

Heyes Farm, Lower Road, Liverpool Flood Risk Assessment

Prepared for Mr Charles Attard



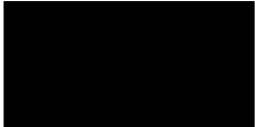
BRICO Water
Environment

February 2024

DOCUMENT CONTROL SHEET

Client: Charles Attard
 Project: Heyes Farm, Lower Road Job No: 3406

	Prepared by	Reviewed by	Approved by
DRAFT v.1	NAME	NAME	NAME H.P.V.Vithana BScEng(Hons) in Civil Engineering, PhD (UCL), CEng
DATE 23/01/2021	SIGNATURE	SIGNATURE	SIGNATURE 

FINAL v1d	NAME	NAME	NAME H.P.V.Vithana BScEng(Hons) in Civil Engineering, PhD (UCL), CEng
DATE 26/02/2024	SIGNATURE	SIGNATURE	SIGNATURE 

	NAME	NAME	NAME
DATE	SIGNATURE	SIGNATURE	SIGNATURE

Brighton Consulting Engineers Limited has prepared this report in accordance with the instructions of Mr Charles Attard for his sole and specific use. The material may not be reproduced without the permission of the copyright owner BRICO Water Environment Ltd.

© Copyright Brighton Consulting Engineers Limited, BRICO Water Environment 2004-2024

E: info@brightonconsulting.co.uk and brightonconsulting@hotmail.co.uk
 W: <http://www.brightonconsulting.co.uk/>

CONTENTS

1.	INTRODUCTION	5
2.	EXECUTIVE SUMMARY	6
3.	SITE LOCATION	9
4.	EXISTING SITE CONDITION	10
5.	FLOOD ZONE	11
6.	DEVELOPMENT DESCRIPTION	12
7.	OCCUPANTS AND USERS OF THE DEVELOPMENT	13
8.	HYDROLOGY/HYDRO-GEOLOGY	14
9.	SOURCES, MECHANISMS AND PATHWAYS OF FLOODING	15
10.	PROBABILITY OF FLOODING	17
11.	SEQUENTIAL TEST	20
12.	EXCEPTION TEST	21
13.	DURATION OF FLOODING	23
14.	SURFACE WATER MANAGEMENT	24
15.	DRY ACCESS AND EGRESS	26
16.	CLIMATE CHANGE	27
17.	FLOOD DEFENCES	29
18.	BUFFER ZONE	30
19.	OFF SITE IMPACTS AND THEIR MITIGATION	31
20.	RESIDUAL RISKS AND THEIR MITIGATION	32
21.	FLOOD RESILIENT/RESISTANT BUILDINGS	34
22.	HEALTH AND SAFETY	37
23.	EMERGENCY FLOOD PLAN	38
24.	SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS	40
25.	REFERENCES	42

APPENDIX – A: PLANS & FIGURES	43
APPENDIX – B: PHOTOS	56
APPENDIX – C: CORRESPONDENCE	57
APPENDIX – D: FLOOD PLAN	60
APPENDIX – E: SURFACE WATER STORAGE CALCULATION	63
APPENDIX – F: RECOMMENDED FLOOD RESILIENT MEASURES	65

1. INTRODUCTION

In October 2020 BRICO Water Environment were commissioned by Mr Charles Attard to carry out a Flood Risk Assessment for the proposed development at Heyes Farm, Lower Road, Halewood Liverpool, L26 2XA. The development proposal is for a residential development consisting of 11 dwellings. However, this proposal was revised to include total 18 dwellings and hence, this revised FRA was prepared to accompany this new scheme.

This flood risk assessment was prepared complying with the requirements in National Planning Policy Framework, March, 2012 and the Technical Guidance to the National Planning Policy Framework (March, 2012).

In carrying out this Flood Risk Assessment, information was obtained from the Environment Agency and Knowsley Metropolitan Borough Council. Development plans and topography survey were provided by the Project Architect, Mr Andrew James of Architectural Emporium Ltd.

For the avoidance of doubt and for clarity, some information is repeated in more than one section.

2. EXECUTIVE SUMMARY

1. **LOCATION:** The proposed residential development is situated at Heyes Farm, Lower Road, Halewood Liverpool, L26 2XA.
2. **DEVELOPMENT DESCRIPTION:** The proposal is for a residential development consisting of 18 dwellings together with associated infrastructure and landscaping.
3. **VULNERABILITY:** As the proposal is for a residential development it falls into “more vulnerable” land use category according to Table 2 - Flood Risk Vulnerability Classification in the Technical Guidance to NPPF.
4. **FLOOD ZONE:** The site is located in Flood Zone 1.
5. **PROBABILITY OF FLOODING:** Probability of flooding from river and tidal sources is low. 1 in 100 year+ 30% CC flood level corresponding to “central” climate change scenario is 8.37mAOD. 0.5% AEP flood level in 2115 is 7.98mAOD. 0.1% AEP extreme flood level is 8.29mAOD. Ground levels of the site are above 8.5mAOD. Therefore, the probability fluvial/tidal flooding at the site can be assessed as “low”.

Surface water and groundwater flood risk could be assessed as “low to moderate” and “moderate to high” respectively.

The design flood level therefore, can be assumed as 8.37mAOD.

6. **RESIDUAL FLOOD RISK AND FLOOR LEVEL:** The climate change flood level corresponding to “central” scenario (1 in 100-year AEP+30%) is 8.37mAOD. With 600mm freeboard FFL should be set above 8.97mAOD. All proposed dwellings have a ground FFL above 9.00mAOD+. The lowest FFL is 9.1mAOD. Therefore, the development satisfies the freeboard requirement. All bed rooms are located on the first floor above the extreme flood level. It is also recommended to raise the ground floor level 300mm above surrounding average ground level to reduce the risk of surface water ingress.
7. **CLIMATE CHANGE IMPACT:** 1 in 100-year 30% climate change flood level corresponding to “central” scenario was derived from the Environment Agency data (i.e., 8.37mAOD). 1 in 100-year AEP + 70% cc (upper end) flood level is 8.92mAOD. However, the FFL of the proposed dwellings is above 9.10mAOD and hence, the dwellings will be safe from internal flooding due to increased climate change risks up to the upper end scenario.
8. **FLOOD RESISTANT/RESILIENT CONSTRUCTION:** It is recommended to use flood resistant/resilient techniques to reduce the impact of flooding. Section 21 and Appendix – F lists

industry accepted methods for flood resistant/resilient construction from which suitable methods for the proposed development may be chosen as appropriate.

9. **SURFACE RUNOFF:** The proposed development will increase hard (impermeable) area from existing 1150 sq.m to developed 6983 sq.m resulting in an increase of surface runoff volume and rate. Based on storage volume calculation tool available at HR Wallingford (www.uksuds.com) it was estimated that a storage volume of 924m³ will be required to attenuate run-off volume on site to reduce outflow rate from the property to 2 l/s. This calculation is based on 1 in 100-year 6-hour rainfall event with 40% increase to account for climate change with lower return period events up to 100 years being also considered (see Appendix-E).

It is recommended to use sustainable urban drainage systems (SuDS) methods to attenuate surface runoff flow volume and rate and manage run-off water within the development site. It is recommended to develop SuDS strategy to address this issue.

10. **FLOOD STORAGE DISPLACEMENT:** The site is outside 1 in 1000-year extreme flood outline and hence, flood storage volume will not be displaced due to the development for the design event.
11. **DRY ACCESS & EGRESS:** The site and access routes are in low probability Flood Zone 1. Therefore, dry access and egress is available for the design event.
12. **SEQUENTIAL TEST:** The proposed development is in Flood Zone 1 and is consistent with existing residential use and nearby allocated sites in scale, type and location.
13. **EXCEPTION TEST:** The proposal will meet sustainability requirements of the Knowsley Metropolitan Borough Council in terms of energy, water, space, waste etc., and the development will not increase flood risk elsewhere if recommended mitigation measures are carried out and hence, the proposal is consistent with the Exception Test related requirements.
14. **SUMMARY:** (1) The site is in Flood Zone 1. Therefore, fluvial and tidal flood risk is low. The site is well above the 1%, 0.5%, 0.1% AEP climate change flood levels in 2115 (2) The development will increase surface run-off volume and rate. Therefore, it is recommended to attenuate surface run-off on-site to greenfield levels using SuDS (3) It is also recommended to incorporate flood resilient/resistant measures into the building design including raising of the FFL 300mm above surrounding average ground level of the dwelling (4) FFL of all proposed dwellings is above 9.00mAOD and hence, a freeboard of 600mm is available above 1 in 100-year climate change flood level. Upper floors are well

above the extreme flood level. (5) It is recommended to prepare a Drainage Strategy and Emergency Flood Plan.

3. SITE LOCATION

The site comprises the land at Heyes Farm, Lower Road, Halewood Liverpool, L26 2XA.

The application site consists of land off Lower Road between existing dwellings at Railway Cottage and The Heyes. The site is located to the rear of a former agricultural building that has previously been converted into residential use. The site includes the fishing pond, which is a man-made feature in the landscape. Open land adjoins the site to the north and east and this is land allocated for residential use subject to current planning applications. A railway line is located to the east and Lower Road is to the south of the site.

The proposed residential development is to be situated about 350m west of the Netherley Brook/Ditton Brook.

A Location Plan is shown in Appendix - A as Figure A2.

4. EXISTING SITE CONDITION

Total area of the site is 2.43 ha as informed by the developer. Total hard (impermeable) surface area has been calculated as 6983 sq.m. 71% of the site area can be considered permeable in terms of surface runoff generation with the pond and soft landscaping.

The site at present consists of 3 existing dwellings. The site includes the fishing pond, which is a man-made feature. Open land adjoins the site to the north and east and this is land allocated for residential use subject to current planning applications. A railway line is located to the east and Lower Road is to the south of the site.

The topography survey (Figures A4, Appendix-A) indicates that the ground levels at the development area is above 8.5mAOD which the lowest level in the east of the site. The levels rise up to 10.4mAOD in the west of the site.

Currently, surface water runoff from the site is connected to a public sewer.

5. FLOOD ZONE

The proposed site is located in Low Probability Flood Zone 1.

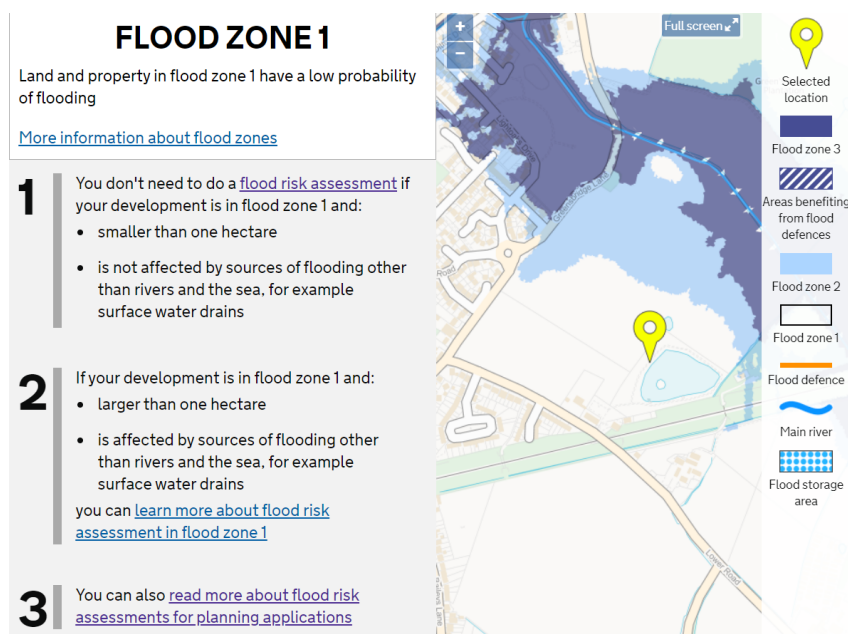


Figure 1. Flood Zone Summary Map (Copyright Environment Agency)

6. DEVELOPMENT DESCRIPTION

6.1 Development Proposals

The proposal is for a residential development consisting of 18 dwellings together with associated infrastructure and landscaping.

The post-development impermeable surface area will increase to 6983 sq.m from existing 1150 sq.m. Therefore, impermeable area will be 29% of the total site area of 24,346 sq.m after development.

Site Layouts, floor plans and elevations are shown in Appendix-A as Figures A3.1-A3.7.

6.2 Vulnerability

The proposed development is for “more vulnerable” land use according to Flood Risk Vulnerability Classification (Table 2) of the Technical Guidance to the NPPF (March, 2012).

6.3 Expected life time

Residential development should be considered for a minimum of 100 years, unless there is specific justification for considering a shorter period.

This assessment was carried out on the assumption that the proposed buildings will last for 100 years.

7. OCCUPANTS AND USERS OF THE DEVELOPMENT

The proposal is for a residential development consisting of 18 dwellings together with associated infrastructure and landscaping.

The site is located outside the 1 in 1000-year and 1 in 100-year AEP climate change flood outlines. Therefore, river and tidal flood risk is low. However, there is a risk of flooding from surface water.

More vulnerable people like children and elderly are likely to occupy the residential units in the future. However, sleeping accommodation is on the first and second-floor level well above the extreme flood level and hence, the exposure of vulnerable occupants to flood hazard will be reduced and will remain at a low level.

8. HYDROLOGY/HYDRO-GEOLOGY

8.1 Hydrology

The area is drained by the Ditton Brook which is a tributary of River Mersey.

8.2 Hydro-geology

British Geological Survey (BGS) groundwater maps obtained from the magic.gov.uk web site show that the site is located over a principal (major) aquifer of low to medium vulnerability (Figure 2 and 3).

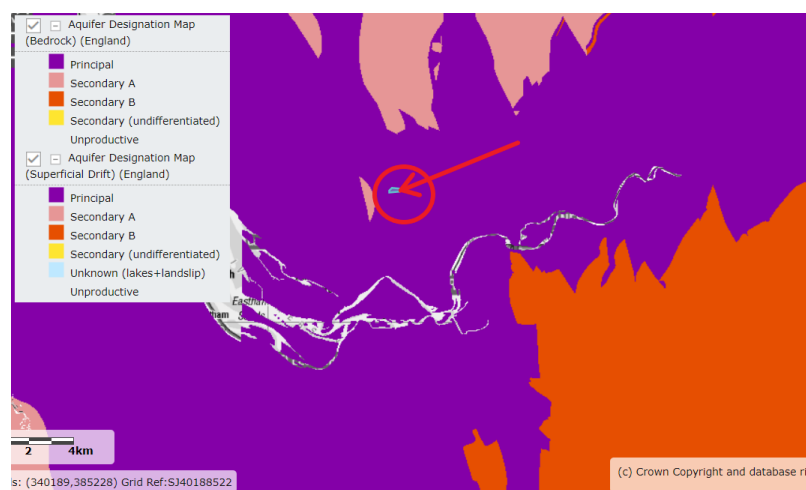


Figure 2. Groundwater Map (Copyright BGS/MAGIC.GOV.UK)

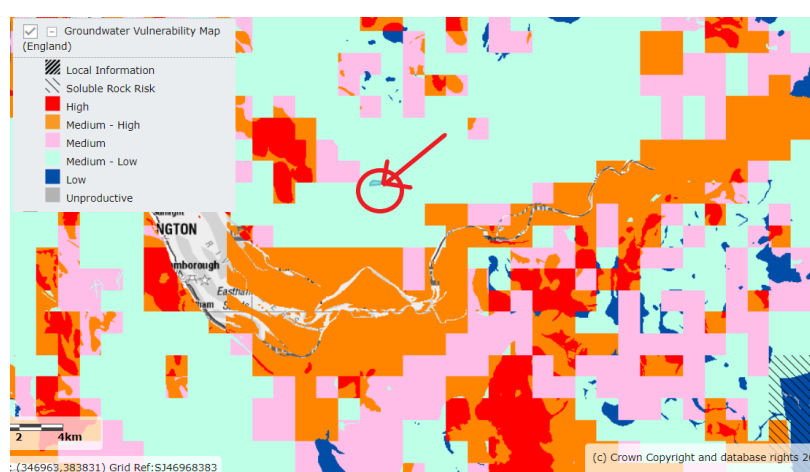


Figure 3. Groundwater Vulnerability Map (Copyright BGS/MAGIC.GOV.UK)

9. SOURCES, MECHANISMS AND PATHWAYS OF FLOODING

The sources of flooding are tidal and fluvial from streams like Netherley Brook/ Ditton Brook which are tributaries of the River Mersey, groundwater, surface water, sewer surcharging and infrastructure failure.

Flooding to low-lying land from the sea and tidal estuaries is caused by storm surges and high tides. Where tidal defences exist, they can be overtopped or breached during a severe storm, which may be more likely with climate change. Tidal flooding is due to the propagation of a surge up river channel.

Fluvial flooding from the Netherley Brook/Ditton Brook would enter the site from the east of the site where the ground levels are the lowest.

Intense rainfall, often of short duration, that is unable to soak into the ground or enter the sewer system due to insufficient capacity or blockages, can run quickly off land and result in local flooding. Surface water could enter the site from southern and eastern sides of the site. Figure 4 shows how surface water/overland flow spread with speed and direction also indicated.

Groundwater flooding occurs when water levels in the ground rise above surface elevations. Water levels below the ground rise during wet winter months, and fall again in the summer as water flows out into rivers. In very wet winters, high water levels may lead to the flooding of normally dry land.

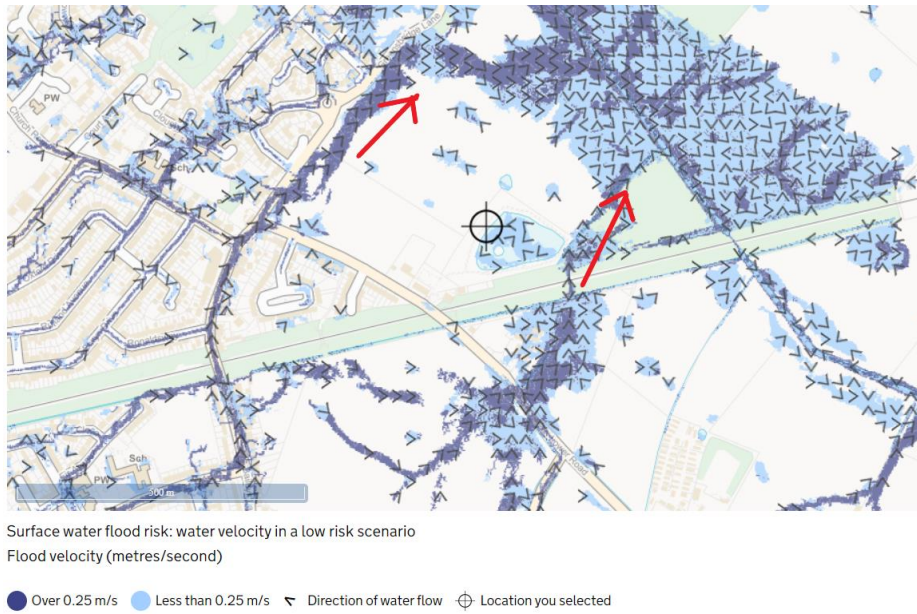


Figure 4. Surface water speed and direction (Copyright Environment Agency)

10. PROBABILITY OF FLOODING

10.1 Fluvial and Tidal

The average ground level of the site is 9.4mAOD with levels varying from 8.5mAOD and 10.3mAOD.

Therefore, the site is above 1% and 0.1% AEP flood levels of 7.89mAOD and 8.29mAOD respectively.

The proposed lowest FFL is 9.1mAOD.

Therefore, the annual probability of fluvial and tidal flooding at the site is “low” and probability of internal flooding of the dwellings is of “very low” probability due to fluvial and tidal sources.

The site is also above 1% AEP+30% climate change flood level of 8.37mAOD in 2115 which may be considered as the design flood level.

Following Table 1 gives the current and future (2115) predicted fluvial flood levels at the site obtained from Mersey Estuary Study (2016).

Table 1. Predicted flood levels (mAOD) ¹

Return period (years)	Water Level (mAOD) for 2115
100	7.86
100+20% cc	8.23*
100+30% cc (central)	8.37*
100+70% cc (higher central)	8.92*
100+95% cc (H++)	9.27*
200	7.98
1000	8.29

Note: * extrapolated based on a rating curve.

¹ Environment Agency Copyright.

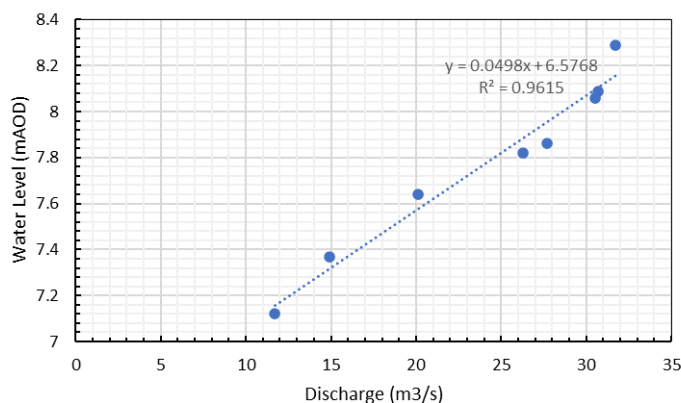


Figure 5. Rating curve

10.2 Surface water

Surface water flooding is typically generated by short duration, intense rainfall events exceeding the design event where precipitation is unable to infiltrate to the ground or enter the drainage system (i.e., saturated soil, paved surfaces, sewer blockages, lack of sewer capacity).

Environment agency Surface Water Flood Map (Figure 6) shows that the surface water flood depths for the low probability (rare, extreme) events could be below 300mm.

Therefore, the surface water flood risk could be assessed as “low to moderate” due to run-off and sewer surcharge flooding during extreme events.

10.3 Groundwater

British Geological Survey (BGS) groundwater maps indicate that the area is a principal (major) aquifer (Figure 2) of low to medium vulnerability (Figure 3). Therefore, the risk of groundwater flooding could be assessed as “moderate to high”.



Figure 6. Surface water flood map – low probability (Copyright Environment Agency)

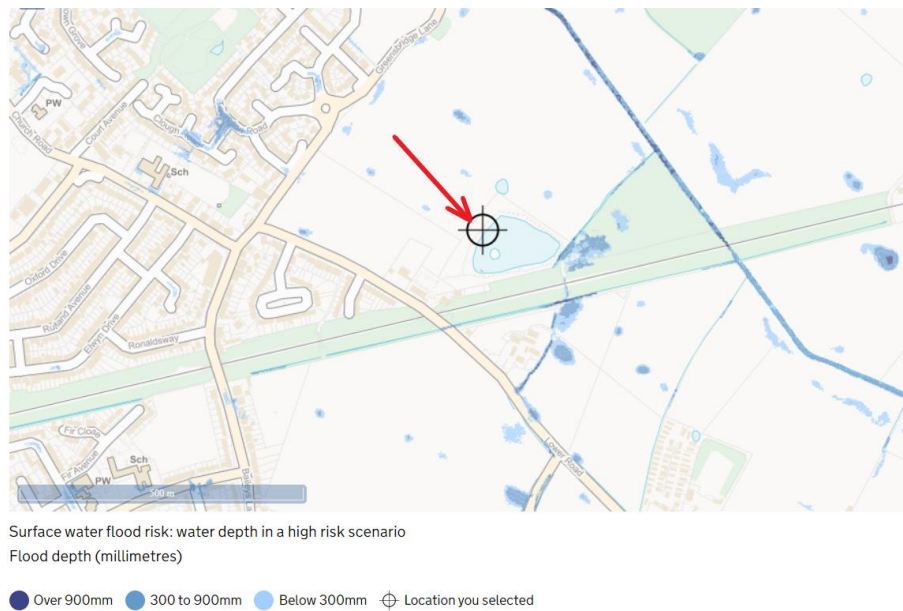


Figure 7. Surface water flood map – high probability (Copyright Environment Agency)

11. SEQUENTIAL TEST

NPPF requires that a Sequential Test be carried out by the LPA to steer the developments first into low-risk Flood Zone 1 and then to medium risk Flood Zone 2 following a sequential approach. PPS25 states “Only where there are no ‘reasonably available’ sites in Flood Zone 1 and 2 should decision makers consider suitability of sites in high-risk Flood Zone 3, applying Exception Test if required”.

The Environment Agency Flood Map, Figure A1, Appendix-A, shows that the site is in Flood Zone 1. There are existing residential houses within the site at present.

The application site consists of land off Lower Road between existing dwellings at Railway Cottage and The Heyes. The site is located to the rear of a former agricultural building that has previously been converted into residential use. The site includes the fishing pond, which is a man-made feature in the landscape. Open land adjoins the site to the north and east and this is land allocated for residential use subject to current planning applications.

The site forms part of the sustainable urban extension site at the East of Halewood. The wider site is allocated for approximately 1100 dwellings, although through the masterplan process it is now considered the allocation could accommodate up to 1500 dwellings. Therefore, the proposed development is considered acceptable in principle by the LPA unless other material considerations indicating otherwise.

The proposed development is consistent in location, type and scale with existing land use and adjacent allocated sites in the Local Plan. Therefore, the proposed development complies with the sequential test requirements.

12. EXCEPTION TEST

Para 102 of the NPPF (March, 2012) states that:

If, following application of the Sequential Test, it is not possible, consistent with wider sustainability objectives, for the development to be located in zones with a lower probability of flooding, the Exception Test can be applied if appropriate.

For the Exception Test to be passed:

- it must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a Strategic Flood Risk Assessment where one has been prepared; and
- 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.

Flood risk vulnerability classification (see table 2)		Essential infrastructure	Water compatible	Highly vulnerable	More vulnerable	Less vulnerable
Flood zone (see table 1)	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test required	✓	✓
	Zone 3a	Exception Test required	✓	×	Exception Test required	✓
	Zone 3b functional floodplain	Exception Test required	✓	×	×	×

Key: ✓ Development is appropriate.
 × Development should not be permitted.

Figure 8. Flood risk vulnerability and flood zone compatibility (Technical Guide, NPPF, March 2012).

For 'more vulnerable' developments in Flood Zone 1, an Exception Test, as shown in Figure 8, is not required. Nevertheless, following information is provided to support the requirements of the Exception Test:

12.1 Sustainability: The proposal will meet sustainability requirements of the Knowsley Metropolitan Borough Council in terms of energy, water, space, waste etc.

12.2 Flood Risk: The development will not increase flood risk elsewhere as surface run-off volume will be attenuated to greenfield levels using SuDS. The site and the access/egress routes are located in low-risk Flood Zone 1. The site is also well above the 1% AEP, 0.5% AEP and extreme flood levels including climate change up to 2115 and hence, the site is unlikely to be affected by river and tidal flood events of above-mentioned annual probability magnitudes. Therefore, the proposed development is relatively safe for its lifetime for its users with various vulnerability levels.

13. DURATION OF FLOODING

The time for the flood to peak could vary depending on parameters like catchment size, slope and land use. It could be 12 - 24 hours for a small catchment while it could be several days for large catchments like Severn and Thames. In large, relatively flat catchments flood levels will rise slowly and natural flood plain may remain flooded for several days. In small, steep catchments, local intense rainfall can result in the rapid onset of deep and fast-flowing flooding with little warning. Such “flash” flooding, which may only last a few hours, can cause considerable damage and possible threat to life.

Peak of the tidal flood could last around 3-4 hours.

Floods due to surface water and surcharging of sewers could last days and even weeks as high river levels or pipe blockages could cause backing up of water in the sewers.

Joint occurrence of several flood events from different sources, such as tidal surges, blockage of sewers, culverts, flash flooding, fluvial floods could increase the severity of flooding and may even take weeks to subside.

14. SURFACE WATER MANAGEMENT

NPPF requires that the developed rate of runoff and volume to a water course or receiving water body should not be greater than the existing run-off rate and volume.

The post-development impermeable surface area will increase to 6983 sq.m from existing 1150 sq.m as shown in the planning drawings. Therefore, impermeable area will consist 29% of the total site area of 24,346 sq.m after development.

14.1 Existing surface water drainage arrangement

Currently surface water drainage from the site is connected to a public sewer.

14.2 SUDS storage requirement

Required surface water storage to be provided on site to attenuate surface run-off discharge to 5 l/s was calculated using tools available at HR Wallingford site (<http://www.uksuds.com>). Based on this calculation it was determined that the attenuation storage required for the 24,346 sq.m site is 924m³. This calculation is based on 1 in 100-year 6-hour rainfall event with 40% increase to account for climate change. A range of return period events up to and including 1 in 100-year event was considered in the calculation. The calculation sheet is shown as Appendix – E.

It is recommended to attenuate surface water volume using SuDS following the hierarchy given in Table 2 choosing most sustainable method first.

14.3 Regular inspection and sewer maintenance

It is recommended to install a regular maintenance regime to ensure the efficient functioning of the sewers and sustainable drainage systems (if installed).

Table 2. SUDS hierarchy

	SUDS Technique	Flood Reduction	Water Quality Improvement	Landscape & Wildlife benefit
Most sustainable  Least sustainable	Living roofs	✓	✓	✓
	Basins and ponds -constructed wetlands - Balancing ponds - Detention basins - Retention ponds	✓	✓	✓
	Filter strips & swales	✓	✓	✓
	Infiltration devices - soakaways - infiltration trenches & basins	✓	✓	✓
	Permeable surfaces & filter drains - gravelled areas - solid paving blocks - porous paving	✓	✓	
	Tanked systems - oversized pipes / tanks - storms cells	✓		

15. DRY ACCESS AND EGRESS

As shown in Figure 9, the site and access roads are in Flood Zone 1. Therefore, safe dry access to and egress from the site can be provided for the design event.

Possible access/egress routes are indicated by red arrows in Figure 9.

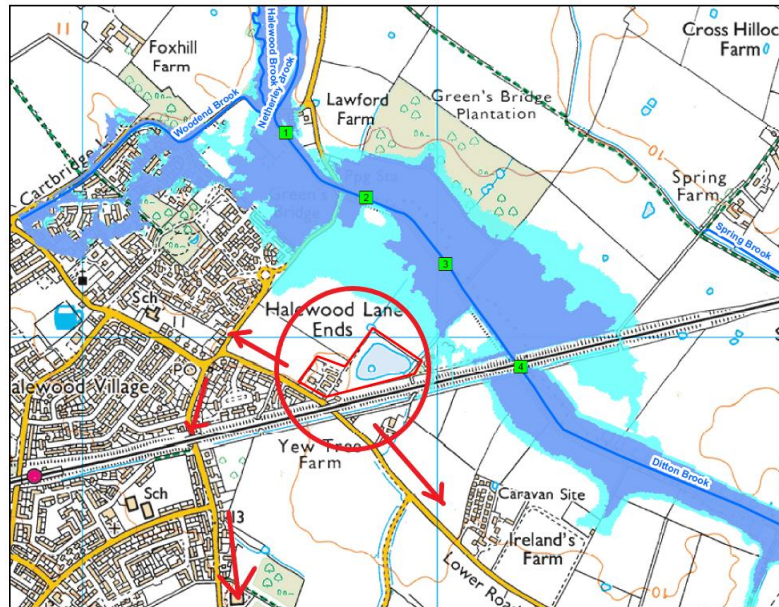


Figure 9. Escape route (EA Copyright)

The site is also located in Environment Agency's Flood Warning Area (<https://flood-warning-information.service.gov.uk/warnings>).

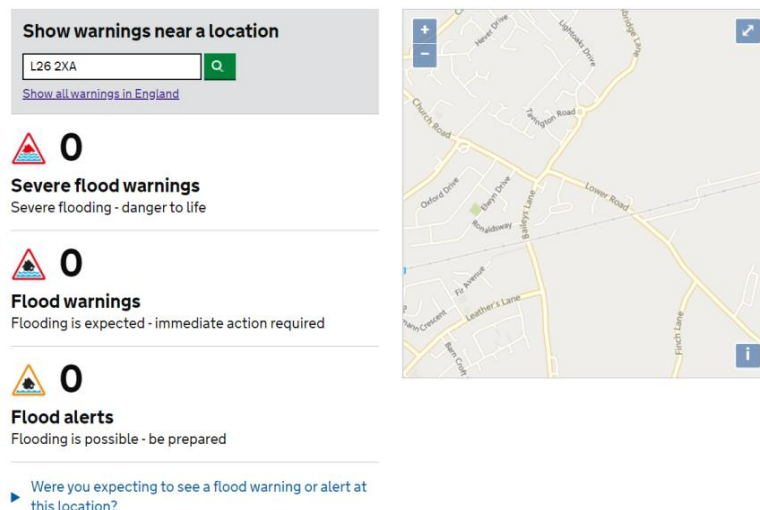


Figure 10. Environment Agency Flood Warning Area (EA Copyright)

16. CLIMATE CHANGE

UK Climate Change allowance guidance for planning changed since February, 2016 and the latest allowances for rainfall intensity, peak river discharge, sea level rise, offshore wind speed, extreme wave height are available at:

<https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>

Table 2 peak rainfall intensity allowance in small and urban catchments (use 1961 to 1990 baseline)

Applies across all of England	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper end	10%	20%	40%
Central	5%	10%	20%

Figure 11. Peak rainfall intensities

The latest guidance requires that the rainfall intensity to be increased up to 40% for the epoch 2070-2115.

Based on climate change allowances recommended for North West region 30, 70 and 95% climate change allowances were calculated after constructing a rating curve using flow-stage data supplied by the Environment Agency (Table 3 and Figure 12).

Table 3 gives the current and future (2115) predicted fluvial flood levels at the site obtained from Mersey Estuary Study (2016).

Table 3. Predicted flood levels (mAOD) ¹

Return period (years)	Water Level (mAOD) for 2115
100	7.86
100+20% cc	8.23*
100+30% cc (central)	8.37*
100+70% cc (upper end)	8.92*
100+95% cc (H++)	9.27*
200	7.98
1000	8.29

Note: * extrapolated based on a rating curve.

¹ Environment Agency Copyright

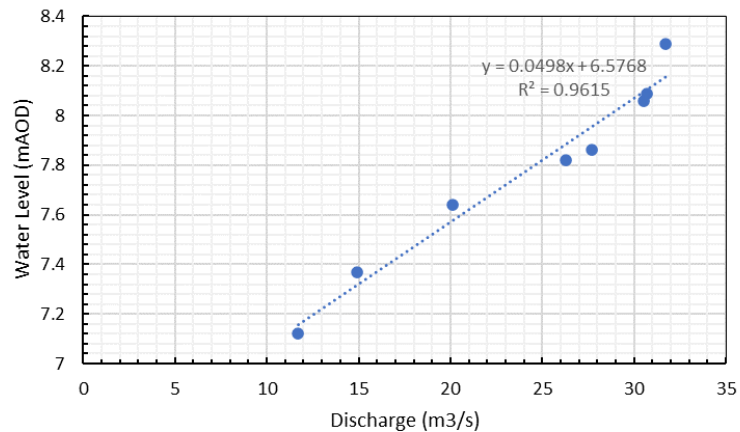


Figure 12. Rating curve

The risk of flash flooding could increase as storminess and frequency of storms increases in the future. Sewers are generally designed to 1 in 30-year standard according to 'Sewers for Adoption'. However, climate change could bring intense rainfall events exceeding current design standard overwhelming the existing sewers.

The site is classified as principal aquifer of low to moderate vulnerability. Therefore, the risk of groundwater flooding is moderate to high at present. However, this risk could increase if climate change brings more rainfall and higher river levels. This will be especially severe during winter as winter rainfall is predicted to increase as a result of climate change.

Therefore, the standard of flood defence could fall from current levels while the risk of fluvial, tidal, groundwater and surface water flooding could increase as a consequence of the climate change.

The adverse impact of the climate change could be mitigated to some extent by appropriate planning and design. Following steps could be taken to mitigate climate change impact.

- Design, new pipes, soakaways, Permeable Pavements and other Sustainable Drainage Systems with a 40% allowance provided for rainfall to store increased run-off volume due to climate change.
- Raise threshold ground floor level whichever is higher of 600mm above 1 in 100-year climate change flood level and at least 300mm above surrounding average ground level if it is practicable in terms of level access and roof height requirements. If the 1 in 100-year annual probability "central" climate change flood level is considered with 600mm freeboard, the finished floor level must be above 8.97mAOD. FFL of the all proposed dwellings is above 9.1mAOD and hence, the floor levels satisfy climate change guidance.

17. FLOOD DEFENCES

There are no purpose-built flood defences at the site.

18. BUFFER ZONE

8m buffer zone should be provided from the top of the bank to allow access for channel maintenance/improvements, maintain the character of the watercourse and provide undisturbed refuges for wildlife using the river corridor as required under the Water Resources Act, 1991.

19. OFF SITE IMPACTS AND THEIR MITIGATION

19.1 Loss of flood storage and level-to-level compensation

Flood storage will not be displaced as the site is outside the 1 in 1000-year extreme flood outline.

19.2 Increase of run-off volume

The post-development impermeable surface area will increase to 6983 sq.m from existing 1150 sq.m as informed by the developer. Therefore, impermeable area will consist 29% of the total site area of 24,346 sq.m after development.

Therefore, surface runoff volume and run-off rate will be increased due to the proposed development. It is recommended to attenuate surface runoff to greenfield level on-site using sustainable urban drainage systems (SuDS) to increase the sustainability of the development.

19.3 Sustainable drainage systems (SUDS)

Table 2 shows a hierarchy of recommended sustainable drainage systems in order of sustainability. It is recommended to consider using one or more of the listed methods to attenuate surface run-off on site depending on site conditions. SUDS Hierarchy should be followed in choosing attenuation methods.

These SUDS methods include living roofs, detention basins (depressions which are normally dry except after storm events), ponds (ponds contain water in dry weather, and are designed to hold more when it rains), filter strips and swales, infiltration devices such as soakaways, permeable pavements, rain water harvesting etc.

It is recommended to attenuate the surface runoff volume to 1 in 100-year 6-hour standard before discharging to the nearby stream.

19.4 Effect on coastal & river morphology

There is no effect on river and coastal morphology as the development will not cause scour or deposition of sediment in the main river channel or coastal zone.

20. RESIDUAL RISKS AND THEIR MITIGATION

Residual risks may occur due to extreme events exceeding the design event and breach/overtopping of defences. Residual risks can be reduced by appropriate planning and design.

20.1 Increased sewer and SUDS storage capacity

It is recommended to design new pipes to absorb run-off from 1 in 100-year rainfall events with 40% increase in rainfall intensity for climate change. It is also recommended to design sewers and storm water storage conservatively to absorb exceedance flows.

20.2 Breach and overtopping of flood defences

There is a low probability of the breach/overtopping of defences. Though the probability of occurrence is low, the impact of a breach/overtopping event on the development would be high.

20.3 Finished ground floor level

It was recommended by the Environment Agency guidance to use “central” climate change scenario in the Flood Zone 2. The site is in Flood Zone 1. The climate change flood level corresponding to this scenario (central or 30%) is 8.37mAOD.

All proposed dwellings have a ground FFL of 9.0mAOD+. This is well above the recommended 600mm freeboard and hence, the threshold floor levels provided are satisfactory.

20.4 Sleeping accommodation

Planning drawings show that all bed rooms are on the first and second floors.

20.5 Management of residual risks during life time of the development

The designers should take measures to reduce flood risk by incorporating mitigation measures into the design taking into account the design life of the building. The owners will be vested with the responsibility of maintaining the mitigation measures periodically, including sewers, sustainable drainage systems and manage the risks (floods, health & safety risks to occupants and public) during the life time of the development. This includes obtaining of insurance cover as appropriate.

20.6 Flood insurance

It is recommended that the owners obtain adequate flood insurance cover to minimise the economic losses and manage the risks during the lifetime of the development.

21. FLOOD RESILIENT/RESISTANT BUILDINGS

The document “[Improving the flood performance of new buildings – flood resilient construction, May 2007](#)” defines *avoidance* as measures that can be taken to prevent floodwater from reaching a property. For example, these can take the form of low defence mounds or barriers surrounding a development or individual property, or landscaping the ground surrounding a building to divert floodwaters away or into temporary storage.

Flood Resistance is defined as measures taken at building level to prevent floodwater entering the building and damaging its fabric.

Flood Resilience is defined as sustainable measures that can be incorporated into the building fabric, fixtures and fittings to reduce the impact of floodwater on the property. This allows easier drying and cleaning, ensures that the structural integrity of the building is not compromised and reduces the amount of time until the building can be re-occupied.

Building Designers are also requested to refer to the publication “[Home owners Guide to Flood Resilience – A Living Document](#)” to decide on measures to increase the flood resilience in buildings.

21.1 Flood Resistance (Dry Proofing)

This requires choosing flood proof materials and construction methods to exclude water (increase *flood resistance*). Finished threshold floor level should be placed 300mm above the flood level and surrounding ground level. Seepage/ingress of water through floors, walls, foundation, doors, windows should be prevented. The risk of groundwater emergence and surface water ingress can be reduced by using concrete floors, damp proof course, damp proof membranes etc., which will cut-off moisture pathways.

Ground supported floors are the preferred option and concrete slabs of at least 150mm thickness should be specified for non-reinforced construction to prevent cracking due to uplift water pressure. Hollow slabs are not suitable if the elements are not effectively sealed.

Damp Proof Membranes (d.p.m.) should be included in any design to minimise the passage of water through ground floors. Impermeable polythene membranes should be at least 1200 gauge to minimise ripping.

21.2 Flood Resilience (Wet Proofing)

Wet proofing allows for some flooding and aims to increase *flood resilience* by using suitable construction methods and materials. A variety of water-resistant paints and coatings are available to help prevent floodwater soaking into the external face of the wall, thus

allowing the wall to dry out more quickly. For new properties the choice of materials including bricks, mortars and renders should be carefully considered to limit water penetration. Generally denser materials will provide greater flood resistance.

Undermining of foundations due to scour, hydrostatic and hydrodynamic loads on the structure, load impacts of floating debris, pressure on the floor slab, foundation due to groundwater should be considered during engineering design.

Floodwater can backflow through sewers into properties. Therefore, it is recommended to install non-return valves.

Table 4 extracted from the publication - *Improving flood resilience of buildings through improved materials, methods and details, June 2005 published by CIRIA* - lists suitable building materials for flood proofing. Also see Appendix-F for a list of flood resistant/resilient measures that can be chosen as appropriate for the development.

Table 4. Summary of material suitability for building components (source: Scottish Executive, 2004b)

Component	Most suitable	Suitable	Unsuitable
Flooring	Concrete, pre-cast or in situ	Timber floor, fully sealed, use of marine plywood	Untreated timber Chipboard
Floor covering	Clay tiles Rubber sheet floors Vinyl sheet floors	Vinyl tiles Ceramic tiles	
External walls – to Max flood level	Engineering brick Reinforced concrete	Low water absorption brick	Large window openings
Doors	Solid panels with waterproof adhesives Aluminium, plastic or steel	Epoxy sealed doors	Hollow core plywood doors
Internal partitions	Brick with waterproof mortar Lime based plasters	Common bricks	Chipboard Fibreboard panels Plasterboard Gypsum plaster
Insulation	Foam or closed cell types	Reflective insulation	Open cell fibres
Windows	Plastic, metal	Epoxy sealed timber with waterproof	Timber with PVA glues and mild steel

		glues and steel or brass fittings	fittings
--	--	---	----------

Guidance on flood resilient building design can be obtained from the following web sites.

The publication “Improving the Flood Performance of New Buildings- Flood Resilient Construction, Defra, May, 2007”.

http://www.planningportal.gov.uk/uploads/br/flood_performance.pdf

Repair and restoration of buildings following floods, CIRIA.

<http://www.ciria.org.uk/flooding>

22. HEALTH AND SAFETY

Health & safety issues arising due to floods before, during and after the construction should be addressed according to CDM (2015) regulations.

Exit routes should be provided within the building and within the site to be used in a flooding situation.

There is a risk of people falling into pits, manholes during floods and hence, manhole covers should be designed to resist uplifting.

There is a risk of electrocution and failure of services during floods. Therefore, all electrics – switches, socket outlets, plants, substations, transformers, service meters, boilers and all wall mounted accessories - should be located well above the finished ground floor level, between 450mm and 1.2m above the floor level with cables dropping from distribution raised above flood level. (For England) consumer units are mounted so that the operating switches, (of circuit breakers, RCDs and the like therein) are 1350 -1450 mm above floor level. In flood-prone areas, electrical equipment should be installed at the higher limit of these tolerances. In this case it is recommended to assume at least 900mm internal flooding depth.

Chemicals and fuel storage tanks should be stored securely well above the flood level.

Floods may cause buoyancy of stored container units, boxes, and materials. This can cause health and safety hazards. Therefore, they should be stored above the flood level.

Prepare an emergency Flood Plan (see Appendix-D). The Flood Plan should be given to the first occupants of the house.

23. EMERGENCY FLOOD PLAN

It is important that every house and business develop an Emergency Flood Plan to minimise the damage from floods. An emergency flood plan would include a list of useful contact numbers of the Environment Agency FloodLine, Emergency Services, an awareness of the escape routes and instructions how to respond to a flooding situation.

- Register with Environment Agency Floodline. Contact number 0345 988 1188 to receive flood warnings, by telephone, mobile, fax.
- Know emergency services contact 999 and 112.
- Know your escape routes to the outside of the flood plain. Identify exit routes within the building and within the site.
- Prepare an emergency Flood Response Plan. A form to design a flood response plan is attached as Appendix-D.
- More information on the preparation of an emergency flood plan is available on the following web site.
<http://www.environment-agency.gov.uk/business/topics/flooding/32362.aspx>

23.1 Flood warning service

The Environment Agency operates a flood warning service in all areas at risk of flooding which is available on the web site: <https://flood-warning-information.service.gov.uk/warnings>

The proposed site is located in an Environment Agency's Flood Warning Area. It is recommended to subscribe to flood alert/warning service.

There are four flood warning codes that indicate the level of severity of flooding expected in the area.

Table 5. Flood warning codes

Flood Warning Code	Description
Flood Alert	Flooding of low-lying land and roads is expected. Make the necessary actions to prepare for a flood event.
Flood Warning	Flooding of homes and businesses is expected. Take immediate action.
Severe Flood Warning	Severe flooding is expected. Extreme danger to life and property is expected. Take immediate action.
All clear	Flood watches or warnings are no longer in force for this area

As stated on their web site the Environment Agency aim to give a minimum of two hours warning prior to the onset of a flood event. However, the rapid onset of some flood events, particularly with a high intensity rainfall event within an urban catchment means that sometimes a sufficient warning cannot always be raised.

Show warnings near a location

[Show all warnings in England](#)



0

Severe flood warnings

Severe flooding - danger to life



0

Flood warnings

Flooding is expected - immediate action required



0

Flood alerts

Flooding is possible - be prepared

[Were you expecting to see a flood warning or alert at this location?](#)



39

24. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Table 6. Summary of flood risk related issues/constraints and recommendations for their mitigation

Issues/Constraints	Impact	Mitigation
Flood Zone 3	Flood risk is high	The site is in Flood Zone 1.
Run-off	Flood risk in adjacent areas will increase if runoff volume increases.	Impermeable area will increase from 4.7% to 29% relative to total site area after development. It is recommended to attenuate run-off volume to greenfield level using SuDS before discharging.
Flood storage	Flood risk in adjacent areas will increase if flood storage is displaced.	The site is on ground above 8.37mAOD flood level (1% AEP +30%CC). Therefore, flood storage will not be displaced for the design flood event.
Dry access and egress	Emergency services will not have access, people cannot escape to safer areas if safe access and egress is not available.	The site and access/egress routes are outside 0.1% AEP extreme flood plain, i.e., in Flood Zone 1. Therefore, dry access and egress is available for the design event.
Residual risks	Flooding the ground floor	Finished ground floor level (FFL) of the proposed dwellings is above 9.10mAOD. The design flood level with climate change accounted in 2115 is 8.37mAOD. Therefore, the freeboard available is satisfactory (i.e., 600mm). Sleeping accommodation is provided on the first and second floors of the proposed dwellings.
Exceedance of design flood water level		
Surface water, flash floods		
Defence breach or overtopping		
Flood resilience	Increased flood resilience/resistance reduces property damage and economic losses	It is recommended to use flood proof materials, concrete floors, damp proof courses/membranes to cut off groundwater emergence, surface water ingress, water absorption. It is also recommended to consider undermining of foundations due to scour, hydraulic loads and impact forces from floating debris during the engineering design (see Section 21 and Appendix-F). It is recommended to raise the FFL 300mm above surrounding average ground level.
Health and safety	Injury, fatalities	Electrics, boilers, chemical & fuel storage, should be kept 450mm to 1.2m above the finished ground floor level. Consumer units should be mounted so that the operating switches are 1350 -1450 mm above the floor level with wires dropping from above.
Buffer Zone	Effect character of watercourse,	8m buffer zone from the top of the bank should be provided.

undisturbed refuge to
wild life and access
for watercourse
maintenance

25. REFERENCES

Association of British Insurers (ABI), undated, Flood Resilient Homes – What homeowners can do to reduce flood damage

CIRIA, Designing for Exceedance in Urban Drainage-Good Practice, C635, 2006

CIRIA, The SUDS Manual, C697, 2007

CIRIA Sustainable Urban Drainage Systems Initiative
<http://www.ciria.org/suds/index.html>

Defra/Environment Agency, Flood Risk Assessment Guidance for New Developments, Phase 2, R&D Technical Report, FD2320/TR2, October 2005

Department for Communities and Local Government, March, 2010, Planning Policy Statement 25: Development and Flood Risk

Department for Communities and Local Government, February 2007, Development and Flood Risk: A Practice Guide Companion to PPS25, 'Living Draft', A Consultation Paper

Department for Communities and Local Government, National Planning Policy Framework (NPPF), March, 2012.

Department for Communities and Local Government, Technical Guidance to the National Planning Policy Framework (NPPF), March, 2012.

Environment Agency, 2000, Fluvial Freeboard Guidance Note, R&D Technical Report W187

Environment Agency Flood Map – <http://www.environment-agency.gov.uk/>

Institute of Hydrology, 1999, Flood Estimation Handbook, Institute of Hydrology, Wallingford, UK

Marshall D C W & Bayliss, A C, 1994, Flood Estimation for Small Catchments, Report 124, Institute for Hydrology Wallingford, UK

FEH Handbook, Centre for Ecology & Hydrology, Version 2.0

APPENDIX – A: PLANS & FIGURES



Figure A1.1 Environment Agency Flood Map (EA Copyright)

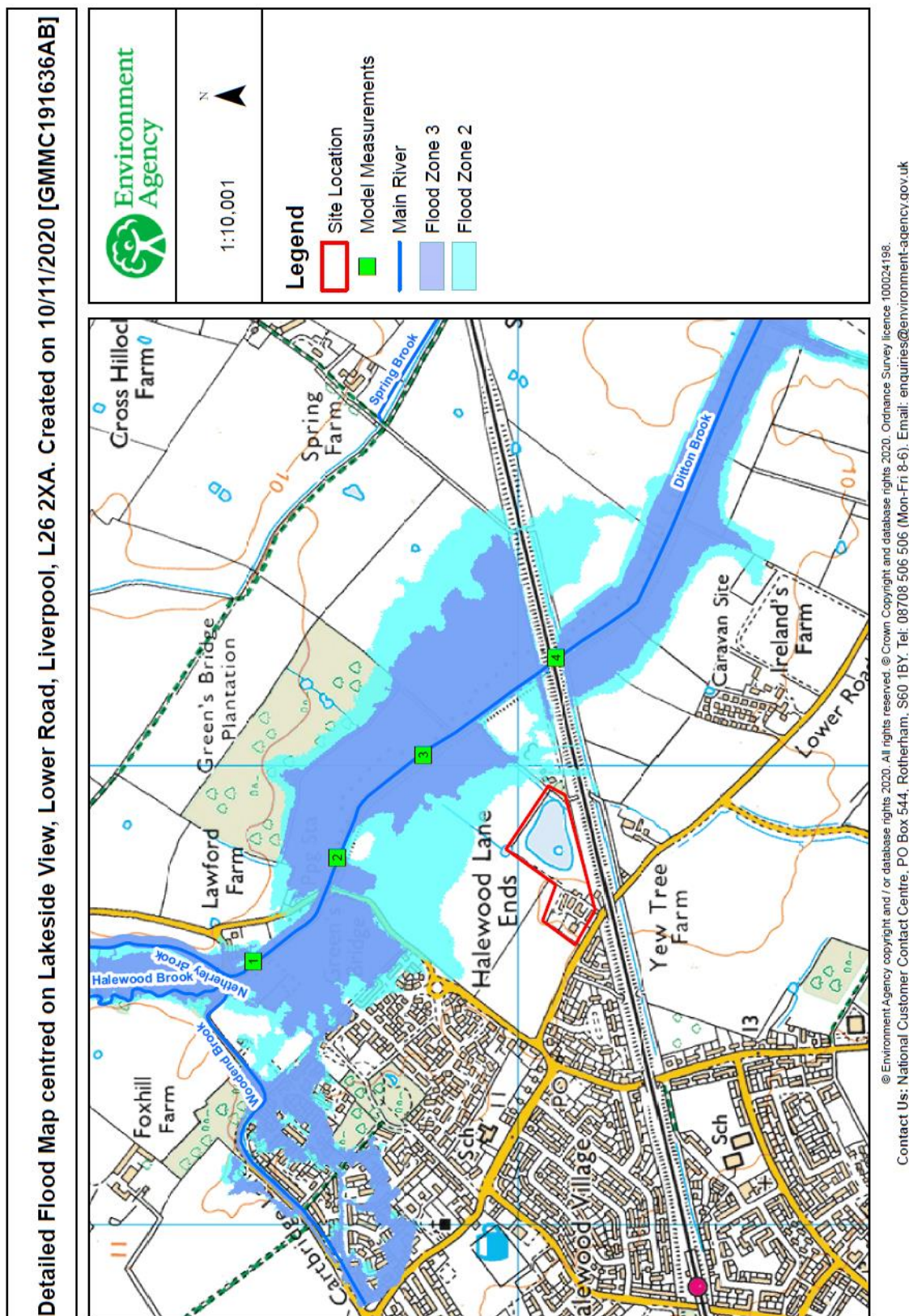


Figure A1.2 Environment Agency Flood Map (EA Copyright)

Case	Model	Model name	Unimodal				Bimodal							
			5-N, 5-T (1.5-2.5 yrs)	1-N, 1-T (1.5-2.5 yrs)	2-N, 2-T (1.5-2.5 yrs)	3-N, 3-T (1.5-2.5 yrs)	5-N, 5-T (1.5-2.5 yrs)	1-N, 1-T (1.5-2.5 yrs)	2-N, 2-T (1.5-2.5 yrs)	3-N, 3-T (1.5-2.5 yrs)				
1	40575	40575, 40575, 40575, 40575	1.64	1.68	1.13	1.17	1.64	1.67	1.13	1.17	1.64	1.67	1.13	1.17
2	300306	Model 1: 1-N, 1-T (1.5-2.5 yrs)	28.15	27.71	19.19	18.96	19.41	20.15	25.22	24.22	26.36	30.12	27.92	8.15
		Model 2: 1-N, 1-T (1.5-2.5 yrs)	7.28	7.45	8.15	8.17	7.22	7.39	7.37	7.43	7.48	7.66	7.70	7.69
3	340575	Model 1: 1-N, 1-T (1.5-2.5 yrs)	19.19	18.96	19.41	20.15	25.22	24.22	26.36	30.12	27.92	8.15	8.15	
		Model 2: 1-N, 1-T (1.5-2.5 yrs)	7.28	7.45	8.15	8.17	7.22	7.39	7.37	7.43	7.48	7.66	7.70	7.69
4	340575	Model 1: 1-N, 1-T (1.5-2.5 yrs)	19.19	18.96	19.41	20.15	25.22	24.22	26.36	30.12	27.92	8.15	8.15	
		Model 2: 1-N, 1-T (1.5-2.5 yrs)	7.28	7.45	8.15	8.17	7.22	7.39	7.37	7.43	7.48	7.66	7.70	7.69

Model data taken from Memory Estuary 2016 Study

MEP - Annual Exceedence Probability

run adult - runnen above endurance datum Nederland
runners - cyclic runners run second

continued... *containing material for inclusion*

Notes

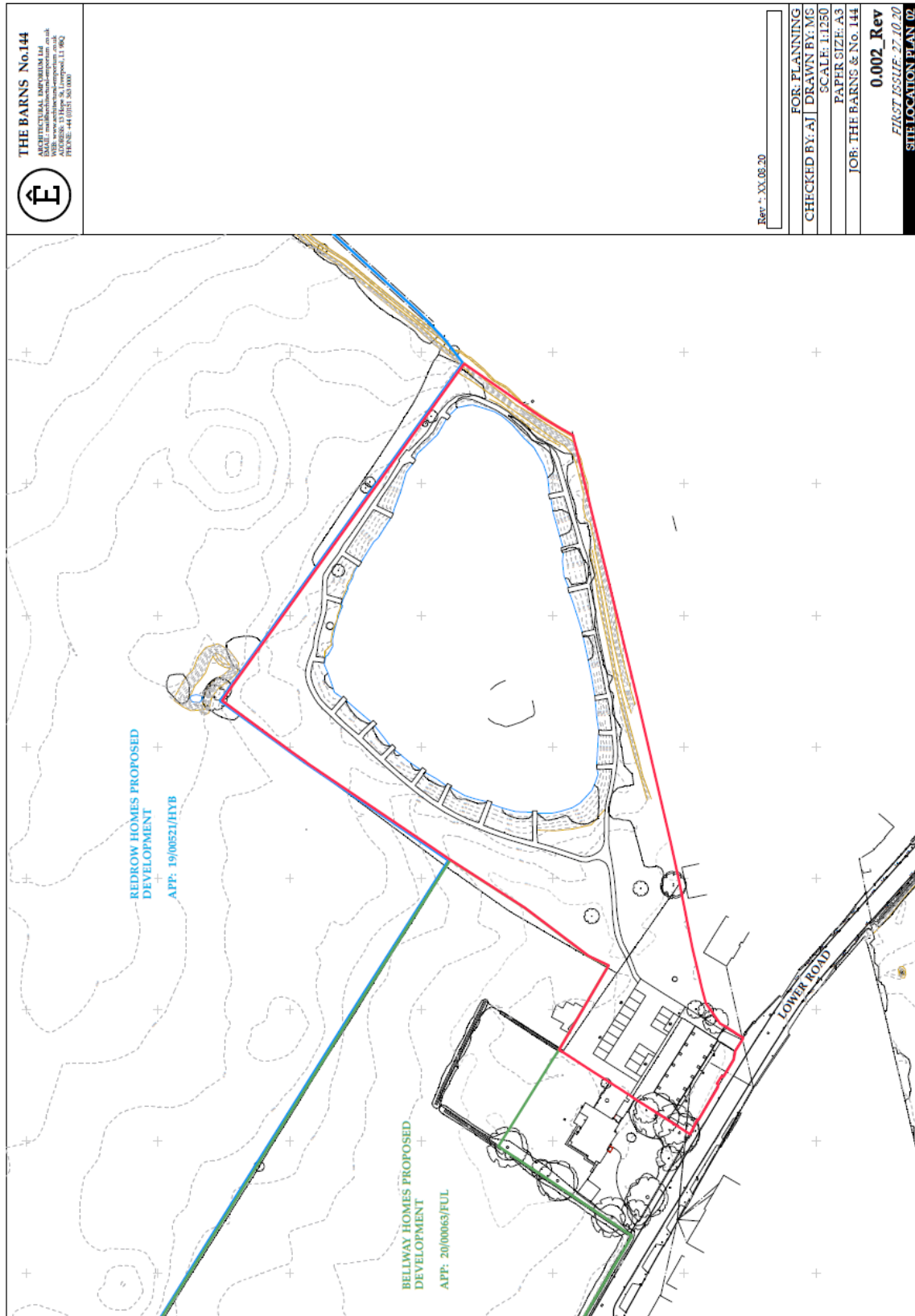
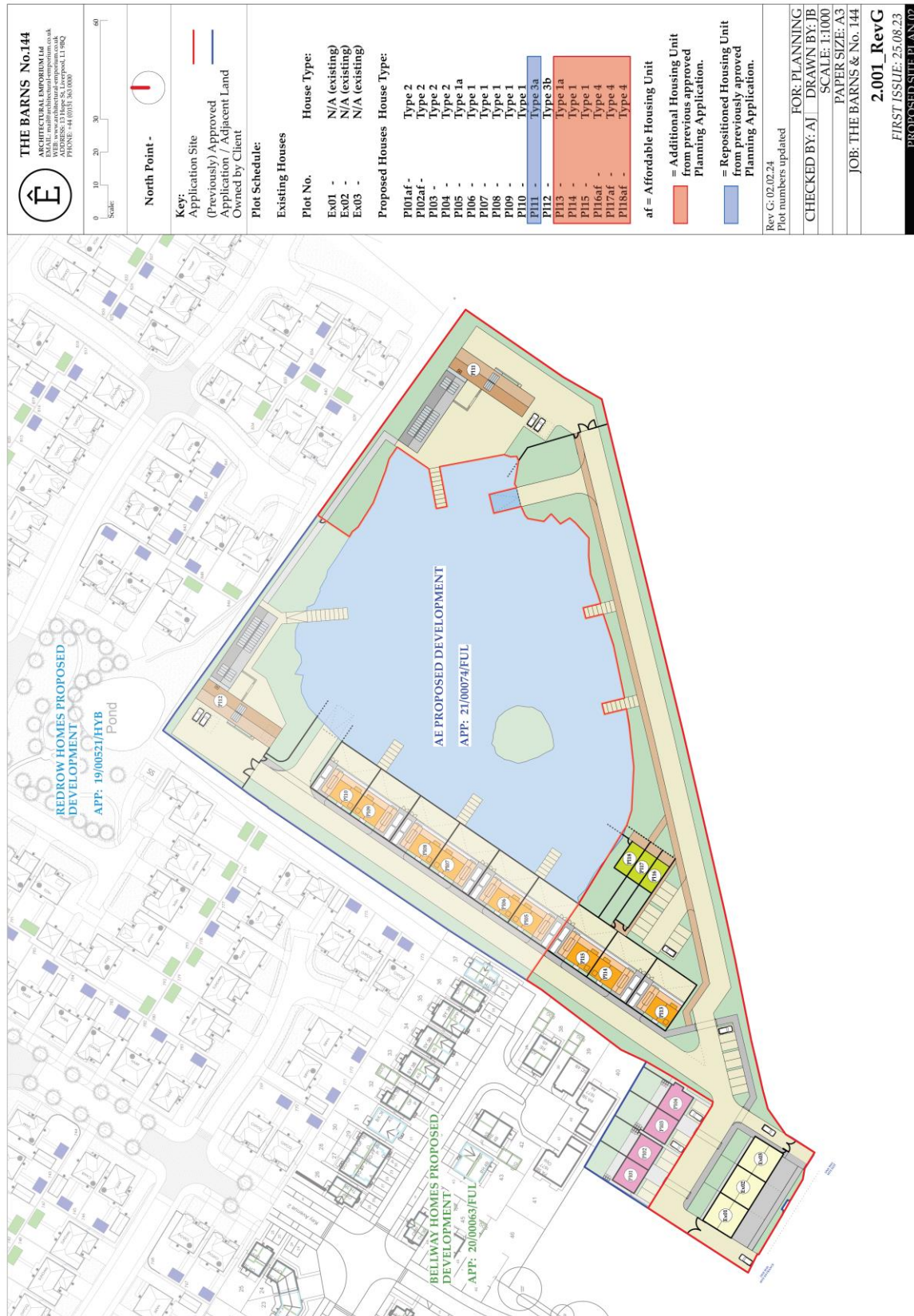


Figure A2. Location Plan



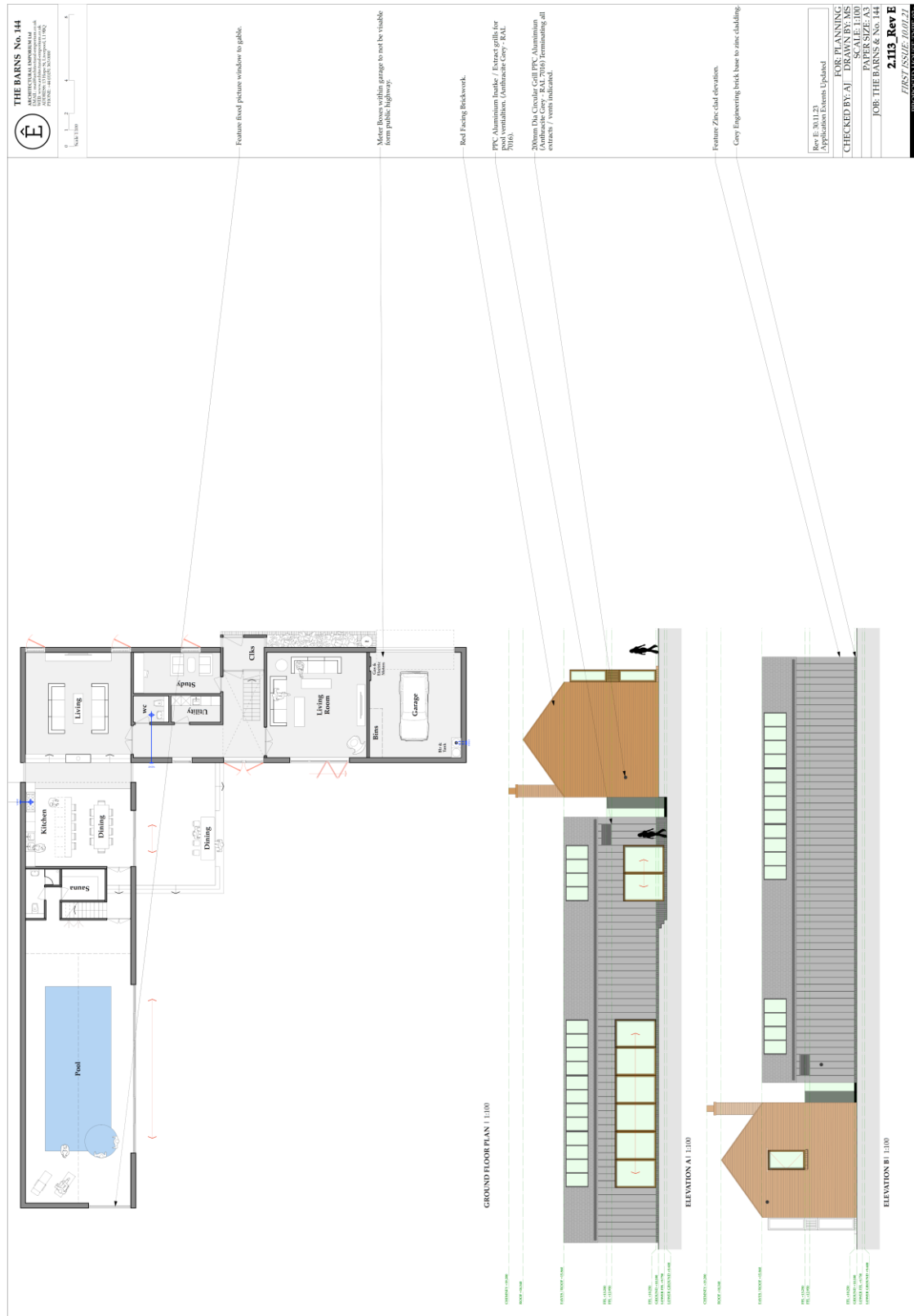


Figure A3.4 Building Floor Plan & Elevation – House Type 3a



Figure A3.6 Proposed Soft Landscape Plan



Figure A3.7 Site Layout Landscape Plan

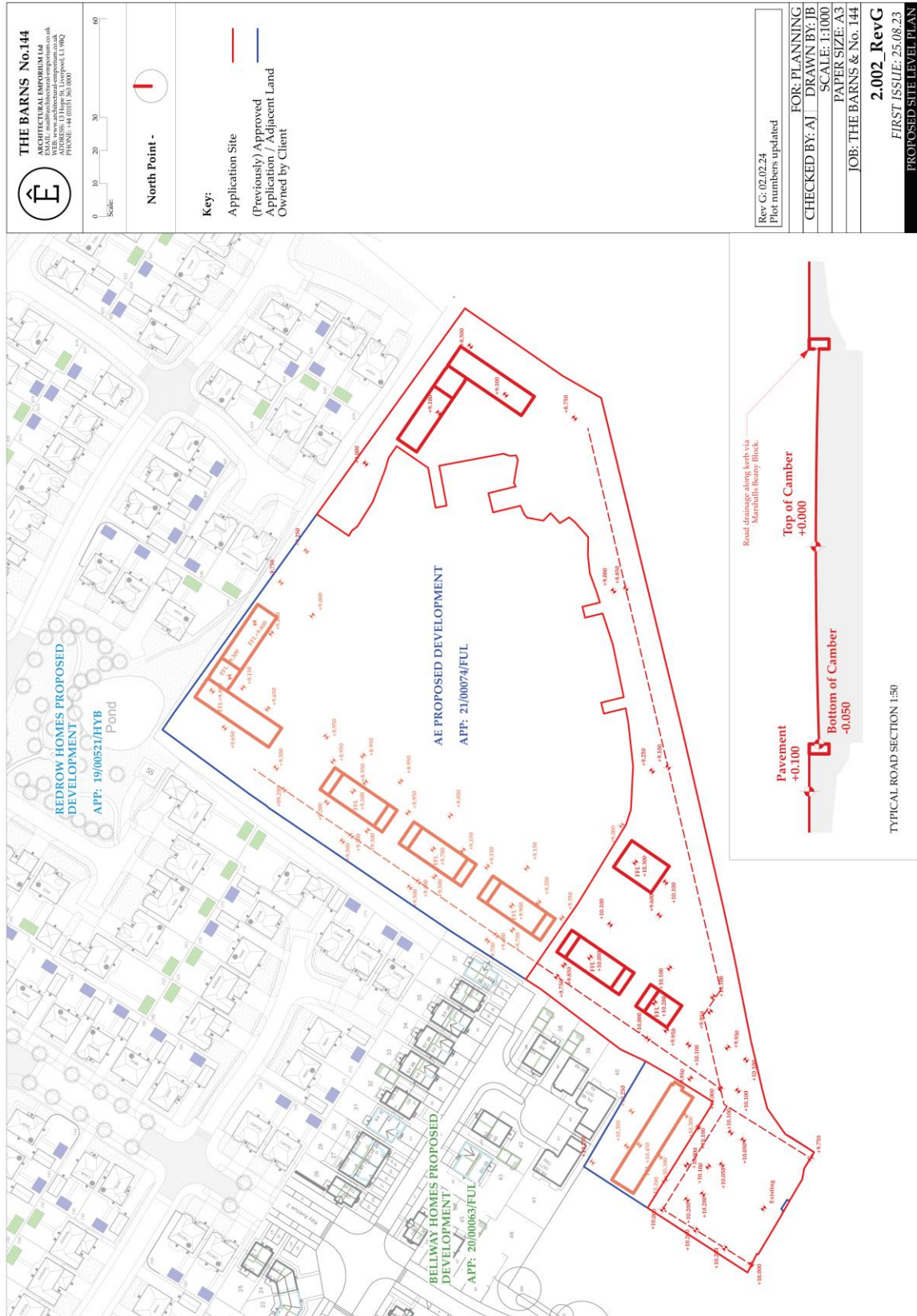


Figure A4 Topography Survey with Finished Floor Levels

APPENDIX – B: PHOTOS



Photo B1. Existing man-made fishing pond



Photo B2. Existing Buildings

APPENDIX – C: CORRESPONDENCE

GMMC Info Requests <inforequests.gmmc@environment-agency.gov.uk>

12/11/2020 16:37

GMMC191636AB Response attached from the Environment Agency

To vidura.vithana@brightonconsulting.co.uk <vidura.vithana@brightonconsulting.co.uk>

Dear Vidura,

Thank you for your enquiry which was received on 2/11/20.

We respond to requests under the Freedom of Information Act 2000 and Environmental Information Regulations 2004.

I enclose the data requested.

Defences - There are no flood defences in the vicinity of the site.

Historic - We have no records of flooding affecting the site. However, this does not mean flooding has not occurred in the past or that it will not flood in future. We recommend that you also contact United Utilities and Knowsley Council who may hold additional information (the former especially in relation to sewer flooding).

Please be aware you can check your risk of flooding on our external website <https://flood-warning-information.service.gov.uk/long-term-flood-risk/>

Here are some useful links below:

<https://www.gov.uk/guidance/flood-risk-assessment-local-planning-authorities>

<https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>

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

Please get in touch if you have any further queries or contact us within two months if you'd like us to review the information we have sent.

Kind regards,

Anne Ball
Customer and Engagement Officer
Greater Manchester, Merseyside and Cheshire
External: 020 302 51232
Mobile: 07769285094
Email: inforequests.gmmc@environment-agency.gov.uk

[cid:image021.png@01D61CB1.90D22A90]

From: vidura vithana [<mailto:vidura.vithana@brightonconsulting.co.uk>]
Sent: 02 November 2020 10:55
To: Enquiries, Unit >
Subject: REF 201103/BM05 Data request to carry out a flood risk assessment for 1 Lakeside View, Lower Road,

Liverpool, L26 2XA
Importance: High

Environment Agency
National Customer Contact Centre
PO Box 544
Rotherham
S60 1BY

Dear Sirs,

I will be thankful if you could send us Product 4 and 8 data to carry out a Flood Risk Assessment for the above site to accompany a planning application complying with the NPPF.

A data request letter and a location plan are attached herewith.

Best regards,

Vidura

Vidura Vithana
BSc Civil Eng(Hons), MEng, PhD (UCL, London), CEng
Senior Civil Engineer
Brighton Consulting Engineers Limited
60 Windsor Avenue London SW19 2RR
T:020 3289 0613
E: brightonconsulting@hotmail.co.uk
info@brightonconsulting.co.uk
<http://www.brightonconsulting.co.uk/>

Information in this message may be confidential and may be legally privileged. If you have received this message by mistake, please notify the sender immediately, delete it and do not copy it to anyone else. We have checked this email and its attachments for viruses. But you should still check any attachment before opening it. We may have to make this message and any reply to it public if asked to under the Freedom of Information Act, Data Protection Act or for litigation. Email messages and attachments sent to or from any Environment Agency address may also be accessed by someone other than the sender or recipient, for business purposes.

-
- Part_1.1.2.html (14 KB)
 - Flood Risk Data Request 3355 - Brighton Consulting Engineers.pdf (60 KB)
 - Location Plan.pdf (408 KB)
 - GMMC191636AB - Table.pdf (19 KB)
 - GMMC191636AB - DFM.PDF (4 MB)
 - Flood Risk Assessments - Climate Change Allowances.pdf (169 KB)
 - image002.png (22 KB)

APPENDIX – D: FLOOD PLAN

Personal flood plan



Name

Which flood warnings are you registered to receive?

River:

Quickdial no:

Reach:

General contact list	Company name	Contact name	Telephone
Floodline	Environment Agency		0845 988 1188
Electricity provider			
Gas provider			
Water company			
Telephone provider			
Insurance company and policy number			
Local council			
Local radio station			
Travel/weather info			

Key locations

Service cut-off	Description of location
Electricity	
Gas	
Water	

Who can help?

Relationship	Name	Contact details	How they can help?
Relative			
Friend or neighbour			

Be prepared for flooding. Act now

Personal flood plan

What can I do NOW?



Put important documents out of flood risk and protect in polythene ☐

Check your insurance covers you for flooding ☐

Look at the best way of stopping floodwater entering your property ☐

Make a flood plan and prepare a flood kit ☐

Find out where you can get sandbags ☐

Identify who can help you ☐

Identify what you would need to take with you if you had to leave your home ☐

Understand the flood warning codes ☐

What can you do when you receive a flood warning?

Actions	Location
Home	
● Move furniture and electrical items upstairs	
● Put flood boards, polythene and sandbags in place	
● Make a list now of what you can move upstairs or away from the risk	
● Turn off electricity, water and gas supplies	
● Roll up carpets and rugs	
● Unless you have time to remove them hang curtains over rods	
● Move sentimental items to safety	
● Put important documents in polythene bags and move to safety	
Garden and outside	
● Move your car out of the flood risk area	
● Move any large or loose items or weigh them down	
Business	
● Move important documents, computers and stock	
● Alert staff and request their help	
● Farmers move animals and livestock to safety	
Evacuation - Prepare a flood kit in advance	
● Inform your family or friends that you may need to leave your home	
● Get your flood kit together and include a torch, warm and waterproof clothing, water, food, medication, toys for children and pets, rubber gloves and wellingtons	

Be prepared for flooding. Act now

APPENDIX – E: SURFACE WATER STORAGE CALCULATION



Surface water storage requirements for sites

www.uksuds.com | Storage estimation tool

Calculated by:

Site name:

Site location:

Site Details

Latitude:

Longitude:

Reference:

Date:

This is an estimation of the storage volume requirements that are needed to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013), the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). It is not to be used for detailed design of drainage systems. It is recommended that hydraulic modelling software is used to calculate volume requirements and design details before finalising the design of the drainage scheme.

Site characteristics

Total site area (ha):

Significant public open space (ha):

Area positively drained (ha):

Impermeable area (ha):

Percentage of drained area that is impermeable (%):

Impervious area drained via infiltration (ha):

Return period for infiltration system design (year):

Impervious area drained to rainwater harvesting (ha):

Return period for rainwater harvesting system (year):

Compliance factor for rainwater harvesting system (%):

Net site area for storage volume design (ha):

Net impermeable area for storage volume design (ha):

Pervious area contribution to runoff (%):

* where rainwater harvesting or infiltration has been used for managing surface water runoff such that the effective impermeable area is less than 50% of the 'area positively drained', the 'net site area' and the estimates of Q_{BAR} and other flow rates will have been reduced accordingly.

Design criteria

Climate change allowance factor:

Urban creep allowance factor:

Volume control approach:

Interception rainfall depth (mm):

Minimum flow rate (l/s):

Methodology

esti:

Q_{BAR} estimation method:

SPR estimation method:

Soil characteristics

	Default	Edited
SOIL type:	4	4
SPR:	0.47	0.47

Hydrological characteristics

	Default	Edited
Rainfall 100 yrs 6 hrs:	--	63
Rainfall 100 yrs 12 hrs:	--	80.85
FEH / FSR conversion factor:	1.05	1.05
SAAR (mm):	789	789
M5-60 Rainfall Depth (mm):	20	20
'r' Ratio M5-60/M5-2 day:	0.4	0.4
Hydrological region:	10	10
Growth curve factor 1 year:	0.87	0.87
Growth curve factor 10 year:	1.38	1.38
Growth curve factor 30 year:	1.7	1.7
Growth curve factor 100 years:	2.08	2.08
Q_{BAR} for total site area (l/s):	13.5	13.5
Q_{BAR} for net site area (l/s):	13.5	13.5

Site discharge rates

	Default	Edited
1 in 1 year (l/s):	11.7	11.7
1 in 30 years (l/s):	22.9	22.9
1 in 100 year (l/s):	28.1	28.1

Estimated storage volumes

	Default	Edited
Attenuation storage 1/100 years (m³):	924	924
Long term storage 1/100 years (m³):	0	0
Total storage 1/100 years (m³):	924	924

This report was produced using the storage estimation tool developed by HR Wallingford and available at www.uksuds.com. The use of this tool is subject to the UK SuDS terms and conditions and licence agreement, which can both be found at <http://uksuds.com/terms-and-conditions.htm>. The outputs from this tool have been used to estimate storage volume requirements. The use of these results is the responsibility of the users of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, CEH, Hydrosolutions or any other organisation for the use of these data in the design or operational characteristics of any drainage scheme.

APPENDIX – F: RECOMMENDED FLOOD RESILIENT MEASURES

Component	Recommended materials and methods for flood resilience
Flooring	- Concrete ground supported (pre-cast or in situ) or - Timber floors, fully sealed, made of marine plywood - D.p.m. - impermeable polythene membranes at least 1200 gauge with overlaps of 300mm and also 50mm taping overlap
Floor covering	- Clay tiles or Rubber sheet floors or Vinyl sheet floors/skirting - Use water resistant cement and grout
Internal partitions	Engineering bricks with waterproof mortar/Lime based plasters
External walls – to Max flood level (assumed 0.9m, i.e. from finished floor level to window sill level)	- Engineering bricks (Class A and B) or Reinforced concrete - Cement or Cement/lime renders - Mortars Cement: Sand – 1:3 below DPC, 1:6 above DPC - Auto closing air vents (ex: SMART AirBrick) - sealed and waterproof cover boards on doors
Sealing cracks / Weep holes / service inlets and service entry and exit points; duct sealing products, sealing external doors/windows	Silicone or similar products
Sewers/appliances	Anti-back flow valves for sewer pipes/Non-return valves
Doors	- Epoxy sealed/waterproof PVC, Aluminium or steel doors or - Timber doors fitted and sealed to frames
Insulation	Foam or closed cell types
Windows	- Made of Plastic or metal - Double glazed units and set-in waterproof seals - Epoxy sealed timber with waterproof glues and steel or brass fittings
White goods, boiler, refrigerator	- Raise 300mm or more above the finished floor level on plinths. - Electric wiring above flood level