



Royal Borough of Greenwich Level 2 Strategic Flood Risk Assessment

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1 Introduction

1.1 Terms of Reference

AECOM has been commissioned by the Royal Borough (RB) of Greenwich to review and update their Level 2 Strategic Flood Risk Assessment (SFRA¹).

1.2 Project Background

The National Planning Policy Framework² (NPPF) and associated Planning Practice Guidance for Flood Risk and Coastal Change (PPG)³ emphasise the active role Local Planning Authorities (LPAs) should take to ensure that flood risk is understood and managed effectively and sustainably throughout all stages of the planning process. The NPPF outlines that Local Plans should be supported by a Strategic Flood Risk Assessments (SFRA) and LPAs should use the findings to inform strategic land use planning. The overall approach of the NPPF to flood risk is broadly summarised Paragraph 103:

When determining planning applications, LPAs should ensure flood risk is not increased elsewhere and only consider development appropriate in areas at risk of flooding where, informed by a site-specific FRA following the Sequential Test, and if required the Exception Test, it can be demonstrated that:

- 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, and
- development is appropriately flood resilient and resistant, including safe access and escape routes where required, and that any residual risk can be safely managed, including by emergency planning; and it gives priority to the use of sustainable drainage systems.”

1.2.1 Level 1 SFRA Deliverables

The purpose of the Level 1 SFRA⁴ was to collate and analyse the most up to date readily available flood risk information for all sources of flooding, and provide an overview of flood risk issues across the study area to inform planning decisions. The borough wide mapping deliverables for the RB of Greenwich are presented in the Level 1 SFRA Appendix A Figures 1-11.

The Level 1 SFRA provides guidance on:

- The application of the Sequential Test by the LPA when allocating future development sites to inform their Local Plans, as well as by developers promoting development on windfall sites.
- Managing and mitigating flood risk, the application of sustainable drainage systems (SuDS), and the preparation of site specific Flood Risk Assessments (FRAs).
- Potential flood risk management objectives and policy considerations which may be developed and adopted by the RB of Greenwich as formal policies within their developing Local Plan.

1.3 Level 2 SFRA

Using the strategic flood risk information presented within the Level 1 SFRA, RB of Greenwich undertook the Sequential Test to document the process whereby future development is steered towards areas of lowest flood risk. Where it was not possible to accommodate potential development sites outside those areas identified to be at risk of flooding, the Exception Test may be required, as set out in Table 1-1. This Level 2 SFRA Report provides information to support the application of the Exception Test for future development sites. Table A.1 in Appendix A provides a list of the 136 sites assessed as part of this process.

¹ JBA Consulting Strategic Flood Risk Assessment Royal Borough of Greenwich October 2011

² Ministry of Housing, Communities and Local Government . 2012. *National Planning Policy Framework*. Available at: <https://www.gov.uk/government/publications/national-planning-policy-framework-2>

³ Ministry of Housing, Communities and Local Government . 2014. *Planning Practice Guidance: Flood Risk and Coastal Change*. Available at: <http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/>

⁴ AECOM Royal Borough of Greenwich Level 1 Strategic Flood Risk Assessment August 2017

Table 1-1 Flood Risk Vulnerability and Flood Zone 'Compatibility' (PPG, 2014)

Flood Risk Vulnerability Classification		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test Required	✓	✓
	3a	Exception Test Required	✓	✗	Exception Test Required	✓
	3b	Exception Test Required	✓	✗	✗	✗

✓ - Development is appropriate ✗ - Development should not be permitted

1.3.1 Exception Test

The purpose of the Exception Test is to ensure that where it may be necessary to locate development in areas at risk of flooding, new development is only permitted where the flood risk is clearly outweighed by other sustainability factors and where the development will be safe during its lifetime, considering climate change.

The NPPF states that for the Exception Test to be passed:

- Part 1 - "It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by the SFRA where one has been prepared; and
- Part 2 - 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."

Both elements of the test will have to be passed for development to be allocated or permitted.

In order to determine Part 1 of the Exception Test, applicants should assess their scheme against the objectives set out in the LPA's Sustainability Appraisal (Level 1 SFRA Section 5.2 Table 5-4).

In order to demonstrate satisfaction of Part 2 of the Exception Test, relevant measures, related to those presented within Section 5.4 of the Level 1 SFRA, should be applied and demonstrated within a site-specific flood risk assessment (FRA).

1.3.2 Level 2 SFRA deliverables

The Level 2 SFRA provides a detailed assessment of the flood risk for specific development sites which have been identified by the RB of Greenwich as requiring the application of the Exception Test. For each site, a 'Site Assessment Pro Forma' has been completed as presented in Appendix A.

It should be noted that some of the sites included within the site assessment stage of this Level 2 report are located in Flood Zones 1 or 2 and in accordance with the NPPF (Table 1-1) the Exception Test is not typically required. However, given the risk of flooding from other sources to the sites and surrounding areas, the RB of Greenwich has considered it appropriate to encourage the principles of the Exception Test to be applied, and therefore recommendations have been provided to indicate how development may be made safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, may reduce flood risk overall.

2 Site Assessment Approach

2.1 Site-specific Pro Forma

A site assessment pro forma has been prepared for each site included in the Level 2 SFRA containing the following information:

- Proposed Development
- Strategic Assessment of Flood Risk
- Site Specific Recommendations
- Summary

The information used to complete each of these sections is described below.

2.1.1 Proposed Development

Details of the site, as provided by the Council, including site ID, address, area, current use and proposed use. The vulnerability classification of the site has been defined according to the NPPF, (refer also to Section 5 Table 5-2 in the Level 1 SFRA).

2.1.2 Level 2 Flood Risk Assessment

Summary of the flood risk posed to the site, referring to data contained within the Level 1 SFRA as outlined below:

- For the assessment of flood risk from rivers, the proportion of the site within each flood zone has been identified, along with the flood zone map showing the site.
- The defences protecting the site and Flood Warning area associated with the site is has been identified as well as local Emergency Rest Centres.
- To provide a greater resolution of detail with regard to fluvial flood risk within flood zones, reference has been made to fluvial Flood Hazard, Depth and Velocity data and mapping as provided by the Environment Agency.
- The residual tidal flood risk across each site (where applicable) has been identified using Environment Agency Thames Tidal Breach Modelling (refer to Sections 2.2.1 – 2.2.5), and is presented within each site assessment. The RB of Greenwich is protected by the presence of defences and is therefore at residual tidal flood risk. The Environment Agency breach modelling provides a worst case scenario for flooding in Greenwich if there was to be a breach in the flood defences.
- The risk of flooding from surface water has been identified and mapped for each site using the Environment Agency Risk of Flooding from Surface Water (RoFSW) data which classifies surface water flood risk into three probability bands:
 - 3.33% AEP (1 in 30 year) High Risk
 - 1% AEP (1 in 100 year) Medium Risk
 - 0.1% AEP (1 in 1000 year) Low Risk
- Groundwater flooding usually occurs in low lying areas underlain with permeable rock and aquifers that allow groundwater to rise to the surface. Reference has been made to mapped outputs from the Groundwater Flooding Study being undertaken by MWH to identify potential risk across each specific site.
- The number of historic sewer records of internal and external flooding, within a 100m radius of the potential development site, has been identified using the historic records provided by Thames Water Utilities Limited (TWUL).
- Reference has been made to Ordnance Survey mapping and Environment Agency data to identify any artificial sources that pose a flood risk to the site.

Further details on each of the datasets, their uses and limitations can be found within the RB of Greenwich Level 1 SFRA and Developer Guidance⁵ (the specific sections are referenced in Table 2-1).

Table 2-1 Location of dataset information in the RB of Greenwich Level 1 SFRA and Developer Guidance

Flood Risk Source	Dataset	RB of Greenwich Level 1 SFRA reference/ Developer Guidance
Flooding from Sea	Environment Agency Flood Map for Planning NPPF Flood Zones Flood Defences Thames Tidal Breach Modelling Flood Warning Areas Emergency Rest Centres	Section 4.2.1 Section 4.2.1 Section 4.2.3 Section 4.2.5 Section 4.9.1 Developer Guidance Section 3
Flooding from Rivers	Environment Agency Main Rivers Environment Agency Flood Map for Planning NPPF Flood Zones Functional Floodplain Flood Zone 3b Flood defences	Section 4.3.1 Section 4.3.3 Section 4.3.3 Section 4.3.4 Section 4.3.5
Flooding from Surface Water	Critical Drainage Areas (CDAs) Risk of flooding from Surface Water	Section 4.5.1 Section 4.5.2
Flooding from Groundwater	Susceptibility to Groundwater Flooding Historic Records	Section 4.6.1 Section 4.6.2
Flooding from Sewers	DG5 sewer flooding risk register	Section 4.7.2
Flooding from Reservoirs and Other Artificial Sources	Risk of Flooding from Reservoirs	Section 4.8.2

2.1.2.1 Thames Tidal Breach Modelling

The scope of this Level 2 SFRA is to build upon data contained within the Level 1 SFRA to consider the detailed nature of the flood risk within flood zones as well as outlining site specific recommendations for planning and site design. Due to the location of Greenwich, bordering the River Thames, much of its frontage is located within Flood Zone 3. However, the presence of the River Thames Tidal Defences (flood walls and the Thames Barrier) places much of the borough at a 'residual risk' in the unlikely event that existing defences fail. In order to further assess the residual risk posed by the River Thames, reference has been made to outputs from Breach Modelling provided by the Environment Agency.

Outputs from two Environment Agency modelling studies have been used to assess the impact of potential breaches in the flood defences as part of this Level 2 SFRA:

- Thames Tidal Upriver Breach Inundation Assessment (May 2017)⁶
- Thames Estuary Breach Assessment (May 2018)⁷

Both of these studies simulate multiple breach locations along the entire frontage of the RB Greenwich. The Upriver Breach Inundation Assessment simulates breaches in the flood defences upstream of the Thames Barrier, and the Thames Estuary Breach Assessment provides outputs associated with a breach in the flood defences downstream of the Barrier.

As part of the studies, the results from the individual breach scenarios have then been combined to generate a single maximum flood extent, depth and hazard output covering the two study areas.

2.1.2.2 Tidal Flood Depth

Maps of the composite maximum flood depth are provided in Appendix B.

2.1.2.3 Tidal Flood Hazard

As described in the RB of Greenwich Level 1 SFRA Section 4.2.5, flood hazard information further refines Environment Agency flood zones into areas of low, medium, high and extreme hazard (based on the methodology set out by DEFRA FD2320)⁸. In essence, the flood hazard is derived by assessing the combined effects of the velocity of flood waters at a particular location, the maximum depth of floodwaters that will be achieved and a debris factor. The velocity and depth are affected by the proximity to the flooding source and also the local topography. Therefore, the maximum flood hazard at a particular location within the flood cell may be experienced at any stage of the flood. In a flood event

⁵ Royal Borough of Greenwich (2017) Developer Guide for Flood Risk and Surface Water Management

⁶ Atkins, May 2017, Thames Tidal Upriver Breach Inundation Assessment.

⁷ Atkins, May 2018, Thames Estuary Breach Assessment. Thames Barrier to Gravesend and Linford.

⁸ Defra/Environment Agency Flood and Coastal Defence R&D Programme (2005) Flood Risk Assessment Guidance for New Development (R&D Technical Report FD2320/TR2. http://evidence.environment-agency.gov.uk/FCERM/Libraries/FCERM_Project_Documents/FD2320_3364_TRP_pdf.sflb.aspx

caused by a breach in the defences, those areas closest to the breach location will experience the highest hazards because it is here that the velocity of floodwater will be highest. Further away from the breach location, the maximum hazard will depend on local factors affecting both the depth of the floodwaters and velocities at each instant. On the periphery of the flood extent, maximum flood hazard occurs nearer the peak water depth, towards the end of the breach simulation.

Hazard mapping is provided in Appendix C.

2.1.3 Site Specific Recommendations

Site specific recommendations are provided for potential development on each site to provide an indication of how Part 2 of the Exception Test could be satisfied. It follows the guidance set out in the RB of Greenwich Level 1 SFRA Developer Guidance⁹. Table 2-2 shows the typical fields within the site assessment pro forma and how these relate to the Developer Guidance.

Table 2-2 Site Pro Forma Recommendations Fields

Recommendation	Level 1 SFRA Developer Guidance reference
Development Layout	Section 2-1, Section 2-5, Section 2-7
Finished Floor Levels	Section 2-6
Flood Resistant and Resilient Design	Section 2-6
Flood Plain Compensation	Section 2-7
Flood Routing	Section 2-7
Safe Access and Egress	Section 2-8, Section 3
Flood Warning and Evacuation Plan	Section 3
SuDS Suitability	Section 4
Drainage Strategy	Section 2, Section 4

2.1.4 Summary

Summarises the key outcomes from the site assessment and highlights any recommendations and mitigation measures required for the site to pass the Exception Test.

2.2 Impact of additional development on flood risk

New developments can increase flood risk through:

- Siting a building within an area at risk of flooding which will increase the direct risk posed to the building and may also create indirect impacts elsewhere;
- Increasing the amount of runoff from a site, especially where permeable surfaces are reduced;
- Increasing flood risk upstream where development constricts flow paths or impairs the conveyancing capacity of the floodplain;
- Reducing floodplain storage, where buildings are located within the fluvial floodplain;
- Interfering with natural flow paths and reducing capacity for a floodplain to store water through land raising; and,
- Obstructing overland flow paths.

All of these risks must be considered as part of a site specific Flood Risk Assessment. Potential mitigation measures are discussed for each site within the site specific pro formas included in Appendix A.

⁹ Royal Borough of Greenwich (2017) Developer Guide for Flood Risk and Surface Water Management

Appendix A.Site Assessments

Table A.1 Royal Borough of Greenwich Level 2 SFRA sites for assessment

Site ID	Site Name	Site Location
AW1	Lyndean Industrial Estate	Abbey Wood
AW2	Abbey Wood telephone exchange	Abbey Wood
C1	Charlton Riverside North West Industrial	Charlton
C2	Charlton Riverside West	Charlton
C3	Land to the south of Thames Barrier	Charlton
C4	Thames Barrier approach and Eastmoor Street	Charlton
C5	Charlton Riverside Central	Charlton
C6	Angerstein Triangle, Bramshot Avenue	N/A
C7	Westminster Industrial Estate	Charlton
C8	Harrington Way	Charlton
C9	Charlton Educational	Charlton
C10	40 Victoria Way	N/A
E2	Land to north of Eltham High Street	Eltham
E3	Reservoir	Eltham
E4	Mecca Bingo	Eltham
E5	Site next to Eltham bowling green	Eltham
G1	Site on the corner of Horseferry Place and Thames Street	Greenwich
G2	Creek Road, south side, west of Deptford Creek (Meridian Gateway)	Greenwich
G3	Royal Hill Court, off Greenwich High Road	Greenwich
G4	Davy's site, 161-171 Greenwich High Road	Greenwich
G5	25-81 Greenwich High Road	Greenwich
G6	Greenwich Police Station, Burney Street	Greenwich
G7	Brookmarsh Industrial Estate & Phoenix Wharf, Lower Norman Road	Greenwich
G8	55-71 Norman Road & railway arches	Greenwich
G9	Greenwich High Road backland	Greenwich
G10	Greenwich Park Street telephone exchange	Greenwich
GP1	Lovell's Wharf	Greenwich Peninsula
GP2	Former Tunnel Glucose Wharf (West)	Greenwich Peninsula
GP3	Site to east of A102 (M), west of Bugsby's Way	Greenwich Peninsula
GP4	Delta/Blackwall Wharf and land west of North Greenwich station	Greenwich Peninsula
GP5	East Parkside/Bugsby's Reach	Greenwich Peninsula
GP6	Site south of O2 Arena including North Greenwich station	Greenwich Peninsula
GP7	O2 arena, Sports arena, conference, event and leisure centre with retail uses included	Greenwich Peninsula

Site ID	Site Name	Site Location
GP8	O2 arena open space	Greenwich Peninsula
GP9	Greenwich Millennium Village (Phases 3-5)	Greenwich Peninsula
GP10	Site between A102M and West Parkside, north of Millennium Village	Greenwich Peninsula
GP11	Heart of East Greenwich	Greenwich Peninsula
GP12	Site at junction of John Harrison Way and Millennium Way	Greenwich Peninsula
GP13	Enderby Wharf/ Enderby Place	Greenwich Peninsula
K1	Kidbrooke station area	Kidbrooke
K2	Phases 4 and 5 Kidbrooke Village East	Kidbrooke
K3	Huntsmans	Kidbrooke
K4	Phases 2 and 6 Kidbrooke Village West	Kidbrooke
K5	Phase 3, Kidbrooke Village Centre	Kidbrooke
K6	Former Thomas Tallis school	Kidbrooke
K7	Sutcliffe Park extension	Kidbrooke
P1	Abery Street Car Park	Plumstead
P2	Plumstead Library	Plumstead
P3	Plumstead Leisure Centre	Plumstead
P4	Motor services site	Plumstead
P5	Plumstead fire station and land adjacent to fire station	Plumstead
P6	Former Electricity Generating Station, White Hart Road	Plumstead
P7	Car Wash site	Plumstead
T1	Site North of White Hart Avenue	Thamesmead
T2	Community/civic site, Thamesmere Drive	Thamesmead
T3	Tripcock Point school site	Thamesmead
T4	Site fronting Nathan Way	Thamesmead
T5	Tripcock Park East and West	Thamesmead
T6	Tripcock Point, Thamesmead SE28	Thamesmead
T7	Titmuss Avenue	Thamesmead
T8	Battery Road Thames Reach	Thamesmead
T9	Pettman Crescent, Griffin Manor Way	Thamesmead
T10	Broadwater Dock West of Winchat Road	Thamesmead
T11	Land adjacent to Broadwater Dock	Thamesmead
W1	Lower Spray Street	Woolwich
W2	Land enclosing Mortgramit Square (Hare and Powis Street)	Woolwich
W3	Glass Yard	Woolwich
W4	Wilkinson	Woolwich
W5	Callis Yard, Macbean Centre, Woolwich Poly, Murrays Yard	Woolwich
W6	Crossrail (N/A)	Woolwich
W7	Spray Street SPD area	Woolwich
W8	Former public baths building, Bathway	Woolwich

Site ID	Site Name	Site Location
W9	DLR Woolwich (2 sites)	Woolwich
W10	Warren Lane 'teardrop' site	Woolwich
W11	Woolwich Campus "island" site, Calderwood Street	Woolwich
W12	Arsenal Way	Woolwich
W13	Thomas Street SPD site	Woolwich
W14	Dial Arch Square	Woolwich
W15	Wellington Park	Woolwich
W16	Maryon Estate	Woolwich
W17	Connaught Estate	Woolwich
W18	Morris Walk and Marion Grove Estate	Woolwich
SA1	Co-op McLeod Road, Abbey Wood	Thamesmead and Abbey Wood
SA2	Grass Area Abbey Wood Rd/Bostall Manorway (opposite st Nic convenience store)	Thamesmead and Abbey Wood
SA3	90 Abbey Wood Road	Thamesmead and Abbey Wood
SA4	Parade of shops McLeod Road	Thamesmead and Abbey Wood
SA6	Wilton Road shops	Thamesmead and Abbey Wood
SA7	Rochester Way Social Club	N/A
SA8	Green space along Rochester Way	N/A
SA9	St Richard's Church Centre Swallowfield Rd Charlton	N/A
SA10	Eynsham Drive	Thamesmead and Abbey Wood
SA11	Former M&S outlet store Woolwich	Woolwich
SA12	Anstridge community hall	N/A
SA13	Flintmill Community Hall, Flintmill Crescent, Kidbrooke, SE3 8LU	Kidbrooke
SA14	Lionel Road Community Hall, 540 Westhorne Avenue, SE9 6DH	Eltham
SA15	Progress Community Hall, Next to 12 Admiral Seymour Road, SE9 1SL	Eltham
SA16	St Mary's Community Centre, 180 Eltham High Street, SE9 1BJ	Eltham
SA17	Greenwich Peninsula Gas Holder	Greenwich Peninsula
SA18	Land at Footscray Road	Eltham
SA19	1 Warspite Road Woolwich	Charlton
SA20	Old Tesco building/ Stacks Eltham	Eltham
SA21	Former Alders building Eltham	Eltham
SA22	Mansion site, University of Greenwich Avery Hill, Eltham	Eltham
SA23	New Eltham Day Nursey, Sidcup Road	Eltham
SA24	BT building, Well Hall Road, Eltham	N/A
SA25	Police station, Well Hall Road, Eltham	Eltham
SA26	Greenwich Hotel and Magistrates Court Greenwich High Road	Greenwich
SA27	Gaelic Athletic Sports Ground, Avery Hill Road	Eltham
SA28	Well Hall Sports Ground, Kidbrooke Lane, Eltham	Eltham
SA29	The University of Greenwich Bathway Quarter, Woolwich	Woolwich
SA30	Units 2-4, Commonwealth Buildings, Woolwich	Woolwich

Site ID	Site Name	Site Location
SA31	Former Bowring Sports Ground, Lee SE12 8ES	Kidbrooke
SA32	Land East of Oaks Care Home, New Eltham	Eltham
SA33	Eltham Town Sports Club, New Eltham	Eltham
SA34	110-114 Norman Road, Greenwich	Greenwich
SA35	28 Court Yard New Eltham	Eltham
SA36	Pippenhall Avery Hill, Eltham (open space)	Eltham
SA37	Woolwich Bus Station and Trade Park (plumstead Gyrotory)	Plumstead
SA38	NHS Ambulance station, Glass Yard Woolwich	Woolwich
SA39	Cathedral Corner Plot of John Wilson Street and Powis Street	Woolwich
SA40	Mast Quay Plot/Mast pond wharf	Woolwich
SA41	Sovereign House and Derelict docks, Woolwich	Woolwich
SA42	Woolwich Dockyard Industrial Estate	Woolwich
SA43	Powis Street Car Park, Woolwich	Woolwich
SA44	Borgard Road car parking	Woolwich
SA45	Northern Stretch of Maryon Road (between W18)	Woolwich
SA46	Belmarsh Prison	Woolwich
SA47	Charlton Station and surrounds	Charlton
SA49	Anchor and Hope Pub and Cory Premises, Riverside Charlton	Charlton
SA50	Menzies site, Greenwich Peninsula	Greenwich Peninsula
SA51	Millennium retail park (Sainsbury's, Nandos, B&Q etc)	Greenwich Peninsula
SA52	Post office distribution centre/ Angerstein sites	Charlton
SA54	Blackheath and Greenwich bowling green	N/A
SA55	Tennis courts Blackheath Park	N/A
SA56	Saxon's Wharf, Norman Road	Greenwich
SA57	Ahoy Centre	Greenwich

Appendix B.Flood Depth Maps

- Figure B.1 Upriver Breach Assessment Maximum Flood Depth ((MLWL for 2100)
- Figure B.2 Downriver Breach Assessment Maximum Flood Depth (0.5% AEP 2115)
- Figure B.3 Downriver Breach Assessment Maximum Flood Depth (0.5% AEP 2115)
- Figure B.4 Downriver Breach Assessment Maximum Flood Depth (0.1% AEP 2115)
- Figure B.5 Downriver Breach Assessment Maximum Flood Depth (0.1% AEP 2115)

Appendix C.Flood Hazard Maps

Figure C.1 Upriver Breach Assessment Maximum Flood Hazard Rating ((MLWL for 2100)

Figure C.2 Downriver Breach Assessment Maximum Flood Hazard Rating (0.5% AEP 2115)

Figure C.3 Downriver Breach Assessment Maximum Flood Hazard Rating (0.5% AEP 2115)

Figure C.4 Downriver Breach Assessment Maximum Flood Hazard Rating (0.1% AEP 2115)

Figure C.5 Downriver Breach Assessment Maximum Flood Hazard Rating (0.1% AEP 2115)

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