusion of the Plot Flood Risk Assessments this neighbourhood Flood Risk Resilience Strategy (Condition 21) and neighbourhood Flood Risk Resilience Plan (Condition 33) will be updated and re-issued if needed for consistency.