

SIM – Sitewide Capital Works

Flood Risk Assessment

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Glossary

Term	Definition
Annual Exceedance Probability (AEP)	The probability that a storm event will be exceeded in any given year.
Attenuation	A method to reduce a flood peak to prevent flooding, often utilising temporary storage, but increasing the duration of the flow.
Flood Risk	The level of risk to personal safety and damage to property resulting from flooding due to the frequency or likelihood of flood events.
Flood Risk Assessment (FRA)	An assessment of the flood risks to the proposed development over its expected lifetime and the possible flood risks to the surrounding areas, assessing flood flows, flood storage capacity and runoff.
Fluvial Flooding	Flooding resulting from an exceedance event in a river or watercourse.
Groundwater	Water present within underground strata known as aquifers.
Groundwater Flooding	Water occurring below ground in natural formations (typically rocks, gravels and sands).
Impermeable Surface	A surface that does not permit the infiltration of water and, therefore, generates surface water runoff during periods of rainfall.
Inundation	Flooding of land with water
Mitigation	Positive measures taken to reduce either the probability of flooding or the consequences of flooding or a combination of the two.
Permeability	The measures of ease with which a fluid can flow through a porous medium.
Resilience	The degree to which an asset or development can recover from a flooding event.
Return Period	The average frequency of a specified condition. An 'n' year event is one that occurs on average over the long term, once every 'n' years
Risk	Risk is the probability that an event will occur and the impact (or consequences) associated with that event.
Runoff	Water flow over surfaces to the drainage system. Runoff occurs when rainfall exceeds the rate of permeability of a surface.
Strategic Flood Risk Assessment (SFRA)	An SFRA is the assessment and 'categorisation' of flood risk on an area-wide basis in accordance with the NPPF, usually carried out by the Local Planning Authority.
Surface Water Flooding	Surface water flooding occurs when the volume of water is unable to filtrate through the ground to enter drainage systems, and therefore runs quickly off land and results in localised flooding. This type of flooding is usually associated with intense rainfall.
Sustainable Drainage Systems (SuDS)	SuDS are used as a strategy to manage surface water in a sustainable manner or least damaging solution through management practices and physical structures.

1 Executive Summary

Subject		Findings
Site Description		The proposed development is located in Castlefield, Manchester. It has an total area of 12,590m ² and is currently home to the Science and Industry Museum. The nearest watercourses are the River Irwell, approximately 70m to the west of the site, and the Bridgewater Canal and River Medlock, whose confluence is approximately 250m to the south of the site. The site generally slopes east to west, sloping downwards towards the River Irwell.
Proposal Description		The proposed development is a phased refurbishment of the Upper Yard and Station Approach public realm areas, temporary landscaping in the Heart Space, and repairs and making good to the plant room deck and the former vehicle ramp area.
Vulnerability classifications & Design Life		Museums and warehouses are used for commercial use and are classified as <i>Less Vulnerable</i> , according to the National Planning Policy Framework (NPPF). Based on the commercial use of the site, the design life for the development has been assessed at 75 years to 2099.
Sequential & Exception Test		The Sequential Test and Exception Test are not required as the site is in Flood Zone 1.
Site Flood Risk	Fluvial & Tidal	The site is located within Flood Zone 1, defined as being at <i>Low</i> risk (probability of less than 1 in 1,000 years) of fluvial and tidal flooding. The Environment Agency (EA) has no record of flooding in the area.
	Groundwater	The local authority's latest Strategic Flood Risk Assessment (SFRA) states that the site is not located within an area at risk of groundwater flooding. Although there are existing basements, the risk of groundwater flooding is considered to be <i>Low</i> .
	Surface Water & Sewers	The site is primarily at <i>very low risk</i> from surface water flooding, with two small areas of the site at a <i>low risk</i> ; These areas are concentrated to the internal site roads. There is no record of flooding associated with the combined sewers, however there is a risk associated with failure or blockage of the sewer network in the area. Despite this, the risk of flooding from sewer network is considered to be <i>Low</i> .
	Artificial Sources	Part of the site is located within the maximum extent of flooding from reservoirs when river levels are normal and when they are flooded. The site is located to the north of the Bridgewater Canal, which is a regulated waterbody that is unlikely to flood. There is a risk of flooding during breach or failure of the Bridgewater Canal. The probability of reservoir failure and breach of the Canal is considered to be very low and therefore the risk of flooding from artificial sources is considered to be <i>Low</i> on the site.
Mitigation Measures	Drainage Strategy	The proposed drainage strategy will retain the existing drainage regime and points of connection with a like-for-like proposal. This has been discussed and agreed with Manchester City Council, in their capacity as the Lead Local Flood Authority (LLFA). It is proposed that the surface water from the newly landscaped area in the Upper Yard will be drained towards the existing stormwater outfall via a series of linear channel drains and gullies whilst the existing drainage regime at the Station Approach relies on the infiltration of surface water through the existing ballast will also be retained. Both areas will ultimately discharge into the existing public sewer connection in Water Street.
Summary and Conclusion		It is concluded that the risk of flooding from all sources, for the design life, is considered to be <i>Low</i> and that the proposed development will not increase the risk of flooding elsewhere.

2 Introduction

2.1 Background

This site-specific Flood Risk Assessment (FRA) has been prepared by Buro Happold as part of a full planning application and listed building consent for a suite of projects at the Science and Industry Museum (SIM) site in Manchester that form part of the Sitewide Capital Works 2025 project. The proposed development is the phased refurbishment of the Upper Yard and Station Approach public realm areas, temporary landscaping in the Heart Space, and repairs and making good to the plant room deck and the former vehicle ramp area.

This assessment has been carried out in accordance with the UK National Planning Policy Framework (NPPF) and considers the risk of flooding from fluvial, tidal, surface water (pluvial), combined sewer, artificial (reservoir and canal) and groundwater sources.

2.2 Site Description

The site, shown in Figure 2—1, is located in Central Manchester, within the Castlefield Conservation Area. Greater Manchester and is centred on Ordnance Survey grid reference SJ 83150 97851. The site address is Science and Industry Museum, Liverpool Road, Castlefield, M3 4JP.

The site ownership area is circa 2.21 hectares. It is bounded by Lower Byrom to the east, Liverpool Road to the south, Water Street to the west and commercial developments directly north of the site. At the southwest corner of the site there is a railway that continues across the River Irwell to the west.

The planning application boundary encompasses two primary areas within the wider ownership boundary: the Upper Yard and the Station Approach. The Upper Yard is an area of external landscaping situated to the east of the site, in-between the New Warehouse and Power Hall. The Station Approach is a section of a historic railway viaduct and station platform located between the 1830s Warehouse to the north and the Station Building and Station Master's house to the south. Figure 2—1 presents the site boundary and its relative location.

The site gradually slopes down from east to west, towards the River Irwell. Elevations at the eastern boundary are approximately +33mAOD, whilst those along the western boundary reach a minimum of approximately +26mAOD as shown in Figure 2—2. Elevations along the southern boundary of the site are approximately +32.6mAOD and +26.4mAOD at the south-eastern and south-western corner, respectively.

The site is situated within the Croal Irwell Operational catchment, which sits within the wider River Irwell Catchment. The River Irwell runs from north to south to the west of the site. The Bridgewater Canal is situated to the south of the site which is fed by the River Mersey.

The site is located within Flood Zone 1, which is classified as having less than a 0.1% (1 in 1000) annual probability of river (fluvial) or the sea (tidal) flooding. The nearest land within Flood Zone 2 or 3 (medium and high risk respectively) is approximately 30m and 100m, respectively, to the north of the site, associated with the River Irwell. There is also an area of Flood Zone 2 approximately 35m away from the southern site boundary. This is associated with the Bridgewater Canal.

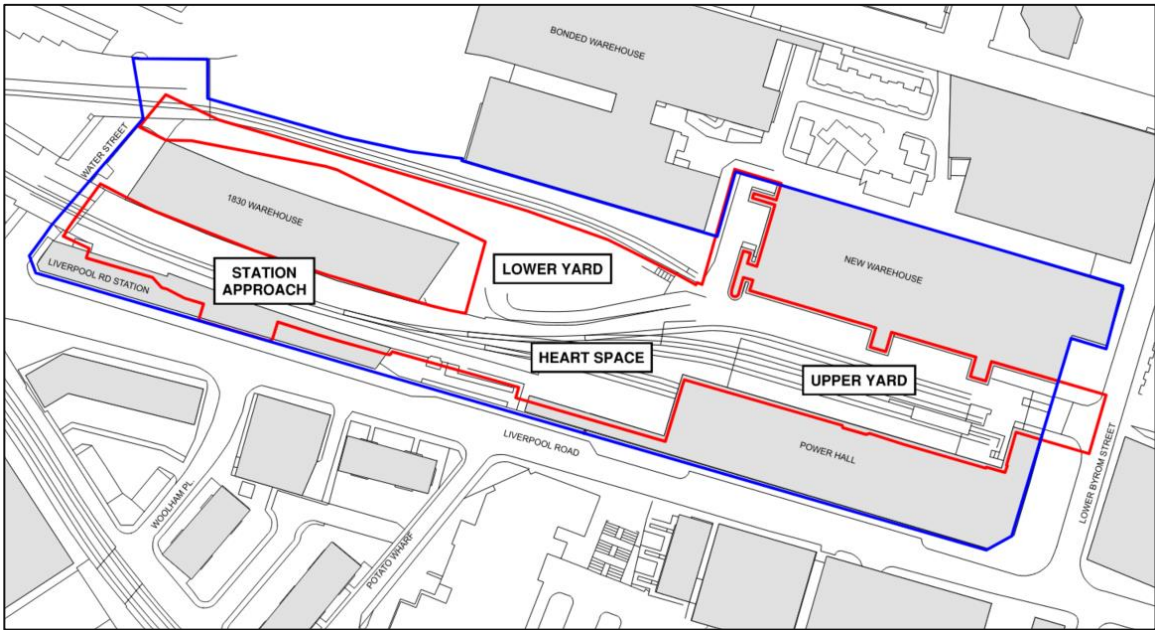


Figure 2—1 Science and Industry Site Location Plan and Ownership Boundary (Planit I.E. limited, Issued 26th October 2023, Drawing No. 2913-PLA-XX-XX-DR-L-0006).

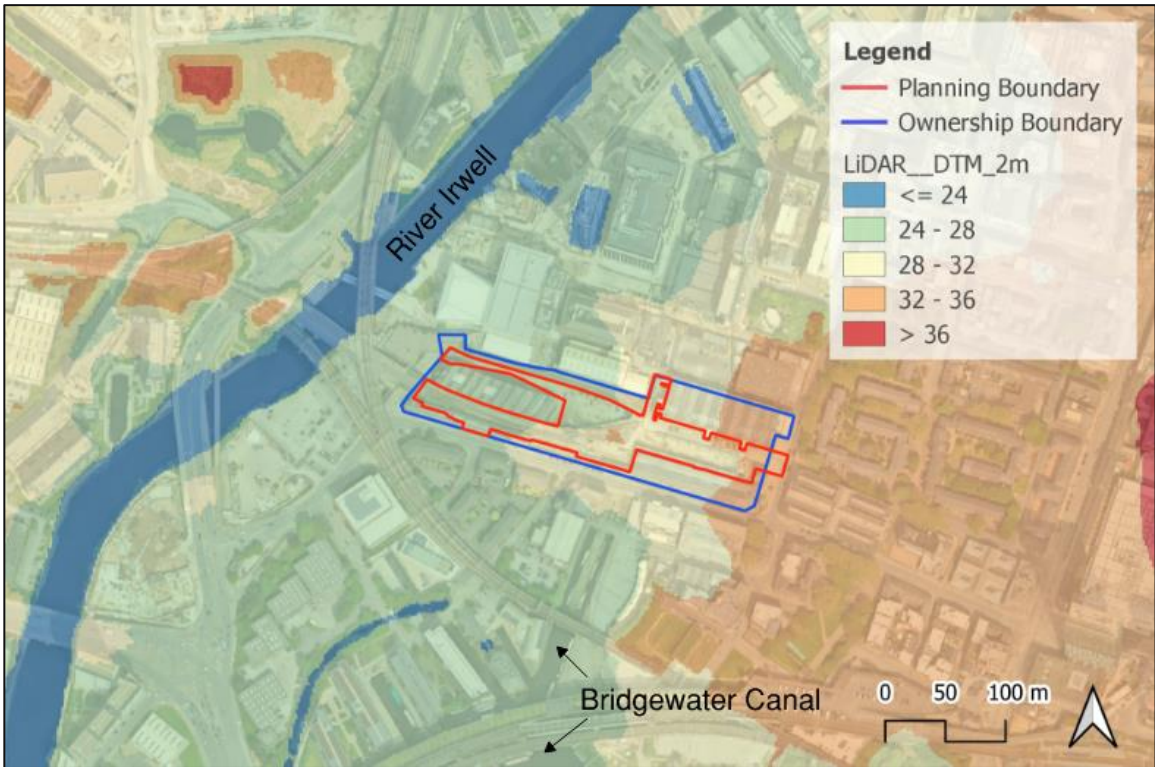


Figure 2—2 Environment Agency LIDAR Composite DTM 2019 2m data (© Environment Agency copyright and/or database right 2022. All rights reserved. © Environment Agency copyright and/or database right 2015. All rights reserved)

2.3 Proposed Development

The proposed development is a phased refurbishment of the Upper Yard and Station Approach public realm areas, temporary landscaping in the Heart Space, and repairs and making good to the plant room deck and the former vehicle ramp area. As defined on the phasing plan 2913-PLA-XX-XX-DR-L-0024, Phase 1 includes works to Upper Yard areas including: new accessible routes; new planters; new fixed furniture; re-surfacing including with new materials; repair and relaying of existing cobbles; works to underground services to accommodate the scheme, building repairs and associated works. Phase 2 includes works to Station Approach areas including: new accessible routes; new planting areas; new fixed furniture; re-surfacing including with new materials; works to underground services to accommodate the scheme, building repairs and associated works. Phase 3 includes temporary re-surfacing works in the Heart space. Phase 4 includes repairs and making good works to the hard landscaping beneath and the viaduct façade adjacent to the location of the former vehicle ramp. The phases of the development are severable. Figure 2—3 illustrates the proposed masterplan.

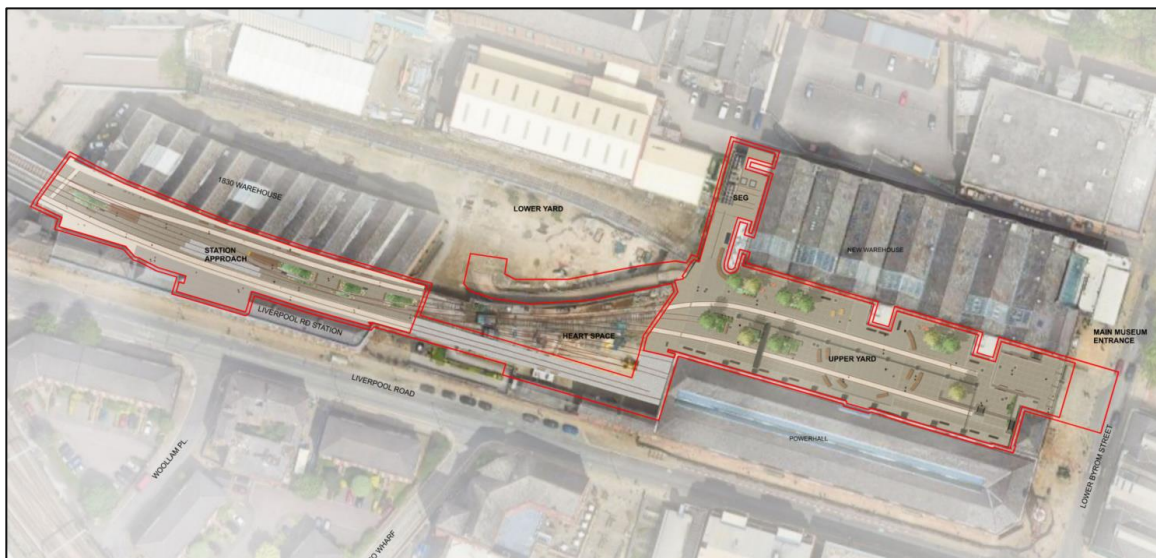


Figure 2—3 Proposed General Arrangement Illustrative Plan (Planit I.E. limited, Issued 17th October 2023, Drawing No. 2913-PLA-XX-XX-DR-L-0008).

3 Planning Context

3.1 Overview

This Flood Risk Assessment (FRA) has been prepared in accordance with the policies and guidance applicable to the proposed development, outlined within the following publications:

- National Planning Policy Framework (March 2012, Updated December 2023);
- National Planning Policy Framework Planning Practice Guidance website (Updated: September 2023);
- Manchester City, Salford City and Trafford Council Level 2 Hybrid Strategic Flood Risk Assessment (SFRA); Level 1 SFRA (March 2010);
- Manchester City, Salford City and Trafford Council Level 2 Hybrid Strategic Flood Risk Assessment (SFRA); Level 2 SFRA (March 2011);
- Greater Manchester Combined Authority (GMCA), 2019-2020 SFRA (October 2020).

3.2 National Planning Policy Framework (NPPF)

Land use planning policy in England is governed by the NPPF, introduced in 2012 and revised in 2018, 2019, 2021 and 2023. This FRA has been carried out in accordance with the December 2023 revision of the NPPF. The NPPF is issued by the Government Department for Levelling Up, Housing and Communities (DLUCH), as named since September 2021, formerly known as the Ministry of Housing, Communities and Local Government (MHCLG) at the time of issue.

As part of the wider sustainability objectives of the NPPF, the framework asks proposed developments to mitigate and adapt to the impacts of climate change, accounting for the long-term implications for flood risk (Ref. 153).

The framework also requires that inappropriate development in areas of flood risk be avoided (Ref. 159), stating that where development is necessary in areas of flood risk, it should 'be made safe' for its lifetime without increasing flood risk elsewhere.

3.2.1 Responsible Authorities

The Flood and Water Management Act (2010) stipulated the duty imposed on the Environment Agency for supervision of matters relating to flood defence in England with a focus on the risk associated with statutory 'Main Rivers', 'Critical Ordinary Watercourses', coastal and reservoir risk. The act also created the designation of a Lead Local Flood Authority (LLFA) for management of risk including from Ordinary Watercourses, surface water, ground water and sewer flood risk. The LLFA for the site is Manchester City Council (MCC).

Successive Land Drainage Acts from 1930 have also established Internal Drainage Boards (IDBs) for catchment wide management of flood risk in areas of special drainage needs. No IDBs have presently been established within Greater Manchester.

3.2.2 Strategic Flood Risk Assessment

As stipulated in the NPPF, local authorities are required to carry out and keep up to date a strategic assessment of flood risk (SFRA) for the governed area, considering the management of risk from all sources and the cumulative impacts of flooding in local areas susceptible. The risk of flooding to the proposed development and site from each flood source will be assessed in Section 4.

The most relevant SFRAs to the site are as follows :

- **Manchester City, Salford City and Trafford Council (MST), 2010-2011** - A Level 1 SFRA , Level 2 SFRA and accompanying maps were prepared by JBA in 2010-2011 for Manchester City, Salford City and Trafford Councils covering the site. The risk of groundwater flooding is covered in the Level 1 report only while a more detailed assessment of the risk of fluvial, canal, surface water and sewer flooding were provided in the Level 2 report. The SFRA does not cover the risk of reservoir flooding on the grounds of national security.
- **Greater Manchester Combined Authority (GMCA), 2019-2020** - A Level 1 SFRA has been prepared by JBA for the Greater Manchester Combined Authority (GMCA) in March 2019, of which Manchester City Council (MCC) is a constituent authority. A Level 2 SFRA was also prepared in October 2020. This SFRA had a focus on sites related to the development of the Greater Manchester Spatial Framework.

3.3 Flood Risk Assessments

Applications are required to be supported by a Flood Risk Assessment where the site is located in Flood Zone 2 or 3 (NPPF Ref. 173 Footnote 59) or where a site in Flood Zone 1 is:

- Greater in area than 1 hectare;
- Land which has been identified by the Environment Agency (EA) as being Areas with Critical Drainage Problems (ACDPs - currently only applicable in Devon and Cornwall);
- Land identified in an SFRA as being at increased risk of flooding in the future;
- Land that may be susceptible to other sources of flooding (e.g. pluvial flooding) where the development would introduce a more vulnerable use.

The site covers an area of 2.21 hectares and therefore qualifies for assessment by site area.

3.3.1 Flood Zones

The NPPF aims to avoid inappropriate development in areas at highest risk of flooding. The risk of flooding from fluvial and coastal sources has been compiled into zoning maps for planning by the EA. The Planning Practice Guidance to the NPPF contains a series of tables that help identify the risk of flooding to a development. These tables are presented in Appendix B to Appendix D.

- Table 1 (Appendix B) defines four Flood Zones by flood risk, gives the land use classification appropriate to the flood risk and specifies the requirements of a FRA within each zone;
- Table 2 (Appendix C) presents the flood risk vulnerability and flood zone 'incompatibility' and identifies where development is appropriate for each flood risk vulnerability classification and whether the Exception Test is required.

- Annex 3 of the NPPF (Appendix D) provides information on the flood risk vulnerability classifications given in Table 2.

The Flood Zones defined in the NPPF are as follows:

Table 3—1 Flood Zone definitions by the NPPF.

Flood Zone	Definition
Flood Zone 1 Low Probability	Land having a less than 0.1% annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map for Planning – all land outside Zones 2, 3a and 3b).
Flood Zone 2 Medium Probability	Land having between a 1% and 0.1% annual probability of river flooding; or land having between a 0.5% and 0.1% annual probability of sea flooding. (Land shown in light blue on the Flood Map).
Flood Zone 3a High Probability	Land having a 1% or greater annual probability of river flooding; or Land having a 0.5% or greater annual probability of sea. (Land shown in dark blue on the Flood Map).
Flood Zone 3b Functional floodplain	This zone comprises land where water from rivers or the sea has to flow or be stored in times of flood. The identification of functional floodplain should take account of local circumstances and not be defined solely on rigid probability parameters. Functional floodplain will normally comprise: - land having a 3.3% or greater annual probability of flooding, with any existing flood risk management infrastructure operating effectively; or - land that is designed to flood (such as a flood attenuation scheme), even if it would only flood in more extreme events (such as 0.1% annual probability of flooding). Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. (Not separately distinguished from Zone 3a on the Flood Map).

3.3.2 Sequential Test

It is stated in the NPPF that all plans should take a sequential approach to locating development (Ref. 167), providing a risk-based assessment of the location of the development. The aim is to steer development to areas with the lowest risk of flooding from all sources (NPPF Ref. 168). A formal Sequential Test is not considered to be required for the site as the site is located within Flood Zone 1 according to MST Level 2 Hybrid SFRA; Level 1 SFRA.

3.3.3 Climate Change

The flood zones shown in the EA flood maps for planning do not consider the possible impacts of climate change or consequent changes in the future probability of flooding.

Allowances for the predicted effects of climate change should be considered when preparing site-specific flood risk assessments. The guidance published by the EA to support the NPPF contains sensitivity ranges that are recommended to be applied to peak rainfall intensities, peak river flows, sea level rise, offshore wind speeds and extreme wave heights. The general trend is for each parameter to increase in the future, which in turn increases the risk of flooding to any site. The allowances for peak rainfall intensity for the Irwell Management catchment are provided by the Department for Environment, Food and Rural Affairs (Climate change allowances for peak rainfall in England (data.gov.uk)) and are presented in Table 3—2. Climate change allowances for peak river flow are also provided using information generated by the UK Centre for

Ecology and Hydrology using UK Climate projections and are summarised for the Irwell Management catchment in Table 3—3.

It is recommended by the EA that both the central and upper end allowances are assessed to understand the range of the impact. The guidance further notes that the following considerations be made to decide which allowances are used to inform the flood risk management strategy for a development:

- Likely depth, speed and extent of flooding for each allowance of climate change over time considering the allowances for the relevant epoch (2020s, 2050s and 2080s);
- Vulnerability of the Proposed Development types or land use allocations to flooding;
- ‘Built in’ resilience measures used, for example, raised floor levels; and
- Capacity or space in the development to include additional resilience measures in the future, using a ‘managed adaptive’ approach.

Table 3—2 Climate Change Allowances for 1% AEP peak rainfall intensity for the Irwell Management Catchment.

Epoch	Central Allowance	Upper End Allowance
2050s	25%	40%
2070s*	30%	45%
* Use 2050s for development with a lifetime up to 2060 and use the 2070s epoch for development with a lifetime between 2061 and 2125		

Table 3—3 Climate change allowances for peak river flow in the River Irwell.

Epoch	Central Allowance (based on 50 th percentile)	Higher Central Allowance (based on 70 th percentile)	Upper End Allowance (based on 95 th percentile)
2020s (2015-2039)	12%	15%	24%
2050s (2040-2069)	19%	26%	43%
2080s (2070-2125)	35%	46%	75%

4 Flood Risk Appraisal

This section describes the flood risk within the ownership boundary. For all cases, the findings are applicable for the application boundary.

4.1 National Planning Policy Framework

4.1.1 Flood Zone

The Flood Map for Planning (Figure 4—1) produced by the EA shows that the site is located entirely within Flood Zone 1. Flood Zone 1 is defined as an area with an annual probability of flooding from rivers or the sea of less than 0.1%.

The risk of flooding from rivers or the sea in Flood Zone 1 is classified as low, having an annual exceedance probability (AEP) of 0.1% or 1 in 1,000 years. In accordance with EA guidance, the focus of this FRA will therefore be on the management of surface water run-off and the risk of flooding from other sources.

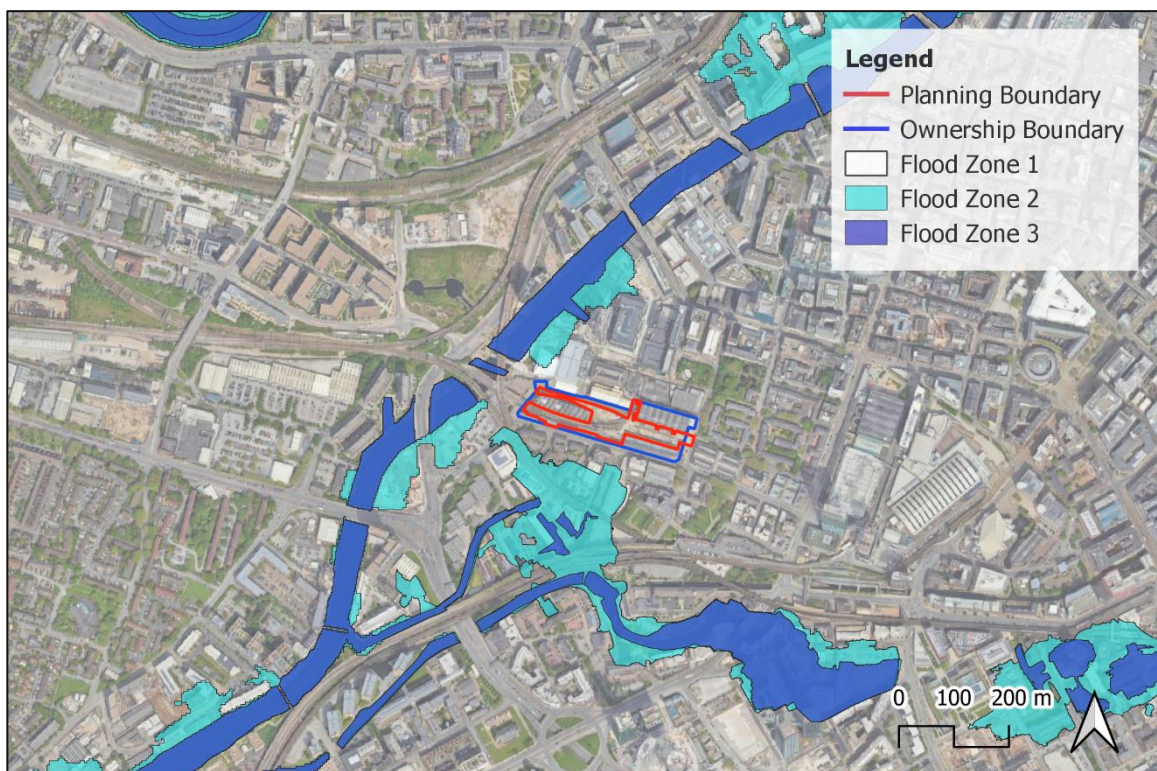


Figure 4—1 Environment Agency Flood Zone map with the ownership and planning boundaries indicated (©Environment Agency copyright and/or database right 2015. All rights reserved. Map data ©2021 Google)

4.1.2 Flood Risk Vulnerability Classification

The NPPF Planning Practice Guidance contains a series of tables which identify where development should be permitted, based on the Flood Zone in which the development is located and the proposed uses of that development. These tables are included in Appendix B to Appendix D.

The proposed development is a phased refurbishment of the Upper Yard and Station Approach public realm areas, temporary landscaping in the Heart Space, and repairs and making good to the plant room deck and the former vehicle ramp areas. According to the NPPF, these proposed land uses are classified as *Less Vulnerable*.

All of the above land uses are considered appropriate for development within Flood Zone 1, in accordance with Annex 3 of the Planning Practice Guidance.

4.2 Fluvial and Tidal Flooding

Fluvial flooding occurs when sustained or intense rainfall events increase the flow in rivers causing the water level to rise above the level of the banks and into the surrounding areas.

Tidal flooding occurs when particularly high tides coincide with storm surges. Storm surges are caused by low atmospheric pressure events resulting in temporary localised raising of sea levels.

The nearest watercourse is the River Irwell, approximately 150m to the west of the site. EA flood maps for planning show that the site is currently within Flood Zone 1, which is defined as land having a low annual probability of flooding from rivers or from the sea. This is land having less than 1 in 1,000 annual probability of flooding (less than 0.1% AEP).

The site, shown in Figure 4—2 is located within the Irwell Management Catchment and on the boundary of the Roch Irk Medlock and Croal Irwell operational catchments. Part of the site falls within the Irwell/Manchester Ship Canal sub-catchment and part falls within the Medlock sub-catchment. The River Irwell flows through the Manchester city centre and into the Manchester Ship Canal at the Salford Quays approximately 2km downstream of the site. To the south of the site is the confluence of the River Medlock and Bridgewater Canal, Medlock Clows. Upstream of Medlock Clows, the Bridgewater Canal is the Rochdale Canal.

The Manchester Ship Canal discharges into the River Mersey estuary at the coast ~60km from the site. Due to the distance from the estuary and the site being located above 25mAOD in its entirety, the site is not expected to be impacted by coastal flood risk in any form for the design life of the proposed development.

The EA has provided flood data for flood events with different AEP and various allowances for climate change along the River Irwell and River Medlock. By comparing the estimated flood levels to the LiDAR data along the site boundary, an assessment of the risk of fluvial flooding, with an allowance for climate change has been undertaken.

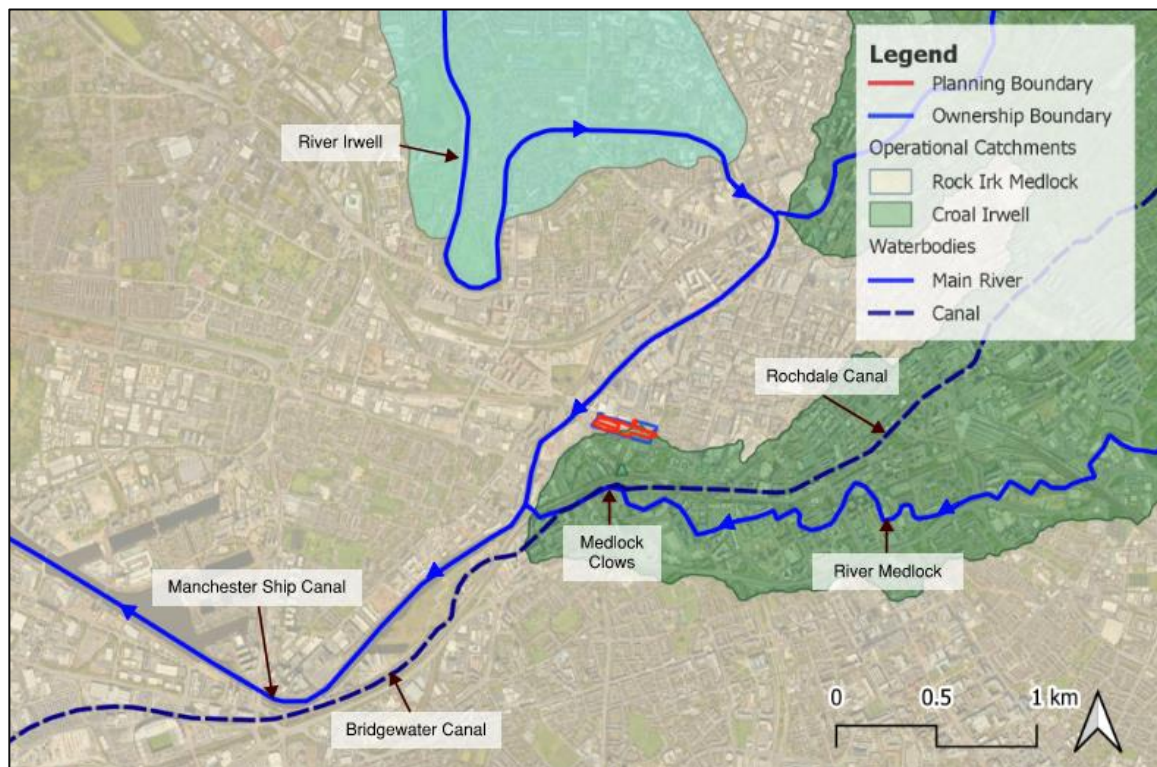
The lowest elevation along the western and southern site boundary is +26.2mAOD and +26.4mAOD, respectively. According to the EA data and considering a freeboard of 0.5m between flood level and site elevation, the site is therefore at low risk of flooding for all events up to an including the 1 in 100-year plus + 35% increase in flow from both the River Irwell and the Bridgewater Canal. The site is additionally at low risk of flooding from the River Irwell during the 1 in 200-year event. A freeboard of 0.5m to add safety is not possible for the flood level associated with the 1 in 100-year plus 70% increase in flow nor the 1 in 1,000-year event for both waterbodies, however flood levels are still lower than site elevations.

Table 4—1 EA flood data for River Irwell at a location adjacent to the site (Eastings, Northings: 382959, 398059).

AEP (Return Period)	Modelled Water level (mAOD)
20% AEP (1 in 5 year)	23.14
10% AEP (1 in 10 year)	23.39
4% AEP (1 in 25 year)	23.75
1% AEP (1 in 100 year)	24.26
1% AEP + 30% increase in flow (1 in 100 year)	24.69
1% AEP + 35% increase in flow (1 in 100 year)	24.78
1% AEP + 70% increase in flow (1 in 100 year)	25.84
0.5 % AEP (1 in 200 year)	24.59
0.01% AEP (1 in 1000 year)	26.14

Table 4—2 EA flood data for the Bridgewater Canal at a location adjacent to the site (Eastings, Northings: 383026, 397582).

AEP (Return Period)	Modelled Water level (mAOD)
4% AEP (1 in 25 year)	25.53
1% AEP (1 in 100 year)	25.70
1% AEP + 35% increase in flow (1 in 100 year)	25.91
1% AEP + 70% increase in flow (1 in 100 year)	26.16
0.01% AEP (1 in 100 year)	26.34

**Figure 4—2 The site's fluvial Catchment and Waterbodies.**

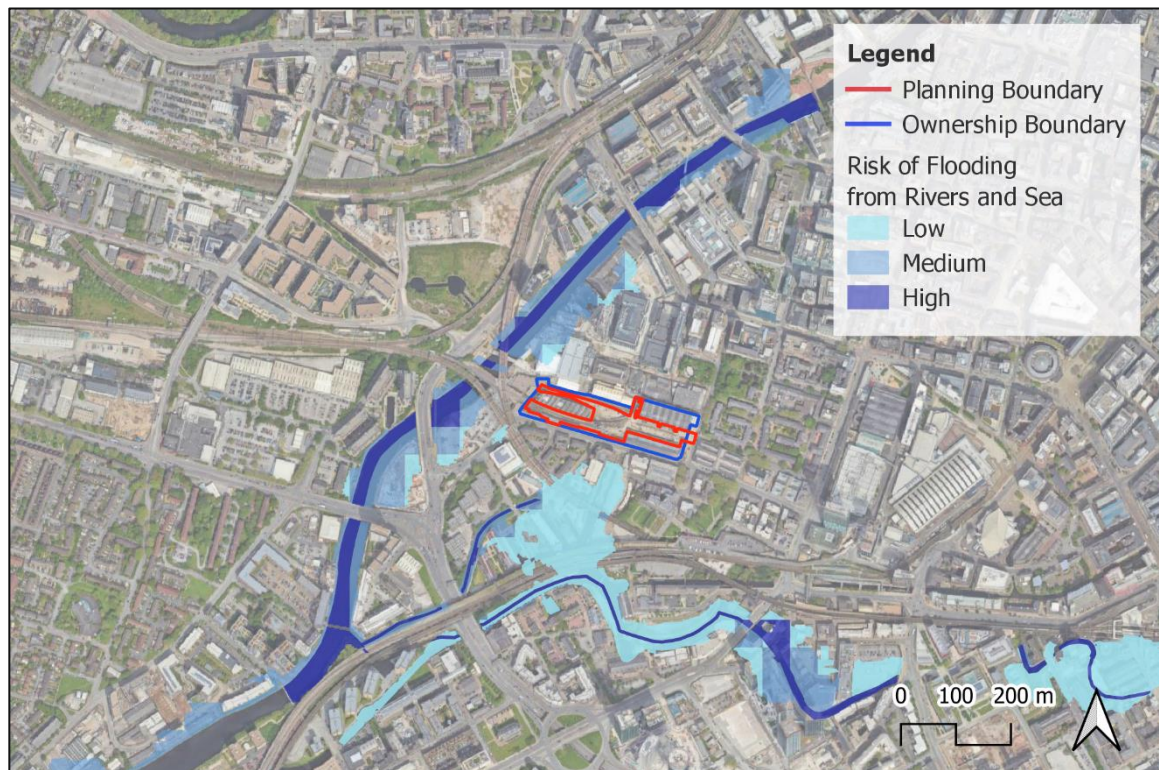


Figure 4—3 Environment Agency Fluvial and Tidal Flood Risk Map with the ownership and planning boundaries indicated.

4.3 Surface Water Flooding

Surface water flooding occurs when intense rainfall is unable to naturally soak into the ground due to impermeable ground covering such as concrete or tarmac, or low permeability ground conditions preventing infiltration. This excess surface water can flow through built-up areas and open space and pond in lower-lying areas causing localised flooding.

4.3.1 Baseline

The EA provides Surface Water flood risk maps for the extent, depths and velocities however no climate change allowance is accounted for in the mapping. The mapping in Figure 4—4 shows that the site is primarily at very low risk from surface water flooding, with two small areas of the site at a low risk; These areas are concentrated to the internal site roads within the ownership boundary. There is a low to medium risk of surface water flooding over 100m to the south of the site relating to the confluence of Medlock and Bridgewater Canal – where the Rochdale Canal becomes Bridgewater Canal.

The existing site consists almost entirely of impermeable paving or roofing. During a rainfall event, there is therefore very little potential for infiltration, and almost all of the rainfall falling on the site would be converted to surface water run-off which, in turn, can result in surface water flooding.

The Upper Yard mainly consists of cobbled stone with some areas of macadam. Based on CCTV surveys and site inspections, the Upper Yard drains via a series of existing gullies and linear channels into a below ground surface water network.

The Station Approach drains as a permeable paving with the infiltrated water encouraged towards the existing drainage troughs.

The Special Exhibition Gallery is located at basement level in the New Warehouse. It is situated directly below an external landscaped area of cobbled stone that shows evidence of water ingress evidenced by visible algae growth on the masonry walls. Drainage surveys undertaken indicate that some of the channels are not watertight.

The station viaduct shows evidence of water ingress underneath the arches thought to be from water migration from the track levels above but also noting the likelihood of multiple sources of water ingress. Surveys provided information on the condition and connectivity of the drainage network.

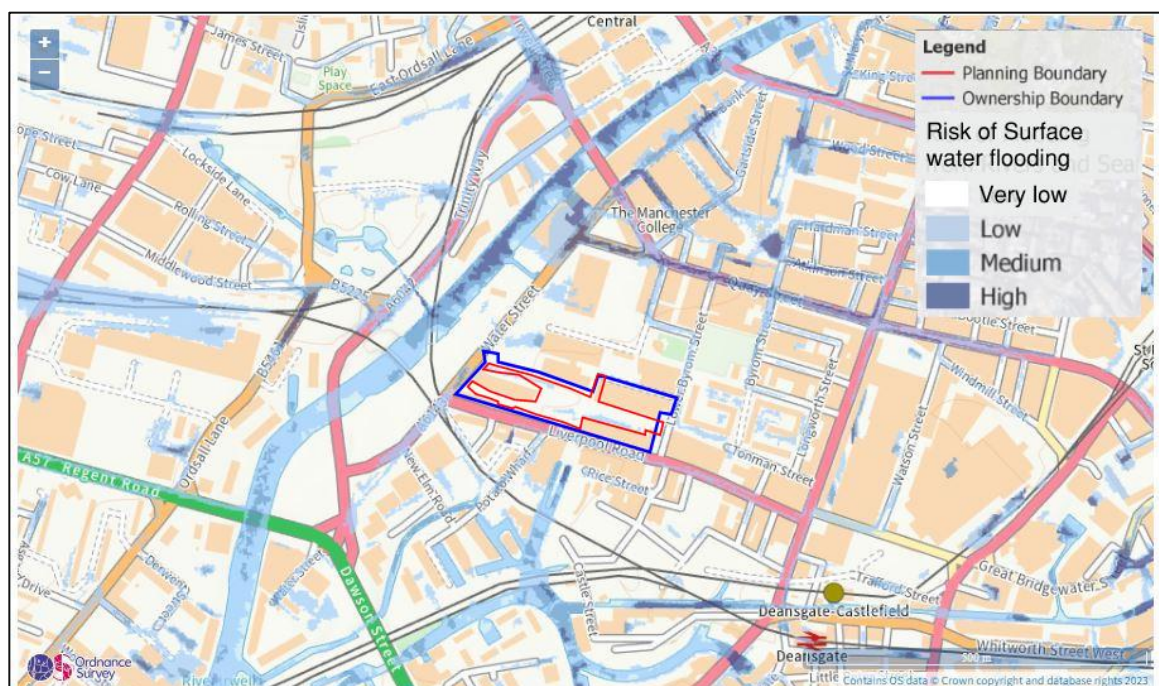


Figure 4—4 Environment Agency Surface water extents and flood risk map with the ownership and planning boundaries indicated © Crown copyright and database rights 2019 Ordnance Survey (OS) 100024198.

4.3.2 Proposed

In accordance with associated legislation and local policy, the aspiration for all new developments is to reduce surface water runoff rates to the equivalent greenfield rate. This can equate to a reduction of over 95% using stormwater storage. However, guidance issued by the LLFA acknowledges that such significant reductions in discharge rate may not be achievable on previously developed sites.

A consultation with the LLFA was held, with the discussion summarised below. Please refer to the Surface Water Drainage Strategy (SIM-BHE-XX-XX-RP-C-0003) for further details and the full correspondence.

The LLFA acknowledged that the historic nature of the site poses significant constraints to development. It was agreed that the proposed drainage strategy will retain the existing drainage regime and points of connection with a like-for-like proposal. All existing sitewide drainage outside of the planning boundary in

Upper Yard and Station Approach is to be retained. It was noted that more stringent policy requirements will need to be met if the drainage strategy requires alterations to the existing strategy.

It is proposed that the surface water from the newly landscaped area in the Upper Yard will be drained towards the existing stormwater outfall at the western end of the Upper Yard via a series of linear channel drains and gullies. This retains the existing drainage regime as agreed with the LLFA. This will continue to drain to the Lower Yard before ultimately discharging via the existing public sewer connection in Water Street.

It is proposed to retain the existing drainage regime at the Station Approach which relies on the infiltration of surface water through the existing ballast to the underlying structural slab. To retain this approach, the surfacing and associated subgrade will be permeable to promote the infiltration of rainwater and replicate the permeable nature of the ballast. The surface water is then directed towards existing drainage troughs and ultimately discharges into the existing public sewer connection in Water Street.

The 2011 MST Level 2 SFRA identifies that the site is located within the Conurbation Core Critical Drainage Area (CDA). Although the site itself is not named, the SFRA highlights that a focus on major regeneration and redevelopment can have a significant impact on surface water run off to local watercourses and sewer networks. The risk associated with the connection of lost watercourses to open channels and canals is highlighted.

4.4 Flooding from Combined Sewers

Flooding from combined sewers may occur during periods of intense rainfall when high volumes of surface water run-off exceed the capacity of the sewer pipes and cause manholes to become surcharged, causing localised foul water flooding.

The GMCA SFRA acknowledges that there is a risk of localised flooding associated with the drainage infrastructure of the urban areas across Greater Manchester due, in part, to undersized existing drainage capacity and sewer systems and possible blockages of the network.

The MST Level 2 SFRA has identified Critical Drainage Areas where there is a high risk of localised flooding from watercourse surcharging, surface water flow, flooding from sewers due to failure or exceedance and/or where significant redevelopment is proposed that could impact the surface water runoff to local water courses and sewer networks. The site is located within the Conurbation Core area on the Critical Drainage Area Map which highlights the risk associated with the major regeneration and redevelopment in the area and the interconnectivity of the sewer network with many lost watercourses in the area.

The GMCA SFRA states that according to UU there are numerous historic sewer flooding hotspots around the site, however no incidents of sewer flooding have been recorded.

It has been agreed by the LLFA that the drainage strategy will adopt a like-for-like surface water drainage network that discharges into the existing public sewer connection in Water Street. This approach will not increase the risk of flooding from combined sewers.

Based on the agreed surface water drainage strategy and the information available in the SFRA documents, the risk of flooding from combined sewers can be deemed as *Low*.

4.5 Groundwater flooding

Groundwater flooding generally occurs in low-lying areas above permeable rock aquifers where the water table meets, and rises above, the ground surface. Groundwater flooding can lead to:

- Flooding of basements of buildings below ground level;
- Flooding of buried services or other assets below ground level;
- Inundation of roads, commercial, residential and amenity areas;
- Flooding of ground floors of buildings above ground levels; and/or
- Overflowing of sewers and drains.

The Risk of Ground Water flooding was assessed in the MST SFRA. The Groundwater Flooding Map (Appendix A**Error! Reference source not found.**) shows that the site is not at risk of groundwater flooding. Therefore, despite the on-site basement, the risk of groundwater flooding on site is considered to be *Low*.

4.6 Flooding from Artificial Sources

Flooding from artificial sources includes flooding from reservoirs, canals and lakes instances where water is retained above the natural ground level. The failure of an artificial source of water has the potential to cause catastrophic damage to its surroundings due to the sudden release of large volumes of water. However, the likelihood of such a failure occurring is extremely low.

The EA produce maps indicating the risk of flooding from reservoirs on “Dry” and “Wet” days. This means on days when the river levels are normal and when the river is already flooded, respectively. The map showing the risk of flooding from reservoirs (Figure 4—5) indicates that part of the site is located within the maximum extent of flooding that would occur if an upstream reservoir were to fail on both wet and dry days. Three reservoirs impact the site when river levels are normal, namely Entwistle, Heaton Park Open and Wayoh, with the first having the widest flood extent and impacting the site the most. However, the EA does indicate that flooding from reservoirs is extremely unlikely in this area and therefore the risk is extremely low due to the regular safety work undertaken at reservoirs to meet the Reservoirs Act 1975.

The Bridgewater Canal is a regulated waterbody that is located to the south of the site. The Rochdale Canal becomes the Bridgewater Canal at the confluence of the Canal route and the River Medlock. This is at Medlock Clows (where the Medlock goes into a shaft and culvert in Deansgate), approximately 250m south of the site. The Bridgewater Canal is the nearest Canal to the site. The MST SFRA mentions that the confluence of the Canal and River is complex and is prone to blockages with debris which could affect water levels upstream. As the Bridgewater Canal is a regulated waterbody, it generally does not pose a direct flood risk. The residual risk of Canal flooding is therefore associated with overtopping/breach of embankments or failure. The probability of a breach is managed by continued maintenance by the respective canal owners, however, is considered a very low probability. As such, the site is considered to be at *Low* risk of flooding from canals.

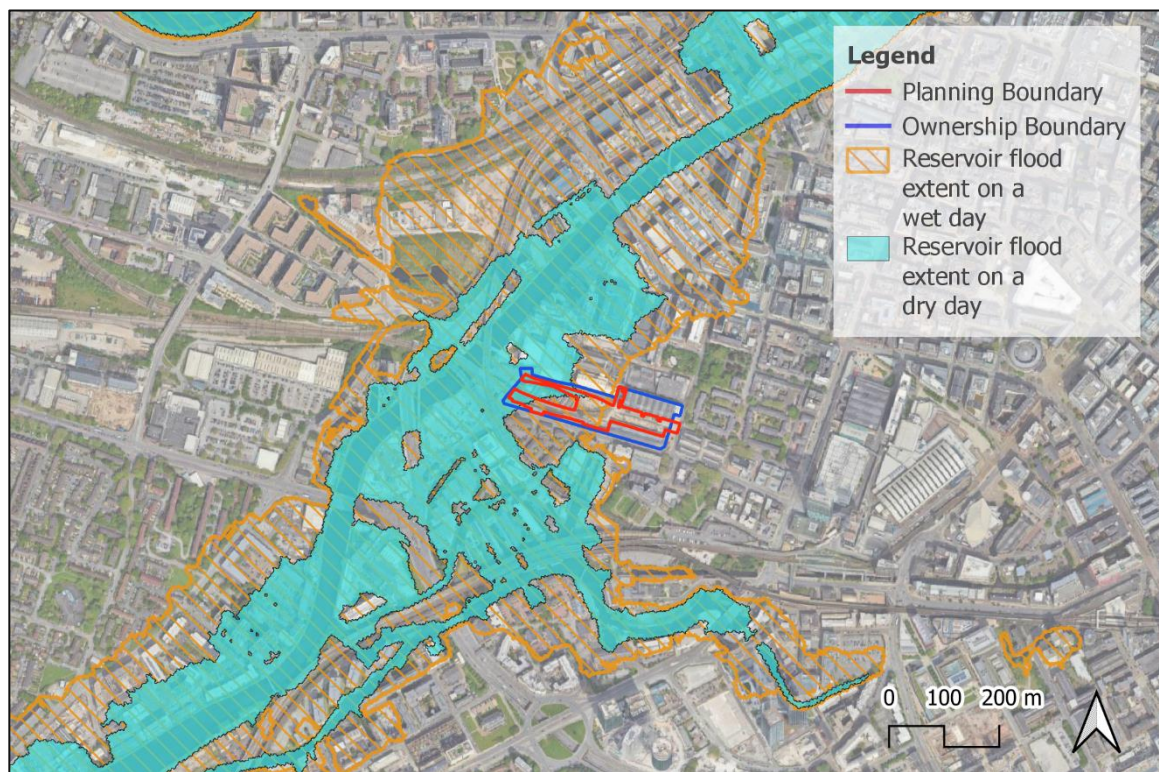


Figure 4—5 Environment Agency Reservoir Flood Map extents with the ownership and planning boundaries indicated.

4.7 Historical Flooding

According to the EA historical flood mapping (Figure 4—6), MTC SFRA and the GMCA SFRA, there is no historical flooding within the ownership boundary.

The EA map does however demonstrate historical fluvial of the River Irwell approximately 1.8km upstream of the site. A small area to the south of the site at the confluence of the River Medlock and Bridgewater Canal is also recognised as having been flooded on the EA maps. This is recognised in the MST SFRA whereby the flow in the River Medlock caused overtopping of the Bridgewater Canal in 1872, 1991 and 2001. The later event resulted in flooding of the Castlefield Hotel, along Liverpool Road, immediately south of the site.

The GMCA SFRA states that according to UU there are numerous historic sewer flooding hotspots around the site, however no incidents of sewer flooding have been recorded.

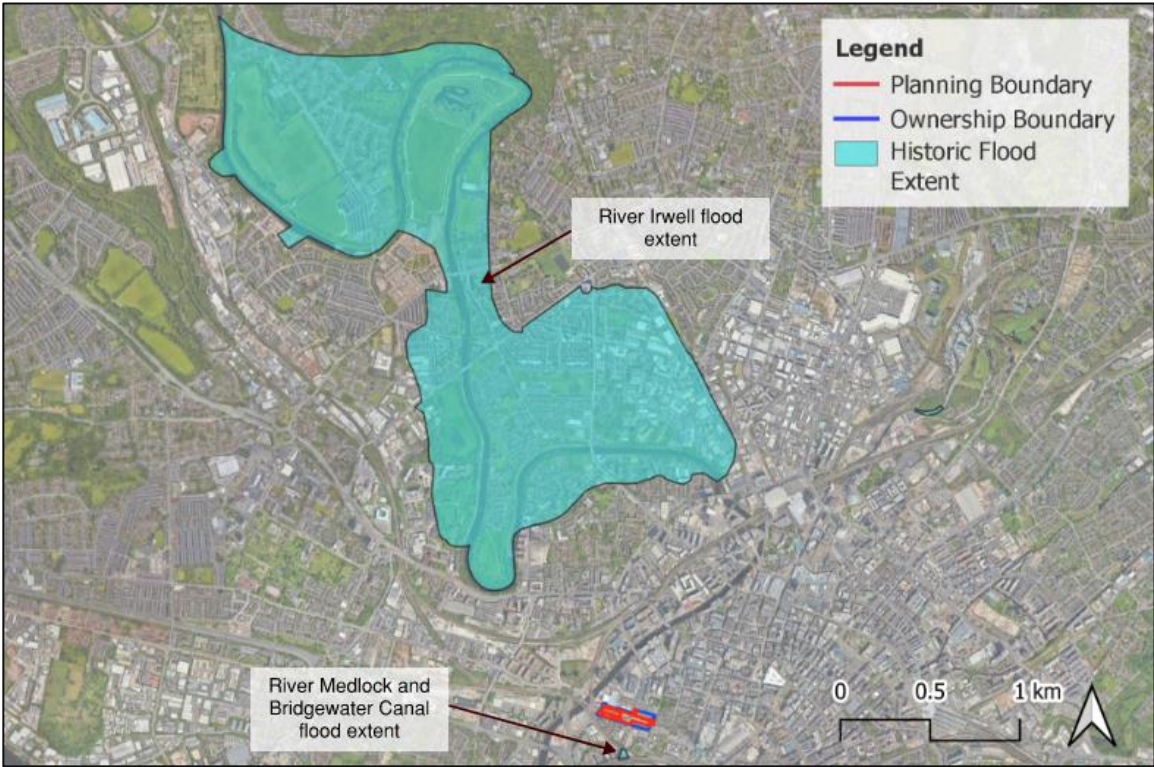


Figure 4—6 Environment Agency Historical Flood Extents with the ownership and planning boundaries indicated.

5 Summary and Conclusion

This FRA has been prepared to support the outline planning application for the proposed repair and refurbishment of The Science and Industry Museum, Manchester.

This report specifically relates to the full planning application for the phased refurbishment of the Upper Yard and Station Approach public realm areas, temporary landscaping in the Heart Space, and repairs and making good to the plant room deck and the former vehicle ramp area.

According to the national flood map produced by the EA, the entirety of the site is located within Flood Zone 1, which is defined as having a low risk of flooding, less than 1 in 1,000 years (0.1%) in any given year, from rivers and the sea. Tidal and fluvial flood risk is therefore considered to be low and additional measures to reduce this risk will not be required.

In accordance with the NPPF, all of the land uses for the proposed development are appropriate for Flood Zone 1. The proposed land uses in the proposed development are classified as Less Vulnerable within the NPPF.

The surface water flood map produced by the EA indicates that the site is classified as having a low probability of surface water flooding.

The proposed drainage strategy will retain the existing drainage regime and points of connection with a like-for-like proposal. This has been discussed and agreed with MCC, in their capacity as the Lead Local Flood Authority (LLFA). It is proposed that the surface water from the newly landscaped area in the Upper Yard will be drained towards the existing stormwater outfall via a series of linear channel drains and gullies whilst the existing drainage regime at the Station Approach relies on the infiltration of surface water through the existing ballast will also be retained. Both areas will ultimately discharge into the existing public sewer connection in Water Street.

With the surface water drainage strategy in place, the risk of surface water flooding is considered to be low.

The risk of flooding from combined sewers is considered to be low based upon the lack of historic flooding and the proposed surface water drainage strategy.

The site is not located within an area at risk of groundwater flooding according to the Groundwater Flooding Map in the MST SFRA.

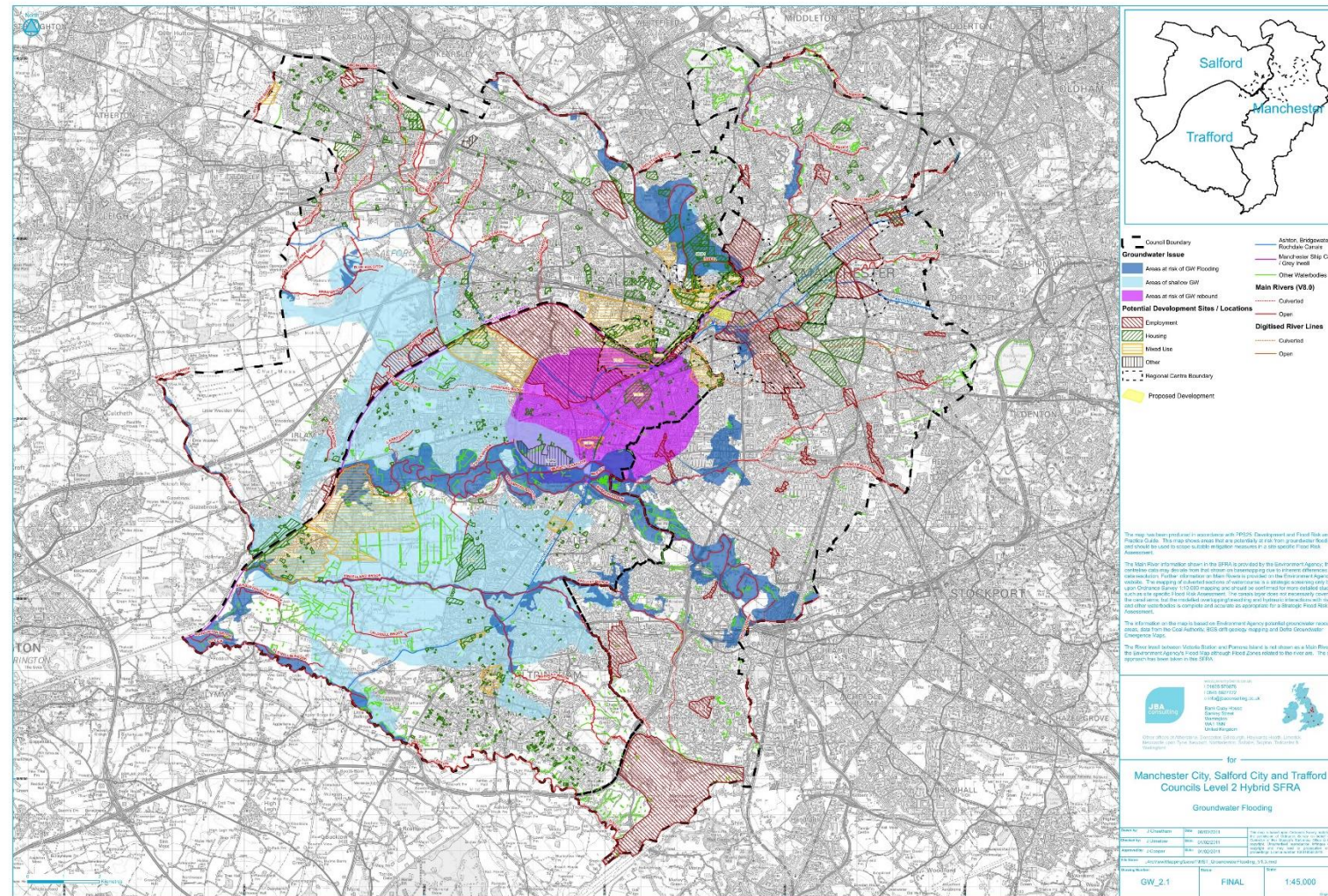
The map showing the risk of flooding from reservoirs produced by the EA indicates that part of the site is located within the maximum extent of flooding that would occur if an upstream reservoir were to fail when river levels are normal and when they are flooded. However, the EA advise that flood risk from reservoir flooding is extremely low due to the regular safety work undertaken at reservoirs to meet the Reservoirs Act 1975.

The Bridgewater Canal is situated to the south of the site. As it is a regulated waterbody, it does not pose a direct flood risk, therefore the residual risk is associated with overtopping/breach of embankments or failure. The probability of a breach is considered a very low probability.

The site is considered to be at low risk of flooding from artificial sources.

It is concluded that the risk of flooding from all sources, for the entire development design life is considered to be low and that the site and the proposed development will not increase the risk of flooding elsewhere.

Appendix A Level SFRA Groundwater Flood Map



Appendix B NPPF Planning Practice Guidance Table 1: Flood Zones

Table 1: Flood zones

(Note: These flood zones refer to the probability of river and sea flooding, ignoring the presence of defences)

Zone 1 - low probability Definition This zone comprises land assessed as having a less than 1 in 1,000 annual probability of river or sea flooding (<0.1%). Appropriate uses All uses of land are appropriate in this zone. Flood risk assessment requirements For development proposals on sites comprising one hectare or above the vulnerability to flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water run-off, should be incorporated in a flood risk assessment. This need only be brief unless the factors above or other local considerations require particular attention. Policy aims In this zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of sustainable drainage systems¹.
Zone 2 - medium probability Definition This zone comprises land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% – 0.1%), or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% – 0.1%) in any year. Appropriate uses Essential infrastructure and the water-compatible, less vulnerable and more vulnerable uses, as set out in table 2, are appropriate in this zone. The highly vulnerable uses are only appropriate in this zone if the Exception Test is passed. Flood risk assessment requirements All development proposals in this zone should be accompanied by a flood risk assessment. Policy aims In this zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area through the layout and form of the development, and the appropriate application of sustainable drainage systems.
Zone 3a - high probability Definition This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year. Appropriate uses The water-compatible and less vulnerable uses of land (table 2) are appropriate in this zone. The highly vulnerable uses should not be permitted in this zone. The more vulnerable uses and essential infrastructure should only be permitted in this zone if the Exception Test is passed. Essential infrastructure permitted in this zone should be designed and constructed to remain operational and safe for users in times of flood.

¹ Sustainable drainage systems cover the whole range of sustainable approaches to surface drainage management. They are designed to control surface water run off close to where it falls and mimic natural drainage as closely as possible.

Appendix C NPPF Planning Practice Guidance Table 2: Flood Risk Vulnerability and Flood Zone ‘Incompatibility’

Table 2: Flood risk vulnerability and flood zone ‘compatibility’

Flood risk vulnerability classification (see table 2)		Essential infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less vulnerable
Flood zones (see table 1)	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.

Notes to table 2 :

This table does not show:

- a. the application of the Sequential Test which guides development to Flood Zone 1 first, then Zone 2, and then Zone 3;
- b. flood risk assessment requirements; or
- c. the policy aims for each flood zone.

Appendix D Planning Practice Guidance Annex 3: Flood Risk Vulnerability Classification

Annex 3: Flood risk vulnerability classification

Essential infrastructure • Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. • Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood. • Wind turbines.
Highly vulnerable • Police stations, ambulance stations and fire stations and command centres and telecommunications installations required to be operational during flooding. • Emergency dispersal points. • Basement dwellings. • Caravans, mobile homes and park homes intended for permanent residential use². • Installations requiring hazardous substances consent³. (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as "essential infrastructure")⁴.
More vulnerable • Hospitals. • Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. • Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels. • Non-residential uses for health services, nurseries and educational establishments. • Landfill and sites used for waste management facilities for hazardous waste⁵. • Sites used for holiday or short-let caravans and camping, <i>subject to a specific warning and evacuation plan</i>.⁶
Less vulnerable • Police, ambulance and fire stations which are <i>not</i> required to be operational during flooding. • Buildings used for shops, financial, professional and other services, • restaurants and cafes, hot food takeaways, offices, general industry, storage and distribution, non-residential institutions not included in "more vulnerable", and assembly and leisure. • • Land and buildings used for agriculture and forestry. • • Waste treatment (except landfill and hazardous waste facilities). • • Minerals working and processing (except for sand and gravel working). • • Water treatment works which do not need to remain operational during times of flood. • • Sewage treatment works (if adequate measures to control pollution and manage sewage during flooding events are in place).

² For any proposal involving a change of use of land to a caravan, camping or chalet site, or to a mobile home site or park home site, the Sequential and Exception Tests should be applied.

³ See Circular 04/00: *Planning controls for hazardous substances* (paragraph 18) at: www.communities.gov.uk/publications/planningandbuilding/circularplanningcontrols

⁴ In considering any development proposal for such an installation, local planning authorities should have regard to planning policy on pollution in the National Planning Policy Framework

⁵ For definition, see *Planning for Sustainable Waste Management: Companion Guide to Planning Policy Statement 10* at www.communities.gov.uk/publications/planningandbuilding/planningsustainable

⁶ See footnote 3

Water-compatible development

- Flood control infrastructure.
- Water transmission infrastructure and pumping stations.
- Sewage transmission infrastructure and pumping stations.
- Sand and gravel working.
- Docks, marinas and wharves.
- Navigation facilities.
- Ministry of Defence defence installations.
- Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location.
- Water-based recreation (excluding sleeping accommodation).
- Lifeguard and coastguard stations.
- Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms.
- Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

Notes to Annex 3

a. This classification is based partly on Department for Environment, Food and Rural Affairs and Environment Agency research on *Flood Risks to People (FD2321/TR2)*⁷ and also on the need of some uses to keep functioning during flooding.

b. Buildings that combine a mixture of uses should be placed into the higher of the relevant classes of flood risk sensitivity. Developments that allow uses to be distributed over the site may fall within several classes of flood risk sensitivity.

c. The impact of a flood on the particular uses identified within this flood risk vulnerability classification will vary within each vulnerability class. Therefore, the flood risk management infrastructure and other risk mitigation measures needed to ensure the development is safe may differ between uses within a particular vulnerability classification.

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