CANARY WHARF
GROUP PLC

NQ.PA.29

North Quay
Flood Risk Assessment and Drainage Strategy

Arup
July 2020

Contents

Executive Summary

1.1 This Flood Risk Assessment (FRA) has been prepared by Ove Arup and Partners Ltd (hereafter, Arup) on behalf of Canary Wharf (North Quay) Ltd (hereafter, the Applicant) in support of an Outline Planning Application (OPA) for North Quay (hereafter, the Proposed Development) and an associated application for Listed Building Consent (LBC). This FRA has been prepared following a design freeze to reflect the most up to date information. The Proposed Development is located on a site on North Quay, Canary Wharf (hereafter, the Site). For the purposes of this FRA the area of the application site relevant to the flood risk assessment is referred to as the 'development area'.

1.2 The applicant is seeking outline planning permission for comprehensive mixed-use redevelopment of North Quay. Therefore, this FRA has assessed a reasonable worst-case scenario for flood risk based on the Indicative Scheme and Parameter Plans.

1.3 The development area is located in Flood Zone 2 and 3. Therefore, a site-specific FRA is required in line with the National Planning Policy Framework (NPPF) and the accompanying National Planning Practice Guidance (NPPG). The Environment Agency (EA) has been contacted to request their Product 8 which was received in April 2020 and incorporated into the FRA.

1.4 The findings of the site-specific FRA for the Proposed Development can be summarised as follows:

- The Proposed Development has a flood vulnerability classification of 'less vulnerable' according to the EA because the residential elements are positioned well above the Thames Estuary 2100 flood levels.
- Although it is located in Flood Zone 3 (high risk) the development area benefits from the protection of the Thames Tidal Defences and as such the EA classify the Site as having a low residual flood risk.
- The proposed promenade levels along the south of the development area are such that the Proposed Development is adequately protected from fluvial/tidal flood risk. On the north side of the development area, the proposed building edge and landscaping will be raised to provide adequate protection in the event of a breach in the Thames Tidal Defences.
- The Proposed Development will convey surface and foul water away from the development area in an appropriate manner. The majority of the surface water would be discharged to the docks. This is the most sustainable solution for the development area and is acceptable to both the EA and the Canal & River Trust (CRT). It will be necessary to provide attenuation for limited areas which cannot be discharged to the docks because of either hydraulic or water quality constraints. This runoff will discharge to the public sewer in Aspen Way at a limited rate agreed with Thames Water Utilities Limited (TWUL).

- Artificial water sources (reservoir breach) do not present a significant risk to the Proposed Development.
- Groundwater does not present a flood risk to the Proposed Development.
- The Proposed Development will not apply additional loading to the Banana Wall.
- The existing false quay will be replaced with a new suspended deck structure that will support the new promenade. The flood storage loss associated with the new structure and retained marine piles results in a negligible impact on the future flood water levels in the Docks and the River Thames. This has been demonstrated by modelling which has been accepted by the EA back in 2017 and is still relevant. It has been confirmed by the structural engineers that the hydraulic modelling is in line with the most up to date 2020 false quay design.

1. Introduction

1.1 Arup has been commissioned by the Applicant to prepare an FRA to support an OPA for the Proposed Development of a site at North Quay, Canary Wharf (‘the Site’). The Site is located on the Isle of Dogs within the administrative boundary of the London Borough of Tower Hamlets (LBTH) as shown on Figure 1.1. This FRA has been undertaken in accordance with the NPPF and associated NPPG.

1.2 Canary Wharf (North Quay) Ltd (“the Applicant”) are submitting applications for Outline Planning Permission ("OPP") and Listed Building Consent ("LBC") to enable the redevelopment of the North Quay site, Aspen Way, London (“the Site”).

1.3 Two separate applications are being submitted for the works. The applications will seek permission for as follows:

- Application NQ.1: Outline Planning Application (all matters reserved) ("OPA") - Application for the mixed-use redevelopment of the Site comprising demolition of existing buildings and structures and the erection of buildings comprising business floorspace, hotel/serviced apartments, residential, co-living, student housing, retail, community and leisure and sui generis uses with associated infrastructure, parking and servicing space, public realm, highways and access works; and.
- Application NQ.2: Listed Building Consent Application ("LBCA") - to stabilise listed quay wall and any associated/necessary remedial works as well as demolition of the false quay in connection with Application NQ.1.

Site Description

1.4 The North Quay site (“the Site”) is located in the north of the Isle of Dogs, within the administrative boundary of the London Borough of Tower Hamlets (the "LBTH"), at Canary Wharf. It is bounded by Canary Wharf Crossrail Station to the south, Aspen Way (A1261) to the north, Hertsmere Road to the west and Billingsgate Market to the east. The West India Quay Docklands Light Railway ("DLR") station and Delta Junction are located on the western side of the Site and the Site also incorporates parts of North Dock, Upper Bank Street and Aspen Way.

1.5 The Site is 3.28 hectares (ha) in area. Currently the Site comprises mostly cleared land, being previously used as a construction laydown site for the Canary Wharf Crossrail Station. There are some temporary uses currently on site, including the LBTH Employment and Training Services, WorkPath and advertising structures.

1.6 A Grade I Listed brick dock wall (Banana Wall) exists below the surface of part of the Site, which originally formed the dockside until it was extended over to the south.

1.7 Existing access to the Site for vehicles is from Upper Bank Street to the east and Hertsmere Road to the west, which both link to Aspen Way. The Site is not currently accessible to the public, however pedestrian routes are located on each side of the Site (Aspen Way, Hertsmere Road, Upper Bank Street, and the western part of the dockside to the south). The Aspen Way footbridge which leads to Poplar also lands on the southern side of Aspen Way.

1.8 The Site is highly accessible by public transport. The West India Quay DLR station is located on the Site, the Poplar DLR station is accessed directly from the Aspen Way Footbridge, the Canary Wharf Crossrail Station is located immediately to the south of the Site, beyond which are the Canary Wharf underground and DLR stations. The Site currently has a PTAL level of 5. This will rise to 6a when Crossrail services commence at Canary Wharf. The level of 6a is categorised as 'Excellent'. The Site's PTAL varies from 5 ('very good') to 6a ('excellent'), with improved PTAL closer to Upper Bank Street. The score is expected to improve to 6a across the entire Site by 2021 owing to the planned opening of the Crossrail Station.

1.9 Beyond the Site, 1 West India Quay (the a Marriot Hotel (35 storeys 107m AOD) and 13 storey residential building (41m AOD)) are located to the west, adjacent to the DLR tracks. Beyond these, along Hertsmere Road is a cinema, museum, shops, restaurants and other leisure facilities, forming part of the West India Quay Centre.

1.10 Billingsgate Market is located to the east of the Site, on the opposite side of Upper Bank Street. Billingsgate Market is identified as a Site Allocation (4.2: Billingsgate Market) for redevelopment in LB Tower Hamlet's Local Plan.

1.11 To the north of the Site on the other side of Aspen Way are the Tower Hamlets College and The Workhouse leisure facility. They comprise part of a Site Allocation (4.1: Aspen Way) for redevelopment in LB Tower Hamlet's Local Plan. In close proximity to these there are lower rise residential properties (some with shops beneath them) as well as the Poplar Recreation Ground.

1.12 Beyond the Crossrail station and Crossrail Place to the south of the Site is the Canary Wharf commercial area, with the buildings closest to the Proposed Development core including the HSBC (200m AOD), Bank of America and One Canada Square buildings (235m AOD).

Listed Building Works

1.13 Towards the south of the Site, the edge of the dock is defined by a quay wall known as the Banana Wall. The brickwork has a profile and counterfort buttresses, on a gravel bed. The Banana Wall was constructed between 1800-1802 and was Listed Grade I in 1983.

1.14 The Proposed Development will span over the Banana Wall with piles on either side of the wall providing support to the new structures. The new structures will leave a void or compressible material above to avoid permanent loading of the wall. The adjacent existing false quay deck will be removed. The excavation of the basement may induce ground movements affecting the Banana Wall, as such any necessary require stabilisation works to be will be undertaken to ensure movements are within satisfactory limits there are no impacts to the Banana Wall. Remedial works to the Banana Wall will also be undertaken if required.

1.15 An FRA is required as the Site is located partially within Flood Zone 3, in an area benefiting from raised flood defences according to the Environment Agency's flood maps for planning. Land in Flood Zone 3 would have a high probability of flooding without the local flood defences. These protect the area against a river flood with a 1% chance of happening each year, or a flood from the sea with a 0.5% chance of happening each year.

1.16 The Site, identified by the red line planning boundary (see Figure 1.1), occupies an area of approximately 3.28ha and is centred on grid reference E537632, N180540. For the purposes of this FRA, the assessment is limited to the area of the Site that is of relevance to the assessment of flood risk and to the drainage strategy. This is referred to throughout the FRA as the 'development area' and is distinct from the development area as illustrated by Figure 1.1.

Figure 1.1: Indicative Scheme Site plan showing redline planning boundary and the outline of the area defined in this FRA as the 'development area' (green) (Allies and Morrison, 2020)

2. Policy and Legislation

Legislation

Floods Directive (2007/60/EC)

2.1 The aim of the Directive[1] is to provide a consistent approach across the European Union to reducing and managing the risks posed by flooding to human health, the environment, cultural heritage and economic activity. The Floods Directive is to be delivered in conjunction with the objectives of the Water Framework Directive (2000/60/EC) to deliver a better water environment through river basin management.

2.2 In the UK the Floods Directive is transposed into law via the Flood Risk Regulations (2009) by setting out the duties of local government in assessing flood risk to their area.

Flood Risk Regulations (2009)

2.3 The Flood Risk Regulations[2] transpose the Floods Directive (2007/60/EC) into law in England and Wales.

2.4 The Regulations required the Lead Local Flood Authority (LLFA), in this case LBTH, to produce:

- a Preliminary Flood Risk Assessment (PFRA) by December 2011;
- flood hazard and flood risk maps by December 2013; and
- a Local Flood Risk Management Strategy by December 2015.

The Flood and Water Management Act (2010)

2.5 The Flood and Water Management Act 2010 (FWMA)[3], which received Royal Assent on 8th April 2010, takes forward some of the proposals in three previous documents published by the UK Government:

- Future Water;
- Making Space for Water; and
- The Government's Response to the Sir Michael Pitt's Review of the summer 2007 Floods.

2.6 The Act gives the EA a strategic overview of the management of flood and coastal erosion risk in England. In accordance with the Government's Response to the Pitt Review, it also gives upper tier local authorities in England responsibility for preparing and putting in place strategies

[1] European Parliament and Council, October 2007. Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks.
[2] UK Parliament, November 2009. The Flood Risk Regulations 2009, 2009 No. 3042.
[3] UK Parliament, April 2010. The Flood and Water Management Act 2010, 2010 c. 29.

for managing flood risk from groundwater, surface water and ordinary watercourses in their areas.

The Water Resources Act (1991) and Water Act (2003, 2014)

2.7 The Water Resources Act 1991[4] provides legislation for the control of the pollution of water resources. Under this Act, offences of polluting controlled waters occur if a person knowingly permits any poisonous, noxious or polluting matter or any solid waste matter to enter any controlled waters. The Water Resources Act also provides an all-embracing system for the licensing of the abstraction of water for use, which is administered by the EA. The Water Acts (2003[5], 2014[6]) modernise water legislation and amend the Water Resources Act 1991 to improve long-term water resource management.

Land Drainage Acts (1991, 1994)

2.8 The water quality and flood risk management of controlled waters including rivers and aquifers is protected by legislation under the Land Drainage Acts (1991[7], 1994[8]).

Land Drainage Byelaws (1981)

2.9 This law was made by the Thames Water Authority under Section 34 of Land Drainage Act 1976. The Thames Water Authority Land Drainage Byelaws 1981[9] are in force in the Thames Region of the EA. They are now enforced by the EA by virtue of the Water Resources Act and the Environment Act. These Byelaws have effect within the area of the Thames Regional Flood Defence Committee of the National Rivers Authority for the purposes of their functions relating to land drainage and flood risk management.

National Policy and Guidance

National Planning Policy Framework (June 2019)

2.10 The NPPF[10] includes policies on flood risk and minimising the impact of flooding under *14. Meeting the challenge of climate change, flooding and coastal change (Paragraphs 148 – 168)*.

2.11 The NPPF states that:

[4] UK Parliament, November 2009. Water Resources Act 1991, 1991 c. 57.
[5] UK Parliament, November 2003. Water Act 2003, 2014 c. 37.
[6] UK Parliament, May 2014. Water Act 2014, 2014 c. 21.
[7] UK Parliament, July 1991. Land Drainage Act 1991, 1991 c. 59.
[8] UK Parliament, July 1994. Land Drainage Act 1994, 1994 c. 25.
[9] Environment Agency, April 2014. Thames water authority: land drainage byelaws, Thames Region: Land Drainage Byelaws.
[10] Department for Communities and Local Government, February 2019. National Planning Policy Framework.

- *"All plans should apply a sequential, risk-based approach to the location of development – taking into account the current and future impacts of climate change– so as to avoid, where possible, flood risk to people and property.*
- *If it is not possible for development to be located in zones with a lower risk of flooding (taking into account wider sustainable development objectives), the exception test may have to be applied. The need for the exception test will depend on the potential vulnerability of the site and of the development proposed, in line with the Flood Risk Vulnerability Classification set out in national planning guidance.*
- *The application of the exception test should be informed by a strategic or site specific flood risk assessment, depending on whether it is being applied during plan production or at the application stage. For the exception test to be passed it should be demonstrated that:*
- *a) the development would provide wider sustainability benefits to the community that outweigh the flood risk; and*
- *b) the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall. Both elements of the exception test should be satisfied for development to be allocated or permitted.*
- *When determining any planning applications, local planning authorities should ensure that flood risk is not increased elsewhere. Where appropriate, applications should be supported by a site-specific flood-risk assessment. Development should only be allowed in areas at risk of flooding where, in the light of this assessment (and the sequential and exception tests, as applicable) it can be demonstrated that:*
- *a) within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;*
- *b) the development is appropriately flood resistant and resilient;*
- *c) it incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;*
- *d) any residual risk can be safely managed; and*
- *e) safe access and escape routes are included where appropriate, as part of an agreed emergency plan."*

National Planning Practice Guidance (First published 2014)

2.12 The NPPG[11], comprising a web-based resource, has been issued to ensure the effective implementation of the NPPF and contains a section covering Flood Risk and Coastal Change. With regard to planning for flood risk, the Guidance retains key elements of the aforementioned PPS25 (now withdrawn) and assesses the suitability of the development type with respect to the flood risk zone in which it lies.

[11] Department for Communities and Local Government, November 2016. Planning practice guidance.

2.13 The PPG also provides an overview of the expected effect of climate change and recommends contingency allowances for sensitivity ranges for peak rainfall intensities. Advice regarding allowance for climate change was updated in February 2016. Where development classified as “more vulnerable” is located in Flood Zone 3a, the higher central and upper end allowances are used to assess the impact of climate change.

National Encroachment Policy for Tidal Rivers and Estuaries (2005)

2.14 The EA’s National Encroachment Policy for Tidal Rivers and Estuaries[12] has been approved by the Regional Flood Defence Committees of England and Wales. The EA is generally opposed to works on tidal rivers and estuaries that cause encroachment, but treat developments on a case by case basis.

Code of Practice for Works Affecting Canal and River Trust (April 2016)

2.15 This code[13] has specific requirements for water abstraction and discharge. The Canal & River Trust (CRT) is not a land drainage authority but reviews proposals for discharging water to its waterways in accordance with its guidance on water discharge[14] in accepting new proposals.

Design and Construction Guidance (DCG), 2020

2.16 An adopted drainage network needs to meet the criteria outlined in Design and Construction Guidance (DCG) [15]. A drainage system is required to not flood the ground in a 1 in 30 year flood, or surcharge for a 1 in 2 year event, using a design storm with the critical duration relevant to the site (i.e. the worst-case for a given return period). Private drainage systems also tend to use these criteria as a basis for design. Adoption of new sewers or abandonment of old drainage systems should take place in accordance with the Water Industry Act 1991, Sections 104 and 116 respectively. The most recently updated guidance more includes on guidance on design for adoption of Sustainable Drainage Systems features as well as traditional piped drainage.

Regional Policy and Guidance

The London Plan: The Spatial Development Strategy for London Consolidated with Alterations Since 2011 (March 2016)

[12] Environment Agency, 2005. National Encroachment Policy for Tidal Rivers and Estuaries.
[13] Canal & River Trust, April 2016. Code of Practice for works affecting the Canal & River Trust: Part 1: General Information.
[14] Canal & River Trust, April 2016. Code of Practice for works affecting the Canal & River Trust: Part 2: Detailed Information.
[15] Water UK/WRc plc, April 2020. Design and Construction Guidance for foul and surface water sewers offered for adoption under the Code for adoption agreements for water and sewerage companies operating wholly or mainly in England .

2.17 The document in its current state is *The London Plan* (2011) consolidated with *Revised Early Minor Alteration to The London Plan* (2013), *Further Alterations to The London Plan* (2015), *Housing Standards Minor Alterations to The London Plan* (March 2016) and *Parking Standards Minor Alterations to The London Plan* (March 2016)[16].

2.18 The London Plan is the overall strategic plan for London setting out an integrated economic, environmental, transport and social framework for the development of London; it recognises the need to address the increasing effects of climate change as predictions show there are more people likely to be living and working on the floodplain.

2.19 Relevant policies from the Plan are outlined below:

Policy 5.12: Flood risk management

The policy states:

- *"Development proposals must comply with the flood risk assessment and management requirements set out in the NPPF on flood risk over the lifetime of the development and have regard to measures proposed in Thames Estuary 2100 and Catchment Flood Management Plans.*
- *Developments which are required to pass the Exceptions Test set out in the NPPF will need to address flood resilient design and emergency planning by demonstrating that:*

  a) The development will remain safe and operational under flood conditions;

  b) A strategy of either safe evacuation and/or safely remaining in the building is followed under flood conditions;

  c) Key services including electricity, water etc. will continue to be provided under flood conditions; and

  d) Buildings are designed for quick recovery following a flood.
- *Development adjacent to flood defences will be required to protect the integrity of existing flood defences and wherever possible should aim to be set back from the banks of watercourses and those defences to allow their management, maintenance and upgrading to be undertaken in a sustainable and cost effective way."*

Policy 5.13: Sustainable drainage

The policy states:

- *"Development should utilise Sustainable Urban Drainage Systems (SuDS) unless there are practical reasons for not doing so, and should aim to achieve Greenfield runoff rates and ensure that surface water runoff is managed as close to its source as possible in line with the following drainage hierarchy:"*
  1. *Store rainwater for later use;*
  2. *Use infiltration techniques, such as porous surfaces in non-clay areas;*

[16] Greater London Authority, March 2016. The London Plan: The Spatial Development Strategy for London consolidated with alterations since 2011.

3. *Attenuate rainwater in ponds or open water features for gradual release;*
4. *Attenuate rainwater by storing in tanks or sealed water features for gradual release;*
5. *Discharge rainwater direct to a watercourse;*
6. *Discharge rainwater to a surface water sewer/drain;*
7. *Discharge rainwater to the combined sewer.*

- *Drainage should be designed and implemented in ways that deliver other policy objectives of this plan, including water use efficiency and quality, biodiversity, amenity and recreation."*

Policy 7.13: Safety, security and resilience to emergency

2.20 The policy states that developments should maintain a safe, secure environment and minimise potential physical risks, including those arising from flooding and related hazards.

The London Plan: Supplementary Planning Guidance - Sustainable Design and Construction (April 2014)

2.21 The Supplementary Planning Guidance (SPG)[17] sets out the Mayor's priorities with regard to flooding as follows:

- *Through their Local Flood Risk Management Strategies boroughs should identify areas where there are particular surface water management issues and develop policies and actions to address these risks.*
- *Developers should maximise all opportunities to achieve greenfield runoff rates in their developments.*
- *When designing their schemes developers should follow the drainage hierarchy set out in London Plan policy 5.13.*
- *Developers should design Sustainable Drainage Systems (SuDS) into their schemes that incorporate attenuation for surface water runoff as well as habitat, water quality and amenity benefits.*
- *Development in areas at risk from any form of flooding should include flood resistance and resilience measures in line with industry best practice.*
- *Developments are designed to be flexible and capable of being adapted to and mitigating the potential increase in flood risk as a result of climate change.*
- *Developments incorporate the recommendation of the TE2100 plan for the future tidal flood risk management in the Thames Estuary.*
- *Where development is permitted in a flood risk zone, appropriate residual risk management measures are to be incorporated into the design to ensure resilience and the safety of occupiers.*
- *Development should maximise all opportunities to achieve an 8m setback on fluvial watercourses between built development and watercourses, flood defences and culverts.*

[17] Greater London Authority, April 2016. Sustainable Design and Construction Supplementary Planning Guidance.

- *Development should maximise all opportunities to achieve a 16m setback on tidal watercourses between built development and watercourses and flood defences.*

The Draft New London Plan

2.22 The Mayor of London is currently preparing a new London Plan which when adopted will replace the current London Plan. Its aim is to *'provide a vision for how London should sustainably grow and develop in the future'.*[18]

In December 2019 the Mayor issued a draft version of the London Plan with consolidated suggested changes, following an Examination in Public of the draft Plan and a subsequent report and recommendations from the Panel of Inspectors. In March 2020, the Secretary of State wrote to the Mayor setting out his consideration of the Mayor's Intend of Publish London Plan. At the time of writing the Mayor was considering the Secretary of State's response

2.23 The key draft policies impacting flood risk management are outlined below:

Policy SI12 Flood Risk Management

- *Current and expected flood risk from all sources across London should be managed in a sustainable and cost effective way in collaboration with the Environment Agency, the Lead Local Flood Authorities, developers and infrastructure providers.*
- *Development Plans should use the Mayor's Regional Flood Risk Appraisal and their Strategic Flood Risk Assessment as well as Surface Water Management Plan, where necessary, to identify areas where particular flood risk issues exist and develop actions and policy approaches aimed at reducing these risks. Boroughs should co-operate and jointly address cross-boundary flood risk issues including with authorities outside London.*
- *Development proposals which require specific flood risk assessments should ensure that flood risk is minimised and mitigated, and that residual risk is addressed. This should include, where possible, making space for water and aiming for development to be set back from the banks of watercourses.*
- *Developments Plans and development proposals should contribute to the delivery of the measures set out in Thames Estuary 2100 Plan. The Mayor will work with the Environment Agency and relevant local planning authorities, including authorities outside London, to safeguard an appropriate location for a new Thames Barrier.*
- *Development proposals for utility services should be designed to remain operational under flood conditions and buildings should be designed for quick recovery following a flood.*
- *Development proposals adjacent to flood defences will be required to protect the integrity of flood defences and allow access for future maintenance and upgrading. Where possible,*

[18] Greater London Authority, December 2019. The Draft New London Plan: The Spatial Development Strategy for London

development proposals should set permanent built development back from flood defences to allow for any foreseeable future upgrades.

Thames Estuary 2100 (2012)

2.24 The Thames Estuary 2100 (TE2100) Strategy[19] has been prepared by the EA to consider flood risk management for the next 100 years. The plan that has been prepared looks at the work that is needed to maintain and improve the flood defences. It states that future flood defence raising is recommended along the line of the existing defences around the Isle of Dogs. The EA has a responsibility to manage fluvial and tidal flooding from the Thames and uses statutory powers to assess the condition and height of riparian-owned flood defences, requiring them to be maintained and if necessary, raised by the owners. At present the EA's Statutory Defence Level (SDL) along the reach of the Thames next to the Isle of Dogs is +5.23mOD. The TE2100 suggests that a rise of approximately 0.5m above the SDL should be considered in 2065 and approximately 1.0m should be considered in 2100.

Thames Region Catchment Flood Management Plan (2008)

2.25 A Catchment Flood Management Plan (CFMP) is a high-level strategic plan prepared by the EA, which identifies long-term (50 to 100 year) policies for sustainable flood risk within a catchment.

2.26 The relevant key messages contained within the Thames Region CFMP[20] are that:

- Climate change will be the major cause of increased flood risk in the future. In urban areas and areas of narrow floodplain, flooding from heavy rainfall will be more regular and more severe. Surface water, sewer and fluvial flooding can occur within minutes of a severe rainfall event. Flooding can therefore occur at any time of the year, and there is very little time to provide flood warnings.
- It is increasingly necessary to recognise the value of flood plain in reducing the effects of flooding. Technical, environmental and economic constraints mean there are likely to be very few flood defence schemes in areas of narrow floodplain in the foreseeable future.
- Development and urban regeneration provide a crucial opportunity to manage flood risk. The location, layout and design of development can all reduce flood risk. For example, the use of SuDS can help to control surface water (design).

River Basin Management Plan, Thames River Basin District (2015)

[19] Environment Agency, November 2012. TE2100 Plan: Managing flood risk through London and the Thames estuary.
[20] Environment Agency, December 2009. Thames Catchment Flood Management Plan: Summary Report December 2009.

2.27 River Basin Management Plans[21] are plans for protecting and improving the water environment and have been developed in consultation with organisations and individuals. They contain the main issues for the water environment and actions required. The River Basin Management Plans have been approved by the Secretary of State (SoS) for the Department of the Environment, Food and Rural Affairs (Defra) and the Welsh Minister.

Local Policy and Guidance

LBTH Local Plan (January, 2020)

2.28 The London Borough of Tower Hamlets Local Plan sets out the development and growth within the borough from now until 2031.The Local Plan has also been prepared in line with the London Plan, relevant acts and regulations and the policies set out in the government's National Planning Policy Framework, with input from local residents, businesses, landowners, neighbouring boroughs, statutory bodies and other interested stakeholders. The following policies related to flood risk management have been laid out:

D.ES4: Flood Risk

- *Development is required to be located in areas suitable for the vulnerability level of the proposed uses with:*
    - *highly vulnerable uses not allowed within Flood Zone 3a*
    - *essential infrastructure and more vulnerable uses within Flood Zone 3a required to pass the exception test, and*
    - *highly vulnerable uses within Flood Zone 2 required to pass the exception test.*
- *Development is required to provide a flood risk assessment if it meets any of the following criteria:*
    - *The development site is over 1 hectare in size within Flood Zone 1.*
    - *The site is within Flood Zones 2 or 3a*
    - *The development may be subject to other sources of flooding, as defined in the Tower Hamlets Strategic Flood Risk Assessment.*
- *The flood risk assessment should include:*
    - *A sequential test if the development is in Flood Zone 2 or 3.*
    - *The risks of both on and off-site flooding to and from the development for all sources of flooding including fluvial, tidal, surface run-off, groundwater, ordinary watercourse, sewer and reservoir.*
    - *An assessment of tidal risk in the event of a breach in the River Thames defences.*
    - *The impact of climate change using the latest government guidance.*
    - *Demonstration of safe access and egress, and f. Mitigation measures, taking account of the advice and recommendations set out in the Tower Hamlets Strategic Flood Risk Assessment.*

[21] Department for Environment Food & Rural Affairs/Environment Agency, February 2016. River basin management plans: 2015, Thames river basin district RBMP: 2015.

- *Site design of development which meets criteria outlined in Part 2 above is required to: a. undertake a sequential approach to development layout to direct highest vulnerability uses to areas of the site with lowest flood risk, and b. incorporate flood resilience and/or resistance measures.*
- *Development is required to protect and where possible increase the capacity of existing water spaces and flood storage areas to retain water.*
- *Development is required to enable effective flood risk management through:*
    - *requiring development along the River Thames and the River Lea and its tributaries to be set back by the following distances unless significant constraints are evidenced: i. A minimum of a 16-metre buffer strip along a tidal river, and ii. A minimum of a 8-metre buffer strip along a fluvial river.*
    - *optimising opportunities to realign or set back defences and improve the riverside frontage to provide amenity space and environmental enhancement.*

Surface Water Management Plan (date of publication not specified)

2.29 LBTH has produced the Surface Water Management Plan (SWMP)[22] as required by the FWMA, and as part of the package of works for the Drain London Project. The document outlines the Borough's strategy for management of surface water attributed to sewers and drains flooding, groundwater and surface water runoff from land and ordinary watercourses occurring as a result of heavy rainfall.

2.30 The SWMP concludes that the application site is not located within a Critical Drainage Area (CDA). A CDA is a discrete geographical area where multiple and interlinked sources of flood risk cause flooding during severe weather, thereby affecting people, property and/or local infrastructure.

Strategic Flood Risk Assessment (November 2016)

2.31 LBTH, in its capacity as the LPA, has developed a Strategic Flood Risk Assessment (SFRA). The aim of the SFRA is to give an overview of flood risk issues across the Borough. SFRAs are intended to inform the preparation of local development documents, as well as a source of information for developers, who should consider flood risk to a development as early as possible.

2.32 The SFRA should inform a site-specific FRA. The SFRA provides the information needed to apply a sequential approach in accordance with the NPPF; this is a risk-based approach to determine the suitability for development in flood risk areas. It should be adopted when considering development layout, locating higher vulnerability uses where ground levels are highest and lower vulnerability uses elsewhere on site.

2.33 The application site is one of the allocated development sites identified by the LBTH SFRA. The SFRA identifies the application site as being located in Flood Zone 2 (medium risk)

[22] London Borough of Tower Hamlets, date unknown. Surface Water Management Plan.

and 3a (high risk, but not within the functional floodplain), and therefore a site-specific FRA is required for the development.

2.34 The LBTH SFRA makes the following recommendations specific to development at the application site:

- *More vulnerable development should be sequentially allocated to areas of the site at lower relative risk of flooding (Flood Zone 2 and lower hazard areas), with more flood compatible development (such as parking or open space) located in areas at the highest risk.*
- *No basement dwellings should be permitted within Flood Zone 3a. They might be possible in Flood Zone 2 provided the Exception Test is passed.*
- *To mitigate against residual tidal flood risk, Finished Floor Levels should be raised 300 mm above the 2100 year maximum water level anticipated through a breach of the River Thames defences.*
- *Site specific emergency evacuation procedures must be in place to ensure that the risk to life is minimised should a breach of the River Thames defences occur. Safe access and egress routes should be provided above the 2100 breach flood level and lead to higher ground within Flood Zone 1.*
- *Flood resilient construction techniques should be employed to reduce damage and increase the speed of recovery should any flooding events occur.*
- *SuDS should be implemented to manage surface water flood risk and restrict post-development runoff to greenfield rates. Geological data indicates that the site is potentially suitable for bespoke infiltration SuDS. The drainage system should provide sufficient capacity to cater for up to the 1 in 100 year storm event, incorporating the latest guidance regarding climate change.*
- *The development site is located adjacent to a dock system so consideration should be given to the recommendations of the TE2100 plan with respect to future dock wall raising and advice sought from the EA at an early stage.*

Draft Local Flood Risk Management Strategy (2015)

2.35 The Strategy[23] is intended to provide advice to residents, businesses and developers within the Borough with respect to how the LBTH is dealing with flooding. It identifies the nature, extent and location of predicted flooding.

2.36 The Strategy also explains measures to mitigate the impact of flooding. Among those utilised by the LBTH are gully maintenance and installing SuDS in the Public Realm.

[23] London Borough of Tower Hamlets, 2015. Local Flood Risk Management Strategy: Consultation Draft.

2.37 The current status of this document, as of April 2017, is draft. Consultation on the draft document has now ended and the responses provided will help shape the final strategy document.

LBTH SuDS guidance (date of publication not specified)

2.38 The Borough's SuDS guidance document[24] summarises National, Regional and Local policy on Sustainable Drainage Systems, and gives examples of SuDS techniques likely to be appropriate to the Borough.

2.39 LBTH Development Management Policy DM13 states that:

"Development will be required to show how it reduces the amount of water usage, runoff and discharge from the site, through the use of appropriate water reuse and Sustainable Urban Drainage (SUD) techniques."

2.40 The SWMP Action Plan includes the following actions related to SuDS:

- Developments across the borough to include SUDS measures, resulting in a net improvement in water quantity or quality discharging to sewer compared to existing situation.
- Developments across the borough greater than 0.5 hectares to reduce runoff from site to greenfield runoff rates.

[24] London Borough of Tower Hamlets, date unknown. SuDS Guidance.

3. Consultation

Environment Agency (EA)

3.1 The EA has provided a Product 8 report (Detailed Flood Risk) for the Site (ref HNL/20359/JH) dated 23rd April 2020 (see Appendix 2). The advice provided in this report has been used in the preparation of this FRA and contains flood risk information and advice particular to the Site and local area. The package of information includes Detailed Flood Risk Assessment Maps specific to the application site. The information provided covers:

- Flood Map for Planning (Rivers and Sea);
- Flood Map Extract;
- Thames Estuary 2100 (TE2100) flood modelling:-
    - Thames Tidal Upriver Breach Inundation Modelling
    - Thames Tidal Upriver Breach Inundation Modelling Map
- Defence Details;
- Recorded Flood Events Data;
- Recorded Flood Events Outlines Map; and
- more detailed information from the EA's computer river models (including model extent, information on one or more specific points, flood levels, flood flows, etc.)

3.2 The FRA from a 2017 North Quay planning application, dated 11th January 2017, was issued to the EA for comment in January 2017. A response from the EA was received on 7th February 2017 (see Appendix B). Their feedback on the approach to the management of flood risk at the Proposed Development was positive. They confirmed that 'in principle' they would have no objections to the Proposed Development from a flood risk perspective. This FRA follows the same principles as the 2017 FRA.

3.3 The EA noted that the development area is protected to a very high standard by the Thames Tidal flood defences up to a 0.1% AEP event. They confirmed that as long as 'more vulnerable' uses are above the TE2100 plus climate change flood level, the Proposed Development is classified as 'less vulnerable' and, consequently, an Exception Test in line with NPPF is not required.

3.4 In June 2014, Arup completed a hydraulic modelling assessment on the impact of various developments that encroached into the docks across the Canary Wharf estate. This assessment demonstrated that the impact of these developments was negligible and was subsequently accepted by the EA in July 2014. The modelling was updated in March 2017 (see Appendix 4) to include the encroachment due to the new promenade structure that forms part of the Proposed Development. The results of the modelling showed that the impact on flood risk across the docks and the wider Thames Estuary remained negligible.

3.5 The results of this hydraulic modelling exercise were submitted to the EA in March 2017 for confirmation that the proposed encroachment of the new promenade structure into West India North Dock is acceptable with respect to flood storage. The EA confirmed that they considered the impact of the encroachment to be negligible and that therefore, they did not require flood storage compensation on the Proposed Development. Refer to Section 6.5 for further commentary on the proposed encroachment into the dock water.

3.6 The EA were contacted again in January 2020 and asked to comment on the EIA scoping opinion for the Site, their response contained comments on the FRA which included a request for clarification on the breach modelling, the inclusion of a sequential test and further information on temporary flood barriers proposed as a part of the flood management. These points have all been responded to in this report. Refer to Appendix 4 for the full EA response.

Canal & River Trust (CRT)

3.7 CRT is responsible for the water space within the docks and are the navigation authority.

3.8 Arup have consulted with CRT to gain approval in principle to the key assumptions that are being made in this FRA. A response was received on June 2020 and is contained in Appendix 5.

3.9 CRT confirm that design details going forward would need to be managed by their Third-Party Works Process and would need to be in compliance with their Code of Practice (April 2020). This would specifically be related to:

- Surface water discharge to docks;
- Navigational issues.

3.10 The general principle of discharging surface water to the docks from building roofs, non-trafficked paving and landscaping is acceptable to CRT and is the usual strategy on the Canary Wharf estate.

3.11 An EIA scoping opinion was requested from CRT and a response was received in January 2020, they stated they have no objections to the Proposed Development, however if surface water is to be discharged to the docks, the trust would need to be provided with sufficient evidence to show that this is not a contamination risk.

Thames Water Utilities Ltd (TWUL)

3.12 There has been ongoing consultation with TWUL regarding the impact of developments at Canary Wharf , including this Proposed Development, on the potable water supply and capacity of the existing sewer networks. In 2014, TWUL was commissioned to carry out assessments of the impact of these developments on TWUL assets, based on flows provided by Arup. The results of these assessments were received in early 2015 (the water supply modelling assessment was received in January and the sewer impact study was received in February). The assessments identified that upgrades to the network would be required to cater for the new developments, but limited consideration was given to phasing of the various developments.

3.13 The sewer impact modelling was updated in January 2019 taking into account phasing, and excluding some developments that were considered in the previous study. It concluded that that there is sufficient capacity in the Thames Water combined sewer network to accommodate the flows from each of the phases of the North Quay development. TWUL is still in the process of updating the potable water impact study.

3.14 TWUL has also been consulted in respect to obtaining records showing the local drainage network in the area surrounding the Proposed Development. The Proposed Development is expected to discharge both wastewater flows from the building and surface water collected on the north part of the development area to the existing TWUL sewer in Aspen Way.

3.15 In April 2020 Max Fordham provided the peak foul water flows that are expected to discharge to the combined sewer in Aspen Way. TWUL confirmed that they are in the process of undertaking an Integrated Water Management Strategy for the Isle of Dogs with the GLA and LBTH. TWUL confirmed that the North Quay development is included in this assessment and the peak flows provided by Max Fordham are in line with those previously provided for North Quay, both in terms of peak flows and across the various phases of development.

4. The Site

Site Location

4.1 The North Quay site ("the Site") is bounded by Canary Wharf Crossrail Station to the south, Aspen Way (A1261) to the north, Hertsmere Road to the west and Billingsgate Market to the east. The West India Quay Docklands Light Railway (DLR) station and Delta Junction are located on the western side of the Site and the Site also incorporates parts of North Dock, Upper Bank Street and Aspen Way. (see Figure 4.1).

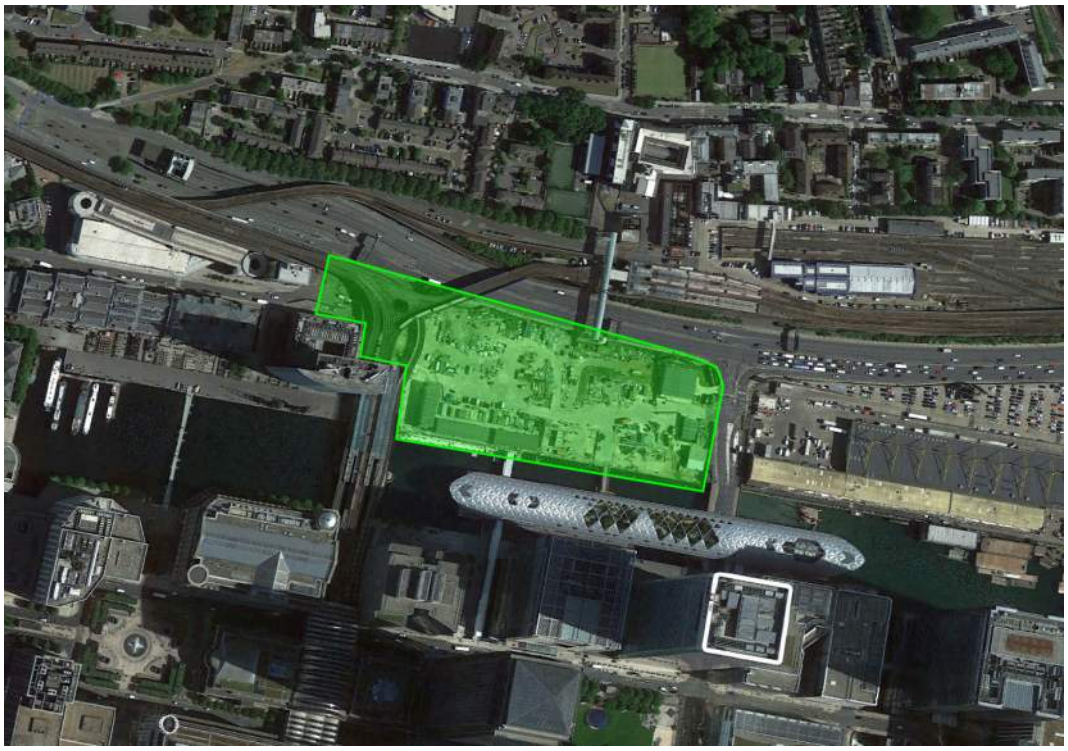


Figure 4.1: The development area, relevant to the flood risk assessment, is highlighted in green (Google Earth)

4.2 The development area is covered by hard surfacing, mainly hardstanding concrete and made ground. Desk studies indicate that it is predominantly at an elevation of around +5.00mOD, with levels ranging from approximately +3.3mOD to +6.50mOD.

4.3 A Grade I Listed brick dock wall, known as the Banana Wall, forms the northern wall of North Dock along the southern boundary of the development area. The top of the Banana Wall is at approximately +5.3mAOD. A false quay extends over the dock water from the south side of the Banana Wall.

4.4 The following information has been used to develop the understanding of the existing development area:

- North Quay Geotechnical Desk Study (Arup, December 2020)

- Initial Report of the Stability of the Banana Wall (Arup, February 2003)
- Crossrail Banana Wall Stability Report (Arup, January 2007).

Existing Dock Wall

Description of Dock Wall

4.5 Banana Walls were constructed to form the West India Docks retaining the ground level of the surrounding wharves. It is thought that the material excavated from the docks was placed behind the Banana Walls, raising the ground levels in the area.

4.6 The Banana Wall is a concave structure, as shown in Figure 4.2, shaped to accommodate ships' hulls. It is understood that the dock is lined with puddle clay and backfilled with Terrace Gravel. The Banana Walls perform a dual function. The walls serve to retain the ground levels outside the dock, and also act as a flood defence. In addition, the dock walls prevent loss of the dock water into the upper aquifer in the Terrace Gravel.

4.7 The Banana Wall is the oldest of the quay walls, constructed between 1803 and 1806, and is a Grade I listed structure. It is of brick construction, is 1.8m thick and formed in a banana shape. Counterforts, i.e., fin walls that add stability to the Banana Wall, are regularly spaced along the length of the wall, approximately every 4.6m. These counterforts are approximately 900mm square. The locations of the counterforts have been identified by survey by Canary Wharf Contractors Limited (CWCL). Mass concrete has been placed around some of the counterforts, but its purpose is unclear. As Figure 4.3 shows, a portion of the Banana Wall sits within the development area.

Figure 4.2: Section through the dock showing the Banana Wall

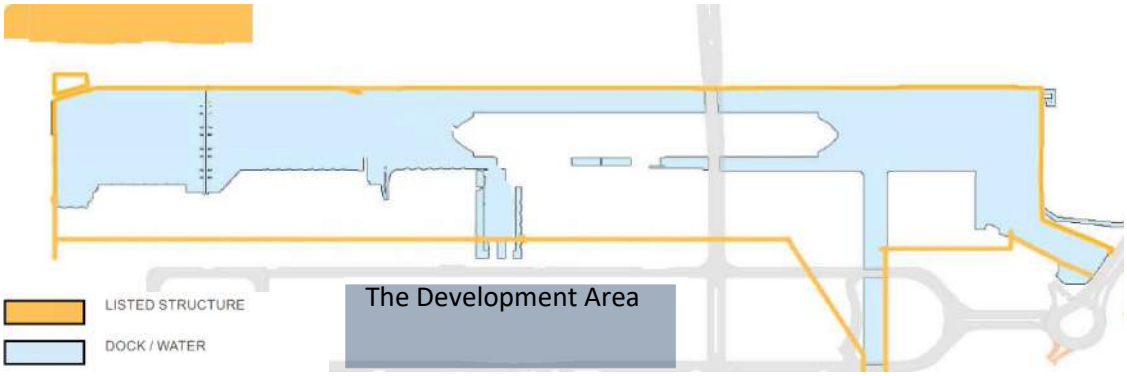


Figure 4.3: Plan of listed structures (Adamson Associates, 2015)

Dock Wall Stability

4.8 A report was prepared by Arup in February 2003 on the stability of the Banana Wall. This report concluded that the current stability is questionable with respect to modern day design standards and that no additional loading should be applied to the Banana Wall as a result of any development.

4.9 The geotechnical desk study, prepared by Arup in December 2016, concluded that the Banana Wall is not considered to be reliant on the false quay for stability or horizontal support. The study also recommended that due consideration be given to preserving the condition of the banana wall when demolishing the existing false quay as part of the Proposed Development.

Existing False Quay

4.10 The false quay was constructed circa 1910 and in its existing state extends approximately 17m into North Dock. It comprises a 150mm thick reinforced concrete slab supported by concrete beams, sitting on three rows of piles as shown in Figure 4.4. The primary beams are 815mm deep by 381mm wide at 6.5m centres; the secondary beams are 560mm deep by 200mm wide at 1.6m centres. The piles are 1.5m diameter concrete-filled cylinders, enclosing 0.35m square precast piles, with the cylinder piles linked by precast braces. The piles extend into the Terrace Gravel beneath the Dock, but their overall length is unknown.

4.11 The false quay structure was strengthened in 1953 with additional precast beams and two additional 0.4m square piles per bay; however, details of these works are not available.

4.12 Visual inspections during a 1988 condition survey of the false quay indicated that the piles appeared to be in good condition, but that there was evidence of reinforcement corrosion and concrete spalling on the deck slab.

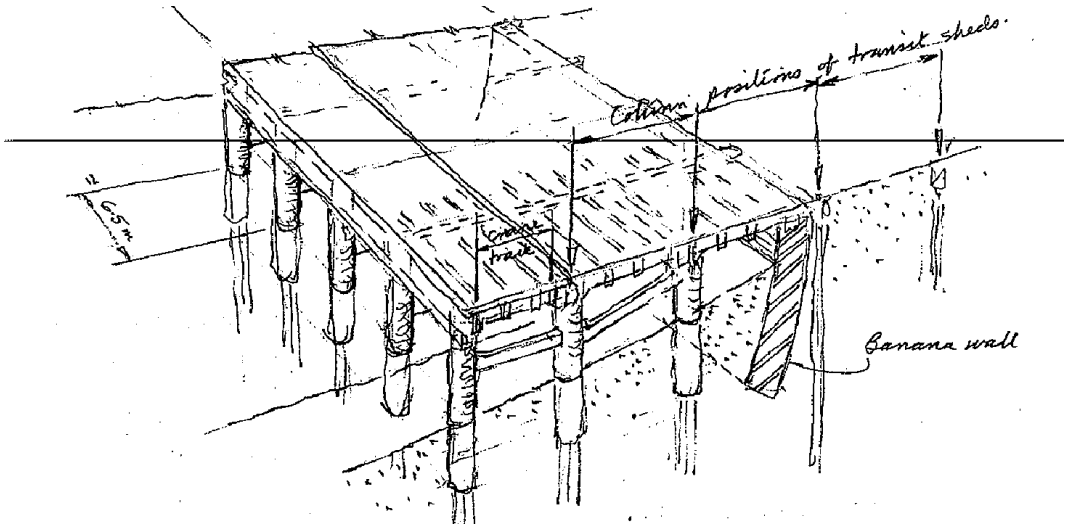


Figure 4.4: Sketch of existing false quay (Arup, 2001)

Canary Wharf Crossrail Station (CWCS)

4.13 Since 2008, the development area has been used for storage of construction equipment and materials during the construction of CWCS and the over-station retail development. The development area had previously been used as a car park (see Figure 4.5).

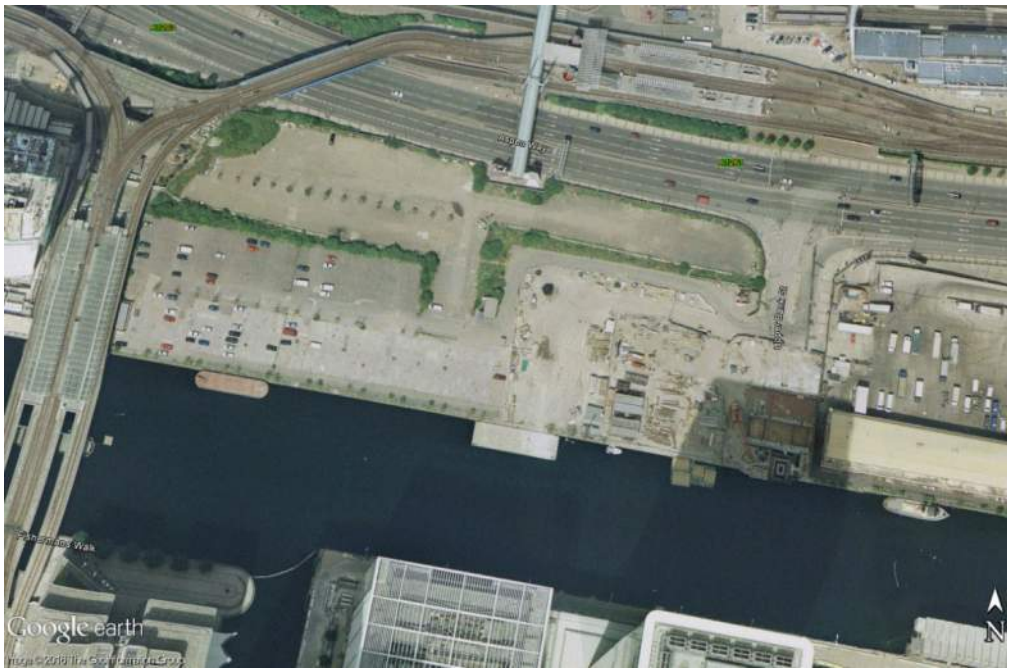


Figure 4.5: Satellite image of the development area taken on December 2003 (Google Earth)

4.14 A satellite photograph (see Figure 4.6) shows the changes to the development area between December 2003 and June 2015. The two images also indicate that the false quay along the south boundary was extended with a decked promenade and bridges linking the development area and Upper Bank Street to CWCS (Figure 4.7).

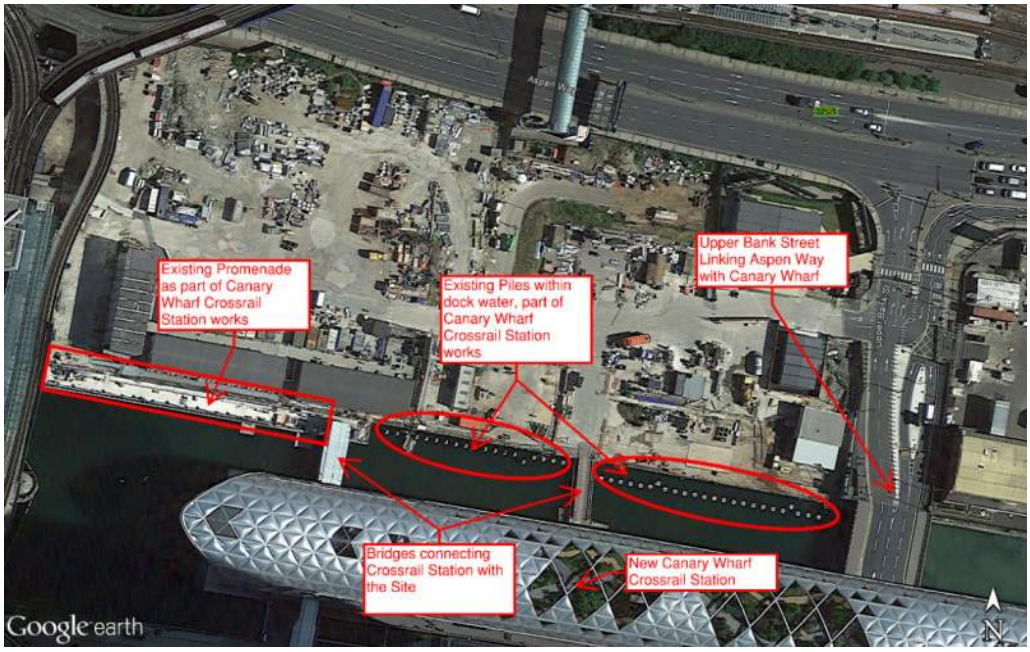


Figure 4.6: Satellite image showing changes to the development area since December 2003 (Google Earth)

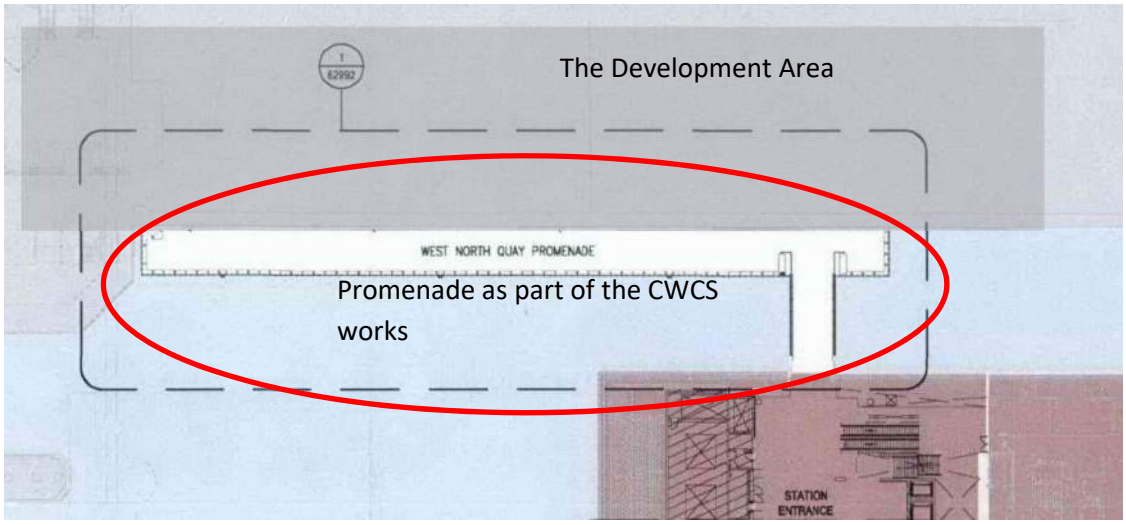


Figure 4.7: Existing promenade as part of the CWCS works (Planning Application PA/10/01135/S – Adamson associates/architects, 2010)

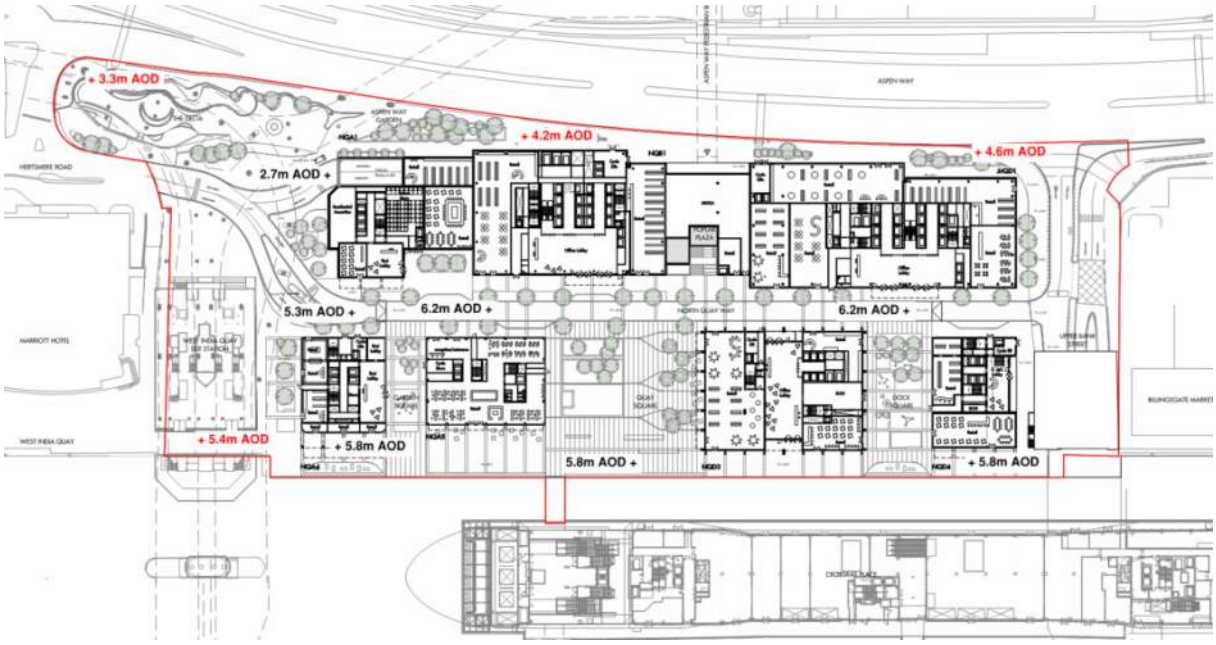
5. The Proposed Development

Indicative Scheme

5.1 The indicative scheme for the Proposed Development includes the erection of buildings and construction of basements; The following uses: Business floorspace (B1), Hotel/Serviced Apartments (C1), Residential (C3), Co-Living (C4/Sui Generis), Student Housing (Sui Generis), Retail (A1-A5), Community and Leisure (D1 and D2), Other Sui Generis Uses. Associated infrastructure, including a new deck over part of the existing dock; Creation of streets, open spaces, hard and soft landscaping and public realm; Creation of new vehicular accesses and associated works to Aspen Way, Upper Bank Street, Hertsmere Road and underneath Delta Junction; Connections to the Aspen Way Footbridge and Crossrail Place (Canary Wharf Crossrail Station); Car, motorcycle, bicycle parking spaces, servicing; Utilities including energy centres and electricity substation(s); and Other minor works incidental to the proposed development.

5.2 Two basement levels are proposed within the indicative scheme (see Figures 5.3 and 5.4), though these do not extend beyond the Banana Wall. The road accessing the Proposed Development ramps down into the first basement level at +2.7mAOD.

5.3 At roof level, areas of intensive green roof are proposed on all of the buildings. The public realm proposed, comprises areas of soft landscaping and hard paving (as illustrated on Figure 5.1).



Key **+ x.x mAOD Proposed level** **+x.x mAOD Existing level**

Figure 5.1: Indicative Scheme for the Proposed Development at Level 01 (Allies and Morrison, 2020)

5.4 There is a proposed new marine deck structure extending over the Banana Wall to the south of the development area. A Listed Building Consent applies to the Banana Wall. The Proposed Development will span over the Banana Wall with piles on either side of the wall providing support to the new structures. The new structures will leave a void or compressible material above to avoid permanent loading of the wall.

5.5 The Proposed Development involves the partial demolition of existing structures, including the old false quay deck structure to the south of the development area and part of the EDF (now UKPN) shaft located on the north-west part of the development area. The proposed works involve removing the majority of the existing false quay deck, with the exception of the south-west corner. If possible, the existing marine piles will be reused. If they are not structurally adequate, they will be left in place, and the proposed structure constructed around them.

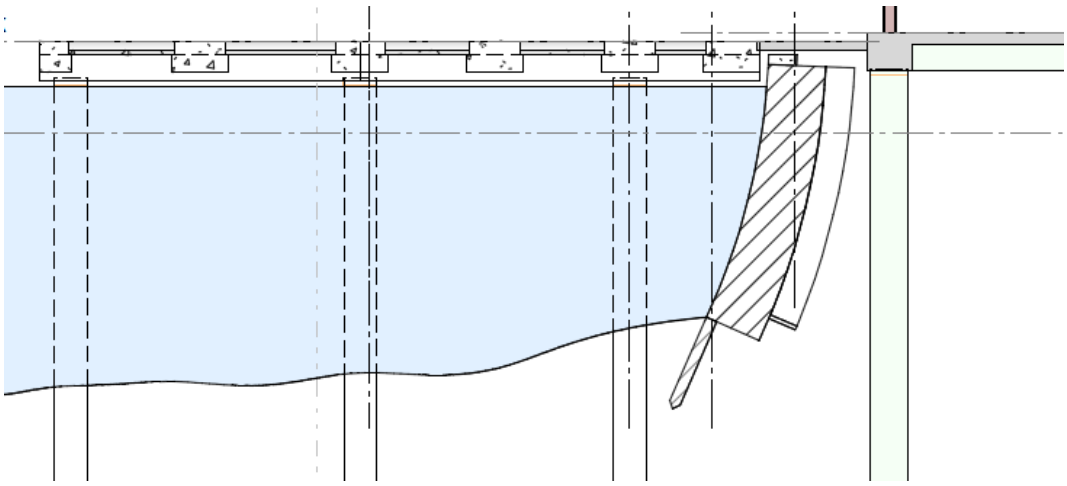


Figure 5.2: Section through proposed deck structure overhanging North Dock, supported by piles (Waterman, 2017)

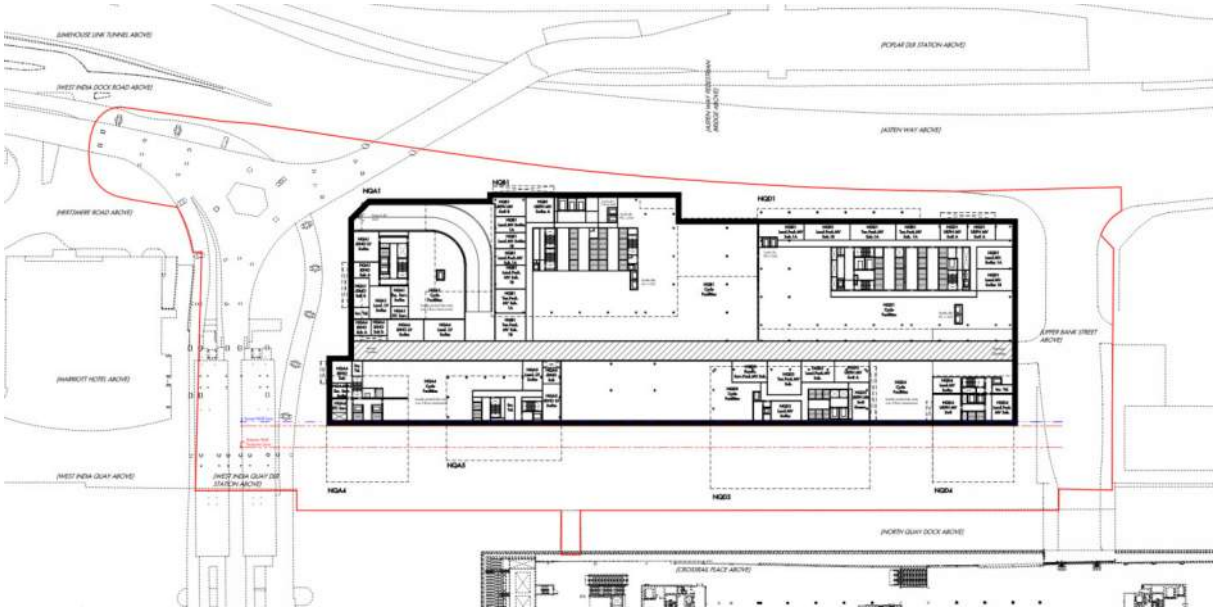


Figure 5.3: Indicative Scheme for Proposed Development Basement Level B1 (Allies and Morrison, 2020)

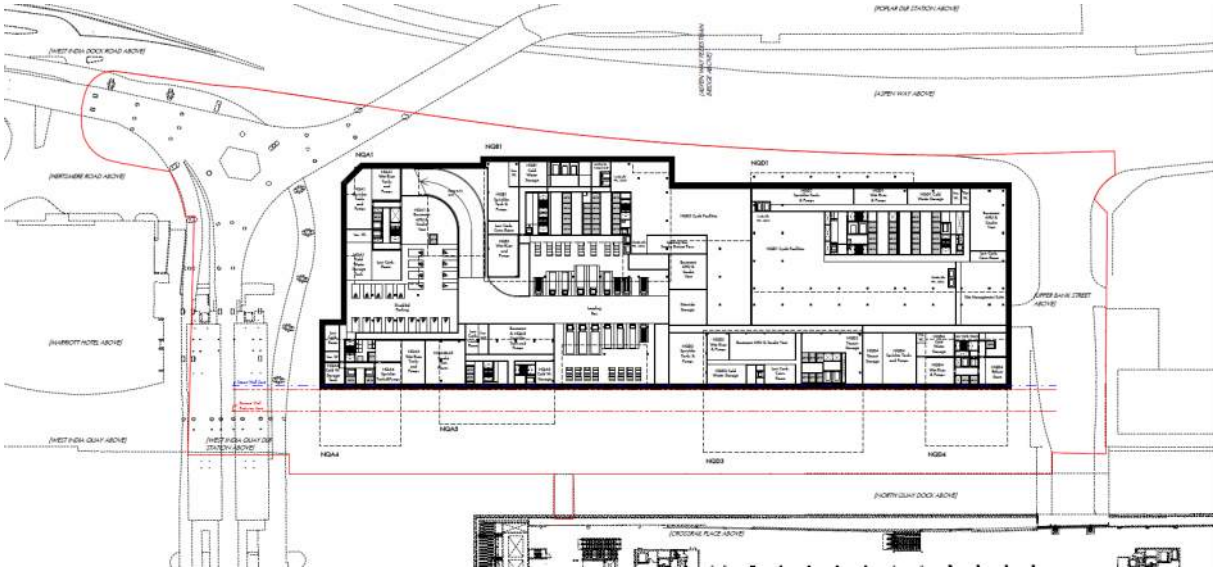


Figure 5.4: Indicative Scheme for Proposed Development Basement Level B2 (Allies and Morrison, 2020)

Parameter Plans

5.6 For the purpose of this FRA, the indicative Scheme has been used to assess flood risk. However, where the Parameter Plans represent a worst-case in terms of flood risk for the development, these plans have been used. The following parameters are applicable within this FRA.

5.7 The deepest allowable level of the basement as defined within the parameter plans is -18mAOD (see Figure 5.5) and the potential uses include Retail (A1-A5), Business (B1), Community (D1), Leisure (D2), and Ancillary floorspace.

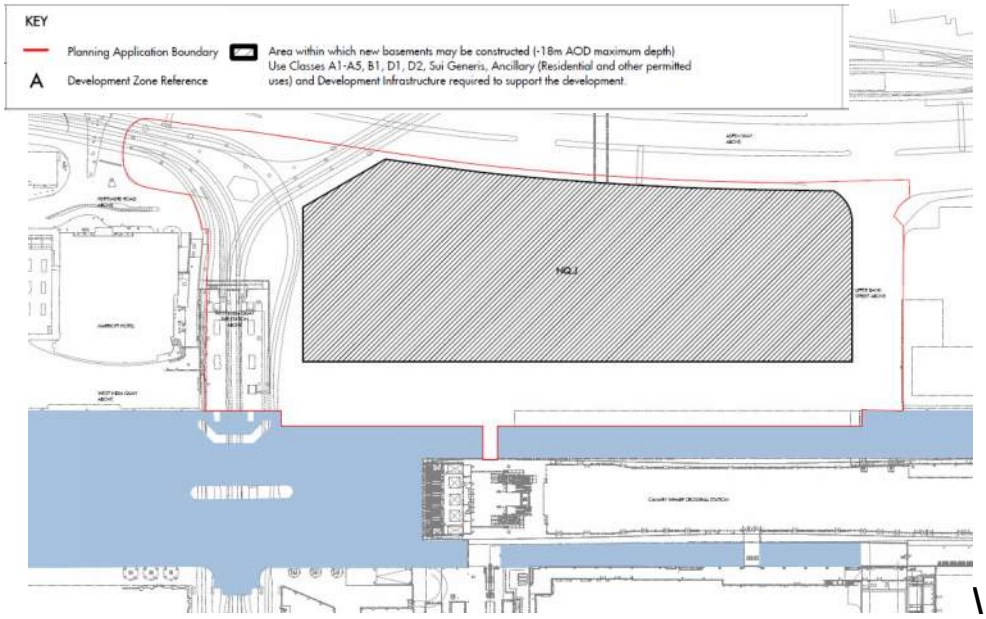


Figure 5.5: Parameter Plan Land Uses Below Ground (Allies and Morrison, 2020)

5.8 As mentioned previously, the existing false quay structure will be demolished, and new marine deck constructed in its place. The parameter plan shown below in figure 5.6 shows the maximum proposed extents of new marine deck to be assumed within this assessment.

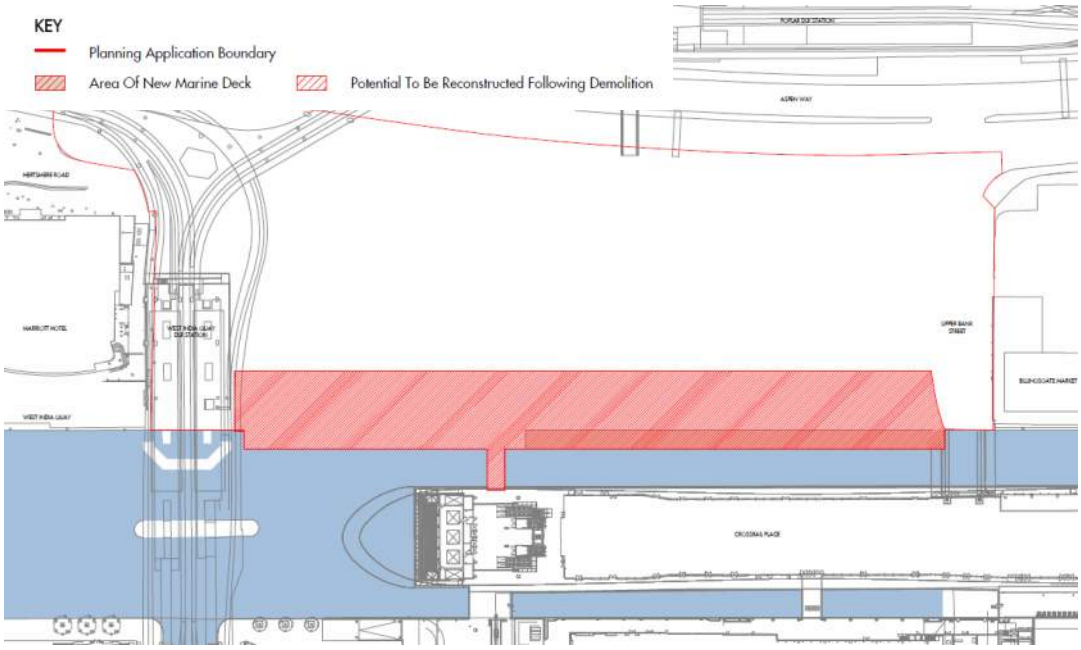


Figure 5.6: Parameter Plan Extents of Proposed Dock (Allies and Morrison, 2020)

5.9 The worst-case for flood risk in terms of the allowable uses for the development will be considered within this FRA, therefore, as outlined in the parameter plan below in Figure 5.7, where the ground floor is labelled as 'Any Permitted Use Class' it will be assumed, for the purpose of this assessment, that it contains residential units.

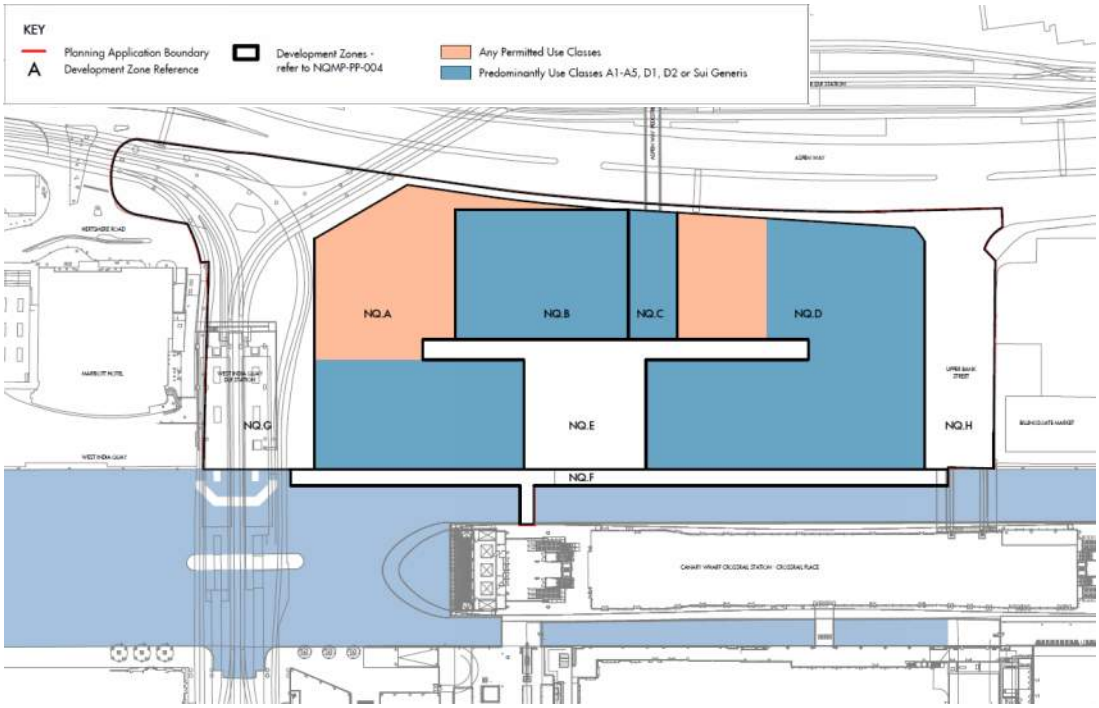


Figure 5.6: Parameter Plan Ground Floor Land Uses (Allies and Morrison, 2020)

6. Fluvial & Tidal Flood Risk

Historic Flood Events

6.1 The EA has knowledge of flood risk in the local area and has provided a Product 8 report (Detailed Flood Risk) (ref HNL/168894/BC), dated 23rd April 2020, with information specific to the Site. These documents have been used as the basis for the assessment of flood risk for the Proposed Development.

6.2 The following historic flood event is described in the report, during which an area to the north of the development area was subject to tidal flooding on the night of the 6th and morning of the 7th January 1928, as shown in Figure 6.1. There was overtopping in the area during a storm surge (which coincided with high fresh water flows). An approximate level in the Thames at the time was +5.03mOD.

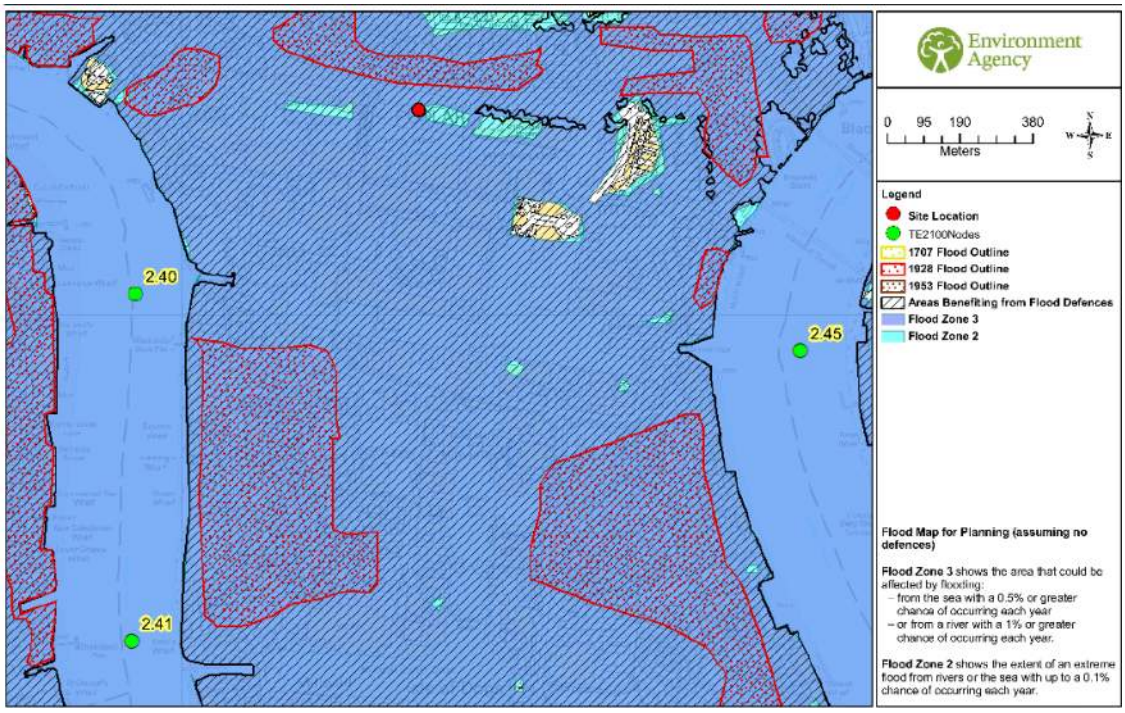


Figure 6.1: Map showing historic flood events (EA, 2020)

Environment Agency Flood Maps

6.3 The EA produces floodplain maps for the UK, which show the areas at risk of fluvial and/or tidal flooding. These are available on the EA website.

6.4 The development area is located within the floodplain of the River Thames. The EA flood map for planning in Figure 6.2 shows that the development area lies entirely in Flood Zone 3. Zone 3 is considered to have a high risk, with land assessed as having a 1% AEP of river flooding, or a 0.5% AEP of flooding from the sea. Flood Zone definitions do not take account of the presence of flood defences.

6.5 The development area is defended by flood defences, shown in orange, along the River Thames. There are also secondary flood defences within the docks in the form of the dock wall structures. Occasionally, when water levels in the River Thames exceed the retained water level in the docks, the lock gates are pushed open by the tide, increasing dock water levels. Under these circumstances, the dock walls act as flood defences.

6.6 Due to London's strategic importance, the Thames Tidal Defences and dock walls provide a level of protection to at least the 0.1% AEP (Annual Exceedance Probability). Throughout London there is a statutory obligation on riparian owners to maintain the river walls at or above this statutory level. The EA has confirmed that it considers the development area to be defended to a very high standard by the Thames Tidal flood defences, despite being located within Flood Zone 3 (see Appendix B).

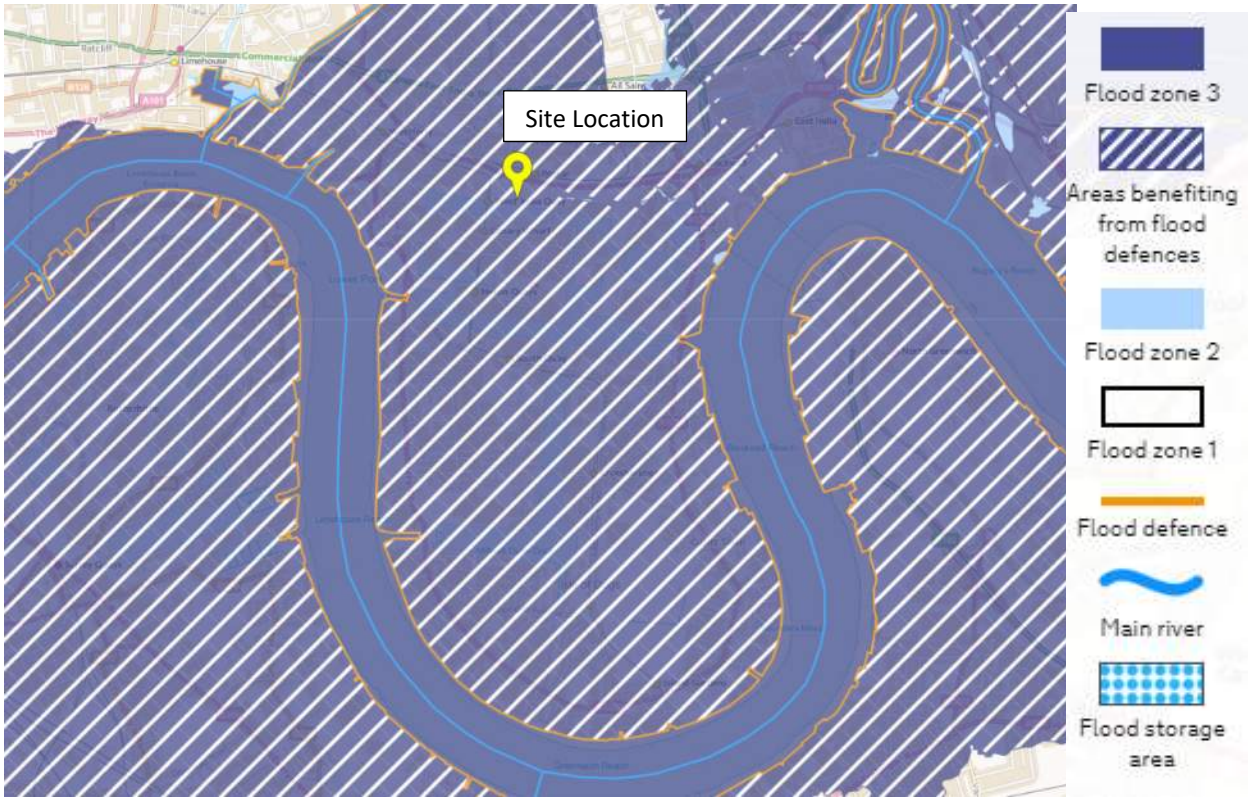


Figure 6.2: EA Flood Map for Planning showing risk of flooding from rivers and sea (EA, 2020)

6.7 The EA modelling work from the Product 8 report considers a flood hazard that could impact the development area from two principal mechanisms. These are as follows:

- flooding caused by a major breach; and
- flooding caused by extreme water levels.

Flooding Caused by a Major Breach

6.8 Flooding caused by a major breach of the flood defence near the development area during significant flood event in the Thames. Breach analyses are theoretical events, looking at how far flooding can extend from a single point of flood defence failure. Depths of flooding generally occur some distance from the breach with long flow paths. Specific points along the Thames defences are considered from Teddington to the Mar Dyke and River Darent. The predicted impacts on the adjacent land are derived from the Thames Tidal Upstream Breach Modelling Study 2015 completed by CH2M Hill in March 2015.

6.9 The model outputs are time dependant and have been provided by the EA for the 2065 and the 2100 epoch. The levels are expressed as Maximum Likely Water Levels (MLWLs), rather than as levels with a statistical recurrence frequency, because they are artificially controlled by the Thames Barrier in response to projected natural events.

6.10 The EA map in Figure 6.3 shows the extent of flooding that would occur by overlaying the flooding extent of each individual flood defence breach. The breach location that most affects the Proposed Development is located east of the development area on the bend of the River Thames where it meanders north to east (model breach point “Dog 07”) as shown in Figures 6.3 and 6.4.

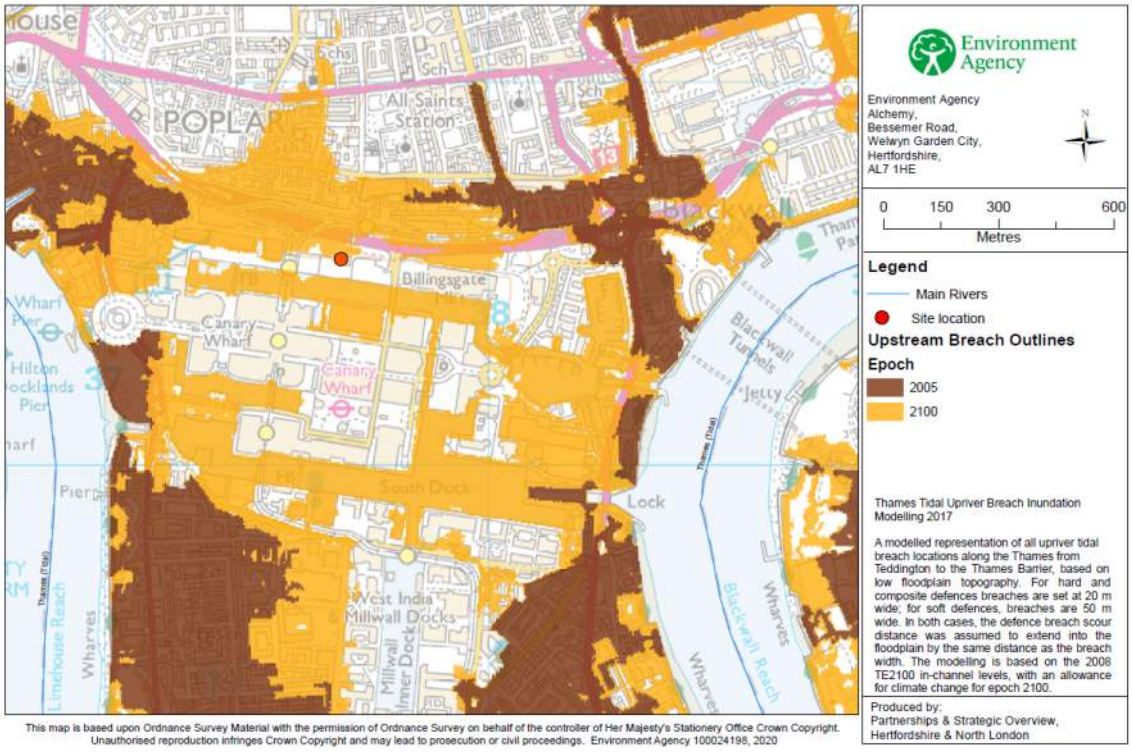


Figure 6.3: Map showing the extent of flooding due to tidal breaches along the Thames (EA, 2020)

6.11 Flooding caused by such a breach affects a significant length of Aspen Way. The predicted peak water levels would affect the north edge of the development area. Currently the north edge is shown to provide the main vehicle access and where the loading bays, the

proposed residential development, estate service rooms and support facilities for the Proposed Development are to be located. The predicted flood levels vary from east to west at the boundary with the development area and are lower at the dock edge to the south. They are summarised in Table 6.1.

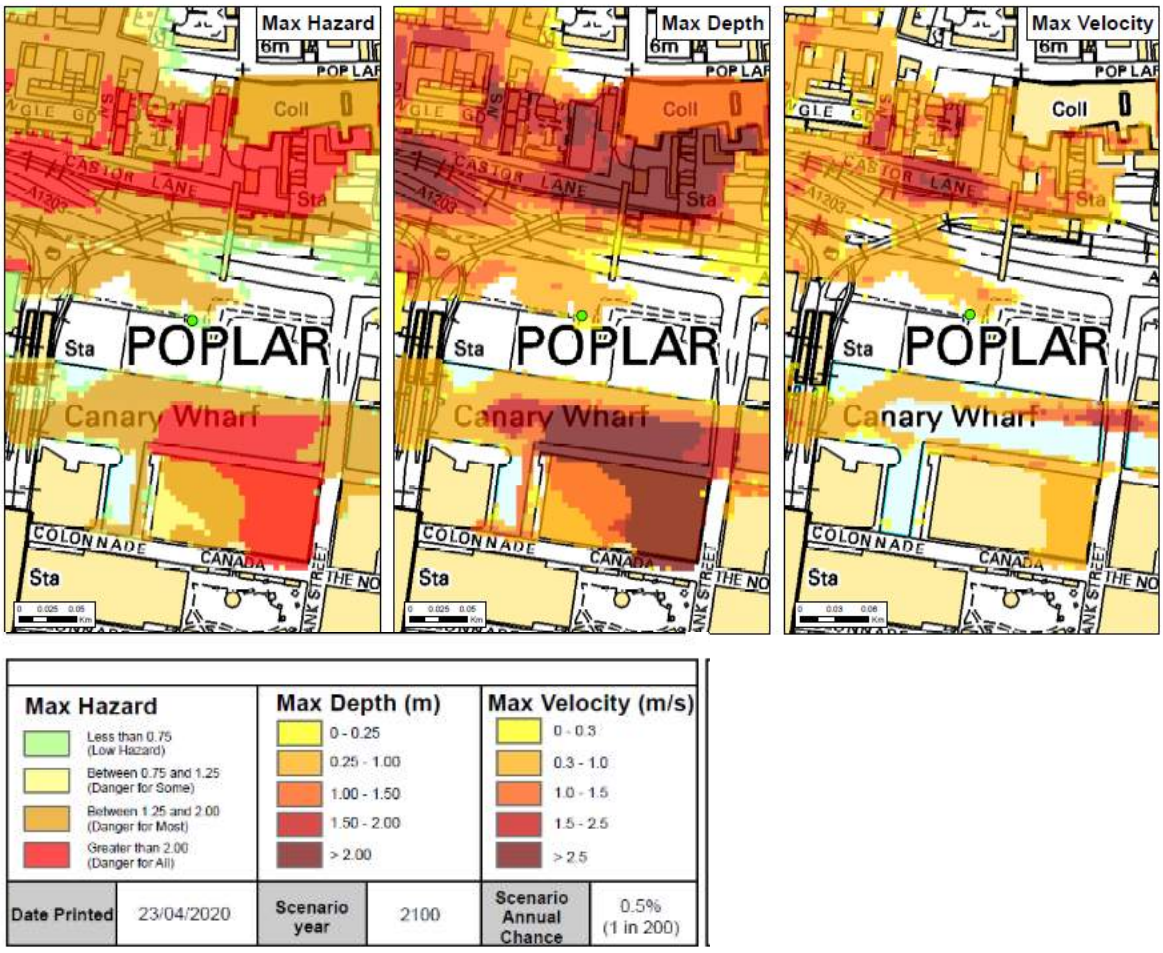


Figure 6.4: Breach Analysis Flood Hazard, Depths, and Velocities for Year 2100, 0.5% AEP Fluvial Flow, Breach Location Dog 07 (EA, 2020)

Table 6.1: Thames Tidal Breach Modelling (2015) Results for 2065 and 2100 epoch (Breach Point Dog 07) based on EA's Product 8 Report (EA, 2020)

	MAX. LIKELY WATER LEVEL (mOD)			
	Boundary with Aspen Way			Dock Edge
	North West	Central	North East	(all points)
Year 2065	+4.283	+4.282	+4.647	+4.036
Year 2100	+4.556	+4.556	+4.724	+4.199

Flood Defence Levels

8.1 The water level in the docks is usually maintained between +3.95mOD and +4.35mOD; these are the normal operating levels.

8.2 The EA provided data on the water levels in the River Thames adjacent to the entrance to the Isle of Dogs docks (at model node 2.45 as shown in Figure 6.6) in the Product 8 Report. The water level data takes account of the TE2100 study that has been completed by the EA. The report stated that the highest present-day level that can be expected adjacent to the entrance of the docks is +4.68mOD (refer to Table 6.3). The EA also state that the future water level from 2065 to 2100 (the 2065 epoch) is +5.17mOD and from 2100 onwards (the 2100 epoch) is +5.66mOD, while the physical flood defence walls should be built to at least +5.7mOD for the 2065 epoch and to +6.2mOD for the 2100 epoch (refer to Table 6.4).

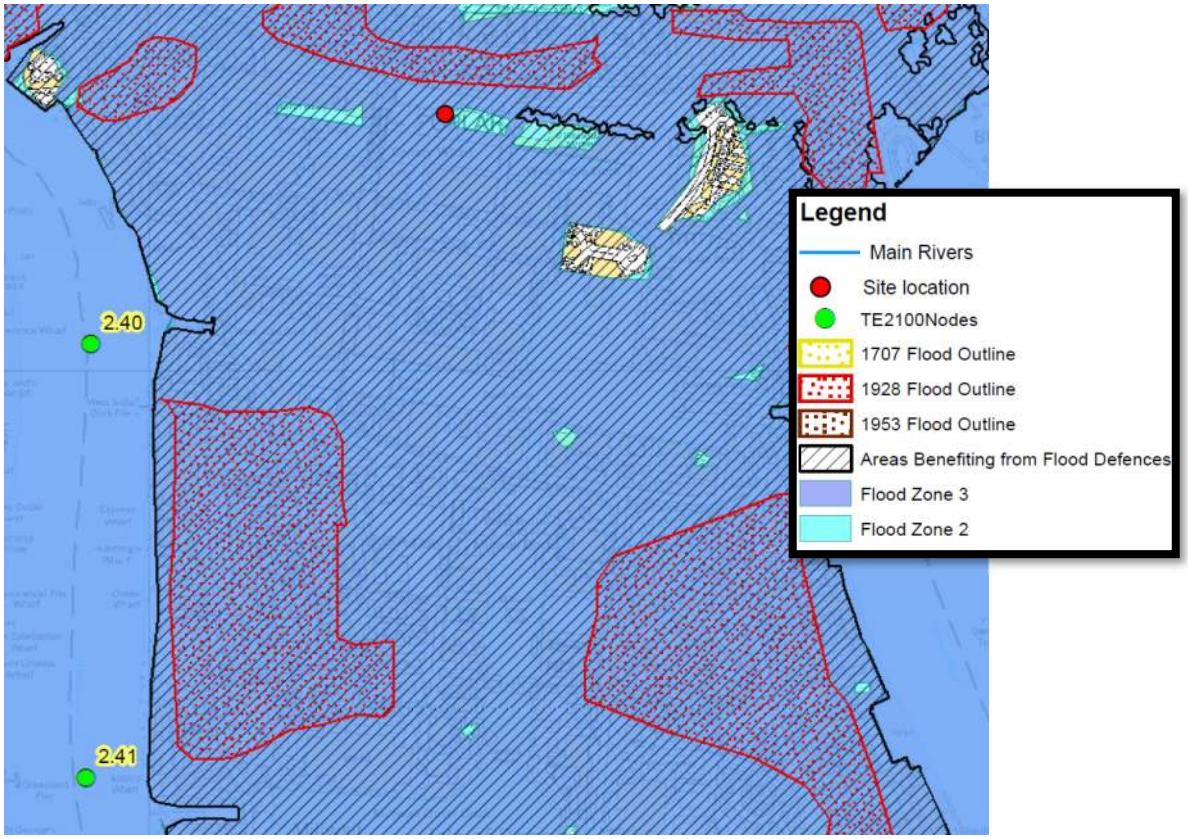


Figure 6.6: Map showing locations of TE2100 modelling nodes (EA, 2020)

Table 6.3: Maximum Likely Water Levels (MLWLs) for present day based on EA's Product 8 Report in Appendix 2. (EA, 2020)

Location	Node	Easting	Northing	Extreme water level (m)	Left defence (m)	Right defence (m)	Allow for future defence raising to a level of...	
							Left Bank (m)	Right Bank (m)
Tower	2.40	536880	180056	4.73	5.23	5.23	6.20	6.20
	2.41	536870	179152	4.72	5.23	5.23	6.20	6.20
Greenwich	2.45	538614	179907	4.68	5.23	5.23	6.20	6.20

Table 6.4: MLWLs for 2065 and 2100 epochs taken from EA Product 8 Report in Appendix 2. (EA, 2020)

				2065 to 2100		2100	
Location	Node	Easting	Northing	Design water level	Defence level (both banks)	Design water level	Defence level (both banks)
Tower	2.40	536880	180056	5.24	5.70	5.73	6.20
	2.41	536870	179152	5.23	5.70	5.72	6.20
Greenwich	2.45	538614	179907	5.17	5.70	5.66	6.20

Fluvial/Tidal Flood Risk Mitigation Strategy

Proposed Levels

8.3 The EA Product 8 information shows that the development area benefits from flood defences to provide protection from the MLWL, but that the defence levels will need to be raised during the life of the Proposed Development to maintain this protection.

8.4 The proposed levels are such that the development area is well protected from fluvial/tidal flooding. The proposed flood protection strategy described in this section is appended to this FRA (see Appendix 7).

8.5 The promenade level is to be a minimum of +5.8mOD, providing sufficient freeboard to thresholds on the south side of the Proposed Development. The structural design will allow for future raising of the promenade level to +6.2m OD to protect the Proposed Development beyond 2100 if this is needed. This could be in the form of a dwarf wall constructed in the future. On the east side of the Proposed Development, flood protection to at least +4.7mOD is provided by the existing levels on Upper Bank Street. On the north side of the development the proposed building edge and landscaping are to provide protection.

8.6 The north-west corner of the Proposed Development is vulnerable to breach flooding due to it being at a level lower than the design flood level recommended by the EA modelling. This is because the access road has to tie in with the existing road level and pass beneath the DLR

viaduct. A temporary flood barrier on the access road at the basement entrance is proposed to mitigate this. Refer to Appendix 7 for plan showing location of flood barrier.

Temporary Flood Barrier

8.7 The main access road ramps down into the basement level at +2.7mOD. If left unprotected a breach incident could result in flooding of the basement via this route. Therefore, a temporary flood barrier (as the examples depicted in Figures 6.7 and 6.8) is proposed on the access road at the basement entrance at +2.7mOD. The barrier would be erected in the event of the EA issuing a flood warning for the area.

Figure 6.7: Example of temporary flood barrier

Figure 6.8: Example of temporary flood barrier

Encroachment of Proposed Structure into the Dock Water

8.8 As mentioned earlier, the existing false quay deck is being demolished and replaced with a new suspended deck to support the promenade. A calculation has been undertaken to assess whether the new deck results in a loss of flood storage in the docks. Refer to Appendix 6 for drawings of the proposed structure. Note that drawings in Appendix 6 are for reference only.

8.9 The following assumptions have been made for the assessment of potential encroachment:

- The design level for future flooding is +5.66;
- The normal water level of the Docks is +4.19mOD;
- The flood storage zone is defined as parts of the proposed structure that fall between the design level for future flooding and the normal dock water level;
- The current encroachment by the existing false quay represents the baseline, such that additional encroachment is considered to be encroachment by the proposed structure exceeding that of the existing structure;
- The deck of the existing false quay structure is to be demolished, but the marine piles are to be left in place;
- The flood storage occupied by the existing false quay structure is calculated based on the dimensions given for the structural elements in Section 4 of this FRA;
- The proposed structure is as per Waterman's preliminary structural design;
- The proposed suspended deck slab is 450mm thick;
- The proposed primary beams supporting the slab are 1800mm wide by 1250mm deep and the proposed secondary beams are 1800mm wide by 1000mm deep;
- 90 no. 1050mm diameter marine piles and 10 no. 1500mm diameter marine piles are to be installed in the dock, is addition to the existing marine piles, which will remain in place.

8.10 Based on the above assumptions, the existing false quay and marine piles occupy approximately 670m3 of flood storage while the proposed structure and retained marine piles occupy approximately 3,230m3. The Proposed Development results in a net loss of flood storage of approximately 2,560m^3.

8.11 In June 2014, Arup completed a hydraulic modelling assessment on the impact of various developments that encroached into the docks across the Canary Wharf estate. This assessment demonstrated that the impact of these developments was negligible as they resulted in an increase in future flood water levels in the River Thames and the West India Docks of far less than the 10mm threshold agreed with the EA.

8.12 The modelling was updated in March 2017 to include the encroachment due to the new promenade structure in the Proposed Development. The results of the modelling showed that the future flood water levels increased by only 0.1mm as a result of the Proposed Development.

The overall impact of the proposed Canary Wharf developments modelled was 0.8mm. Since the overall impact is still less than agreed with the EA the impact on flood risk across the docks and the wider Thames Estuary remains negligible.

8.13 The results of this hydraulic modelling exercise were submitted to the EA in March 2017 for confirmation that the proposed encroachment of the new promenade structure into West India North Dock is acceptable with respect to flood storage. The EA accepted these conclusions.

8.14 In June 2020, Waterman were contacted regarding any changes to their structural design of the false quay. They provided confirmation that the design of the new decking structure hasn't changed to materially affect the conclusions drawn in 2017. Therefore, the additional loss of flood storage due to the Proposed Development is still considered to be negligible.

Access to Safe Havens

8.15 Tidal flooding only lasts a number of hours with levels dropping with the next falling tide allowing escape to the higher land. In the extreme event of a flood on the development area, there is good access to upper floors of the buildings. The general promenade level is set at the maximum likely water level predicted by the EA for beyond 2100. This would enable people to quickly move from areas at risk to the higher promenade level and then to a safe haven in the buildings. It is recommended a Flood Evacuation Plan is prepared prior to occupation to provide detailed guidance to residents on the actions to take in the event of a flood.

The Impact of Climate Change

8.16 The analysis of the impacts of flooding on the development area within this FRA is based on the existing information pertaining to flood levels received from the EA. It is understood that these flood levels have been determined from modelling carried out by the EA based on the TE2100 study, and as such, incorporate a provision for climate change based on the latest Defra guidance.

Sequential and Exception Test

8.17 As this development area is located in Flood Zone 3, according to NPPF a sequential test must be carried out as part of this FRA. Additionally, as the Proposed Development has a flood vulnerability classification of 'less vulnerable' for office and retail land uses, and 'more vulnerable' for residential land use, an Exception Test must be passed before development is permitted as stipulated in NPPF, refer to Table 6.5.

Table 6.5: Flood risk vulnerability and Flood Zone compatibility (Department for Communities and Local Government, 2014)

FLOOD RISK VULNERABILITY CLASS FLOOD ZONE	ESSENTIAL INFRASTRUCTURE	WATER COMPATIBLE	HIGHLY VULNERABLE	MORE VULNERABLE	LESS VULNERABLE
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	✓	Exception test required	✓	✓
Zone 3a	Exception test required	✓	x	Exception test required	✓
Zone 3b (functional floodplain)	Exception test required	✓	x	x	x

Key: ✓ Development is appropriate x Development should not be permitted

8.18 North Quay is an allocated site within the Local Plan of the Local Borough of Tower Hamlets, therefore, a sequential and exception test have already been carried out for the Site as shown in the tables below.

Table 6.6: North Quay Sequential Test (SFRA, London Borough of Tower Hamlets, 2017)

IDENTIFIED USES	STAGE IN SEQUENTIAL TEST	ASSESSMENT
Housing	Are there alternative sites available in zones 1, 2 and 3a?	No reasonably available additional sites (other than windfall sites) that meet the Site selection criteria are available in zones 1, 2 and 3a. The Site is considered to be at the same risk of flooding of those reasonably available within zone 3.
Employment	Are there alternative sites available in zones 1, 2 and 3a?	No reasonably available additional sites (other than windfall sites) that meet the Site selection criteria are available in zones 1 and 2. The Site is considered to be at the same risk of flooding of those reasonably available within zone 3.
Small open space	Are there alternative sites available in zones 1, 2 and 3a?	No reasonably available additional sites (other than windfall sites) that meet the Site selection criteria are available in zones 1 and 2. The Site is considered to be at the same risk of flooding of those reasonably available within zone 3.

Conclusion: Based on the above criteria, no other suitable site was available in a flood risk zone of a lower category. As such this site is the most suitable for the range of uses and therefore the Site passes the sequential test.

Table 6.6: North Quay Exception Test (SFRA, London Borough of Tower Hamlets, 2017)

NPPF REQUIREMENTS	SUGGESTIONS
It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by an SFRA where one has been prepared.	Housing - allocating sites for housing is central to achieving the spatial vision of the Local Plan - specifically policy S. H1 which seeks to deliver 58,965 homes across the borough (equating to at least 3,931 new homes per year) between 2016 and 2031. Employment – allocating employment uses to this site is essential to accommodating employment growth and achieving the spatial vision of the Local Plan - specifically policy S.EMP1 which seeks to maximise and deliver job creation in the borough. Small open space – allocating open space to this site will help to reduce the significant deficit of publicly accessible open space within the borough and will to support the objective of policy S.OWS1 of the Local Plan.
A site specific Flood Risk Assessment must demonstrate that the development will be safe for its lifetime, taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall	A site specific Flood Risk Assessment would be required to address this part of the Exceptions Test, and take into account any site recommendations from the level 2 SFRA. These include: More vulnerable development should be sequentially allocated to areas of the Site at lower relative risk of flooding (Flood Zone 2 and lower hazard areas), with more flood compatible development (such as parking or open space) located in areas at the highest risk. No basement dwellings should be permitted within Flood Zone 3a. They might be possible in Flood Zone 2 provided the exception test is passed. To mitigate against residual tidal flood risk, Finished Floor Levels should be raised 300 mm above the 2100 year maximum water level anticipated through a breach of the River Thames defences. Site specific emergency evacuation procedures must be in place to ensure that the risk to life is minimised should a breach of the River Thames defences occur. Safe access and egress routes should be provided above the 2100 breach flood level and lead to higher ground within Flood Zone 1. Flood resilient construction techniques should be employed to reduce damage and increase the speed of recovery should any flooding events occur. SuDS should be implemented to manage surface water flood risk and restrict post-development runoff to greenfield rates. Geological data indicates that the site is potentially suitable for bespoke infiltration SuDS. The drainage system should provide sufficient capacity to cater for up to the 1 in 100 year storm event, incorporating the latest guidance regarding climate change. The Site is located adjacent to a dock system so consideration should be given to the recommendations of the TE2100 plan with respect to future dock wall raising and advice sought from the EA at an early stage.

Conclusion: Based on the sequential and exception tests above, it was concluded that no other site is reasonably available in a flood risk zone of lower category and that the Site was most suitable. There is a reasonable prospect of compliance with the second part of the exception test subject to an appropriate site layout and a site specific flood risk assessment that takes into account the Site recommendations from the level 2 SFRA.

9. Drainage (surface water and foul) Flood Risk

Surface Water

Existing Surface Water Flood Risk

9.1 The EA's surface water flood maps (see Figures 7.1 to 7.3) show that there is a localised flood risk to the north-west corner of the development area. However, the development area is not located in any of the Borough's Critical Drainage Areas.

9.2 In a 3.3% AEP rainfall event, the EA map does not identify a risk of surface water flooding to the development area (see Figure 7.1). For rainfall events with between a 1% and 3.3% AEP, there is a risk of flooding with a depth of below 300mm in the north-west corner of the development area (see Figure 7.2). For rainfall events with between a 0.1% and 1% AEP, there is a risk of surface water flooding with a depth of up to 900mm in the north-west corner of the development area (see Figure 7.3).

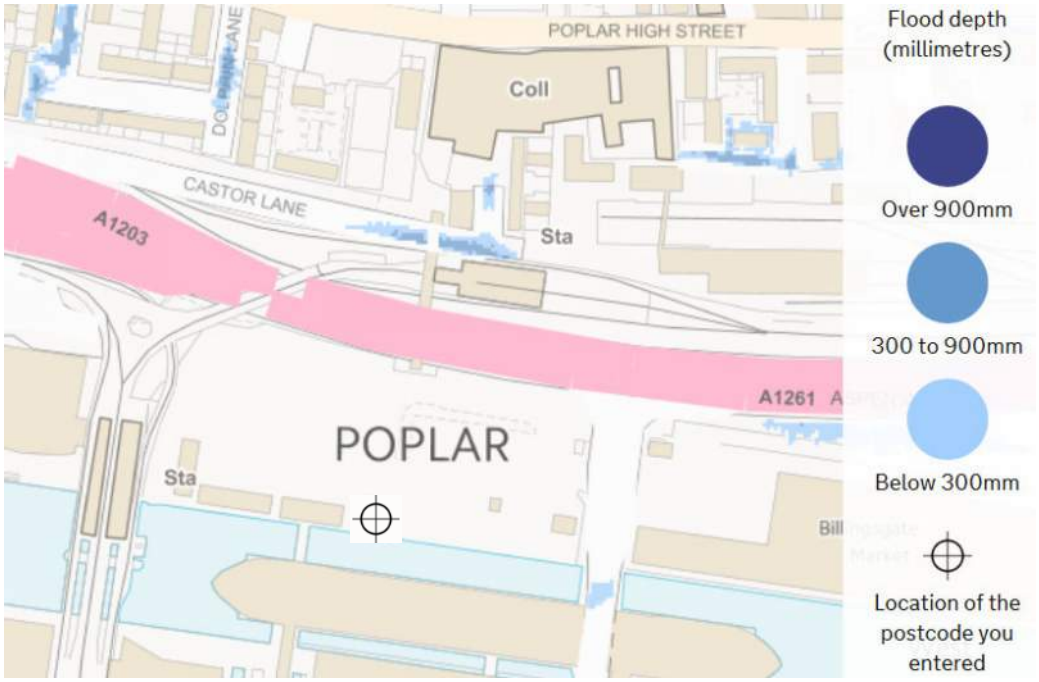


Figure 7.1: EA Flood Map showing depth of surface water flooding for a 3.3% AEP rainfall event (EA, 2020)

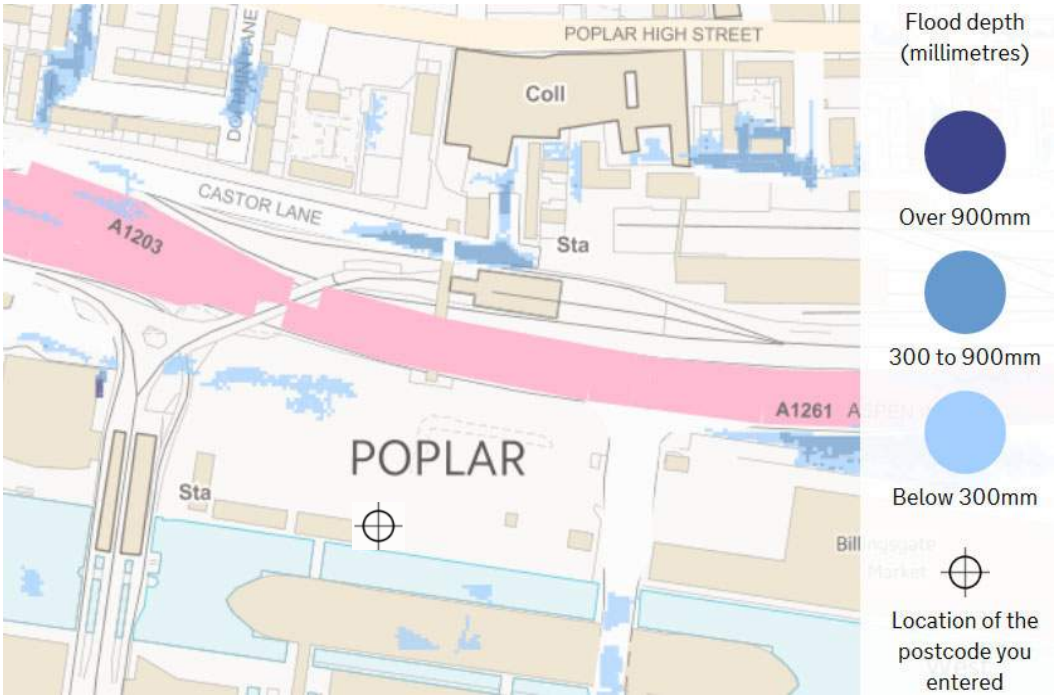


Figure 7.2: EA Flood Map showing depth of surface water flooding for rainfall event with between a 1% and 3.3% AEP (EA, 2020)

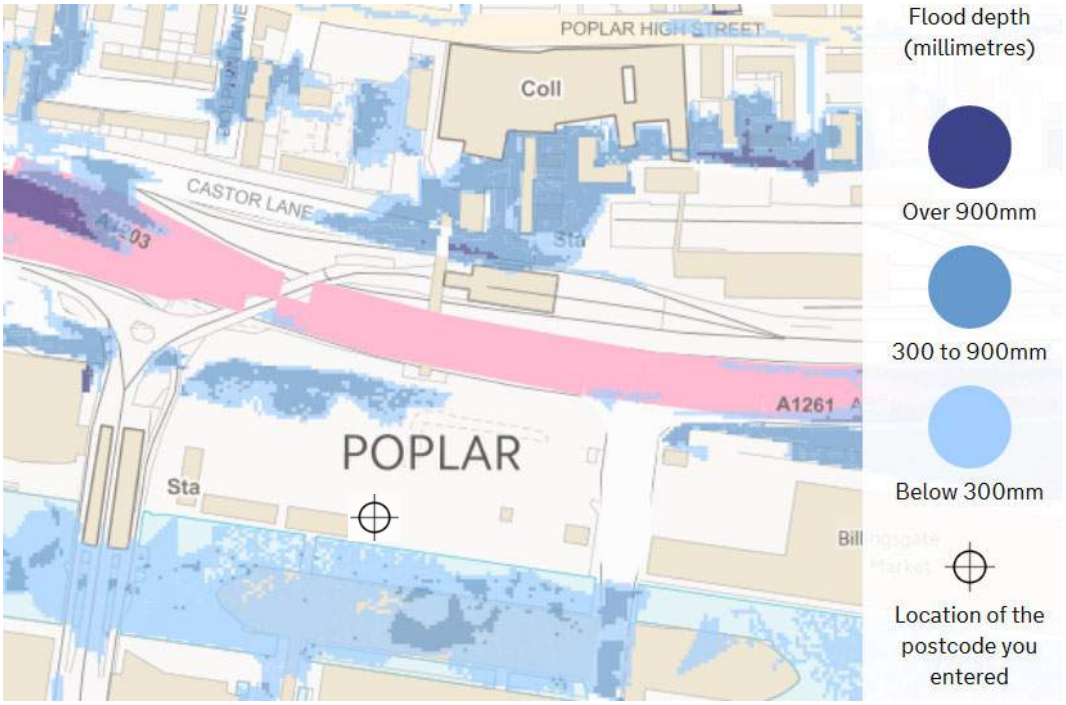


Figure 7.3: EA Flood Map showing depth of surface water flooding for rainfall event with between a 0.1% and 1% AEP (EA, 2020)

Existing Drainage

9.3 The development area in its existing state is not occupied by any buildings. Therefore, there is no foul or direct surface water discharge to the TWUL network at present. TWUL records show a large (1500mm) diameter combined sewer in Aspen Way (see Figure 7.4), identified as North

Quay Sewer. This does not pass through the development area. There is no information from TWUL currently available regarding the invert levels of the nearest manholes in Aspen Way. However, previous desk studies suggest the invert level of the sewer is between -2 and -3mOD. The invert level of one of the manholes upstream of the section of sewer that passes the development area is recorded as being -1.8mOD, suggesting that the sewer invert level is closer to -2mOD.

9.4 The presence of the London Marriot Hotel to the west of the development area, suggests there are smaller diameter drainage connections into Aspen Way.

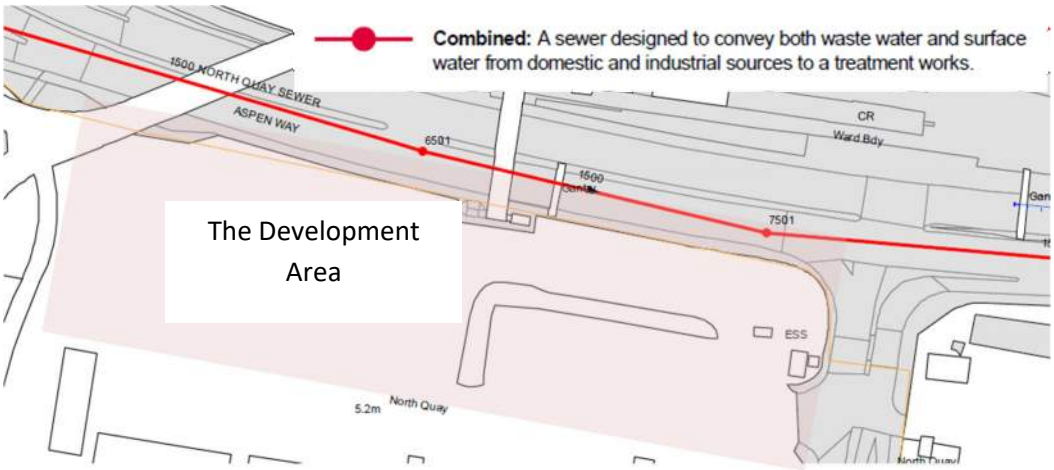


Figure 7.4: Existing Sewer Infrastructure according to TWUL Records (TWUL, 2016)

9.5 A CWCL topographical survey, dated February 2001, shows the private Canary Wharf surface water drainage network in Upper Bank Street (then called Great Wharf Road) to the east of the development area. This is connected to the public sewer in Aspen Way.

Proposed Surface Water Drainage Strategy

9.6 An outline drainage strategy has been developed for the Proposed Development and is shown in Figure 7.5. The design intent is that where possible surface water runoff should be discharged into the North Dock. Discharging directly to the docks has the following advantages:

- Discharging surface water to the docks reduces the loading on the public sewer in Aspen Way
- Clean surface water acts to flush the dock system which benefits water quality in the docks.

9.7 Where surface water cannot be discharged into the docks, due either to the risk of contamination (e.g., road runoff or intensive green roofs) or because of hydraulic constraints, it will be conveyed to the existing combined TWUL sewer on Aspen Way as follows:

- Soft-landscaped areas to the north of the Proposed Development (shown in dark green on Figure 7.5) are too far to discharge to the Docks via gravity and so will drain to buried geo-cellular attenuation tanks before being discharged to the Aspen Way sewer at the greenfield runoff rate.

- Areas of green roof that cannot be discharged to the Docks for reasons relating to water quality will be discharged to the Aspen Way sewer.
- Runoff from the access road, which ramps down into the basement at a level of +2.5mOD, (shown in orange on Figure 7.5) will be stored in a storm pumping station before it is pumped to the high-level attenuation and then discharged to the Aspen Way sewer at the greenfield runoff rate.

9.8 The requirement for a pumping station is due to the Proposed Development levels; the access road as it enters the basement is lower than Aspen Way, such that if the two were hydraulically connected by a drainage system, flooding along Aspen Way could back up and cause flooding of the development area.

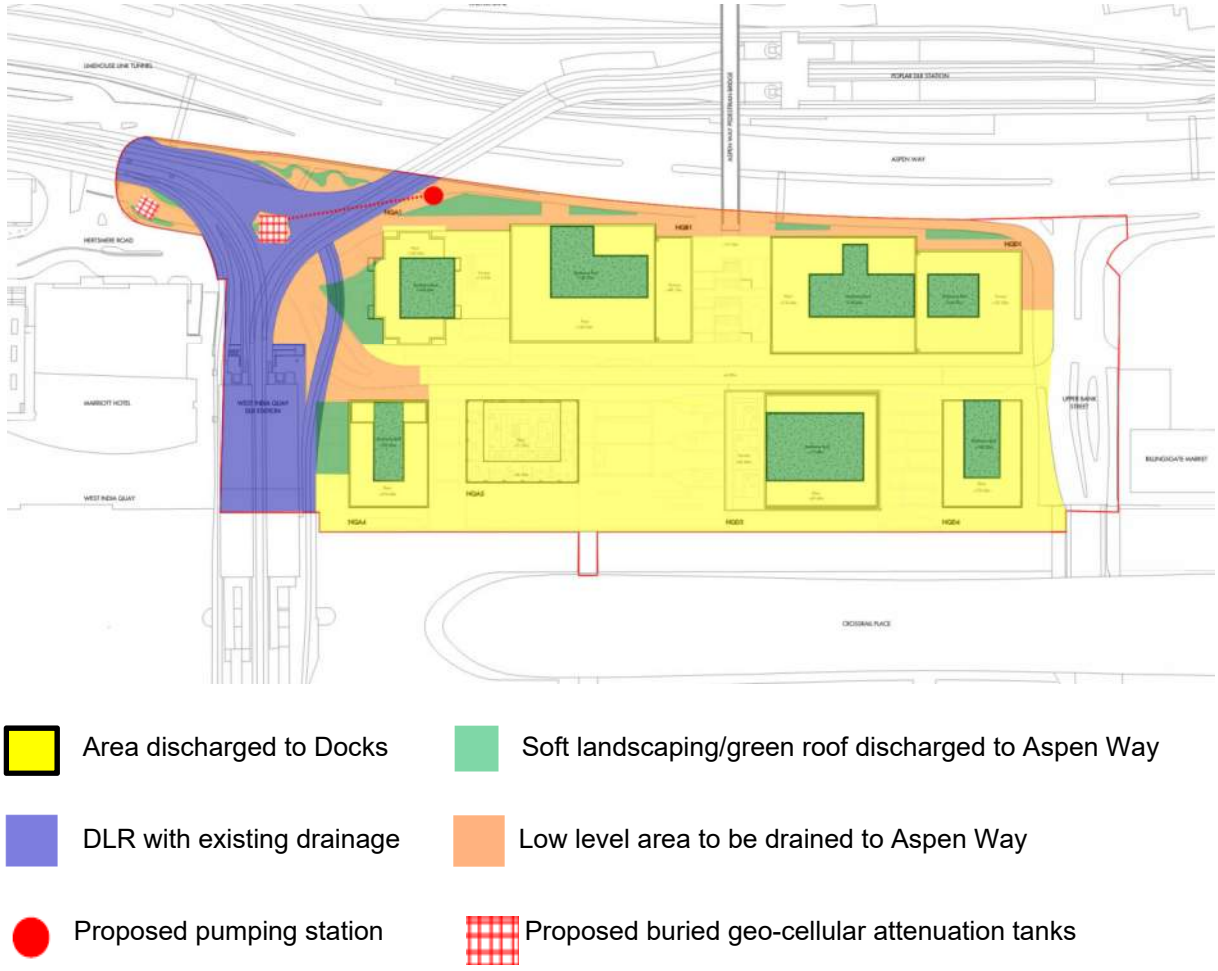


Figure 7.5: Outline surface water drainage strategy for the Proposed Development (Arup, 2020)

Estimated Surface Water Discharge Rates and Attenuation Volumes

9.9 CRT do not impose a limiting discharge rate on surface water runoff from the development area to the Docks. Therefore, there is no requirement for attenuation of surface water intended to be discharged to the Docks.

9.10 Discharge rates to the public sewer will need to be agreed with TWUL. The intention is to limit the surface water discharge to the TWUL sewer to greenfield rate in accordance with sustainable drainage policy in the London Plan.

9.11 Due to the proposed levels, which are dictated by the necessity to tie in with the existing levels of adjacent land, it is not possible to contain the 1% AEP rainfall event within the development area above ground. Therefore, attenuation below ground will be required to achieve the limiting discharge rate imposed on surface water runoff to the TWUL sewer.

Sustainable Drainage Systems

9.12 Sustainable Drainage Systems (SuDS) are techniques that control surface water runoff as close to source as possible to reduce surface water run-off rates and volumes.

9.13 The presence of the basement over much of the development area and the high groundwater levels, limits the opportunity for infiltration of surface water. SuDS measures that require permeable ground conditions, such as soakaways, are therefore not suitable for the Proposed Development. Space constraints preclude the use of features such as swales and ponds.

9.14 Discharging directly into the docks or the River Thames is considered the most sustainable approach to manage surface water on the Proposed Development, for the reasons discussed in Section 7.1.3; this is provided that appropriate water quality protection measures are incorporated.

9.15 The inclusion of soft landscaping and green roof reduces the impermeable area when compared to the existing situation.

Proposed Foul Water Drainage Strategy

9.16 There would be an increase in foul flows due to the Proposed Development compared with the foul flows generated by the existing site. Based on the building use and occupancy figures, Max Fordham have estimated that there will be a peak foul discharge of 65l/s[25].

9.17 Foul effluent from the above ground accommodation would be discharged by gravity to the public foul sewer in Aspen Way. Foul effluent from the basement levels (plant rooms, car parks, cavity wall drainage, off-loading bays and all other waste drainage requirements) would be discharged by a number of small foul pumping stations located at various points within the basement.

[25] Max Fordham, June 2020. Foul Sewerage & Utilities Assessment

9.18 In addition, the levels along Aspen Way are such that in the unlikely event of sewer flooding, foul water will flow along the highway towards Limehouse Link, to the north-west. Therefore, the risk to the development posed by foul sewer flooding is considered to be low.

10. Groundwater Flood Risk

General

10.1 The general hydrogeological setting for the Isle of Dogs consists of two aquifers, the Upper Aquifer within the Terrace Gravel strata, and the Lower Aquifer comprising the Lower Lambeth Sand, Thanet Sand and Chalk. These aquifers are hydraulically separated by the relatively impermeable Lambeth Clay aquitard.

Upper Aquifer

10.2 The groundwater levels of the Upper Aquifer are mainly influenced by rainfall infiltration and flow towards the River Thames over the surface of the clay aquitard. Leaks from water mains, sewers and the Docks can also influence groundwater levels.

10.3 The Upper Aquifer has historically been monitored for short periods during the various ground investigations undertaken on the development area. Refer to North Quay Geotechnical Desk Study (Arup, December 2020) for results of historical ground water monitoring of the Upper Aquifer, covering the period between 1988 and 2016.

10.4 It is understood that permanent dewatering at the basement level of the Marriott Hotel, located approximately 100m to the west of the development area, may be affecting the groundwater levels in the Upper Aquifer. Consequently, more drawdown may be occurring on the west side of the development area compared to the east side.

Lower Aquifer

10.5 The groundwater levels of the Lower Aquifer are influenced by local dewatering activities at Canary Wharf.

10.6 Dewatering of the Lower Aquifer commenced in August 2008 to enable construction of CWCS. A review of the CWCS dewatering was undertaken by Arup in October 2016, which concluded that dewatering at the development area could be discontinued; subsequently, dewatering was stopped in early November 2016.

10.7 Recorded water levels of the Lower Aquifer are at approximately -32mOD at the end of November 2016. The Lower Aquifer has recovered by approximately 10m within one month following the cessation of dewatering.

10.8 In June 2016 dewatering at Wood Wharf started (approximately 800m south-east of the development area).

10.9 In the long term, assuming no dewatering is carried out in the Canary Wharf area, the level of the lower aquifer may rise to as high as +1mOD at North Quay.

Flood Risk

10.10 The LBTH SFRA does not identify groundwater flooding as a risk to the development area (see map in Figure 9.1) and further states that is unlikely to be susceptible, based on geological indicators.

10.11 Groundwater seepage from the aquifers is not considered to present a significant flood hazard. The groundwater is likely to be of a flow rate and volume that can be accommodated by the design of the basement. The basement walls and slabs would be designed for the appropriate hydrostatic pressures and uplift forces.

10.12 If basement waterproofing failed, the residual risk to life would be negligible since the flow rates and volumes of water are very small and the basements are non-habitable spaces.

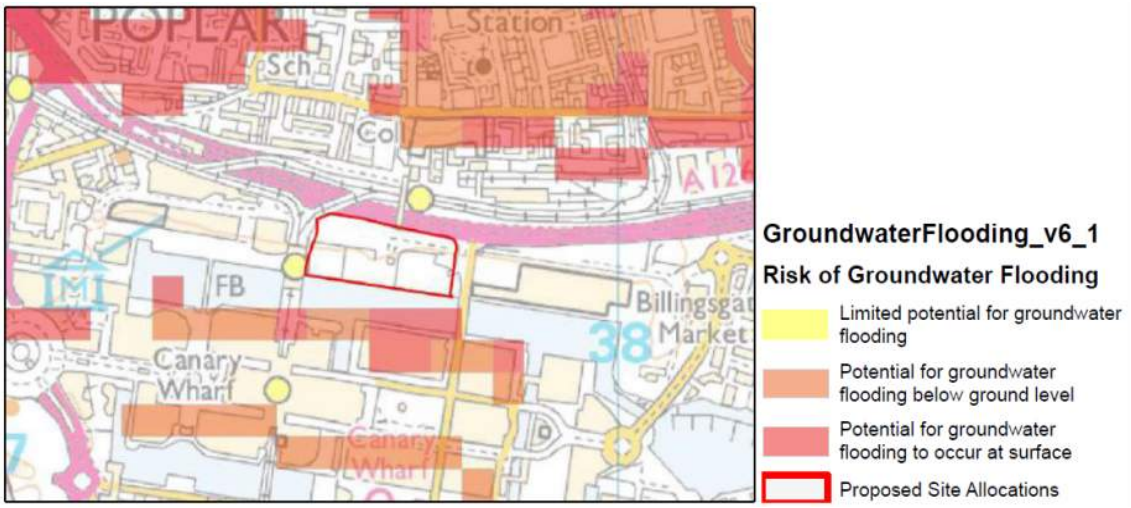


Figure 8.1: Map showing susceptibility of development area to groundwater flooding (SFRA, 2017)

11. Flood Risk from Artificial Water Sources

11.1 The EA has produced reservoir flood maps showing the potential flood risk following a breach of a major reservoir. The extent of flooding and flood depth is illustrated by Figure 9.1. It can be seen from the map that Aspen Way and an area within the development area under the DLR viaduct.

11.2 The area within the development area has a flood depth of below 300mm. No sensitive land use is proposed on that area (neither residential nor commercial development). In addition, the levels along Aspen Way are such that in the event of reservoir breach water will flow along the highway towards the north-west. Therefore, the risk to the Proposed Development posed by reservoir breach flooding is considered to be low.

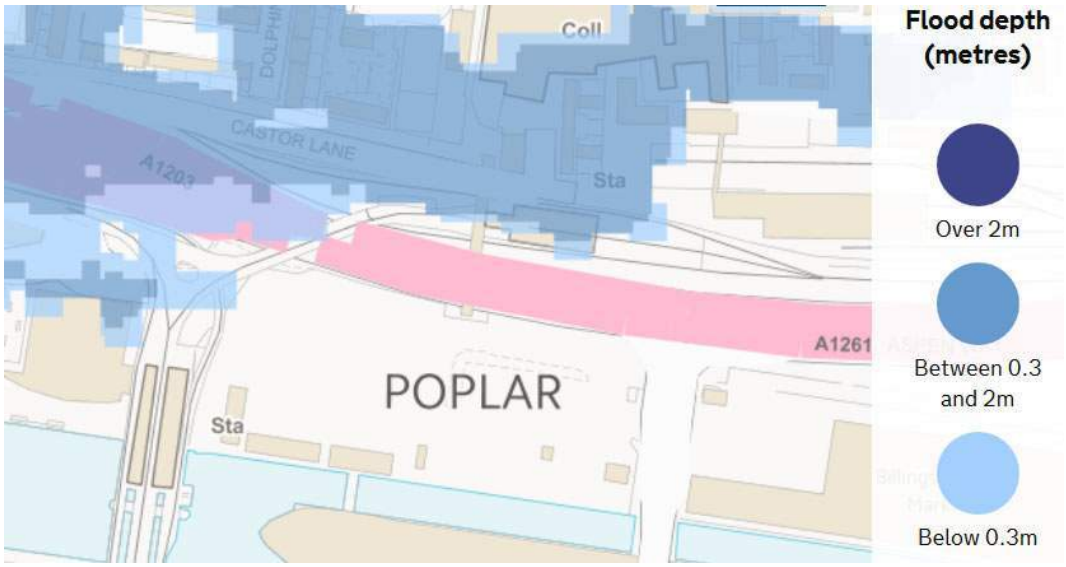


Figure 9.1: Flood Risk Map for Reservoir Breach (EA, 2020)

11.3 The Proposed Development is protected from breach flooding from the north-west corner by:

- the Proposed Development levels along the boundary with Aspen Way (as discussed in Section 6.6);
- a flood barrier positioned where the proposed access road level drops to +2.2mOD to pass under the DLR viaducts.

11.4 No other artificial sources of flood risk have been identified within the boundary of the development area.

12. Conclusions

12.1 As a result of undertaking the FRA, a number of conclusions can be drawn which are identified below:

- The Proposed Development has a flood vulnerability classification of 'less vulnerable' according to the EA because the residential elements are positioned above the Thames Estuary 2100 flood levels.
- Although it is located in Flood Zone 3 (high risk) the development area benefits from the protection of the Thames Tidal Defences and as such the EA classify the Site as having a low residual flood risk.
- The proposed promenade levels along the south of the development area are such that the Proposed Development is adequately protected from fluvial/tidal flood risk. On the north side of the Site, the proposed building edge and landscaping will be raised to provide adequate protection in the event of a breach in the Thames Tidal Defences.
- The Proposed Development will convey surface and foul water away from the development area in an appropriate manner. The Peak foul flows have been agreed with TWUL and form part of their long-term planning for an Integrated Water Management Strategy across the wider Isle of Dogs. The majority of the surface water would be discharged to the docks. This is the most sustainable solution for the development area and is generally preferred by the EA and the Canal & River Trust (CRT). It will be necessary to provide attenuation for limited areas which cannot be discharged to the docks because of either hydraulic or water quality constraints. This surface water runoff will discharge at a greenfield run off rate to the public sewer in Aspen Way.
- Artificial water sources (reservoir breach) do not present a significant risk to the Proposed Development.
- Groundwater does not present a flood risk to the Proposed Development.
- The Proposed Development will not apply additional loading to the Banana Wall.
- The existing false quay will be replaced with a new suspended deck structure that will support the new promenade. The flood storage loss associated with the new structure and retained marine piles results in a negligible impact on the future flood water levels in the Docks and the River Thames. This has been demonstrated by hydraulic modelling which has been accepted by the EA in 2017. It has been confirmed by the structural engineer that the hydraulic modelling is in line with the most up to date 2020 false quay design.

Appendix 1 Abbreviations

LBTH	London Borough of Tower Hamlets
FRA	Flood Risk Assessment
LBC	Listed Building Consent
OPA	Outline Planning Application
NPPF	National Planning Policy Framework
NPPG	National Planning Practice Guidance
EA	Environment Agency
CRT	Canal and River Trust
TWUL	Thames Water Utilities Limited
LLFA	Lead Local Flood Authority
SUDS	Sustainable Urban Drainage Systems
SPG	Supplementary Planning Guidance
TE2100	Thames Estuary 2100
CFMP	Catchment Flood Management Plan
SWMP	Surface Water Management Plan
CDA	Critical Drainage Area
SFRA	Strategic Flood Risk Assessment
DCG	Design and Construction Guidance
SPG	Supplementary Planning Guidance
EIA	Environmental Impact Assessment
DLR	Docklands Light Railway
CWCL	Canary Wharf Contractors Limited
CWCS	Canary Wharf Crossrail Station
AEP	Annual Exceedance Probability
MLWL	Maximum Likely Water Level

Appendix 2 EA Product 8 Report

Product 4 (Detailed Flood Risk) for: Aspen Way, London, E14 5GJ
Reference: HNL 168894 BC
Date: 23/04/2020

Contents

The information provided is based on the best data available as of the date of this letter.

You may feel it is appropriate to contact our office at regular intervals, to check whether any amendments/ improvements to the data for this location have been made. Should you re-contact us after a period of time, please quote the above reference in order to help us deal with your query.

Please refer to the Open Government Licence which explains the permitted use of this information.

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Customer services line: 03708 506 506
Email: NETenquiries@environment-agency.gov.uk
Website: www.environment-agency.gov.uk

Flood Map for Planning (Rivers and Sea)

The Flood Map:

Our Flood Map shows the natural floodplain for areas at risk from river and tidal flooding. The floodplain is specifically mapped ignoring the presence and effect of defences. Although flood defences reduce the risk of flooding they cannot completely remove that risk as they may be over topped or breached during a flood event.

The Flood Map indicates areas with a 1% (0.5% in tidal areas), Annual Exceedance Probability (AEP) - the probability of a flood of a particular magnitude, or greater, occurring in any given year, and a 0.1% AEP of flooding from rivers and/or the sea in any given year. In addition, the map also shows the location of some flood defences and the areas that benefit from them.

The Flood Map is intended to act as a guide to indicate the potential risk of flooding. When producing it we use the best data available to us at the time and also take into account historic flooding and local knowledge. The Flood Map is updated on a quarterly basis to account for any amendments required. These amendments are then displayed on the internet at https://www.gov.uk/check-flood-risk

At this Site:

The Flood Map shows that this site lies within Flood Zone 3 - with a 0.5% chance of flooding from the Thames (tidal Thames flooding) in any given year. Enclosed is an extract of our Flood Map which shows this information for your area.

Method of production

The Flood Map at this location has been derived using detailed modelling of the tidal River Thames through the Thames Tidal Defences Study completed in 2006 by Halcrow Ltd.

Alchemy, Bessemer Road, Welwyn Garden City, Hertfordshire, AL7 1HE
Customer services line: 03708 506 506
Email: NETenquiries@environment-agency.gov.uk
Website: www.environment-agency.gov.uk

Thames Estuary 2100 (TE2100)

You have requested in-channel flood levels for the tidal river Thames. These have been taken from the Thames Estuary 2100 study completed by HR Wallingford in 2008. The modelled Thames node closest to your site is **2.40,** the locations of nearby nodes on the River Thames are also shown on the enclosed map.

Details about the TE2100 plan

The TE2100 plan is now live and within it are a set of levels on which the flood risk management strategy is based. The plan is the overarching flood management strategy for the Thames Estuary and therefore any development planning should be based on the same underlying data.

Details about the TE2100 in-channel levels

The TE2100 in-channel levels take into account operation of the Thames Barrier when considering future levels. The Thames Barrier requires regular maintenance and with additional closures the opportunity for maintenance will be reduced. When this happens, river levels – for which the Barrier would normally shut for the 2008 epoch – will have to be allowed through to ensure that the barrier is not shut too often. For this reason, levels upriver of the barrier will increase and the tidal walls will need to be heightened to match.

Why is there no return period for levels upriver of the barrier?

The levels upriver of the barrier are the highest levels permitted by the operation of the Thames Barrier. If levels and flows are forecast to be any higher, the Thames Barrier would shut, ensuring that the tide is blocked and the river maintained to a low level. For this reason the probability of any given water level upriver of the Barrier is controlled and therefore any associated return period becomes irrelevant. The Thames Barrier and associated defence system has a 1 in 1000 year standard which means it ensures that flood risk is managed up to an event that has a 0.1% annual probability. The probability of water levels upriver is ultimately controlled by the staff at the Thames Barrier.

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TE2100 2008 levels:

Levels downriver of the Thames Barrier are 0.1% AEP (1 in 1000) and levels upriver are the highest levels permitted by the Thames Barrier, described as the Maximum Likely Water Levels (MLWLs). The defence levels (left defence, right defence) are the minimum levels to which the defences should be built.

Node	Easting	Northing	Extreme water level (m)	Present Day Statuatory Defence Level (Thames Left Bank) (m)	Allow for future 2100 defence raising to a level of... (Thames Left Bank)
2.40	536880	180056	4.73	5.23	6.20
2.45	538614	179907	4.68	5.23	6.20
2.46	538943	180471	4.67	5.23	6.20

TE2100 climate change levels:

			2065 to 2100		**2100**	
Node	Easting	Northing	Design water level	Defence level (both banks)	Design water level	Defence level (both banks)
2.40	536880	180056	5.24	5.70	5.73	6.20
2.45	538614	179907	5.17	5.70	5.66	6.20
2.46	538943	180471	5.16	5.70	5.65	6.20

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Email: NETenquiries@environment-agency.gov.uk
Website: www.environment-agency.gov.uk

Thames Tidal Upriver Breach Inundation Modelling

The map attached displays site-specific modelled flood levels at your site. These have been taken from the Thames Tidal Upriver Breach Inundation Modelling Study 2017 completed by Atkins Ltd. in May 2017.

We have developed a modelling approach where all upriver breach locations along the Thames are equitably modelled, to ensure a consistent approach across London. This modelling simulates 5679 continuous tidal breaches along the entire extent of the Thames from Teddington to the Thames Barrier. For hard and composite defences breaches are set at 20 m wide; for soft defences, breaches are 50 m wide. In both cases, the defence breach scour distance was assumed to extend into the floodplain by the same distance as the breach width.

For breaches upriver of the Thames Barrier, there is no return period for modelled levels as the levels are controlled by barrier closures. The levels used are referred to as Maximum Likely Water Levels (MLWLs). Therefore 2005 and 2100 epochs were modelled on that basis.

This modelling has two epochs to consider; the 2005 epoch is a representation of today's flood levels without climate change considerations taken into account, and the 2100 epoch which takes into account changes likely to be seen due to climate change.

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Defence Details

The design standard of protection of the flood defences in this area of the Thames is 0.1% AEP; they are designed to defend London up to a 1 in 1000 year **tidal** flood event. The defences are all raised, man-made and privately owned. It is the riparian owners' responsibility to ensure that they are maintained to a crest level of **5.23m** mAODN (the Statutory Flood Defence Level in this reach of the Thames). We inspect them twice a year to ensure that they remain fit for purpose. The current condition grade for defences in the area are **2 (good)** and **3 (Fair),** on a scale of 1 (very good) to 5 (very poor). For more information on your rights and responsibilities as a riparian owner, please see our document 'Living on the edge' found on our website at:

https://www.gov.uk/government/publications/riverside-ownership-rights-and-responsibilities

There are no planned improvements in this area. Please see the 'Thames Estuary 2100' document on our website for the short, medium and long term Flood Risk Management strategy for London:

https://www.gov.uk/government/publications/thames-estuary-2100-te2100

Areas Benefiting from Flood Defences

This site is within an area benefiting from flood defences, as shown on the enclosed extract of our Flood Map. Areas benefiting from flood defences are defined as those areas which benefit from formal flood defences specifically in the event of flooding from rivers with a 1% (1 in 100) chance in any given year, or flooding from the sea with a 0.5% (1 in 200) chance in any given year.

If the defences were not there, these areas would be flooded. An area of land may benefit from the presence of a flood defence even if the defence has overtopped, if the presence of the defence means that the flood water does not extend as far as it would if the defence were not there.

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Recorded Flood Events Data

We hold records of historic flood events from rivers and the sea. Information on the floods that may have affected the area local to your site are provided in the enclosed map.

Due to the fact that our records are not comprehensive, we would advise that you make further enquiries locally with specific reference to flooding at this location. You should consider contacting the relevant Local Planning Authority and/or water/sewerage undertaker for the area.

We map flooding to land, not individual properties. Our historic flood event record outlines are an indication of the geographical extent of an observed flood event. Our historic flood event outlines do not give any indication of flood levels for individual properties. They also do not imply that any property within the outline has flooded internally.

Please be aware that flooding can come from different sources. Examples of these are:

- from rivers or the sea;
- surface water (i.e. rainwater flowing over or accumulating on the ground before it is able to enter rivers or the drainage system);
- overflowing or backing up of sewer or drainage systems which have been overwhelmed,
- groundwater rising up from underground aquifers

Currently the Environment Agency can only supply flood risk data relating to the chance of flooding from rivers or the sea. However you should be aware that in recent years, there has been an increase in flood damage caused by surface water flooding and drainage systems that have been overwhelmed.

Other Sources of Flood Risk

The Lead Local Flood Authority for your area are responsible for local flood risk (i.e. surface runoff, ground water and ordinary watercourse) and may hold further information .

You may also wish to consider contacting the appropriate relevant Local Planning Authority and/or water/sewerage undertaker for the area. They may be able to provide some knowledge on the risk of flooding from other sources.

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Additional Information

Use of Environment Agency Information for Flood Risk / Flood Consequence Assessments

Important

If you have requested this information to help inform a development proposal, then we recommend that you undertake a formal pre-application enquiry using the form available from our website:-

https://www.gov.uk/government/publications/pre-planning-application-enquiry-form-preliminary-opinion

Depending on the enquiry, we may also provide advice on other issues related to our responsibilities including flooding, waste, land contamination, water quality, biodiversity, navigation, pollution, water resources, foul drainage or Environmental Impact Assessment.

In **England**, you should refer to the Environment Agency's Flood Risk Standing Advice, the technical guidance to the National Planning Policy Framework and the existing PPS25 Practice Guide for information about what flood risk assessment is needed for new development in the different Flood Zones. These documents can be accessed via:

https://www.gov.uk/flood-risk-standing-advice-frsa-for-local-planning-authorities

https://www.gov.uk/government/publications/national-planning-policy-framework-technical-guidance

https://www.gov.uk/government/publications/development-and-flood-risk-practice-guide-planning-policy-statement-25

You should also consult the Strategic Flood Risk Assessment produced by your local planning authority.

You should note that:

1. Information supplied by the Environment Agency may be used to assist in producing a Flood Risk / Consequence Assessment (FRA / FCA) where one is required, but does not constitute such an assessment on its own.
2. This information covers flood risk from main rivers and the sea, and you will need to consider other potential sources of flooding, such as groundwater or overland runoff. The information produced by the local planning authority referred to above may assist here.
3. Where a planning application requires a FRA / FCA and this is not submitted or deficient, the Environment Agency may well raise an objection.
4. For more significant proposals in higher flood risk areas, we would be pleased to discuss details with you ahead of making any planning application, and you should also discuss the matter with your local planning authority.

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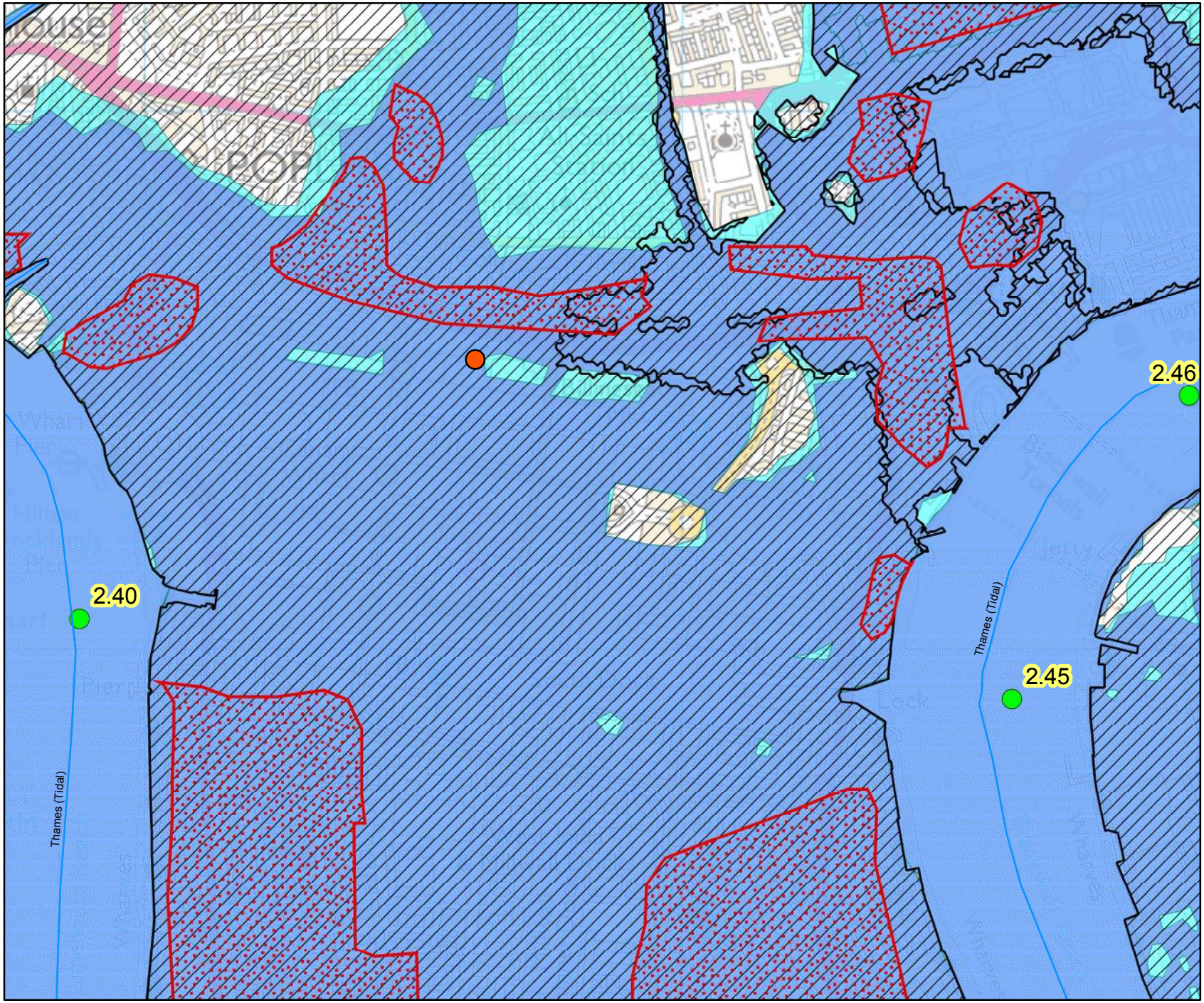
Detailed FRA/FCA for: Aspen Way, London, E14 5GJ - 23/04/2020 - HNL 168894 BC



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Hertfordshire,
AL7 1HE

N

0 150 300 600
Metres

Legend

- Main Rivers
- Site location
- TE2100Nodes
- 1707 Flood Outline
- 1928 Flood Outline
- 1953 Flood Outline
- Areas Benefiting from Flood Defences
- Flood Zone 3
- Flood Zone 2

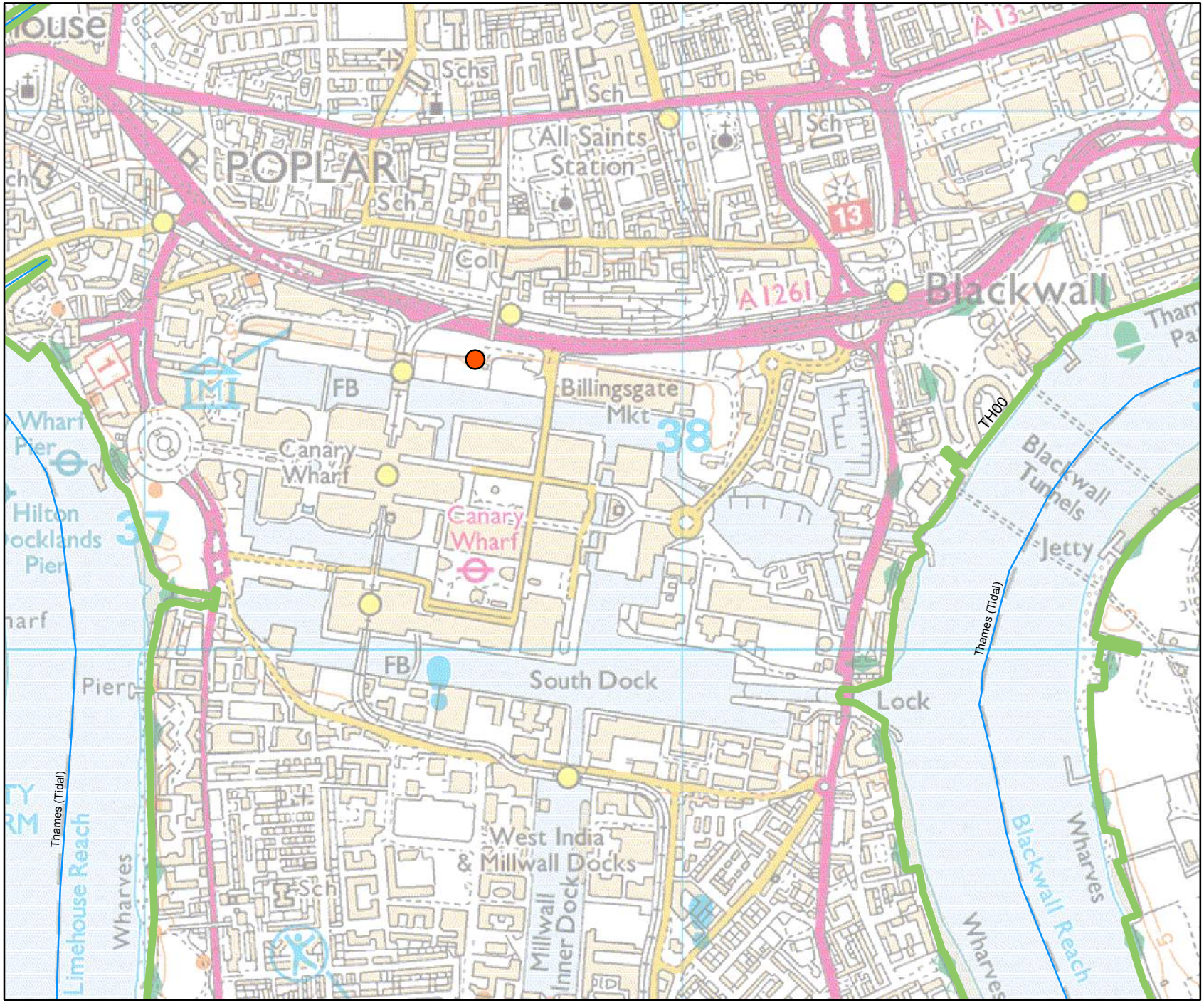
Flood Map for Planning (assuming no defences)

Flood Zone 3 shows the area that could be affected by flooding:
- from the sea with a 1 in 200 or greater chance of happening each year
- or from a river with a 1 in 100 or greater chance of happening each year.

Flood Zone 2 shows the extent of an extreme flood from rivers or the sea with up to a 1 in 1000 chance of occurring each year.

Produced by:
Partnerships & Strategic Overview,
Hertfordshire & North London

Detailed FRA/FCA for: Aspen Way, London, E14 5GJ - 23/04/2020 - HNL 168894 BC



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Hertfordshire,
AL7 1HE

N

0 150 300 600

Metres

Legend

Main Rivers

Site location

TTD Defences SDL (mAODN)

SDL

5.23

The following information on defences has been extracted from the Asset Information Management System (AIMS)

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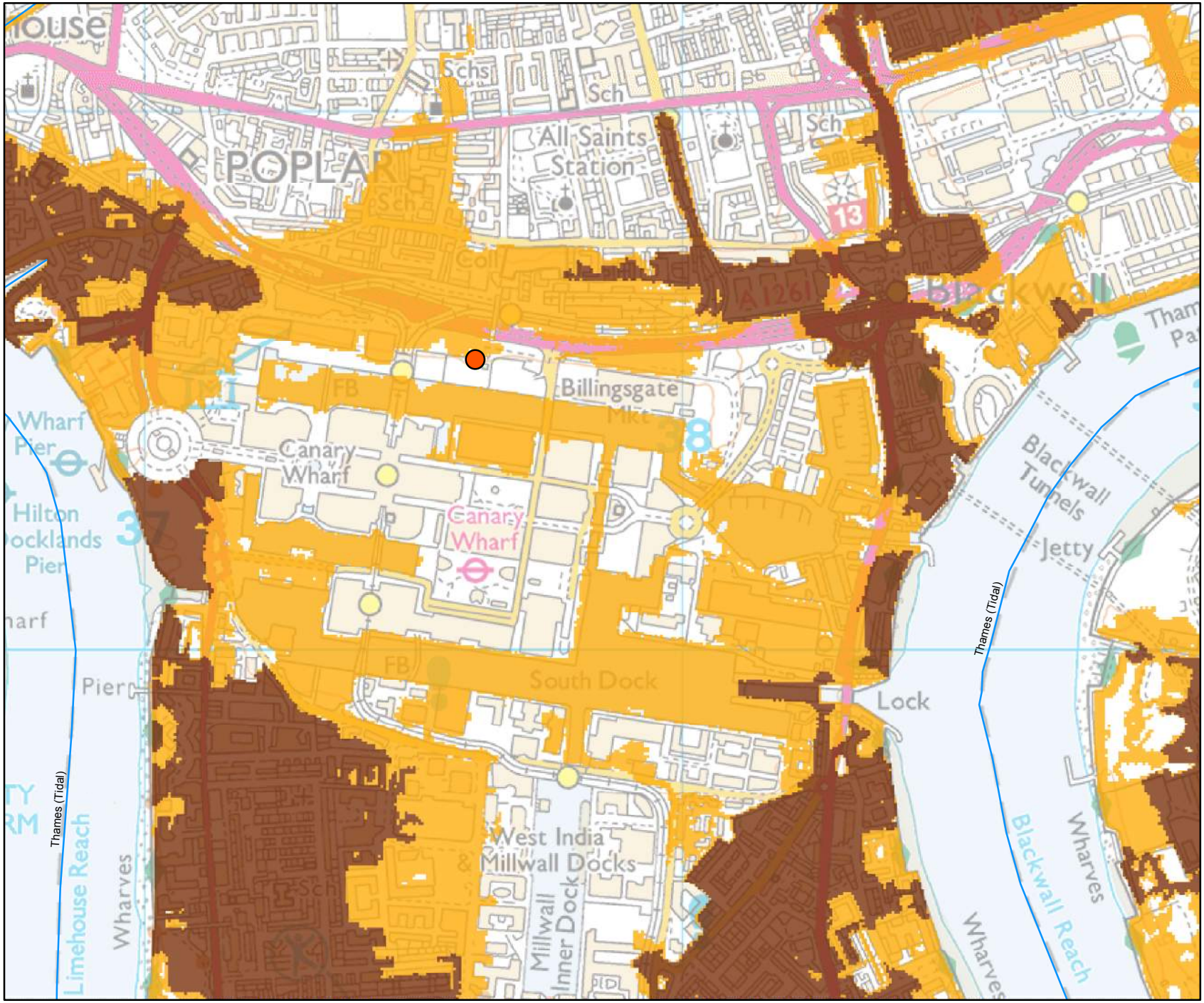
Breach Modelling Map for: Aspen Way, London, E14 5GJ - 23/04/2020 - HNL 168894 BC



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Hertfordshire,
AL7 1HE

N

0 150 300 600

Metres

Legend

- Main Rivers
- Site location

Upstream Breach Outlines

Epoch

- 2005
- 2100

Thames Tidal Upriver Breach Inundation Modelling 2017

A modelled representation of all upriver tidal breach locations along the Thames from Teddington to the Thames Barrier, based on low floodplain topography. For hard and composite defences breaches are set at 20 m wide; for soft defences, breaches are 50 m wide. In both cases, the defence breach scour distance was assumed to extend into the floodplain by the same distance as the breach width. The modelling is based on the 2008 TE2100 in-channel levels, with an allowance for climate change for epoch 2100.

Produced by:
Partnerships & Strategic Overview,
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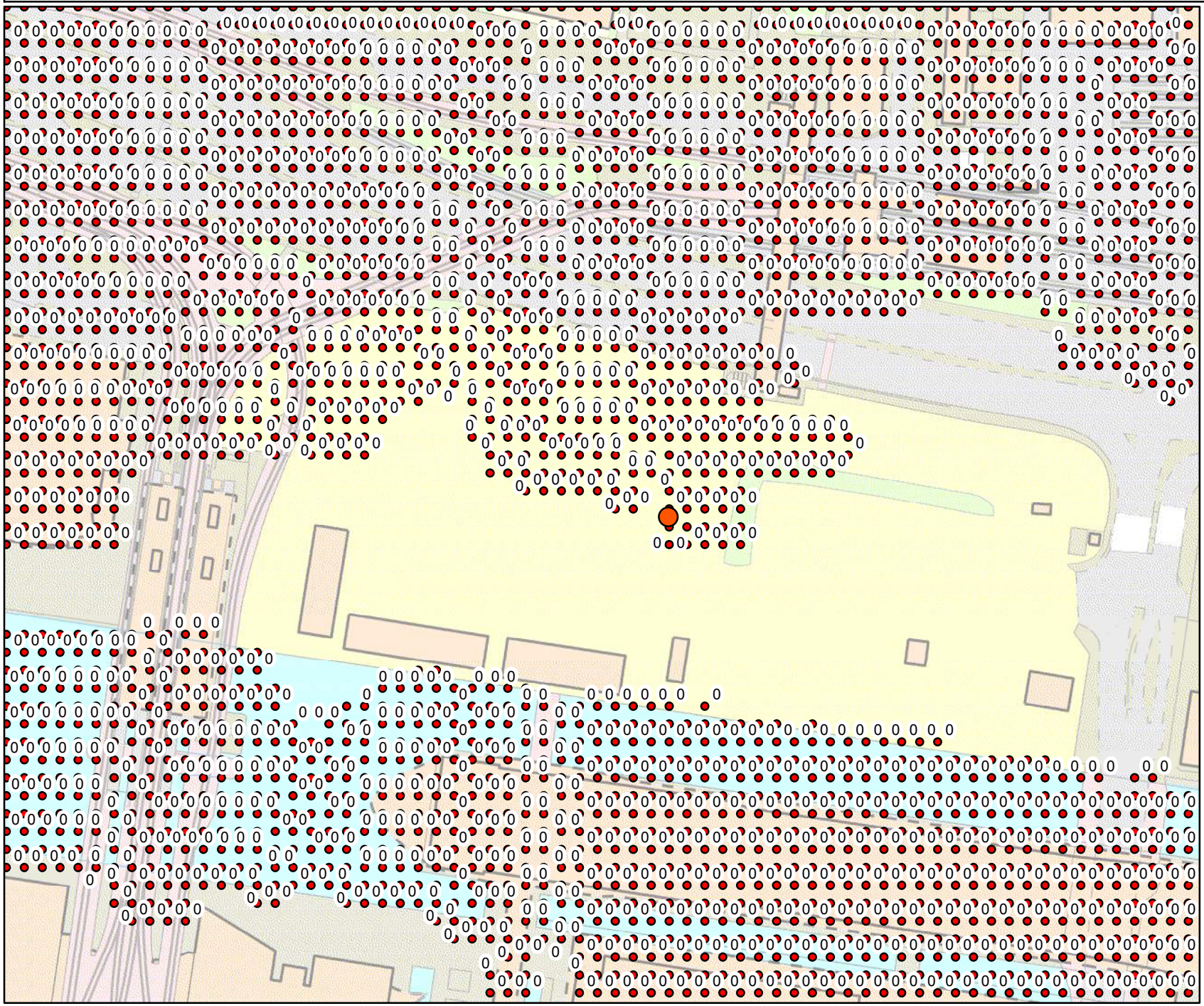
Modelled Flood Levels For: Aspen Way, London, E14 5GJ - 23/04/2020 - HNL 168894 BC



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Hertfordshire,
AL7 1HE

N

0 20 40 80
Metres

Legend

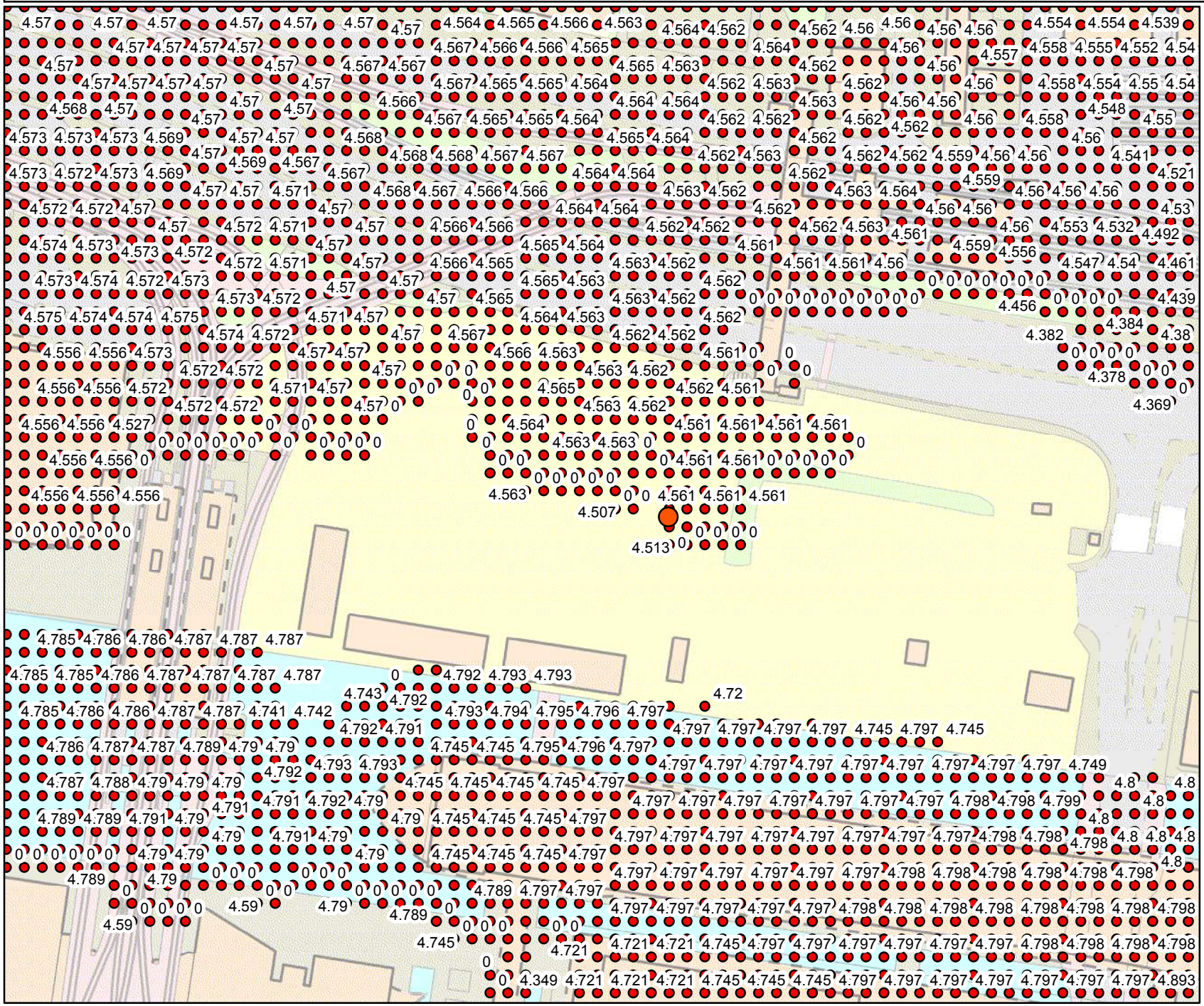
- Main Rivers
- Site location
- Tidal Breach Height (mAOD) 2005

Thames Tidal Upriver Breach Inundation Modelling 2017

A modelled representation of all upriver tidal breach locations along the Thames from Teddington to the Thames Barrier, based on low floodplain topography. For hard and composite defences breaches are set at 20 m wide; for soft defences, breaches are 50 m wide. In both cases, the defence breach scour distance was assumed to extend into the floodplain by the same distance as the breach width. The modelling is based on the 2008 TE2100 in-channel levels, with an allowance for climate change for epoch 2100.

Produced by:
Partnerships & Strategic Overview,
Hertfordshire & North London

Modelled Flood Levels For: Aspen Way, London, E14 5GJ - 23/04/2020 - HNL 168894 BC



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Welwyn Garden City,
Hertfordshire,
AL7 1HE

N

0 20 40 80
Metres

Legend

- Main Rivers
- Site location
- Tidal Breach Height (mAOD) 2100

Thames Tidal Upriver Breach Inundation Modelling 2017

A modelled representation of all upriver tidal breach locations along the Thames from Teddington to the Thames Barrier, based on low floodplain topography. For hard and composite defences breaches are set at 20 m wide; for soft defences, breaches are 50 m wide. In both cases, the defence breach scour distance was assumed to extend into the floodplain by the same distance as the breach width. The modelling is based on the 2008 TE2100 in-channel levels, with an allowance for climate change for epoch 2100.

Produced by:
Partnerships & Strategic Overview,
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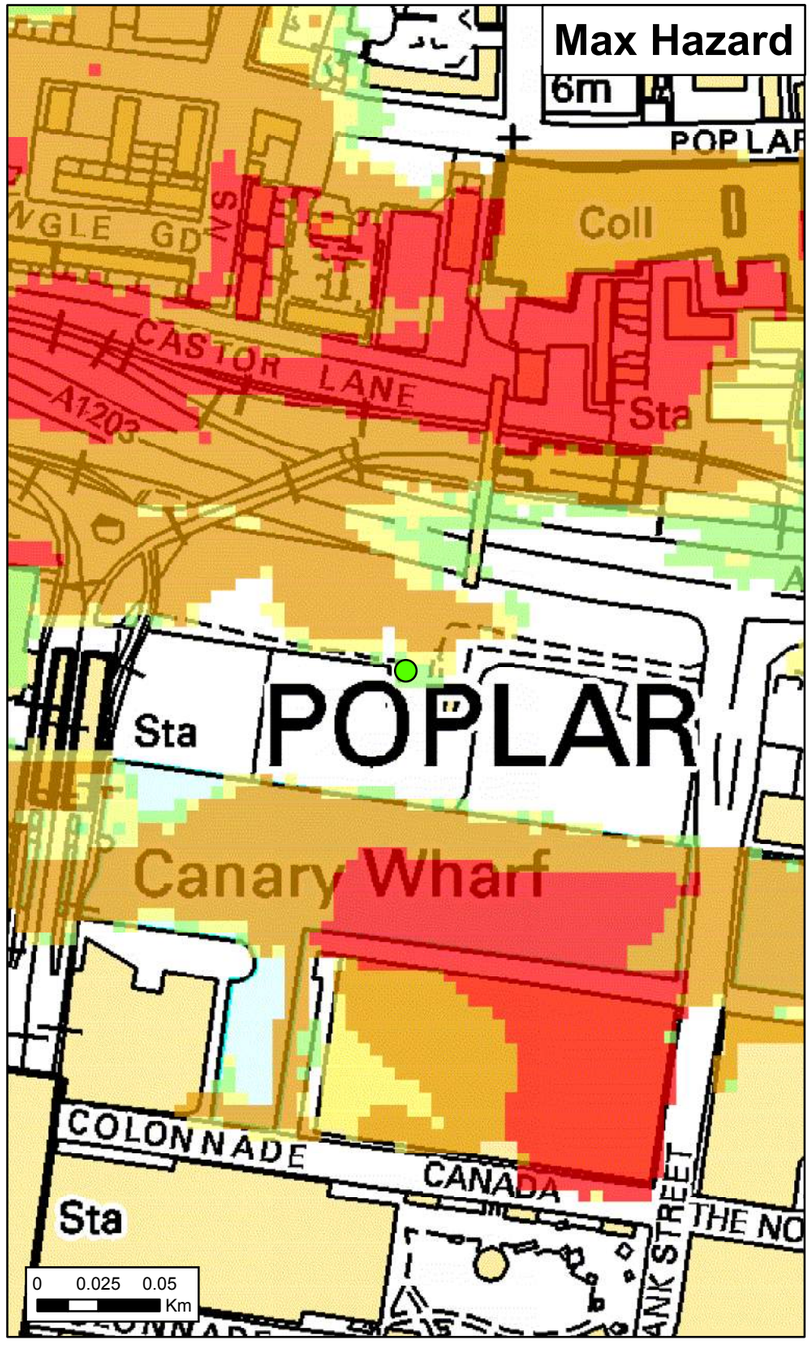
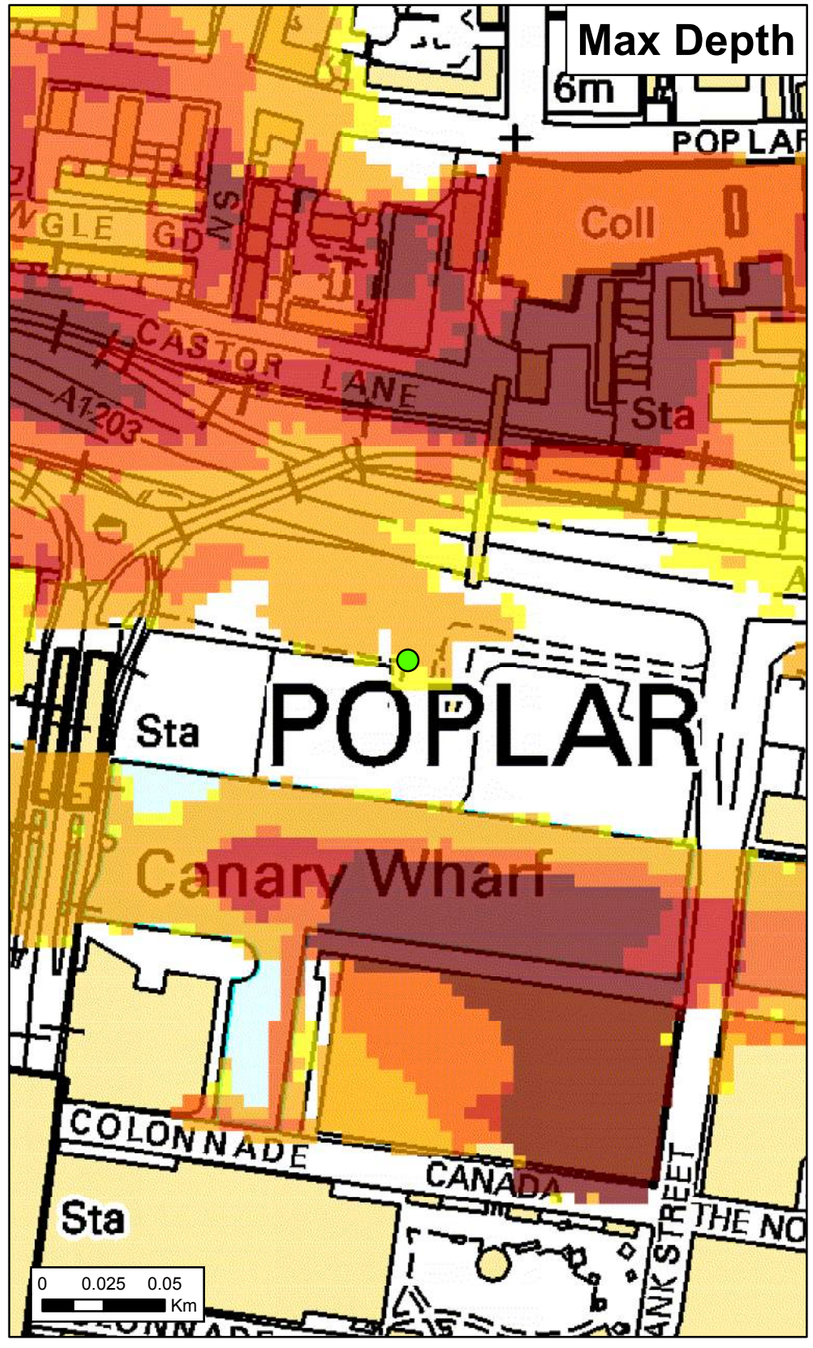
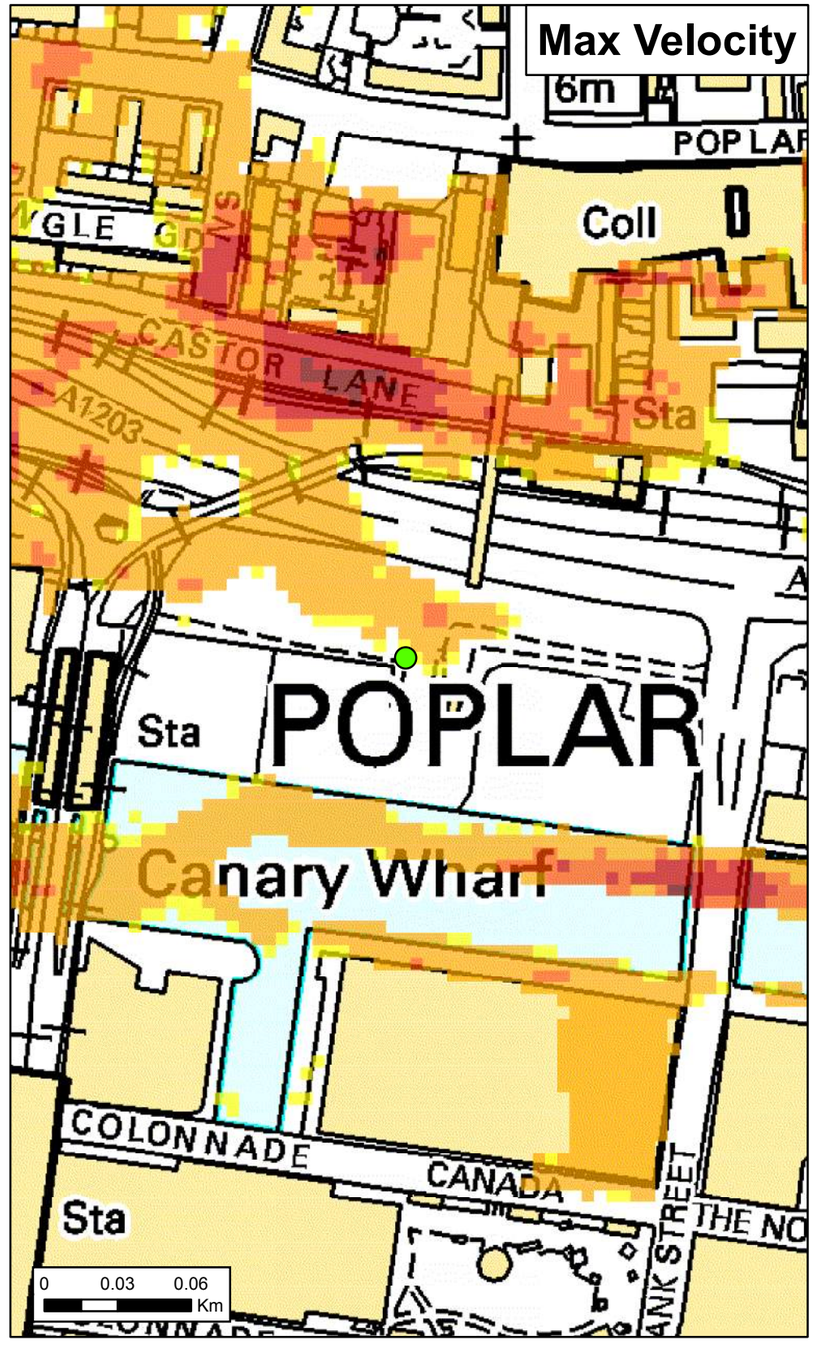






Max Hazard

- Less than 0.75 (Low Hazard)
- Between 0.75 and 1.25 (Danger for Some)
- Between 1.25 and 2.00 (Danger for Most)
- Greater than 2.00 (Danger for All)

Max Depth (m)

- 0 - 0.25
- 0.25 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

Max Velocity (m/s)

- 0 - 0.3
- 0.3 - 1.0
- 1.0 - 1.5
- 1.5 - 2.5
- > 2.5

Date Printed	23/04/2020	Scenario year	2100	Scenario Annual Chance	0.5% (1 in 200)

This map shows the level of flood hazard to people (called a hazard rating) if our flood defences are breached at certain locations, for a range of scenarios. The hazard rating depends on the depth and velocity of floodwater, and maximum values of these are also mapped.

The map is based on computer modelling of simulated breaches at specific locations. Each breach has been modelled individually and the results combined to create this map. Multiple breaches, other combinations of breaches, different sized tidal surges or flood flows may all give different results.

The map only considers the consequences of a breach, it does not make any assumption about the likelihood of a breach occurring. The likelihood of a breach occurring will depend on a number of different factors, including the construction and condition of the defences in the area. A breach is less likely where defences are of a good standard, but a risk of breaching remains.

Please contact the Environment Agency for further information on emergency planning associated with flood risk in this area.

General Enquiries No: 03708 506 506. Weekday Daytime calls cost 5p plus up to 6p per minute from BT Weekend Unlimited. Mobile and other providers' charges may vary

Environment Agency

Thames Tidal Breach Hazard Mapping

Map Centred on 537,617 180,538

Appendix 3 Correspondence with EA

creating a better place

Environment Agency

Bethany O'Brien
Arup
13 Fitzroy Street
London
W1T 4BQ

By email: Bethany.OBrien@arup.com

Our ref: NE/2016/125548/03-L01

Date: 7 February 2017

Dear Bethany

North Quay at Canary Wharf.
Flood risk enquiry for a proposed mixed-use development (commercial and residential).

Thank you for accepting our charged advice for your site. We find the Flood Risk Assessment as submitted acceptable and if we were to receive this as part of a planning application, in principal we would have no objections to the planned development.

The site is located within Flood Zone 3 and protected to a very high standard by the Thames Tidal flood defences up to a 1 in 1000 (0.1%) chance in any year. Our flood modelling shows that it would be at risk if there were to be a breach in the defences or if they were to be overtopped.

Provided the 'more vulnerable' land use for this development is outside of the floodplain, above the 2100+ cc flood level, this site would be classified as 'less vulnerable' in Flood Zone 3. This would mean that an exception test would not be required.

This proposal does have a safe means of access and/ or egress in the event of flooding from all new buildings to an area wholly outside the floodplain. We will advise the Local Authority that they are the competent authority on matters of evacuation or rescue, and therefore should assess the adequacy of the evacuation arrangements. They should consult their emergency planners as they make this assessment.

Please do not hesitate to contact me with any further queries.

Yours sincerely

Mrs Eleri Randall
Planning Advisor

Telephone: 0203 025 5516
E-mail: HNLsustainableplaces@environment-agency.gov.uk
Address: Environment Agency, Ergon House, Horseferry Road, London SW1P 2AL

End

creating a better place

Environment Agency

Bethany O'Brien
Arup

By email: Bathany.Obrien@arup.com

Our ref: NE/2016/125548/04-L01

Date: 6 April 2017

Dear Bethany

North Quay at Canary Wharf

Flood risk enquiry for a proposed mixed-use development (commercial and residential).

Thank you for your email dated 22 March 2017. We are satisfied that the 0.1mm in future flood water levels will not affect the flood storage loss to a point where compensation will be needed. We therefore have no objections.

Yours sincerely

Mrs Jane Wilkin
Planning Advisor

Telephone: 020 3025 5538
E-mail: hnlsustainableplaces@environment-agency.gov.uk

End

Appendix 4 Arup Hydraulic Modelling Technical Note

Technical Note

ARUP

13 Fitzroy Street
London
W1T 4BQ
United Kingdom
www.arup.com

Project title	Isle of Dogs – Dock Water Level Assessment	Job number	250647-00
cc	Canary Wharf Contractors Ltd Environment Agency	File reference	250647 / WIP / YE / TQ
Prepared by	Marcus Shepherd	Date	2017-03-22
Subject	Isle of Dogs – Modelling impact on water levels of proposed development encroachments		

1 Introduction

Canary Wharf Group is proposing a number of developments adjacent to the Isle of Dogs docks that encroach into the dock water space. These developments include:-

- Heron Quay West 2
- Park Place
- Wood Wharf
- North Quay.

This Technical Note has been prepared to respond to the Environment Agency's (EA) request to undertake hydraulic modelling to assess the impact of the encroachment on flood risk. Hydraulic modelling has been undertaken to understand the impact of these encroachments on water levels within the River Thames and the Isle of Dogs docks to determine whether compensatory storage is required to mitigate increases in water level. This note summarises the hydraulic modelling methodology and results, including data and assumptions.

2 Background

During a meeting dated 1st June 2013, the EA asked Canary Wharf Contractor Ltd (CWCL) to consider the potential to lower the normal operating water level of the Isle of Dogs docks to provide additional flood storage rather than installing flood storage reservoirs within various schemes on the Canary Wharf estate. This is because the flood storage reservoirs are not considered the most sustainable solution when you take into account long-term operation and maintenance.

As a result of this request, CWCL commissioned Arup to undertake a review of the dock water levels within the Isle of Dogs. Arup completed this assessment based on information provided by the Canal & River Trust (CRT). The following Technical Note was prepared summarising the findings:-

- Isle of Dogs – Dock Water Level Assessment, rev 4 dated 22nd March 2017.

In parallel with the assessment of the dock water levels, CWCL had discussions with the CRT to identify if lowering the 'normal' dock water levels was feasible. CRT concluded that lowering the water level was not a feasible option due to operational reasons.

Subsequent to this, it was agreed with the EA that an alternative to constructing the flood storage reservoirs or lowering the dock water levels would be to model the actual impact of the encroachment to see if it had an adverse impact on the water levels along the River Thames. If hydraulic modelling proved that the impact on the wider River Thames was so small it could be classed as 'negligible' then there would not be a need to construct the proposed flood storage reservoirs.

The criterion for an impact of 'negligible' has been agreed with the EA as:-

> *The definition of 'negligible' will be to demonstrate that the water levels predicted by the 'with development' model do not result in any additional out of bank flow conditions compared to the baseline model and the rise in water level both in the docks and the River Thames is a maximum of a few millimetres (i.e. <10mm).*

3 Data collection

The following information has been collected and used in this analysis:

- **Hydraulic model:** ISIS 1d hydraulic model of the River Thames tidal reach from just upstream of Teddington Weir to Southend (Environment Agency, March, 2012). This model does not include the Isle of Dogs dock area or locks. The flood event data used within the model is based on the Southend tidal boundary and is approximately a 1 in 5 year return period. The tidal water level is based on the Thames Estuary 2100 extreme water levels and represents the highest water level that the Thames Barrier will allow under the current operating rules. The upstream flow has very little impact on water level at the Isle of dogs due to the strong tidal input.
- **Dimensions of Lock:** Lock dimensions provided by the Canal and River Trust as length = 178m, width = 24m, cills of lock = -7.19m AOD.
- **Docks and lock operation:** Technical Note 'Isle of Dogs - Dock Water Level Assessment', Arup, January 2014 provides the following information:
    - Approximate surface water area of the docks = 38.8 Ha (388,000m^2).
    - Dock impoundment water level used as the base level for flood storage = 4.23m AOD.
    - Operation of the locks.
- **Encroachment area:** Total area of encroachment into the docks of the proposed development = 16,453m^2, provided by Canary Wharf Contractors Ltd.

4 Methodology and assumptions

The following models were set up to determine the impact of the docks on water levels in the River Thames and the impact of potential development encroachments:

- Original baseline model with no changes (does not include docks).
- Updated baseline model with docks and lock added.
- Development scenario model representing encroachments into the docks.

Updated baseline model:

The following amendments were made to the original baseline model to produce the updated baseline model:

- Added docks: Represented using an elevation vs. plan area relationship. Assumed docks are vertically sided with an area of 38.8 Ha and a bed level equal to the cill level of the lock (-7.19m AOD), though model results should not be affected by the bed level. The initial water level in the docks was set to 4.23m AOD.

- Added lock: Added lock between the docks and the River Thames (ISIS river cross-section 2.45), represented using a vertical sluice unit to enable opening and closing of gates to be represented. Control rules have been specified to trigger the lock to open when water level at Woolwich gauge (location estimated as being at cross-section 3.3) is greater than 3.95m AOD* and if the water level in the River Thames adjacent to the lock is greater than the water level in the docks. Control rules were also specified to allow the docks to drain back to around 4.23m AOD when tidal levels drop. The movement rate was specified to enable the lock to fully open in approximately 15 minutes.

  * Value of 3.95m AOD refers to 'critical tide' for lock gates to be operated, based on the winter season; a higher value of 4.15m AOD is given for the summer season. Both seasons have been modelled.

Proposed situation model:
The following amendment was made to the updated baseline model to produce the proposed situation model:

- Reduced area of docks, represented in model using an elevation vs. plan area relationship, by 16,452m^2.

Model simulations and result extraction:
To improve accuracy of results, the model runtime parameters were modified as follows:

- Double precision version of ISIS specified instead of Single precision version to reduce any rounding errors made by the software during model simulations.
- Timestep changed from being adaptive between 5 and 300 seconds to being fixed at 10 seconds.
- Save interval reduced from 300 seconds to 60 seconds to give increased temporal resolution of model results.

Each of the three models, described above, was used to simulate two flood events:
1. The baseline flood event included with the original model, described in Section 2.
2. The baseline flood event but with tidal levels increased by 300mm at Southend.

As identified by Environment Agency staff, Scenario 1 produces the theoretical maximum water levels in the vicinity of the Isle of Dogs, and represents the highest tide scenario before the Thames Barrier is raised. As such, Scenario 2 is a wholly artificial scenario, but is modelled here in response to a request by the Environment Agency.

Tabular model results were extracted through the main user interface using the graph export facility to overcome the limitation of Tabular CSV limited output to three decimal places, i.e. to the nearest millimetre.

5 Results

The model results presented in Table 1 below show:

1. The Isle of Dogs docks are not currently in the hydraulic model of the River Thames. When the dock system is included, the inclusion of the docks have only a very small effect on water levels in the

River Thames. Including the dock system in the updated baseline model (compared to the original baseline model) decreases the maximum water level in the River Thames adjacent to the lock by 1.1mm for the baseline flood event and by 4 – 5.9mm when tidal levels are increased by 300mm. These water level differences represent the impact (for the event modelled) if the docks were to be completely disconnected from the River Thames or completely encroached such that no flood storage was available in the docks.

2. The development scenario encroachments have negligible impact on water levels in the River Thames. The increase in water level in the River Thames adjacent to the locks is 0.3mm for the baseline flood event and 0.4 - 0.7mm when tidal levels are increased by 300mm.

3. The development scenario encroachments have negligible impact on water levels in the Isle of Dogs docks. The increase in water level in the docks is 0.7 - 0.8mm for the baseline flood event and 0.8mm when tidal levels are increased by 300mm.

Table 1: Model results for maximum water level (mAOD)

	Baseline flood event		Tidal levels increased by 300mm	
	River Thames	Docks	River Thames	Docks
Baseline – original (without docks)	4.6278	-	4.9490	-
Baseline – updated to include docks - winter	4.6267	4.6196	4.9450	4.9376
Baseline – updated to include docks - summer	4.6267	4.6195	4.9431	4.9362
Development scenario (with encroachments to docks) - winter	4.6270	4.6203	4.9457	4.9384
Development scenario (with encroachments to docks) - summer	4.6270	4.6203	4.9435	4.9370

The Isle of Dogs docks have a statutory flood defence level of 5.23mAOD. The changes in flood level due to reductions in dock area are negligible, and the docks have a residual freeboard of 0.60m (0.29m if tidal levels are increased by 300mm).

Flood Mechanisms: The results show that the storage in the docks is small compared to the potential flow capacity through the locks, and compared to the rate of rise and the overall volume of water in the River Thames. While the River Thames is rising, or falling, differences in water levels between the Docks and the River Thames may be as much as 0.05m, but at the peak of any given flood event, the rate of change in water level on the Thames will be become zero, meaning that water levels in the docks will “catch-up” with the Thames hydrograph. As a result, the peak water level in the docks will always tend to be very close to the peak levels in the River Thames.

Appendix 5 Correspondence with CRT

meeting notes

Attendees:

Steve Craddock (SC)	-	Canal and River Trust (CRT)
Emma Dandy (ED)	-	Canary Wharf Group (CWG)
Dan Sibert (DS)	-	Foster + Partners (F+P)
Matthew Sherwood (MS)	-	Quod

Project: North Quay

Meeting Title:	Location:	Date & Time:
Canal and River Trust Meeting	One Canada Square, Canary Wharf, London	26.10.16 @ 13.30

Action

a) Presentation

1. DS provided an overview of the site location and existing site condition. DS also presented details of the extant 2007 North Quay scheme including how the approved promenade extended over part of the existing North Dock. DS confirmed that for the emerging North Quay scheme, the proposed promenade would not extend further over the dock than the approved 2007 scheme promenade.

2. DS presented the emerging site layout which included office development on the eastern side, residential development on the western side and key public realm routes through the centre of the site and along the dock side.

3. DS described the different potential typologies for the proposed spaces along the dock side. It was the intention that active retail frontages would be provided along the length of the dock side which SC agreed with. Options to improve the interface with the water were also being explored such as getting the level of the promenade as close to the level of the water as possible having regard to flood level constraints. ED stated that the waterside spaces created would link to the existing Canary Wharf events programme.

b) Discussion

4. SC stated that certain elements of the emerging proposals would need to be discussed with CRT colleagues but the meeting would begin the 21 day period for CRT to respond. **CRT**

5. SC supported how the water space was incorporated as a feature of the development however would obtain further design comments from the CRT's architectural/urban design officer. SC would also liaise with heritage colleagues in relation to views on

the 'stepping down' of the public realm to the dock side. MS explained that CWG had previously presented the emerging proposals to Claire Brady of Historic England. **CRT**

6. It was agreed that SC and ED would check with respective estates/legal colleagues the ownership of the areas within and around the site. CWG would also provide details of the bridge links across the dock approved under the Crossrail development as well as the navigable width of the channel. **CRT/CWG**

7. SC stated that it was ok in principle for clean water to drain into the dock from the proposed development.

8. SC to provide feedback on the acceptability of a third bridge. **CRT**

9. It was agreed that a further CRT presentation would be arranged following CRT feedback and when the emerging scheme was further developed. **Quod**

From:	Steve Craddock
To:	Simon Delves
Subject:	[External] FW: North Quay Development, Canary Wharf, London
Date:	16 June 2020 14:36:01
Attachments:	image001.jpg image002.gif

Hi Simon,

Thank you for the opportunity to comment on these assumptions before you submit the Environmental Statement. We look forward to reviewing the Water Resources chapter, the FRA and other relevant planning application documents in due course and we reserve the right to change our position on these matters once we are able to review the documents fully.

Surface Water Discharge (points 1, 2 and 5)

We have no objection in principle to surface water being discharged to the docks 'as far as possible' but this will be subject to our approval of technical details, including (but not limited to) the design of surface water outfalls, and a commercial agreement. The Trust would need to examine the flood storage implications as part of the mandatory procedure for reviewing applications to discharge. Trust policy is not to accept increased flood risk. We note that you assume that any discharge of the upper aquifer (if necessary) will need to be agreed with us in advance. This is correct. For the avoidance of doubt it also relates to the lower aquifer – should any discharge from it be required.

Loss of waterspace (point 3)

We note that Canary Wharf Group's plan is to extend the quayside south towards the Crossrail Station so that it is on the same line as the current quayside NW of the Crossrail Station, as it was in the previous plans for the site. We will need to consider the acceptability of this from a planning and landowner perspective once more details of the proposal (e.g. exact dimensions) are submitted through the planning application or in pre-app discussions.

Construction methodology (point 4)

As per the previous plans for the site, the construction methodology should have regard to the listed dock wall in situ behind the existing false quay. We welcome recognition that the detailed methodology will be agreed with the Trust prior to the commencement of works and they will be scrutinised by the Trust's Environmental Scientists and Engineers at this point. The developer will need to engage with the Trust's Infrastructure Services team and follow our Code of Practice.

Kind regards

Steve

Steve Craddock
Planning Manager
Swyddog Cynllunio
M 07768 560282

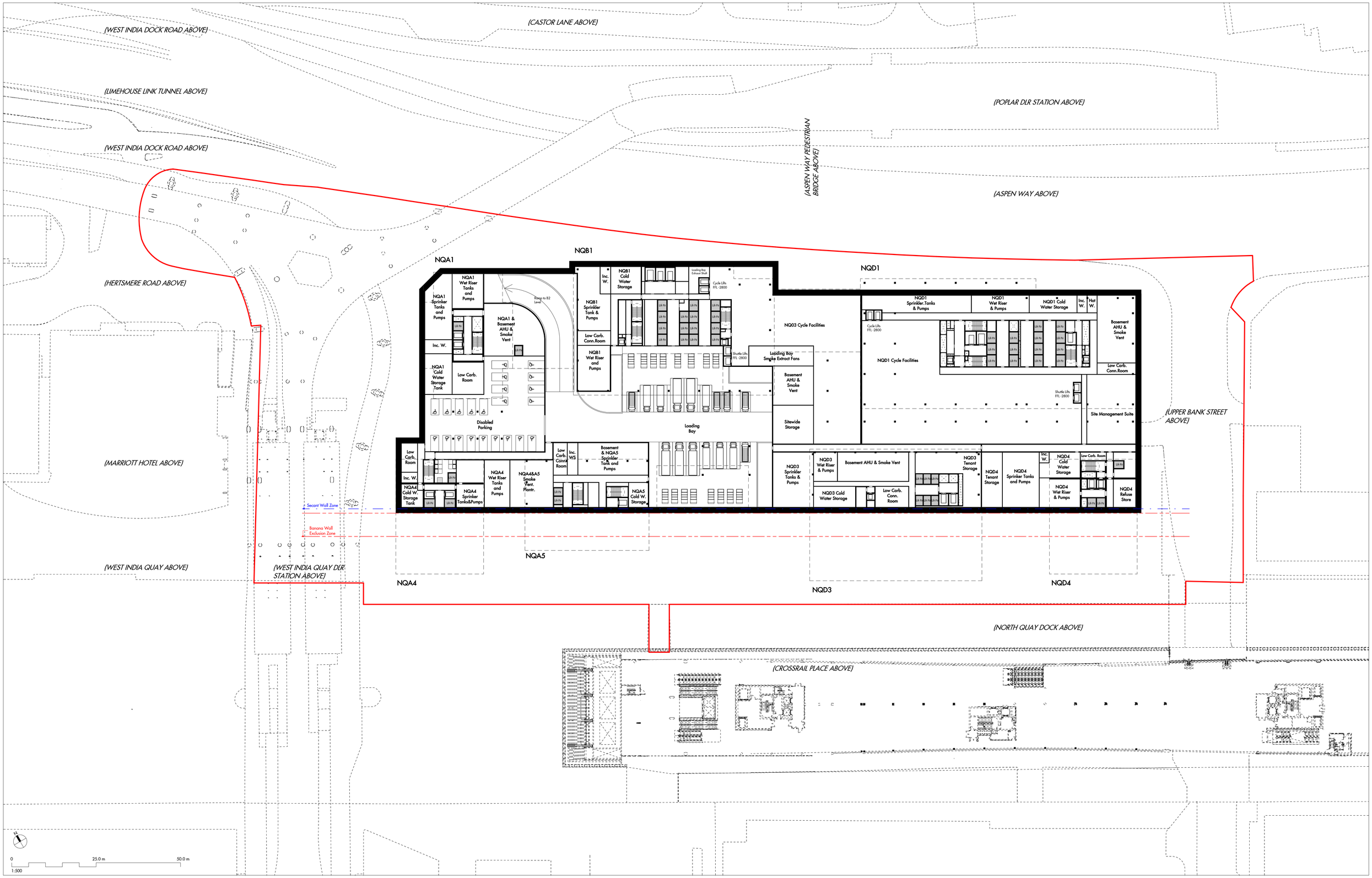
E steve.craddock@canalrivertrust.org.uk

From: Simon Delves [mailto:Simon.Delves@arup.com]
Sent: 09 June 2020 10:20
To: Steve Craddock <Steve.Craddock@canalrivertrust.org.uk>
Cc: Edie Hatter <Edie.Hatter@arup.com>
Subject: RE: North Quay Development, Canary Wharf, London

Hi Steve
As discussed, below are a number of assumptions we are making when preparing the Flood Risk Assessment and Water Resources chapter for the ES for the above development.
We would be grateful if you could review and confirm that these assumptions are acceptable. They are all in line with assumptions we have made in the past on developments like Wood Wharf, Bank Street and Newfoundland. Please note the water resource assessment for the ES doesn't cover navigational issues.

1. As far as possible, uncontaminated surface water will be discharged directly to the docks. This will include roof areas and areas of public realm. Areas of public realm that are regularly trafficked will be discharged to the Thames Water sewer in Aspen Way.
2. All surface water outfalls to the docks will be designed in line with your Code of Practise where appropriate and through your Third party Works Engineer.
3. The parameter plans include for replacing the existing decking structure and extending a section to the south and formalising connections with the Crossrail Isle of Dogs Station. Refer to plan below. Arup have accessed the impact on flood storage loss and it has been agreed with the EA that this is negligible compared to the wider flood storage in the docks and River Thames.
4. Appropriate piling techniques will be used in the docks to extend the promenade. A Construction Environmental management Plan will be prepared to demonstrate contamination risks to the docks will be mitigated. A rotary bored pile technique is proposed. This involves installing a steel tube and casting the concrete pile inside the tube. This method mitigates the risk of dock water contamination by minimising vibrations and thereby reducing the disturbance of silt on the dock bed, as well as the steel tube preventing migration of concrete and excavated material into the dock water. Piling technique used will be agreed with the EA and CRT prior to undertaking the works.
5. There may be a need to dewater groundwater from the upper aquifer to enable the basement construction. If this is required discharge permits will be obtained from the EA and approval will be obtained from CRT.

Appendix 6 Proposed Drawings



REV	DATE	DESCRIPTION	CKD
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North Quay Masterplan

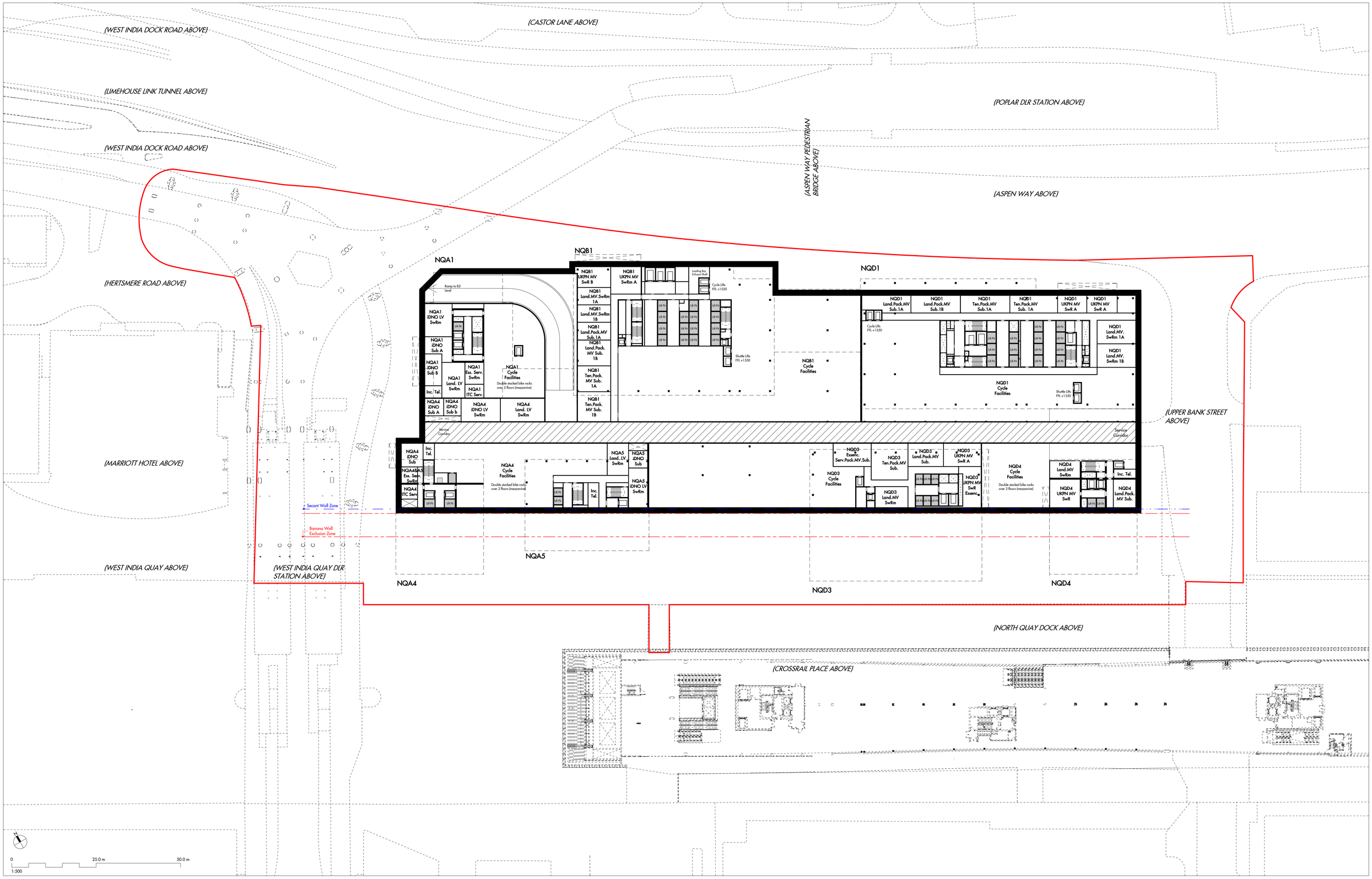
INDICATIVE SCHEME BASEMENT 2 LEVEL GENERAL ARRANGEMENT

19141-00-07-098

P0
Revision

SCALE 1 : 500 @A1 1 : 1000 @A3

FOR INFORMATION



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North Quay Masterplan

INDICATIVE SCHEME BASEMENT 1 LEVEL
GENERAL ARRANGEMENT
19141-00-07-099

SCALE 1 : 500 @A1 1 : 1000 @A3

P0
Revision

FOR INFORMATION

CASTOR LANE

LIMEHOUSE LINK TUNNEL

ASPEN WAY PEDESTRIAN BRIDGE

POPLAR DLR STATION

ASPEN WAY

THE DELTA

ASPEN WAY GARDEN

NQA1

HERTSMERE ROAD

NQB1

Resi Play Space

Communal Amenity Space

Upper Lobby

Retail

Retail

Double Height Lobby

Retail

+13400

+11494

+10150

+8728

+7464

+6200

POPLAR PLAZA

NQD1

Office

Upper Lobby

Retail

Double Height Lobby

Retail

NORTH QUAY WAY

MARRIOTT HOTEL

WEST INDIA QUAY DLR STATION

ASHP plant room

ASHP plant room

Resi Play Space

Store

Resi Play Space

Double Height Space

GARDEN SQUARE

Retail

NQA5

QUAY SQUARE

Retail

DOCK SQUARE

Amenity

Amenity

BOH

Retail

UPPER BANK STREET

BILLINGSGATE MARKET

WEST INDIA QUAY

NQA4

NQD3

NQD4

CROSSRAIL PLACE

N

0 25.0 m 50.0 m

1:500

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North Quay Masterplan

INDICATIVE SCHEME 1ST FLOOR LEVEL
GENERAL ARRANGEMENT
19141-00-07-101

SCALE 1 : 500 @A1 1 : 1000 @A3

P0
Revision

FOR INFORMATION

CASTOR LANE

LIMEHOUSE LINK TUNNEL

ASPEN WAY PEDESTRIAN BRIDGE

POPLAR DLR STATION

ASPEN WAY

HERTSMERE ROAD

NQA1

ASHP plantroom

Resi Play Space

Communal Amenity Space

NQB1

Office

Terrace

NQD1

Terrace

Office

MARRIOTT HOTEL

WEST INDIA QUAY DLR STATION

UPPER BANK STREET

BILLINGSGATE MARKET

WEST INDIA QUAY

2B W

1B

2B

2B

Store

1B

1B

3B

3B

NQA4

Retail

NQA5

Office

NQD3

Studio C - WCH

Studio B

Studio A

Studio A

Studio A

Studio A

Studio A

Studio A

Studio A

Studio A

Studio A

Studio A

1B

1B - WCH

1B

NQD4

CROSSRAIL PLACE

N

0

25.0 m

50.0 m

1:500

REV	DATE	DESCRIPTION	CKD
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North Quay Masterplan

INDICATIVE SCHEME 2ND FLOOR LEVEL
GENERAL ARRANGEMENT

19141-00-07-102

SCALE 1 : 500 @A1 1 : 1000 @A3

P0
Revision

FOR INFORMATION

CASTOR LANE

LIMEHOUSE LINK TUNNEL

POPLAR DLR STATION

ASPEN WAY PEDESTRIAN BRIDGE

ASPEN WAY

THE DELTA

ASPEN WAY GARDEN

HERTSMERE ROAD

NQA1

NQB1

NQD1

Security Hut

Vehicle Ramp to B2

Retail

Residential Amenities

Refuse Store

Cycle Lifts

Resi Lobby

Office Lobby

MUGA

POPLAR PLAZA

Office Lobby

NORTH QUAY WAY

MARRIOTT HOTEL

WEST INDIA QUAY DLR STATION

WEST INDIA QUAY

reception/entrance

Cycle Store

Store

GARDEN SQUARE

QUAY SQUARE

DOCK SQUARE

NQA4

NQA5

NQD3

NQD4

BOH

S. apt. Lobby

UPPER BANK STREET

BILLINGSGATE MARKET

CROSSRAIL PLACE

0 25.0 m 50.0 m

1:500

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North Quay Masterplan

INDICATIVE SCHEME GROUND FLOOR LEVEL
GENERAL ARRANGEMENT
19141-00-07-100

SCALE 1 : 500 @A1 1 : 1000 @A3

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Revision

FOR INFORMATION

CASTOR LANE

LIMEHOUSE LINK TUNNEL

ASPEN WAY PEDESTRIAN BRIDGE

POPLAR DLR STATION

ASPEN WAY

HERTSMERE ROAD

MARRIOTT HOTEL

WEST INDIA QUAY DLR STATION

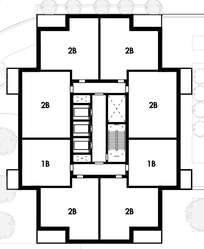
WEST INDIA QUAY

UPPER BANK STREET

BILLINGSGATE MARKET

CROSSRAIL PLACE

NQA1



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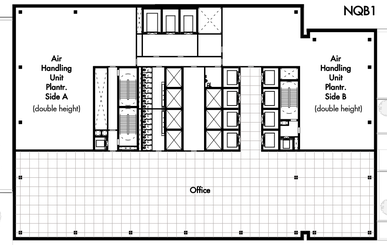

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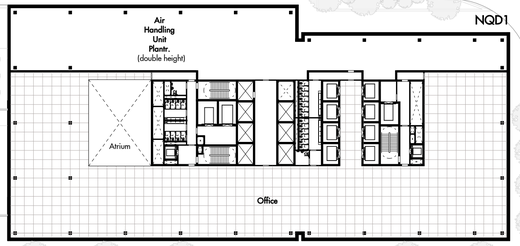

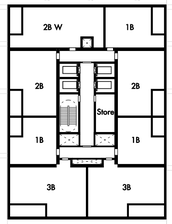

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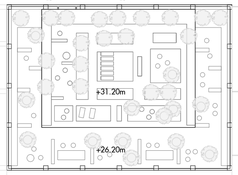
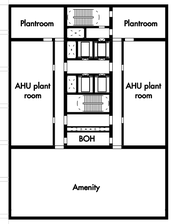


NQA5

NQD3



NQD4 (INTERMEDIATE PLANT)

0 25.0 m 50.0 m
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Figured dimensions are in millimetres unless noted otherwise. All dimensions and levels shall be verified on site before proceeding with works. Detailed site survey to be carried out to verify positions and level relationships with site features and ordnance survey. The Architect must be notified of any discrepancy. Boundaries are indicative only and are to be verified by others.
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NOTE:
This plan shows indicatively all intermediate plant spaces at different levels

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INDICATIVE SCHEME INTERMEDIATE PLANT
GENERAL ARRANGEMENT
19141-00-07-110

SCALE 1 : 500 @A1 1 :1000 @A3

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Revision

FOR INFORMATION

CASTOR LANE

LIMEHOUSE LINK TUNNEL

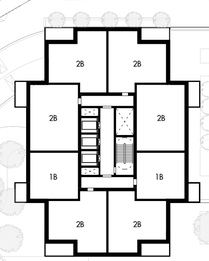
ASPEN WAY PEDESTRIAN BRIDGE

POPLAR DLR STATION

ASPEN WAY

HERTSMERE ROAD

NQA1



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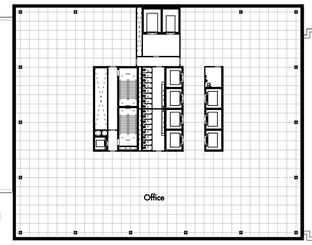

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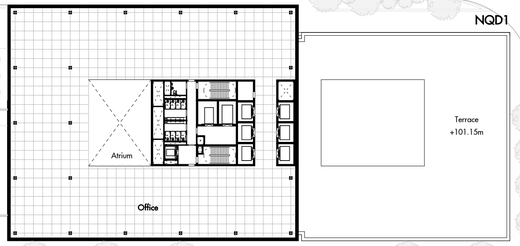
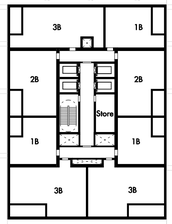


MARRIOTT HOTEL

WEST INDIA QUAY
DLR STATION



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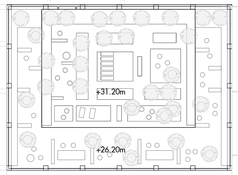

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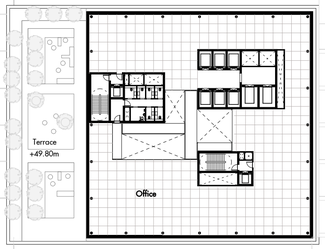

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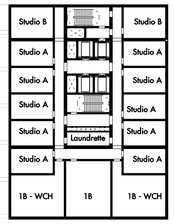

NQD4

UPPER BANK
STREET

BILLINGSGATE MARKET

WEST INDIA QUAY

CROSSRAIL PLACE

N

0 25.0 m 50.0 m

1:500

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North Quay Masterplan

INDICATIVE SCHEME TYPICAL UPPER FLOOR LEVEL
GENERAL ARRANGEMENT

19141-00-07-122

SCALE 1 : 500 @A1 1 : 1000 @A3

P0
Revision

FOR INFORMATION

CASTOR LANE

LIMEHOUSE LINK TUNNEL

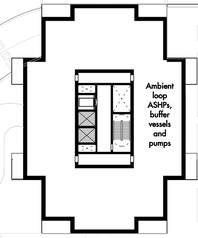
ASPEN WAY PEDESTRIAN BRIDGE

POPLAR DLR STATION

ASPEN WAY

HERTSMERE ROAD

NQA1
(ROOF PLANT - Level 36)



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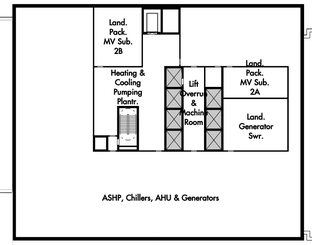

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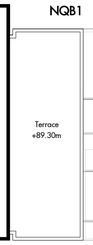
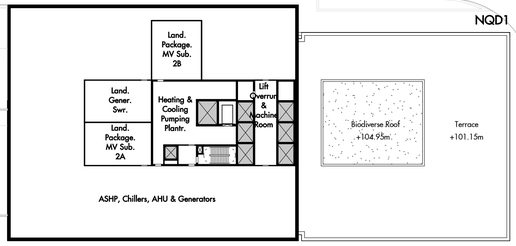


(ROOF PLANT - Level 33)



NQD1

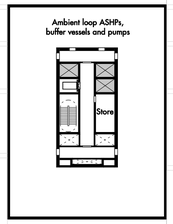
MARRIOTT HOTEL

WEST INDIA QUAY
DLR STATION

UPPER BANK STREET

BILLINGSGATE MARKET

WEST INDIA QUAY



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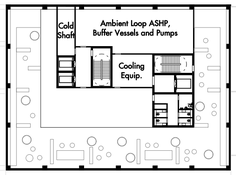
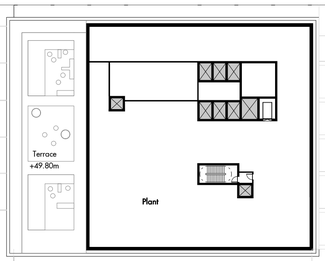
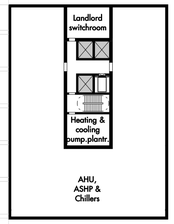


NQA5 (ROOF PLANT - Level 6)



NQD3 (ROOF PLANT - Level 17)



NQD4 (ROOF PLANT - Level 53)

CROSSRAIL PLACE

N

0 25.0 m 50.0 m
1:500

REV	DATE	DESCRIPTION	CKD
P0	JULY 2020	PLANNING SUBMISSION	LP

NOTE:
This plan shows indicatively all roof plant spaces at different levels for each building

Allies and Morrison LLP
85 Southwark Street
London SE1 0HX
telephone 020 7921 0100
facsimile 020 7921 0101
email studio@alliesandmorrison.com

North Quay Masterplan

INDICATIVE SCHEME ROOF PLANT
GENERAL ARRANGEMENT
19141-00-07-131

SCALE 1 : 500 @A1 1 : 1000 @A3

P0
Revision

FOR INFORMATION

CASTOR LANE

LIMEHOUSE LINK TUNNEL

ASPEN WAY PEDESTRIAN BRIDGE

POPLAR DLR STATION

ASPEN WAY

HERTSMERE ROAD

NQA1

NQB1

NQD1

Plant
+120.60m

Biodiverse Roof
+124.60m

Terrace
+14.20m

Biodiverse Roof
+168.25m

Plant
+160.25m

Terrace
+89.15m

+13.34m

Plant
+132.60m

Biodiverse Roof
+140.60m

Biodiverse Roof
+104.95m

Terrace
+101.00m

+6.20m

MARRIOTT HOTEL

WEST INDIA QUAY
DLR STATION

UPPER BANK
STREET

BILLINGSGATE MARKET

WEST INDIA QUAY

Biodiverse Roof
+220.60m

Plant
+216.60m

NQA4

Plant
+31.20m

+26.20m

NQA5

Terrace
+49.65m

Biodiverse Roof
+77.40m

Plant
+69.40m

NQD3

Biodiverse Roof
+182.20m

Plant
+178.20m

NQD4

CROSSRAIL PLACE

N

0 25.0 m 50.0 m

1:500

REV	DATE	DESCRIPTION	CKD
P0	JULY 2020	PLANNING SUBMISSION	LP

Allies and Morrison LLP

85 Southwark Street
London SE1 0HX
telephone 020 7921 0100
facsimile 020 7921 0101
email studio@alliesandmorrison.com

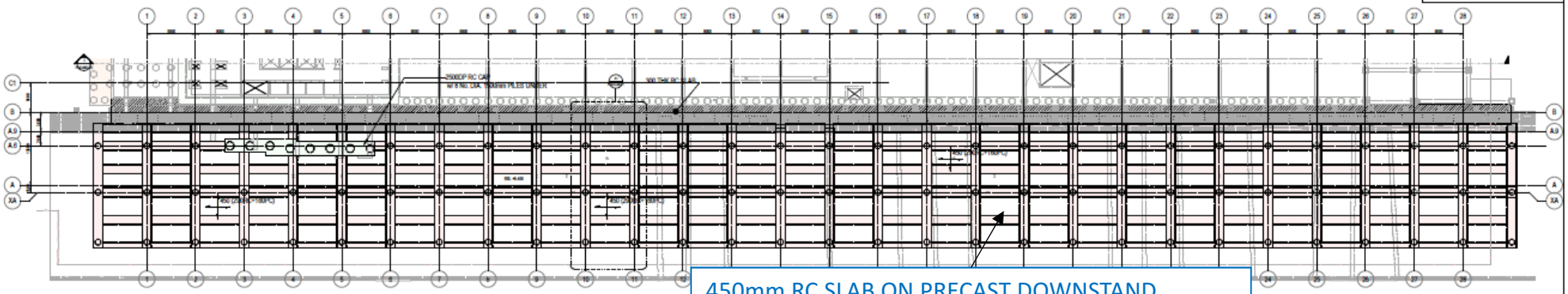
North Quay Masterplan

INDICATIVE SCHEME ROOF LEVEL
GENERAL ARRANGEMENT
19141-00-07-165

SCALE 1 : 500 @A1 1 : 1000 @A3

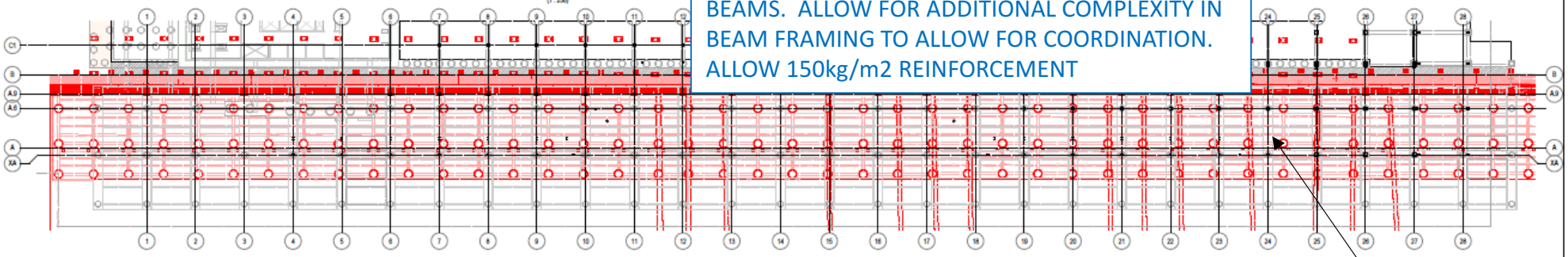
P0
Revision

FOR INFORMATION



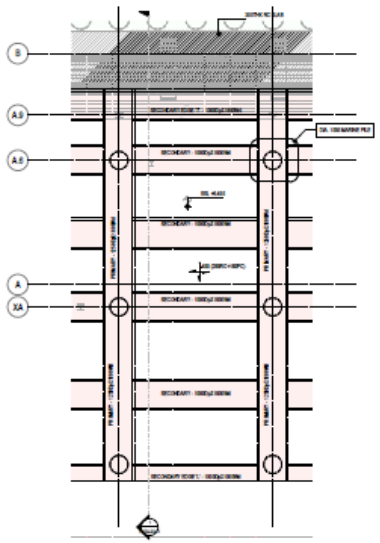
L00 NEW FALSE QUAY STRUCTURE
(1 : 250)

450mm RC SLAB ON PRECAST DOWNSTAND BEAMS. ALLOW FOR ADDITIONAL COMPLEXITY IN BEAM FRAMING TO ALLOW FOR COORDINATION. ALLOW 150kg/m2 REINFORCEMENT

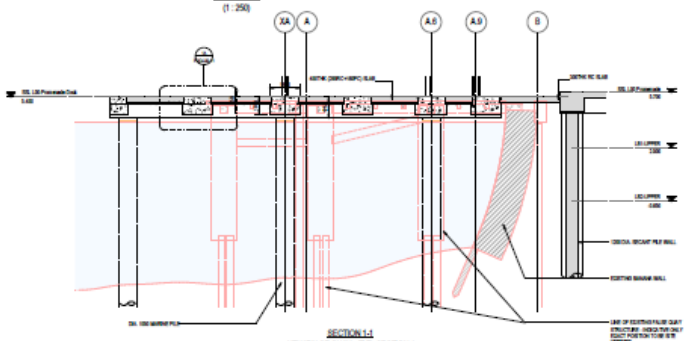


L00 NEW FALSE QUAY STRUCTURE OVERLAY WITH EXISTING STRUCTURE
(1 : 250)

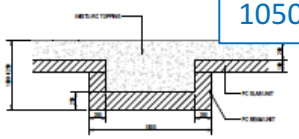
FALSE QUAY PILES ARE TYPICALLY 1050mm DIAMETER SLEEVED PILES



NEW FALSE QUAY STRUCTURE-TYPICAL BAY
(1 : 100)



SECTION 1-1
NEW FALSE QUAY - TYP. SECTION 1
(1 : 100)



DETAIL 1A
FALSE QUAY - TYPICAL BEAM-SLAB DETAIL
(1 : 20)

REFERENCE BACKGROUND DRAWINGS:
1. PODIUM
BASED ON F+P PODIUM DRAWINGS RECEIVED 14.11.2016.
2. RESIDENTIAL TOWERS & OFFICE TOWER:
BASED ON F+P DRAWINGS RECEIVED 14.11.2016

NOTE:
1. EXISTING FALSE QUAY STRUCTURE SHOWN IS INDICATIVE ONLY.
2. EXISTING FALSE QUAY STRUCTURE TO BE SITE VERIFIED AND ANY NEW PILING IN DOCK TO BE POSITIONED TO AVOID ANY EXISTING PILING OR STRUCTURE IN DOCK.
3. PILE DIAMETERS ARE BASED ON THE ASSUMPTION THAT THERE ARE NO SIGNIFICANT TEMPORARY LATERAL LOADS APPLIED TO THE PILES OR THE FALSE QUAY PRIOR TO PERMANENT SLAB CONNECTION BEING COMPLETED BACK TO MAIN PODIUM SLAB.

WSL-QUANTITIES ISSUE RELEASE 05

waterman
CWG
NORTH QUAY
INFORMATION
PODIUM
LEVEL 00 - NEW FALSE QUAY STRUCTURE
STR-AL-04-POD-L00-11

RESI TOWER R02 AND R03 UNDER REVIEW

2000MM THICK RAFT ON 10No. 1200mm DIAMETER BORED PILES

450MM THICK RC SLAB - ALLOW 100kg/m2 REINFORCEMENT

REFER TO COMMERCIAL TOWER QUANTITIES REPORT

RESI TOWER R03 UNDER REVIEW

RESI TOWER 2 - STRUCTURE AND INTERFACE UNDER DEVELOPEMENT REFER TO DRG. STR-AL-04-TR2 SERIES FOR DETAILS

EXISTING FOUNDATION STRUCTURE FOR ASPEN WAY LINK BRIDGE, STAIR AND LIFT. EXACT LOCATION TO BE SITE VERIFIED.

OFFICE TOWER - STRUCTURE AND INTERFACE UNDER DEVELOPMENT REFER TO DRG. STR-AL-04-OFF SERIES FOR DETAILS.

EXISTING TOF SHAFT DEMOLISHED LOCALLY TO ALLOW FOR RAMP CORE CONSTRUCTION

INTERFACE TO RESI R02 TOWER UNDER REVIEW

SECANT WALL/CORE WALL INTERFACE UNDER REVIEW

RESI TOWER 3 - STRUCTURE AND INTERFACE UNDER DEVELOPEMENT REFER TO DRG. STR-AL-04-TR3 SERIES FOR DETAILS.

RESI TOWER 1 - STRUCTURE AND INTERFACE UNDER DEVELOPEMENT REFER TO DRG. STR-AL-04-TR1 SERIES FOR DETAILS.

RAMP UP 1:8

450 RC

350 RC

SSL +5.700

SSL +4.275

SSL +7.100

SSL +5.450

1200DP RC CAP w/ 900Dia. PILE

400 RC 1:12

RAMP UP 1:12

SINGLE DIA. 900mm BORED PILE UNDER PAD FOUNDATION BETWEEN GL 26-28 / F-B

2 No. 1500mm BORED PILES UNDER PAD FOUNDATION BETWEEN GL 26-28 / F-B

TYPICAL OFFICE/PODIUM COLUMN NORTH OF GL D 1000x700-PG COL.

TYPICAL OFFICE/PODIUM COLUMN SOUTH OF GL D 500x500-PG COL.

1200DPx600WD RC GROUND BEAM

1200DP CAPPING BEAM

TYPICAL RETAIL LEVEL 01-02-03 SUPPORT COLUMNS UC356x406 COL

COLUMN EXCLUSION ZONE FOR BANANA WALL

TYPICAL LEVEL 01 TERRACE SUPPORT COLUMNS

UC COLUMNS TO SUPPORT TERRACE @ LEVEL 01 TO BE REVIEWED/CO-ORDINATED ARE WORK IN PROGRESS AND NEED FULL CO-ORDINATION

TYPICAL PROMENADE DECK FRAMING

450 (290RC+160PC)

EXISTING DECK RETAINED IN THIS AREA. FURTHER DETAILS AND COORDINATION TO BE DEVELOPED

VEHICLE BRIDGE 1 REFER TO WATERMAN INFRASTRUCTURE DRAWING WIE-SA-04-001-A02 FOR DETAILS

PEDESTRIAN BRIDGE 1 REFER TO WATERMAN INFRASTRUCTURE DRAWING WIE-SA-04-001-A04 FOR DETAILS

PEDESTRIAN BRIDGE 2 REFER TO WATERMAN INFRASTRUCTURE DRAWING WIE-SA-04-001-A05 FOR DETAILS

VEHICLE BRIDGE 2 REFER TO WATERMAN INFRASTRUCTURE DRAWING WIE-SA-04-002/003-A02 FOR DETAILS

2500MM DEEP PILECAP ON 17No. 1200mm DIAMETER BORED PILES

350MM THICK RC SLAB - ALLOW 70kg/m2 REINFORCEMENT

REFER TO DRAWING STR-AL-04-POD-L00-11 MARKED-UP FOR MARINE DECK QUANTITIES

1200mm SQ COLUMNS - ALLOW 640kg/m REINFORCEMENT
600mm SQ COLUMNS - ALLOW 170kg/m REINFORCEMENT

FOUNDATION NOTES:
1. a. ALL PILES ARE DIA. 900mm CFA PILES U.N.O.
   b. ALL PILES SPACING @ 3x PILE DIA. U.N.O.
2. ALL FOUNDATION CAPS/PADS/RAFTS 1500mm DEEP U.N.O.
3. CAPPING BEAM TO SECANT PILE WALL 1200mm DEEP NOMINAL T.B.C.

WALL THICKNESS
- 250RC WALL
- 300RC WALL
- 350RC WALL
- 400RC WALL
- 500RC WALL
- 600RC WALL
- 700RC WALL
- 800RC WALL

FLOOR TYPE:
- RC SLAB
- PT SLAB
- METAL DECK SLAB

REFERENCE BACKGROUND DRAWINGS:
1. PODIUM:
   BASED ON F+P PODIUM DRAWINGS RECEIVED 02.12.2016 INFOR RELEASE 4
2. RESIDENTIAL TOWERS & OFFICE TOWER:
   BASED ON F+P DRAWINGS RECEIVED 25.11.2016

LIFT PITS AND SUMPS
RAFT AND SLAB MAY REQUIRE STEPS TO ALLOW FOR LIFTS PITS AND SUMPS. DEPTHS AND FOLDS TO THE RAFT TO BE DEVELOPED

BANANA WALL AND FALSE QUAY STRUCTURE
LOCATION AND PROFILE OF BANANA WALL IS APPROXIMATE - BASED ON CWG SITE PROPOSED PLAN "PA003 - PROPOSED SITE PLAN + (CWC Topo 600-BASE_(02) BC.dwg" received 01.08.2016 & "NQ GEOTECHNICAL DESK STUDY" (1989), FIG No. 3.

Date: 16.12.2016
Client: CWG
Project: NORTH QUAY
Drawing Status: INFORMATION
Scales @ A0: As indicated
Project No: STR13490
Title: PODIUM LEVEL 00 - PROMENADE GA
Number: WSL-QUANTITIES ISSUE RELEASE 05
Revision:

Central:\SLNCS\WSL\Projects\STR13490\BIM\Models\STR13490-S-B-m-xx-SBaseModel.rvt 12/01/17 14:21:51 CSRP4

RESI TOWER R02 AND R03 UNDER REVIEW

REFER TO COMMERCIAL TOWER QUANTITIES REPORT

RESI TOWER R03 UNDER REVIEW

RESI TOWER 2 - STRUCTURE AND INTERFACE UNDER DEVELOPEMENT REFER TO DRG. STR-AL-04-TR2 SERIES FOR DETAILS

EXISTING EDF SHAFT DEMOLISHED LOCALLY TO ALLOW FOR RAMP/CORE CONSTRUCTION EXTENT OF DEMOLITION TO BE SITE VERIFIED

EXISTING FOUNDATION STRUCTURE FOR ASPEN WAY LINK BRIDGE, STAIR AND LIFT. EXACT LOCATION TO BE SITE VERIFIED.

OFFICE TOWER - STRUCTURE AND INTERFACE UNDER DEVELOPMENT REFER TO DRG. STR-AL-04-OFF SERIES FOR DETAILS.

INTERFACE TO RESI R02 TOWER UNDER REVIEW

SECANT WALL/CORE WALL INTERFACE UNDER REVIEW

RESI TOWER 3 - STRUCTURE AND INTERFACE UNDER DEVELOPEMENT REFER TO DRG. STR-AL-04-TR3 SERIES FOR DETAILS

RESI TOWER 1 - STRUCTURE AND INTERFACE UNDER DEVELOPEMENT REFER TO DRG. STR-AL-04-TR1 SERIES FOR DETAILS.

DIA. 1200mm BORED PILES @ APPROX. 2.7m c/c SPACING

DIA. 1200mm CONTIGUOUS PILE WALL AT CORNER OF RAFT

1200 Dia SECANT PILE ZONE

250 RC LIVING WALL

DIA. 1200mm PILES TO SUPPORT STRUCTURE OVER

DIA. 1500 MARINE PILE

DIA. 1050 MARINE PILE

EXISTING BANANA WALL STRUCTURE
EXACT LOCATION/PROFILE TO BE SITE VERIFIED

J3 DOCK
EXISTING FALSE QUAY STRUCTURE
(NOT SHOWN FOR CLARITY - TO BE DEMOLISHED)

3000MM DEEP PILECAP ON XXXNo. 1200MM DIAMETER BORED PILES at 3.0m c/c - ALLOW 350kg/m2 REINFORCEMENT

350MM THICK RC SLAB - ALLOW 70KG/M2 REINFORCEMENT

1200mm SQ COLUMNS - ALLOW 640kg/m REINFORCEMENT
600mm SQ COLUMNS - ALLOW 170kg/m2 REINFORCEMENT

FOUNDATION NOTES:
1. a. ALL PILES ARE DIA. 900mm CFA PILES U.N.O.
   b. ALL PILES SPACING @ 3x PILE DIA. U.N.O.
2. ALL FOUNDATION CAPS/PADS/RAFTS 1500mm DEEP U.N.O.
3. CAPPING BEAM TO SECANT PILE WALL 1200mm DEEP NOMINAL T.B.C.

WALL THICKNESS
- 250RC WALL
- 300RC WALL
- 350RC WALL
- 400RC WALL
- 500RC WALL
- 600RC WALL
- 700RC WALL
- 800RC WALL

FLOOR TYPE:
- RC SLAB
- PT SLAB
- METAL DECK SLAB

FOUNDATION RAFT KEY:
- RC RAFT 2000
- RC RAFT 3000

REFERENCE BACKGROUND DRAWINGS:
1. PODIUM:
   BASED ON F+P PODIUM DRAWINGS
   RECEIVED 02.12.2016 INFOR RELEASE 4

2. RESIDENTIAL TOWERS & OFFICE TOWER:
   BASED ON F+P DRAWINGS RECEIVED 25.11.2016

LIFT PITS AND SUMPS
RAFT AND SLAB MAY REQUIRE STEPS TO ALLOW FOR LIFTS PITS AND SUMPS. DEPTHS AND FOLDS TO THE RAFT TO BE DEVELOPED

BANANA WALL AND FALSE QUAY STRUCTURE
LOCATION AND PROFILE OF BANANA WALL IS APPROXIMATE - BASED ON CWG SITE PROPOSED PLAN "PA003 - PROPOSED SITE PLAN + (CWC Topo 600-BASE_(02) BC.dwg" received 01.08.2016 &
"NQ GEOTECHNICAL DESK STUDY" (1989), FIG No. 3.

Date: 16.12.2016
waterman
Client: CWG
Project: NORTH QUAY
Drawing Status: INFORMATION
Scales @ A0: As indicated
Project No: STR13490
Title: PODIUM LEVEL B1 - GA
Number: WSL-QUANTITIES ISSUE RELEASE 05
Revision: 4

1200MM DIAMETER SECANT PILE WALL

1200MM DIAMETER BASE GROUTED SECANT PILE WALL

3000MM DEEP PILECAP ON XXXNo. 1200MM DIAMETER BORED PILES at 3.0m c/c - ALLOW 350kg/m2 REINFORCEMENT

3000MM DEEP PILECAP ON XXXNo. 900MM DIAMETER CFA PILES AT 2.25m c/c- ALLOW 350kg/m2 REINFORCEMENT

3000MM DEEP PILECAP ON XXXNo. 900MM DIAMETER CFA PILES AT 2.25m c/c - ALLOW 350kg/m2 REINFORCEMENT

1200MM DIAMETER SECANT PILE WALL

1200MM DIAMETER BASE GROUTED SECANT PILE WALL

1200MM DIAMETER BASE GROUTED SECANT PILE WALL

3000MM DEEP PILECAP ON XXXNo. 900MM DIAMETER CFA PILES AT 2.2m c/c - ALLOW 350kg/m2 REINFORCEMENT

RESI TOWER R02 AND R03 UNDER REVIEW

R03 foundations in abeyance pending further review

RESI TOWER R03 UNDER REVIEW

EXISTING 'EDF SHAFT' DEMOLISED LOCALLY TO ALLOW FOR SECANT PILING PILING AND BASEMENT RAFT CONSTRUCTION - EXTENT OF DEMOLITION TO BE AGREED

EXISTING FOUNDATION STRUCTURE FOR ASPEN WAY LINK BRIDGE, STAIR AND LIFT. EXACT LOCATION TO BE SITE VERIFIED.

OFFICE TOWER - STRUCTURE AND INTERFACE UNDER DEVELOPEMENT REFER TO DRG. STR-AL-04-OFF SERIES FOR DETAILS.

INTERFACE TO RESI R02 TOWER UNDER REVIEW

SECANT WALL/CORE WALL INTERFACE UNDER REVIEW

RESI TOWER 3 - STRUCTURE AND INTERFACE UNDER DEVELOPEMENT REFER TO DRG. STR-AL-04-TR3 SERIES FOR DETAILS.

RESI TOWER 1 - STRUCTURE AND INTERFACE UNDER DEVELOPEMENT REFER TO DRG. STR-AL-04-TR1 SERIES FOR DETAILS.

1200 Dia SECANT PILE ZONE

250 RC LINING WALL

3000 RC RAFT

SSL -0.650

450 RC

PILES @ APPROX. 2.250m c/c SPACING

DIA. 1200mm PILES UNDER FOLD IN SLAB @ 3m c/c SPACING

DIA. 1200mm BORED PILES @ 3m c/c SPACING

DIA. 1200mm CONTIGUOUS PILE WALL AT CORNER OF RAFT

DIA. 1200mm PILES TO SUPPORT STRUCTURE OVER

6No. 900mm DIAMETER CFA PILES

1200MM DIAMETER SECANT PILE WALL

DIA. 1500 MARINE PILE

EXISTING BANANA WALL STRUCTURE
EXACT LOCATION/PROFILE TO BE SITE VERIFIED

DOCK
EXISTING FALSE QUAY STRUCTURE
(NOT SHOWN FOR CLARITY - TO BE DEMOLISHED)

1500MM DIAMETER BASE GROUTED SECANT PILE WALL

3000MM DEEP PILECAP ON XXXNo. 1200MM DIAMETER BORED PILES at 3.0m c/c - ALLOW 350kg/m2 REINFORCEMENT

3000MM DEEP PILECAP ON XXXNo. 900MM DIAMETER CFA PILES - ALLOW 350kg/m2 REINFORCEMENT

1200mm DIAMETER BORED PILES AT 3.0M C/C

1500mm DEEP RAFT SLAB WITH 900MM DIAMETER CFA PILES - ALLOW 210kg/m2 REINFORCEMENT

1500mm DEEP RAFT SLAB WITH 1200MM DIAMETER BORED PILES - ALLOW 210kg/m2 REINFORCEMENT

450MM THICK RC SLAB WITH 1500mm DEEP PILECAPS ON 900mm DIAMETER CFA PILES - ALLOW 180kg/m2 REINFORCEMENT

REFER TO DRAWING STR-AL-04-POD-L00-11 MARKED-UP FOR MARINE DECK QUANTITIES

FOUNDATION NOTES:
1. a. ALL PILES ARE DIA. 900mm CFA PILES U.N.O.
   b. ALL PILES SPACING @ 3x PILE DIA. U.N.O.
2. ALL FOUNDATION CAPS/PADS/RAFTS 1500mm DEEP U.N.O.
3. CAPPING BEAM TO SECANT PILE WALL 1200mm DEEP NOMINAL T.B.C.

WALL THICKNESS
- 250RC WALL
- 300RC WALL
- 350RC WALL
- 400RC WALL
- 500RC WALL
- 600RC WALL
- 700RC WALL
- 800RC WALL

FLOOR TYPE:
- RC SLAB
- PT SLAB
- METAL DECK SLAB

FOUNDATION RAFT KEY:
- RC RAFT 2000
- RC RAFT 3000

1200mm SQ COLUMNS - ALLOW 640kg/m REINFORCEMENT
600mm SQ COLUMNS - ALLOW 170kg/m REINFORCEMENT

REFERENCE BACKGROUND DRAWINGS:
1. PODIUM:
   BASED ON F+P PODIUM DRAWINGS
   RECEIVED 02.12.2016 INFOR RELEASE 4

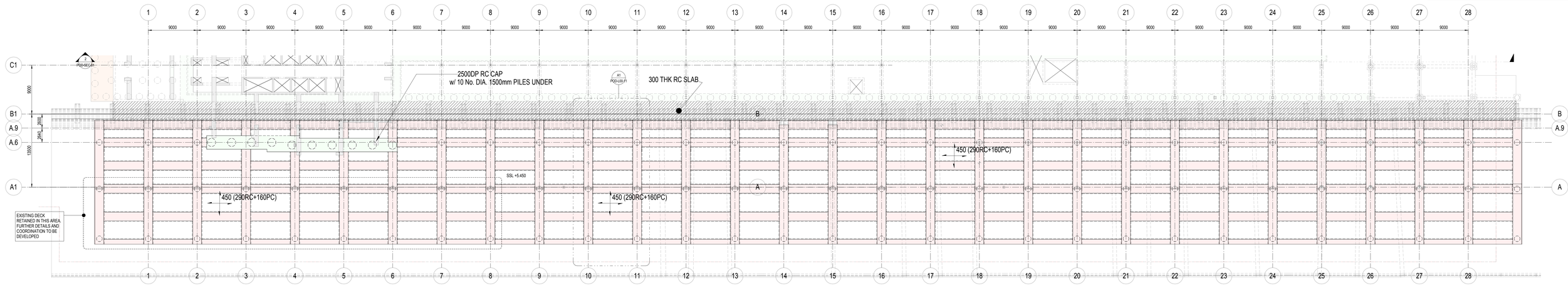
2. RESIDENTIAL TOWERS & OFFICE TOWER:
   BASED ON F+P DRAWINGS RECEIVED 25.11.2016

LIFT PITS AND SUMPS
RAFT AND SLAB MAY REQUIRE STEPS TO ALLOW FOR LIFTS PITS AND SUMPS. DEPTHS AND FOLDS TO THE RAFT TO BE DEVELOPED

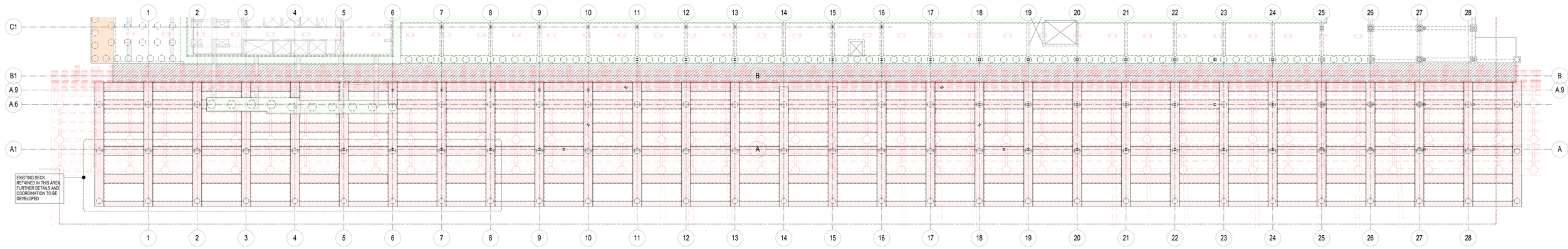
BANANA WALL AND FALSE QUAY STRUCTURE
LOCATION AND PROFILE OF BANANA WALL IS APPROXIMATE - BASED ON CWG SITE PROPOSED PLAN "PA003 - PROPOSED SITE PLAN + (CWC Topo 600-BASE_(02) BC.dwg" received 01.08.2016 &
"NQ GEOTECHNICAL DESK STUDY" (1989), FIG No. 3.

Date: 16.12.2016
Waterman
Client: CWG
Project: NORTH QUAY
Drawing Status: INFORMATION
Scales @ A0: As indicated
Project No.: STR13490
Title: PODIUM LEVEL B2 - GA
Number: WSL-QUANTITIES ISSUE RELEASE 05
Revision: 5

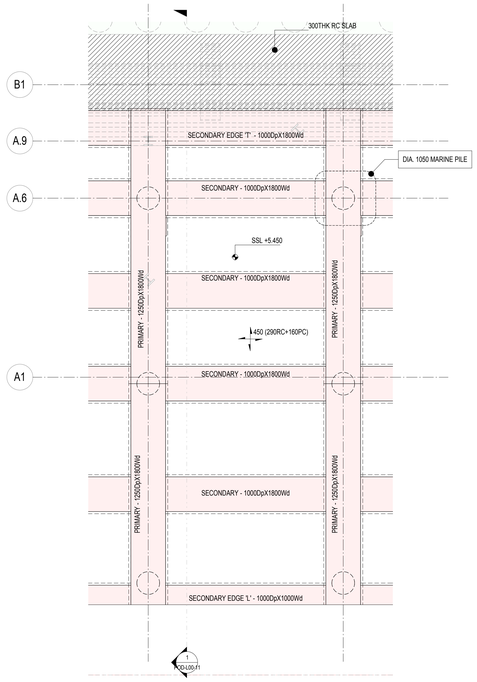
Central: //S3-NCS/VOL1/Projects/STR13490/BIM/Models/STR13490-S-B-m-xx-SBaseModel.rvt 12/01/17 14:10:58 CSRP4



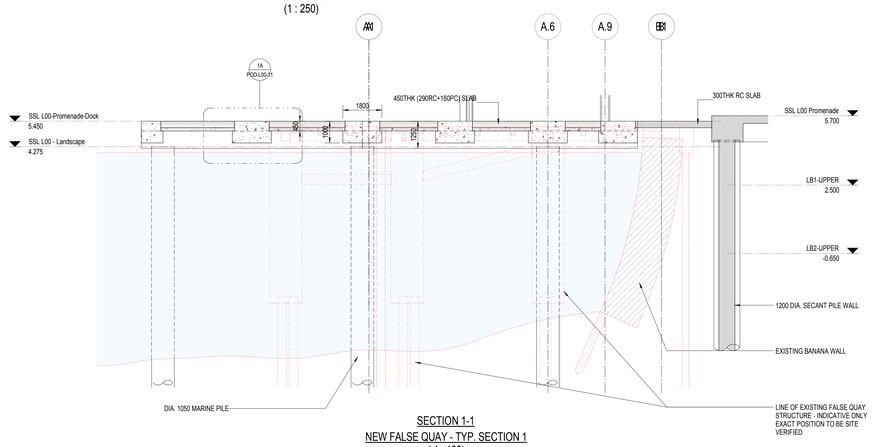
L00 NEW FALSE QUAY STRUCTURE
(1 : 250)



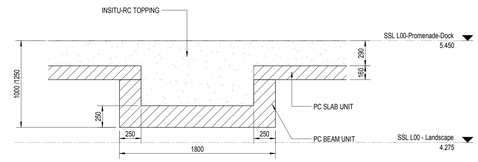
L00 NEW FALSE QUAY STRUCTURE OVERLAY WITH EXISTING STRUCTURE
(1 : 250)



NEW FALSE QUAY STRUCTURE-TYPICAL BAY
(1 : 100)



SECTION 1-1
NEW FALSE QUAY - TYP. SECTION 1
(1 : 100)



DETAIL 1A
FALSE QUAY - TYPICAL BEAM-SLAB DETAIL
(1 : 25)

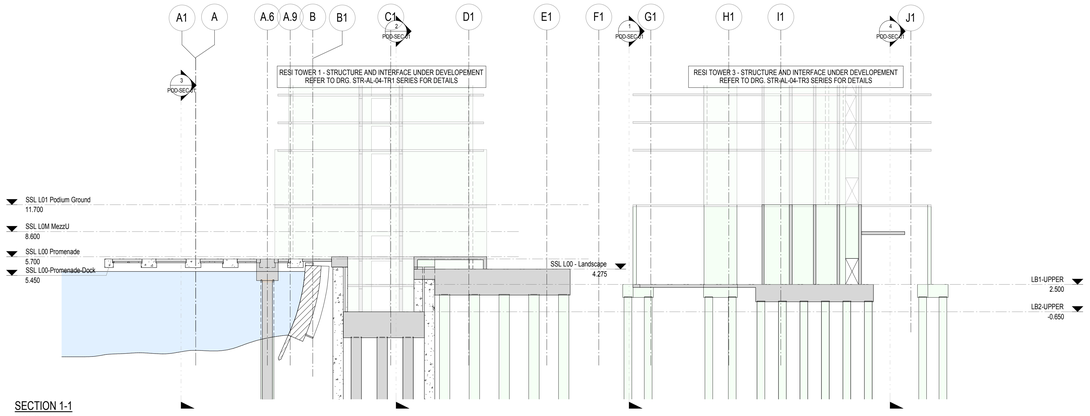
REFERENCE BACKGROUND DRAWINGS:
1. PODIUM:
BASED ON F+P PODIUM DRAWINGS
RECEIVED 02.12.2016 INFOR RELEASE 4

2. RESIDENTIAL TOWERS & OFFICE TOWER:
BASED ON F+P DRAWINGS RECEIVED 25.11.2016

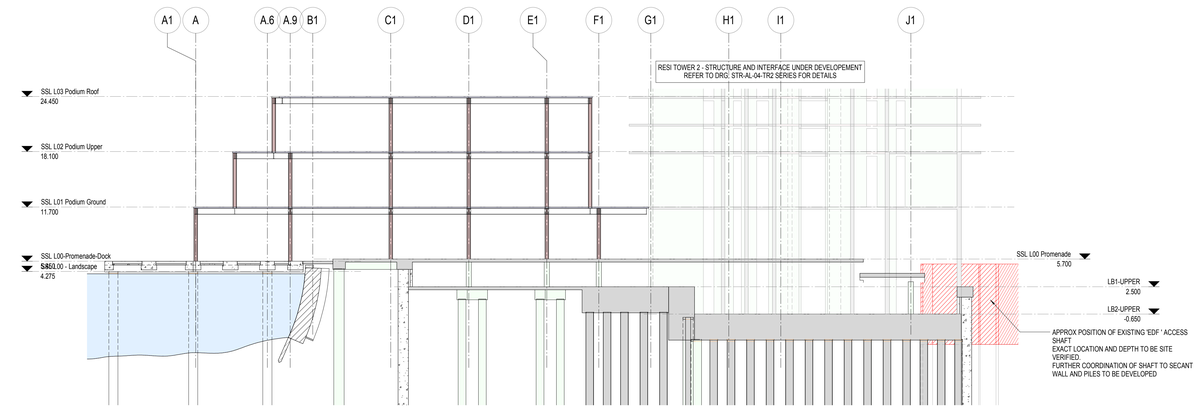
BANANA WALL AND FALSE QUAY STRUCTURE
LOCATION AND PROFILE OF BANANA WALL IS APPROXIMATE - BASED ON CWG SITE PROPOSED PLAN "PA003 - PROPOSED SITE PLAN + (CWC Topo 600-84040_(02) BC.dwg" received 01.08.2016 & "NQ GEOTECHNICAL DESK STUDY" (1989), FIG No. 3.

NOTE:
1. EXISTING FALSE QUAY STRUCTURE SHOWN IS INDICATIVE ONLY.
2. EXISTING FALSE QUAY STRUCTURE TO BE SITE VERIFIED AND ANY NEW PILING IN DOCK TO BE POSITIONED TO AVOID ANY EXISTING PILING OR STRUCTURE IN DOCK.
3. PILE DIAMETERS ARE BASED ON THE ASSUMPTION THAT THERE ARE NO SIGNIFICANT TEMPORARY LATERAL LOADS APPLIED TO THE PILES OR THE FALSE QUAY PRIOR TO PERMANENT SLAB CONNECTION BEING COMPLETED BACK TO MAIN PODIUM SLAB.

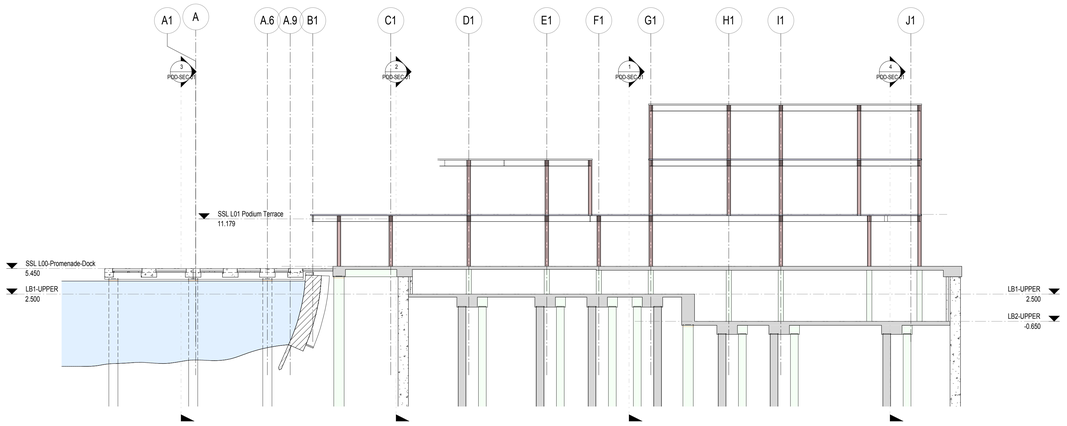
Date: 16.12.2016
Client: CWG
Project: NORTH QUAY
Drawing Status: INFORMATION
Scales @ A0: As indicated
Project No: STR13490
Title: PODIUM LEVEL 00 - NEW FALSE QUAY STRUCTURE
Number: STR-AL-04-POD-L00-11
Revision: 2



SECTION 1-1
NS Section1
(1 : 250)



SECTION 2-2
NS Section2
(1 : 250)



SECTION 3-3
NS Section3
(1 : 250)

REFERENCE BACKGROUND DRAWINGS:
1. PODIUM:
BASED ON F+P PODIUM DRAWINGS
RECEIVED 02.12.2016 INFOR RELEASE 4

2. RESIDENTIAL TOWERS & OFFICE TOWER:
BASED ON F+P DRAWINGS RECEIVED 25.11.2016

LIFT PITS AND SUMPS
RAFT AND SLAB MAY REQUIRE STEPS TO ALLOW FOR LIFTS PITS AND SUMPS. DEPTHS AND FOLDS TO THE RAFT TO BE DEVELOPED

BANANA WALL AND FALSE QUAY STRUCTURE
LOCATION AND PROFILE OF BANANA WALL IS APPROXIMATE - BASED ON CWG SITE PROPOSED PLAN "PA003 - PROPOSED SITE PLAN + (CWC Topo 600-84040_(02)) BC.dwg" received 01.08.2016 & "NQ GEOTECHNICAL DESK STUDY" (1989), FIG No. 3.

Date: 16.12.2016

waterman

Client: CWG

Project: NORTH QUAY

Drawing Status: INFORMATION

Scales @ A0: 1 : 250

Project No: STR13490

Title: PODIUM SECTIONS SHEET 2

Number: STR-AL-04-POD-SEC-02

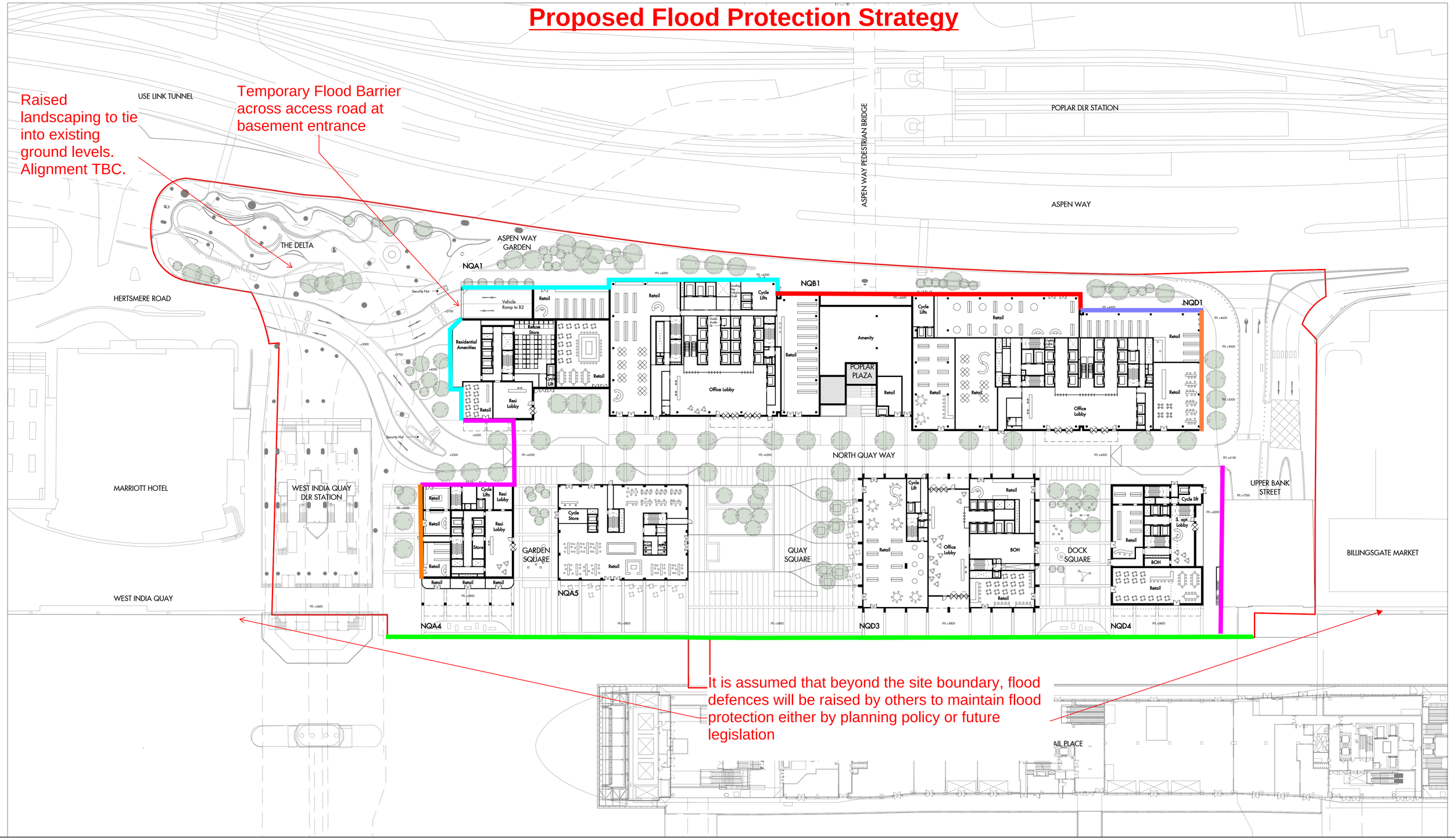
Revision: 3

Appendix 7 Proposed Flood Strategy

Proposed Flood Protection Strategy

Raised landscaping to tie into existing ground levels. Alignment TBC.

Temporary Flood Barrier across access road at basement entrance



It is assumed that beyond the site boundary, flood defences will be raised by others to maintain flood protection either by planning policy or future legislation

Flood protection provided by promenade at 5.8m AOD. Structural design to allow for future provision to raise to 6.2m AOD beyond 2100.

Flood protection to 4.6m AOD provided by proposed landscaping

Flood protection to at least 4.5m AOD provided by existing ground levels

Flood protection to 6.2m AOD provided by proposed building edge

Flood protection to 5.0m AOD provided by proposed landscaping

Flood protection to 4.7m AOD provided by proposed landscaping