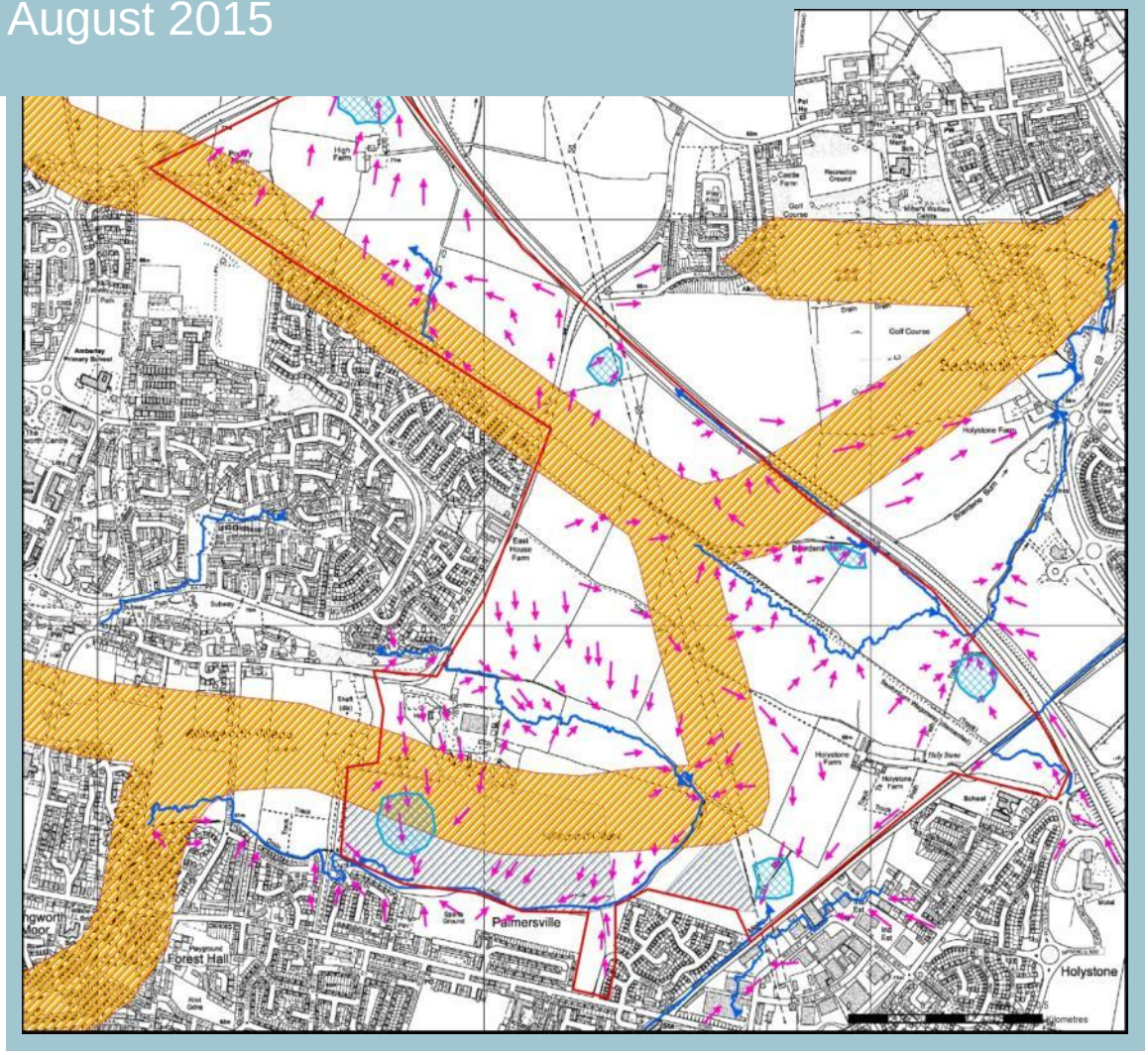
North Tyneside Council

Working in partnership with CAPITA

Killingworth Moor

Broad Scale Flood Risk Assessment and Drainage Strategy – Draft

August 2015



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Quality Management

Job No	CS081335
Project	North Tyneside Murton Gap & Killingworth Moor Assessments
Location	North Tyneside Council
Title	Broad Scale Flood Risk Assessment and Drainage Strategy
File reference	\\cslgrvmu03\data\environment\ZWET\CS081335_NTC_MGKM_FRA
Date	August 2015
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Authorised by	Kerry Foster

Revision Status / History

Rev	Date	Issue / Purpose/ Comment	Prepared	Checked	Authorised
1	17/08/2015	Issued for review	CD	LM	KF

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Executive Summary

1.1.1 Killingworth Moor has been identified in North Tyneside Council's (NTC) 2015 Draft Local Plan as a potential site to accommodate approximately 1,700 - 2,000 homes. Combined with Murton Gap the two sites are required to deliver a significant proportion of the overall needs for growth within NTC up to 2032. An agreed masterplan is required to ensure a suitable framework is in place to support future development of each of the sites. This report details the assessment at the Killingworth Moor site only. Details of the Murton Gap assessment can be found in the report *titled Murton Gap Broad Scale Flood Risk Assessment and Drainage Strategy – Draft (August 2015)*.

1.1.2 Capita Property & Infrastructure was commissioned by NTC in April 2015 to develop a broad scale flood risk and drainage assessment for the Killingworth Moor strategic allocation. Known from here on in as "Killingworth Moor". Note this report does not constitute a National Planning Policy Framework (NPPF) compliant flood risk assessment for planning purposes. It is a strategic assessment to support the allocation of the site in NTC's Local Plan document. If Killingworth Moor is included in the Local plan it will still require planning permission for any development to occur.

1.1.3 This document provides a summary of the technical analyses carried out. The overall aim of the document is to establish the baseline conditions, evaluate the effects of development and provide evidence that development of Killingworth Moor can take place whilst not increasing flood risk at the site and surrounding area. A summary of the technical analyses are contained within the main body of this report, with details provided in the supporting appendices.

1.1.4 A review of the Environment Agency (EA) Flood Zone Mapping indicates that Killingworth Moor is located primarily on land that has a low probability of flooding (Flood Zone 1). A small proportion of the site, constrained to the southern boundary of the site is predicted to be at risk of fluvial flooding from the Forest Hall Letch. Approximately 1.33% of the site falls within Flood Zone 2, 0.48% within Flood Zone 3a and 1.06% within Flood Zone 3b.

1.1.5 Groundwater flood risk varies across the site, and is considered to be moderate to high based upon available data. The EA's updated Flood Map for Surface Water (uFMfSW) and historical flooding records indicate that the site is at low to moderate risk from surface water flooding.

1.1.6 The site currently has natural drainage capacity which is in part unmanaged, and extreme rainfall events can contribute to surface water flooding in surrounding areas. Historical flooding records have been recorded by NTC and Northumbria Water Limited (NWL) for properties surrounding Killingworth Moor. As such the site is located in a Critical Drainage Area (CDA) as defined by the 2012 North Tyneside Surface Water Management Plan, and the risk of surface water flooding (particularly to surrounding properties) is considered to be moderate to high.

1.1.7 To address the existing surface water flood risk for the wider Killingworth area NTC, NWL and the EA are currently developing the Killingworth & Longbenton Sustainable Surface Water Management Scheme.

1.1.8 Development of this drainage strategy took into consideration available information on the Sustainable Surface Water Management Scheme, which is currently under development. Betterment over existing conditions was identified as a key priority to ensure flood risk is appropriately mitigated. As such, surface water attenuation features were sized based on

restricting post-developed flows to less-than-Greenfield runoff rates. Discharge limits of the receiving waterbodies were not available, as such allowable discharges were limited to not exceed one half of the existing Greenfield (‘half Greenfield’) runoff rates. The sizing of attenuation features was undertaken based upon managing surface water runoff from the site up to a 1 in 100 year return period (plus climate change) event.

1.1.9 A preliminary drainage strategy was developed maximising the use of existing topography and the existing drainage regime to manage surface water runoff at the site. Surface water attenuation ponds are proposed at locations where surface water outlets from the site. There may also be opportunities to integrate attenuation features and / or infiltrating SuDS features within the proposed Green Belt in Killingworth Moor.

1.1.10 A SuDS suitability assessment was conducted for Killingworth Moor that identified a number of areas where infiltrating SuDS features may be suitably incorporated into the site design. It is recommended that site investigations be conducted to further assess the suitability of incorporating infiltrating SuDS into the Killingworth Moor masterplan.

1. Introduction

1.1 Scope of assessment

1.1.1 Capita Property and Infrastructure has been appointed by NTC to undertake a broad scale Flood Risk Assessment (FRA) and surface water drainage strategy for Killingworth Moor.

1.1.2 The objectives of this flood risk assessment and surface water drainage strategy are to:

1. Appraise the potential flood risk to proposed future development in Killingworth Moor, as well as the potential impact of any development on flood risk elsewhere;

2. Demonstrate that the proposed development can be implemented safely in compliance with national and local policies and guidance;

3. Assess the suitability of implementing Sustainable Drainage Systems (SuDS) and maximise their use throughout Killingworth Moor; and

4. Demonstrate that development at Killingworth Moor can occur in combination with a SuDS Management Train[1] to sustainably manage surface water runoff from the proposed development and reduce existing flood risk overall.

1.1.3 This FRA and drainage strategy contains the following information that describes how each of the four over arching objectives have been successfully achieved:

1. Existing and historic flood risk have been assessed using available information from the EA, NTC, and published studies;

2. This report is informed by national and local policies, in particular the NTC Strategic Flood Risk Assessment (SFRA), 2010, North Tyneside Surface Water Management Plan (SWMP), 2012 and the North Tyneside Local Plan Consultation Draft - Draft Flooding Sequential Test, 2015;

3. The suitability of implementing SuDS features was assessed using British Geological Society (BGS) data sets and existing borehole records. SuDS have been promoted throughout the development; and

4. The development layout and sizing and location of sustainable drainage features have been designed so that surface water runoff from the development is managed safely within the site. Furthermore an overall reduction in surface water flood risk to local residents in the surrounding areas through managing the effects of climate change on runoff has been provided.

1.1.4 Note this report does not constitute an NPPF compliant flood risk assessment for planning purposes. It is a strategic assessment to support the allocation of the site in NTC's Local Plan

[1] 'Management train' or 'treatment train' are terms used for an integrated sequence of measures employed in a SuDS scheme which, taken together, control volumes of run off and reduce pollution before discharge.

document. If Killingworth Moor is included in the Local plan it will still require planning permission for any development to occur.

1.2 Site Overview

1.2.1 Killingworth Moor is located between the settlements of Backworth (to the east, across the A19) Palmersville and Forest Hall to the south and the existing Killingworth / Killingworth Village settlement to the west. The strategic allocation is approximately 210 hectares, including an area that has already received planning permission in the south eastern portion of the site.

1.2.2 Killingworth Way forms the northern boundary of the strategic lands and A19 makes up the entirety of the eastern boundary. A small parcel of land is located to the south of the Metro line, west of the A19. The remainder of the site is located to the north of the Metro line, and then moving west the site is north of Palmersville and Forest Hall. In the southern portion of the site the western boundary follows Stephenson Trail, to the east of Killingworth Village. The B317 forms part of the western boundary of the site. The site and surrounding area are shown in Figure 1 below.

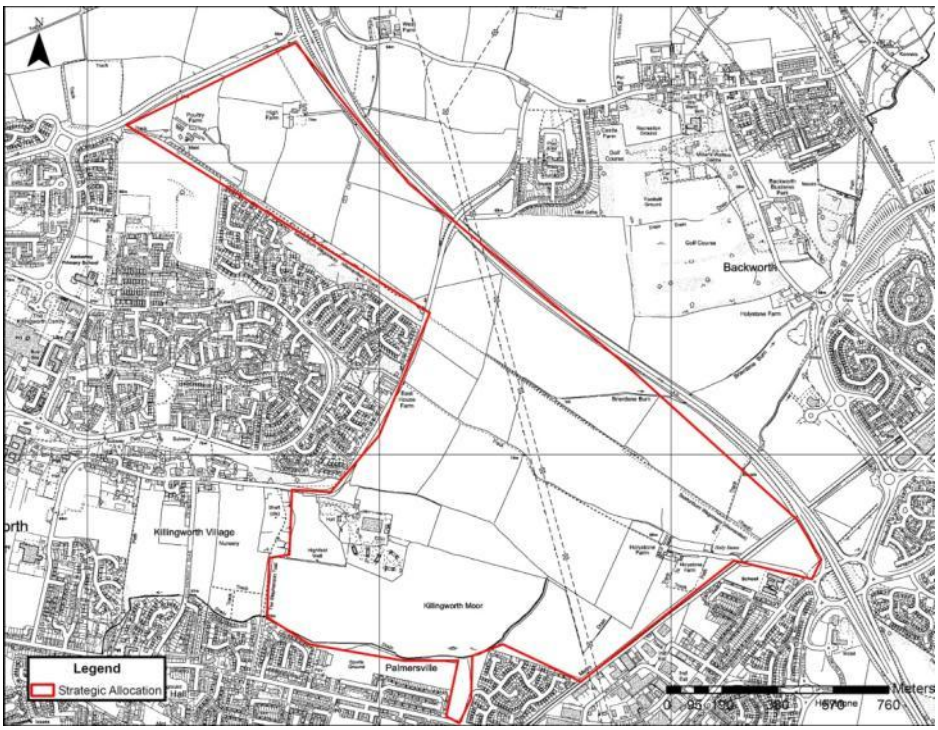


Figure 1: OS Map showing the extent of Killingworth Moor

1.2.3 Killingworth Moor is primarily comprised of farmland, with the High Farm and a Poultry Farm located within the northern portion of the site. To the south, the East House Farm is located along the western boundary formed by the B1317. Holystone Farm is located in the south

eastern portion of the site. The Village of Killingworth lies to the west of the site, outside of the extent of the allocated lands. There are no other major roadways or highways contained within the lands.

1.2.4 The Killingworth Moor strategic allocation is proposed on land previously identified as safeguarded land, and is planned to contribute a maximum of 2,000 new homes and 17 hectares of employment lands to the Local Plan. The proposed development on this site would include a mix of housing tenures, types and sizes along with new educational facilities to support the growth delivered by the proposals.

1.3 Topography and Existing Surface Water Management / Drainage

1.3.1 Killingworth Moor generally slopes from approximate elevations of 82m AOD in the north west corner of the site, down to 65m AOD at its lowest point along the southern boundary of the site. There is some variation in topography in the eastern portion of the catchment, where a topographic low is observed along a north easterly orientation. For further details refer to Figure 2 below.

1.3.2 Killingworth (along with the settlements of Longbenton and Benton) are situated on the west side of the borough. This area falls within the Ouseburn catchment, one of the Tyne's major tributaries. Two former Critical Ordinary Watercourses (COWs), Forest Hall Letch and Longbenton Letch, drain the area as they flow west to the Ouseburn.

1.3.3 Forest Hall Letch (now classified as Main River) and Brierdene Burn are watercourses located within the Killingworth Moor strategic allocation. Forest Hall letch originates near the southern boundary of the strategic allocation (grid reference NZ 29559 70577) and flows south westerly towards Killingworth Village. Brierdene Burn originates near the eastern boundary of the site (grid reference NZ 29626 71186) flowing east, culverted under the A19, where it then continues as open channel. It is joined by a number of small drains originating from Shiremoor and South Wellfield before flowing through Whitley Bay Golf Course and out into the North Sea.

1.3.4 To obtain a greater understanding of how the site currently drains a 'rolling ball analysis' was undertaken using available LiDAR data. Rolling ball analysis is used to identify natural flow path determined by topography only. The analysis is completed within QGIS software and uses terrain data from the digital terrain model (DTM). The results of the rolling ball analysis are shown in Figure 2 below.

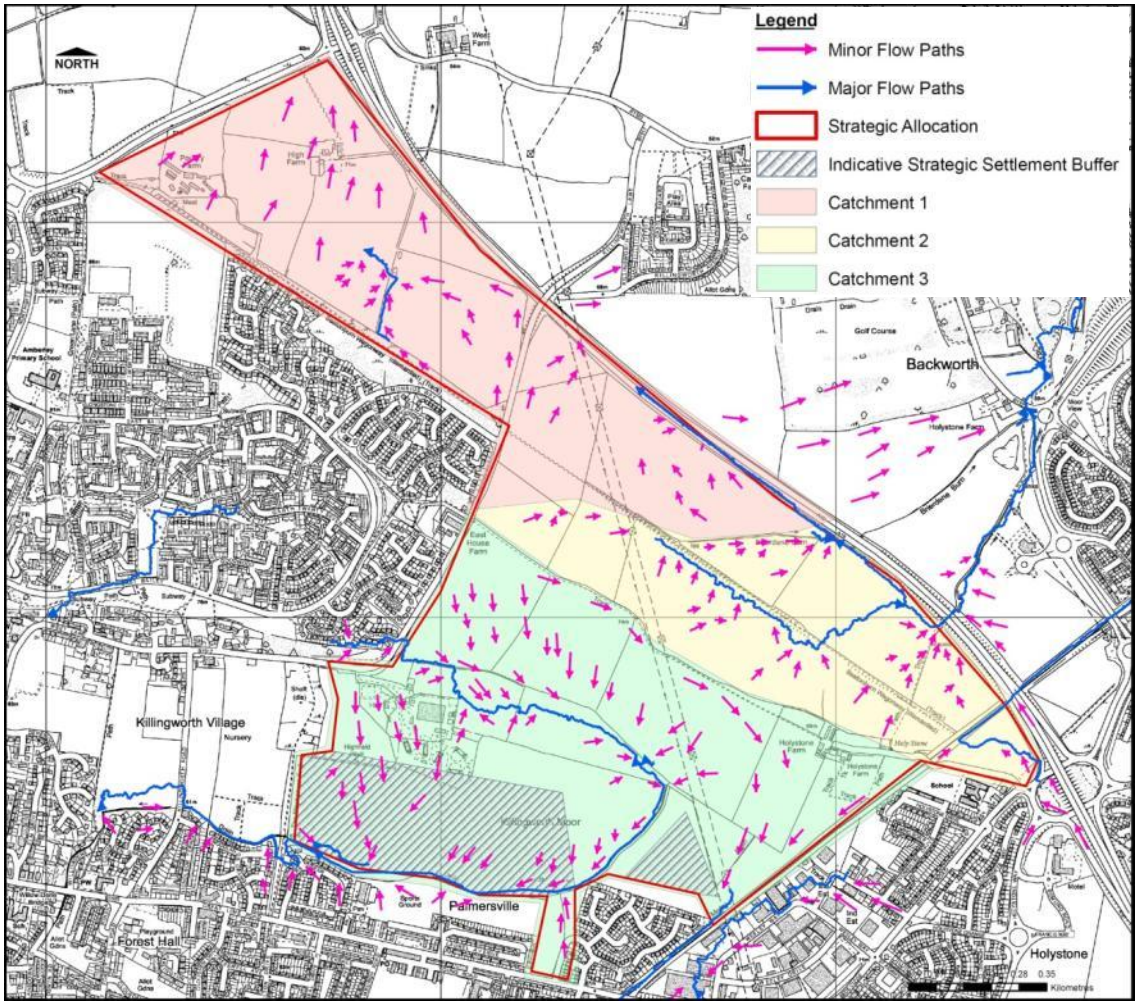


Figure 2: Existing surface water flowpaths at Killingworth Moor and surrounding area

1.3.5 As seen in Figure 2 the site is comprised of three catchments. Catchment 1 (72 ha) conveys overland flows from the centre of the site and from the south eastern corner to two outlet points - Brierdene Burn and an unnamed watercourse to the south. It is assumed that both watercourses are culverted under the A19. Catchment 1 contains the small parcel of land to the south of the Metro line. Catchment 2 (44 ha) conveys flows in the northern portion of the site, including a portion of land south of the B1317. In this area, surface water flows converge in the north eastern corner prior to exiting the site. Catchment 3 (94 ha) is the largest catchment in Killingworth Moor and discharges overland flows into Forest Hall Letch. The Letch flows from north to south where it originates in the centre of the catchment, then flows from east to west.

1.3.6 There are four major surface water flowpaths within the site. In Catchment 1, a majority of the surface water flows south along the (dismantled) Seatonburn Wagonway, then flows east to exit the site. This major flowpath continues to the east, where it passes through the Backworth settlement. In Catchment 2, there are two smaller major flowpaths, one that follows the A19, flowing from south to north, and another major flowpath in the northern portion of the

catchment. The most significant overland flowpath originates in Killingworth to the west of the site where it then traverses the centre of Catchment 3. This flowpath then forms the Forest Hall Letch, which then flows south and then west.

1.3.7 The rolling ball analysis indicates that much of the surface water flows are directed through the Forest Hall Letch and existing network of ditches that traverse the site. The minor flowpaths appear to be well managed within the existing boundary of the Killingworth Moor site. Major flowpaths also appear to be constrained to exiting the site at four major outlet points and do not appear to be exiting the site in inappropriate / uncontrolled areas. Some of the existing surface water flowpaths do follow essential infrastructure, however. These flowpaths close to infrastructure include the Metro line in Catchment 3 and along the A119 in Catchment 2. These flowpaths would benefit from modifications to ensure that they have sufficient capacity and / or have flows redirected to minimise flood risk to these features.

1.3.8 It is assumed that drainage infrastructure is in place to facilitate surface water discharging the site at the identified outlets. Further details regarding the drainage network were not available at the time of writing the report.

1.3.9 For further details regarding existing site topography, refer to Appendix A.

2. Policy and Guidance

2.1 Flood and Water Management Act, 2010

2.1.1 Combined with the Flood Risk Regulations 2009 ('the Regulations'), (which enact the EU Floods Directive in the England and Wales) the Flood and Water Management Act 2010 ('the Act') places significantly greater responsibility on Local Authorities to manage and lead on local flooding issues. The Act and the Regulations together raise the requirements and targets Local Authorities need to meet, including:

- Playing an active role leading Flood Risk Management;
- Development of Local Flood Risk Management Strategies (LFRMS);
- Implementing requirements of Flood and Water Management legislation;
- Development and implementation of drainage and flooding management strategies; and
- Providing guidance on SuDS systems and surface water management within the local planning process via a statutory consultee role (as of April 2015).

2.1.2 The Act also clarifies three key areas that influence development:

1. *Sustainable drainage (SuDS)* - the Act makes provision for a national standard to be prepared on SuDS (The Non-statutory Technical Standards for Sustainable Drainage Systems, published March 2015). The suitability of SuDS will be assessed by the local authority, in consultation with other applicable flood risk management bodies, primarily the lead local flood authority.
2. *Flood risk management structures* - the Act enables the EA and local authorities to designate structures such as flood defences or embankments owned by third parties for protection if they affect flooding or coastal erosion. A developer or landowner will not be able to alter, remove or replace a designated structure or feature without first obtaining consent from the relevant authority.
3. *Permitted flooding of third party land* **-** The EA and local authorities have the power to carry out work which may cause flooding to third party land where the works are deemed to be in the interest of nature conservation, the preservation of cultural heritage or people's enjoyment of the environment or of cultural heritage.

2.2 National Planning Policy Framework (NPPF), March 2012

2.2.1 In determining an approach for the assessment of flood risk for the proposal there is a need to review the policy context. The NPPF requires that consideration be given to flood risk in the planning process. The NPPF was issued in March 2012 and outlines the national policy position on development and flood risk assessment.

2.2.2 The Framework states that the appropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk. Where development is necessary in flood risk areas, it can be permitted provided it is made safe without increasing flood risk elsewhere.

2.2.3 The essence of NPPF is that:

- Local Plans should be supported by Strategic Flood Risk Assessment and develop policies to manage flood risk from all sources, taking advice from the EA and other relevant flood risk management bodies, such as lead local flood authorities and internal drainage boards;
- Polices in development plans should outline the consideration, which will be given to flooding issues, recognising the uncertainties that are inherent in the prediction of flooding and that flood risk is expected to increase as a result of climate change;
- Planning authorities should apply the precautionary principle to the issue of flood risk, using a risk-based search sequence to avoid such risk where possible and managing it elsewhere;
- The vulnerability of a proposed land use should be considered when assessing flood risk;
- Opportunities offered by new developments should be used to reduce the causes and impacts of flooding;
- Planning authorities should recognise the importance of functional floodplains, where water flows or is held at times of flood, and avoid inappropriate development on undeveloped and undefended floodplains; and
- Development is based on the concept of Flood Risk Reduction, particularly in circumstances where development has been sanctioned on the basis of the "Exception Test".

2.3 Planning Practice Guidance Flood Risk and Coastal Change, April 2015

2.3.1 The accompanying practice guidance to the NPPF provides additional guidance to local planning authorities to ensure the effective implementation of the planning policy set out in the NPPF on development in areas at risk of flooding.

2.3.2 The practice guidance provides supporting information on:

- The application of the sequential approach and Sequential and Exception Tests;
- Measures to reduce flood risk to acceptable levels;
- How to manage residual risks; and
- Guidance on how to take climate change into account.

2.3.3 The April 2015 update to the practice guidance provides additional guidance on SuDS, including:

- The importance of SuDS;
- When SuDS should be considered;
- The SuDS discharge hierarchy;
- Factors a local authority will address when considering SuDS as part of a planning application;
- When SuDS are inappropriate and relevant flood risk consultees;
- Applicability of Defra's Non-statutory Technical Standards for Sustainable Drainage Systems;
- Design and construction cost considerations;
- Operation and maintenance considerations; and
- Where to go for further SuDS advice.

2.3.4 As part of the April 2015 update, the practice guidance provides details on the parties responsible for assessing the suitability of SuDS practices. As per paragraph 084 from the practice guidance:

> *The decision on whether a sustainable drainage system would be inappropriate in relation to a particular development proposal is a matter of judgement for the local planning authority. In making this judgement the local planning authority will seek advice from the relevant flood risk management bodies, principally the lead local flood authority, including on what sort of sustainable drainage system they would consider to be reasonably practicable.*

2.4 Non-statutory Technical Standards for Sustainable Drainage Systems, March 2015

2.4.1 This document, published by the Department for Environment, Food and Rural Affairs, sets out non-statutory technical standards for sustainable drainage systems. The non-statutory technical standards should be used in conjunction with the NPPF and Planning Practice Guidance.

2.4.2 Non-statutory technical standards are provided for the following items:

- Flood risk outside the development;
- Peak flow control;
- Volume control;
- Flood risk within the development;
- Structural integrity;
- Designing for maintenance considerations; and
- Construction.

2.5 North Tyneside Council Level 1 Strategic Flood Risk Assessment, July 2010

2.5.1 A Level 1 Strategic Flood Risk Assessment (SFRA) was produced on behalf of NTC to aid in the preparation of a Local Development Framework (LDF) and Local Development Documents (LDDs).

2.5.2 The objectives of the SFRA were predominantly informed by the requirements of Planning Policy Statement 25, which required that decision makers involved in the planning process consider regional and local flood risk issues when planning development.

2.5.3 A broad level of assessment of flood risk was conducted across NTC as part of the SFRA. The following risks were identified:

- Fluvial and Tidal flooding – the SFRA indicates that a small portion of the Killingworth Moor site is at risk of fluvial flooding.
- Surface water and sewer flooding – Surface water flood risk were identified in two preliminary Critical Drainage Areas – Benton and Brierdene / Whitley Bay. The SFRA states that a Surface Water Management Plan should be undertaken in the Benton Critical Drainage Area (containing the Killingworth Moor site) to gain a holistic understanding of surface water flood risk in the area.

- Groundwater Flooding – The SFRA indicates there are no flood defences along the River Tyne through North Tyneside to elevate the river level above the floodplain. It concludes that it is unlikely that alluvial groundwater flooding will occur. The SFRA recommends that the risk of groundwater flooding be investigated at a site-specific FRA level.
- Infrastructure Failure from Artificial Sources - there are no large raised reservoirs directly located within the boundaries of North Tyneside or surrounding Councils. As such, risk of flooding from large artificial sources is considered to be low. There may be smaller reservoirs not assessed as part of the SFRA, and as such FRAs should assess the residual risk associated with them if they are located within the vicinity of the development.

2.5.4 The SFRA made the following comments and recommendations pertaining to Killingworth Moor and the surrounding area:

> *The area of Longbenton is considered as having the highest risk of flood in this SFRA as risk is associated with a number of sources which interact. Fluvial flood risk is associated with Forest Hall and Longbenton Letch. The area is also at considerable risk of surface water flooding and flooding from the drainage network. A significant amount of historical flooding incidents have been collected for this area.*
>
> *As discussed, while proposed development sites [including the Killingworth Moor strategic allocation] are not significantly covered by Flood Zones 2, 3a and 3b or within areas susceptible to surface water flooding, they are located within the CDA of Benton. Benton has been classified as a CDA due to the level of risk to current properties. Allocating and development further large scale developments upstream will significantly increase flood risk downstream to those properties already at risk. It is therefore recommended that these proposed development sites are not allocated until the flood risk issues surrounding this area is fully understood and has been mitigated.*
>
> *Proposed development sites like this should be flagged during the Sequential Test sieving process and avoided as they could significantly increase the amount of surface water runoff in the area by reverting Greenfield land to Brownfield and also place further pressure of the current drainage area.*
>
> *If proposed development sites like these are allocated they should follow the same stringent recommendations as if they were at risk from fluvial or tidal flooding. Site-specific FRAs will be required for each site but a strategic drainage impact assessment will also be needed for the wider area. SUDs should also be considered at the earliest possible stage.*

2.6 North Tyneside Preliminary Flood Risk Assessment (PFRA), 2011

2.6.1 The PFRA produced in 2011 on behalf of NTC is a key document informing the preparation of future Local Flood Risk Management Strategies as required by the Flood and Water Management Act 2010.

2.6.2 Future flood risk within NTC was assessed by looking at the borough as a whole and assessing potential risk areas based on a variety of local flooding sources. Based on the EA's National Flood Map for Surface Water (FMfSW), approximately 2,500 properties are potentially at risk of flooding to a depth of 0.3 metres in a 1 in 200 year rainfall event in the North Tyneside area.

2.7 North Tyneside Surface Water Management Plan (SWMP), 2012

2.7.1 The North Tyneside Surface Water Management Plan (SWMP) was developed to provide flood risk management strategies as required by the Flood and Water Management Act 2010. The plan was produced by the Council in its newly designated role as Lead Local Flood Authority (LLFA) under the Flood and Water Management Act.

2.7.2 The SWMP is intended to provide an understanding of the causes of surface water flooding and agree a preferred strategy for the management of surface water flood risk. The report focuses upon flooding from sewers, drains, groundwater, and runoff from land, ordinary watercourses and ditches that occurs as a result of heavy rainfall.

2.7.3 The SWMP built upon the findings of the Level 1 SFRA with respect to surface water flood risk. In particular, the SWMP refined the initial Critical Drainage Areas (CDAs) identified in the Level 1 SFRA. A pluvial model was created for NTC to assess, in more detail, the areas and the number of properties at risk of surface water flooding over a range of rainfall events. CDAs were identified using pluvial modelling based on the 1 in 75 year return period event.

2.8 North Tyneside Local Flood Risk Management Strategy, 2014

2.8.1 The Local Flood Risk Management Strategy is a tool aimed at helping understand and manage local flood risk within NTC. Local Flood Risk is defined as surface water flooding, ordinary watercourse flooding and groundwater flooding. This area of responsibility is defined by the Flood and Water Management Act.

2.8.2 One of the key purposes of the strategy is to highlight the steps that are to be taken to ensure better co-operation between organisations involved in flood risk management and better communication with the public about those risks and what can be done.

2.9 North Tyneside Local Plan Consultation Draft - Draft Flooding Sequential Test, 2015

2.9.1 This report sets out the Sequential Test and Exception Test of flood risk in NTC specifically focussed on the proposed development sites that have been allocated in the Local Plan Consultation Draft 2015 (LPCD).

2.9.2 For Killingworth Moor, the report states the following:

> *Whilst the area is at risk of fluvial flooding from the Longbenton Letch which is located to the south of the site, the percentage of the site that is located in Flood Zone 3a and 3b is 1.68%. No formal FRA has been prepared at this stage; however as part of the Sustainability Appraisal (SA) the site specific issues were viewed wholly. As set out in the comments from the flooding engineers at the Council, development on this site would require an FRA to be prepared for this site. This would be prepared alongside the development of a concept plan as required by Policy AS7.4 to agree inter alia the co-location of the range of required uses in partnership with the landowners and key agencies.*

The data shows that the area of the site that is located in Flood Zone 3 is concentrated around the letch. This is likely to be one of the options for site access. It sets out in National Planning Practice Guidance (NPPG) that for 'Essential Infrastructure' to be developed at this location, the Exception Test would be required. It states:

> *In Flood Zone 3b (functional floodplain) essential infrastructure that has to be there and has passed the Exception Test, and water-compatible uses, should be designed and constructed to:*
> *• remain operational and safe for users in times of flood;*
> *• result in no net loss of floodplain storage;*
> *• not impede water flows and not increase flood risk elsewhere.*

Due to the small percentage of the site that is at risk from flooding, the principle mitigation for the site would be through site design to avoid the areas which are located within flood zones. The area surrounding the letch could contribute towards the open space area of the site, and this buffer around the letch would mitigate against the potential biodiversity impact and also ensure that the flood plain around the letch remains functional.

Overall whilst there are some flood issues, the level of development forecast for the site has taken into account the level and area to substitute less vulnerable uses. It is likely that this site would pass the Exception Test.

2.10 Local Plan Consultation Draft 2015 (LPCD)

2.10.1 The Local Plan Consultation Draft 2015 sets out the preferred policies and proposals that the Council propose to guide planning decisions and establish the framework for the sustainable growth and development of NTC up to 2032. The consultation draft covers a range of matters including the number of new homes that are needed and where they should be located; the amount and proposed location of new employment land; protection and improvement of important open areas and provision of new ones; provision of new infrastructure and improvement of town centres and community facilities in the Borough.

2.10.2 The Local Plan Consultation Draft 2015 contains a series of policies which are relevant to this report:

> *Policy S/1.1 sets out the spatial policy to help direct development to the most sustainable locations. It sets out development priorities, such as employment development, housing, retail, leisure, tourism and cultural facilities to be built within the main urban area.*
>
> *Policy S/5.2 sets out the provision of land for employment development across the plan period, and how the employment sites set out in the plan have been selected.*
>
> *Policy S/7.3 sets out the distribution of potential development sites across North Tyneside and outlines the process of the selection for each of the sites that are outlined. This policy sets out a breakdown of the potential development sites into 'Strategic Sub Areas', which are outlined as the Main Urban Area, Wallsend, North Shields, Coastal Areas and North West Communities.*

Policy S/6.1 sets out a strategy to pursue growth and regeneration of the existing town centres and retail provision

2.10.3 The two main flood related policies in the Local Plan Consultation Draft are DM 8.12 Development and Flood Risk and DM 10.10 Sustainable Drainage.

2.11 The SuDS Manual, CIRIA, 2007

2.11.1 This guidance provides best practice on planning, design, construction, operation and maintenance of Sustainable Drainage Systems (SuDS) to facilitate their effective implementation within developments.

2.11.2 The guidance supersedes previous general guidance on SuDS and addresses landscaping, biodiversity issues, public perception and community integration as well as water quality treatment and sustainable flood risk management. The output is based on results contained in the Environment Agency R&D Report SCO20114/2.

2.11.3 The SuDS Manual aims to provide comprehensive advice on the implementation of sustainable drainage techniques in the UK. It provides guidance on:

- Initial planning;
- Design through to construction;
- The management of SuDS in the context of the current regulatory framework; and
- Advice on landscaping, waste management, cost, and community engagement.

2.11.4 The SuDS Manual has been used to provide the necessary design guidance for the surface water drainage strategy.

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

2.12.1 This document provides best practice advice for the design and management of urban sewerage and drainage systems to reduce the impacts from drainage exceedance. Information on the effective design of underground systems and overland flood conveyance is included as well as advice on risk assessment procedures and planning to reduce the impacts that extreme events may have on people and property within the surrounding area.

2.12.2 The broad objective is to improve the engineers, planners and designers' appreciation of the risks associated with urban drainage systems and their understanding of how these risks may be mitigated. The guidance is relevant to areas drained by piped systems or SuDS.

3. Existing and Historical Flood Risk

3.1 Fluvial (Main River) and Tidal Flood Risk

3.1.1 A review of the EA's Flood Map for Planning (Rivers and Sea) indicates that a large majority of the Killingworth Moor is located in Flood Zone 1. This zone comprises land assessed as having a less than 1 in 1,000 annual probability of river or sea flooding (<0.1%). A small proportion of the site, constrained to the southern boundary of the site is predicted to be at risk of fluvial flooding from the Forest Hall Letch (formerly a critical ordinary watercourse, now a main river). The North Tyneside Draft Sequential Test, 2015, specifies that approximately 1.33% falls within Flood Zone 2, 0.48% within Flood Zone 3a and 1.06% within Flood Zone 3b. The EA Flood Zone extents for Killingworth Moor and the surrounding areas are illustrated in Figures 3 and 4 below.

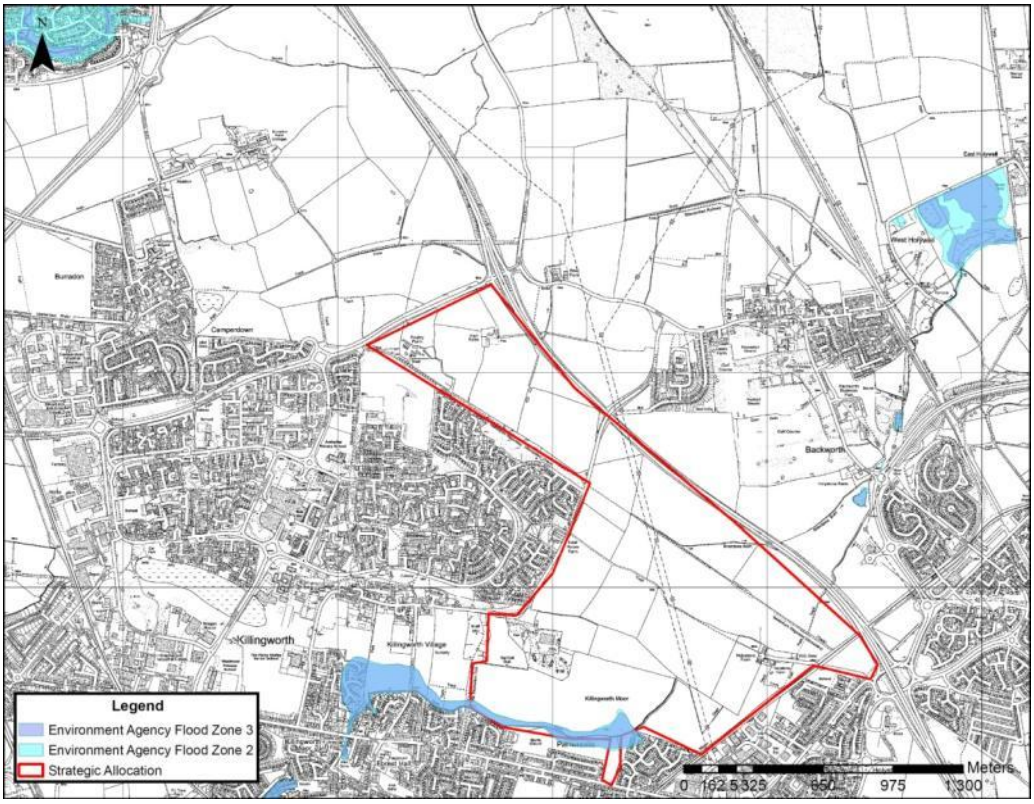


Figure 3: EA Main River Flood Zones

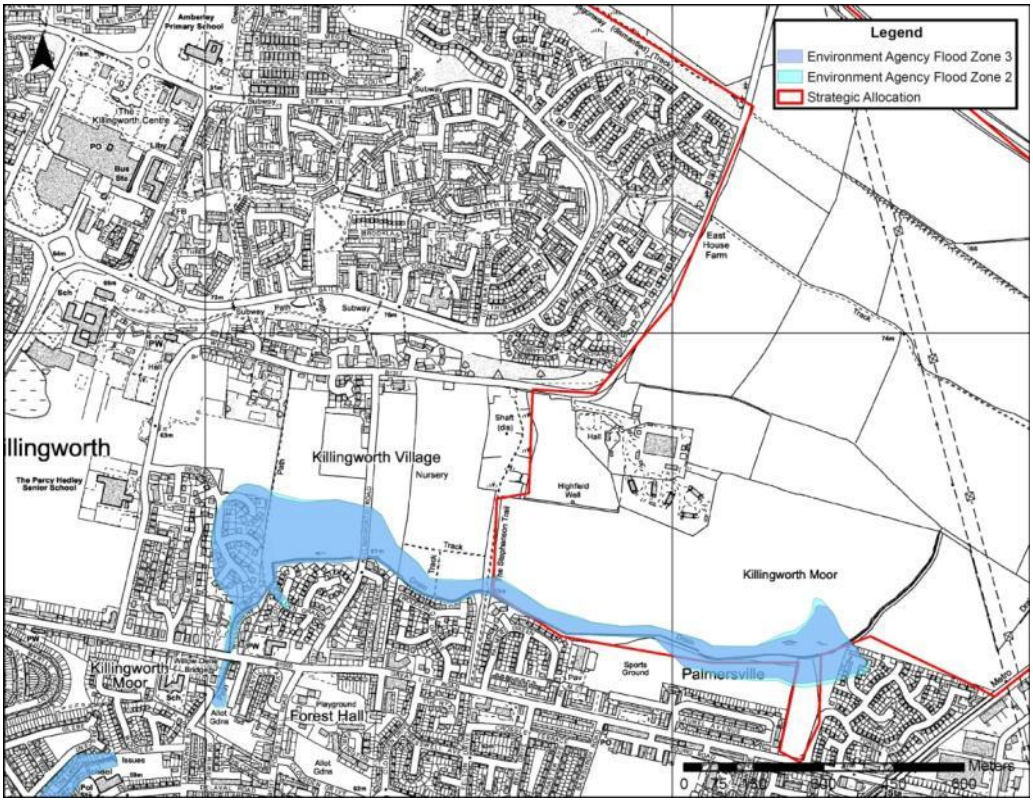


Figure 4: Detailed View of EA Flood Zones along Forest Hall Letch

3.1.2 There are no historic records of fluvial (main river) flooding within Killingworth Moor. The North Tyneside Draft Sequential Test, 2015 states that although there are a number of watercourses that flow through North Tyneside, there is a limited flood history caused by fluvial sources.

3.1.3 Tidal flooding occurs when a high astronomical tide and storm (tidal surge) exceeds the level of coastal land or coastal flood defences. Tidal flooding can also be caused by 'tide locking' of rivers or estuaries. Tide locking prevents a river from discharging into the sea, causing 'backing up' and resulting in tidal / fluvial flooding.

3.1.4 The Forest Hall Letch is not tidally influenced within the site. As such the site is considered to be at low risk of tidal flooding.

3.1.5 Actual risk is the assessment of flood risk taking into account the presence of flood defences. A review of the EA's Flood Map for Planning (Rivers and Sea) indicates that there are no defences along the Forest Hall Letch. As such, the actual risk of flooding is predicted to be as shown on the Flood Map for Planning (Rivers and Sea) (Figures 3 and 4).

3.1.6 Residual Risk is defined as 'the risk which remains after risk avoidance, reduction and mitigation measures have been implemented'. For the purpose of assessing flood risk, it is assumed that events greater than those assessed as Actual Risk are considered a 'Residual Risk'. For Killingworth Moor, the residual risk is considered to be high in areas classified as Flood Zone 3a and 3b.

3.1.7 In summary, the large majority of Killingworth Moor is considered to be at low risk of fluvial flooding. Small portions of the site, constrained to areas surrounding the Forest Hall Letch are at high risk of fluvial flooding. The entire site is considered to be at low risk of tidal flooding.

3.2 Surface Water and Sewer Flood Risk

3.2.1 Surface water flooding happens when rainwater does not drain away through the normal drainage systems or soak into the ground, but lies on or flows over the ground instead.

3.2.2 Figure 5 shows the risk of flooding from surface water (the EA's updated flood map for surface water (uFMfSW)) on Killingworth Moor and surrounding areas.

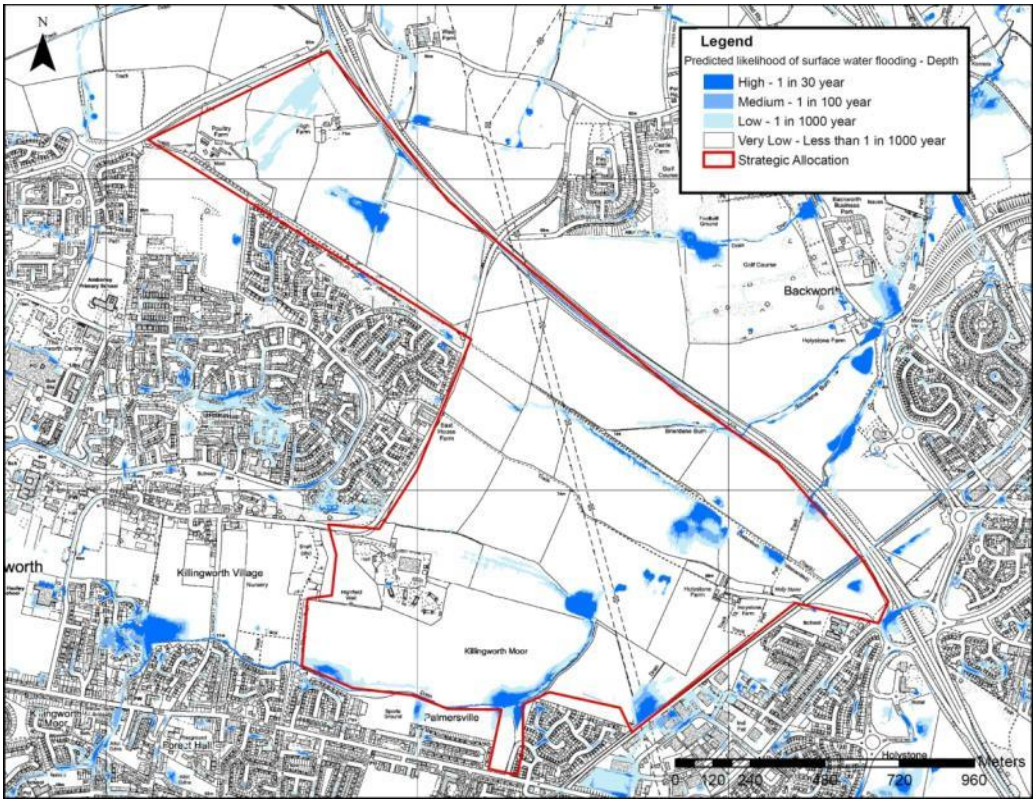


Figure 5: EA Updated flood map for surface water

3.2.3 As seen in Figure 5 there are several areas where surface water ponding is predicted within the site. Within the northern portion of the site high surface water flood risk is predicted over a portion of the High Farm grounds (centred on grid reference NZ 28772 71946). This area appears to correspond with an existing topographic low in the existing farmland where surface water is permitted to pond. Another ponding area is predicted near the northern boundary of the Killingowrth Moor grounds, although the flood risk is categorised as low by the EA. South of the B1317, surface water ponding is noted along the Seatonburn Wagonway (a dismantled

track) that is part of an overland flow path conveying surface water south. Scattered areas of surface water flooding are also predicted along the Forest Hall Letch. Ponding is also predicted at the Metro line that forms the southern boundary of the site.

3.2.4 Surface water runoff from the site is likely also a contributor to wider catchment surface water flooding issues. Figure 5 shows that surface water runoff being conveyed by the Forest Hall Letch may be a contributor to flooding of residential properties along the southern boundary of the strategic lands. Further downstream, a larger area of surface water ponding is predicted in Killingworth Village (between West Lane and the B1317).

3.2.5 The North Tyneside Draft Sequential Test indicated that there is Northumbrian Water sewerage infrastructure throughout Killingworth Moor, including water mains and public sewers. The location of this infrastructure will need to be further assessed as development layouts are produced for the site. The infrastructure will need to be diverted or placed within a suitable easement as part of further consultations with NWL as part of mitigating sewer flooding at the site.

3.2.6 Widespread surface water flooding in North Tyneside was experienced following exceptional, high-intensity levels of rainfall, which fell on the 28th June 2012 and 25th September 2012. The amount of surface water runoff was exacerbated by already saturated ground conditions caused by the prolonged periods of precipitation throughout the summer of 2012. NTC records of areas flooded from the 28th June event are shown in Figure 6 below.

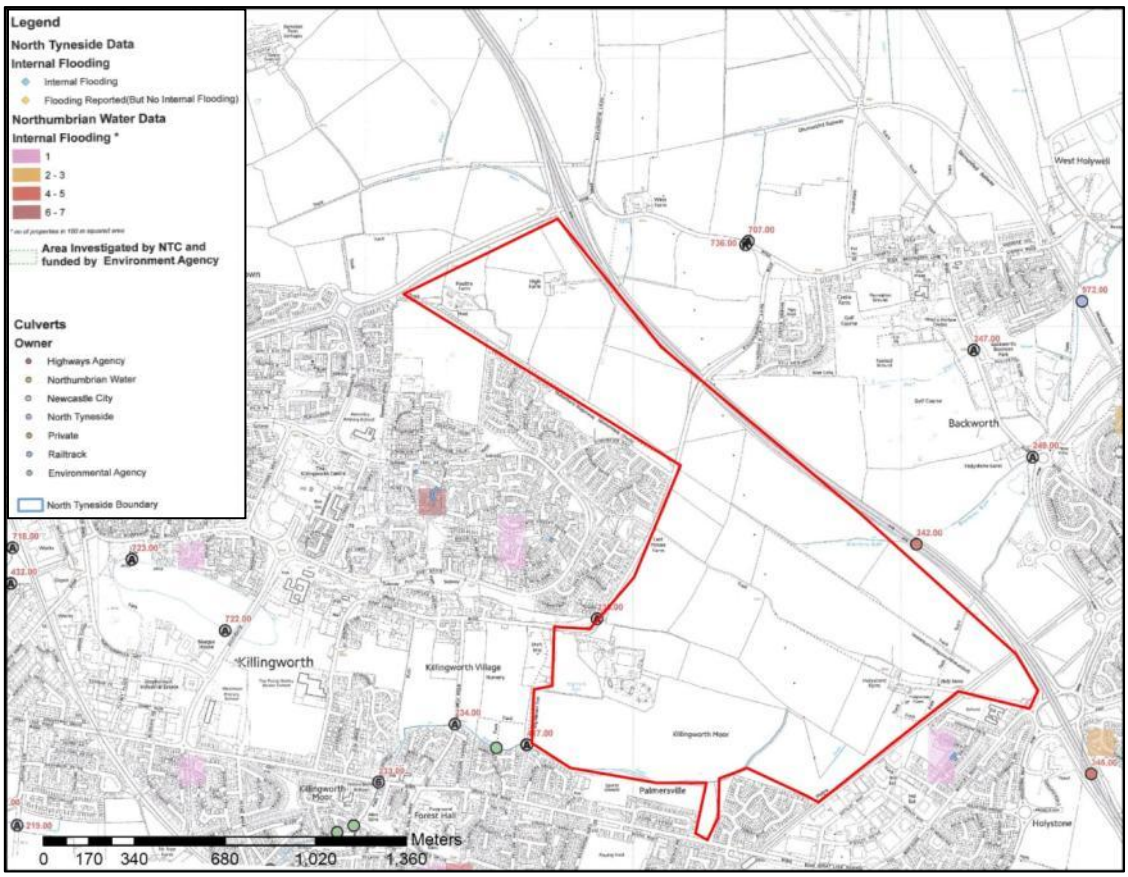


Figure 6: Areas flooded on June 28th 2012

3.2.7 A number of the flooded areas in Figure 6 correspond with the EA's updated flood map for surface water (Figure 5). Several grids, each comprised of 1 or 2-3 internal flooded properties can be seen in the Killingworth area, although the surface water flooding predicted along the Forest Hall Letch did not result in any reported incidents of flooding. A greater number of flooding reports can be observed to the south in the Longbenton area.

3.2.8 The NTC 2012 SWMP states that surface water flooding incidents have also been recorded in the Killingworth area from rainfall events in Killingworth 2005, 2007, 2008 and 2009.

3.2.9 Given the historical records of surface water flooding in the area, a majority of the Killingworth Moor has been identified as lying within the Backworth and West Moor East CDAs. It is also adjacent to the Killingworth CDA to the west and the Percy Main South CDAs. For further details refer to Figure 7 below. The CDAs were identified as part of the SWMP that was undertaken for NTC in 2012. All CDAs for NTC are provided in Appendix B.

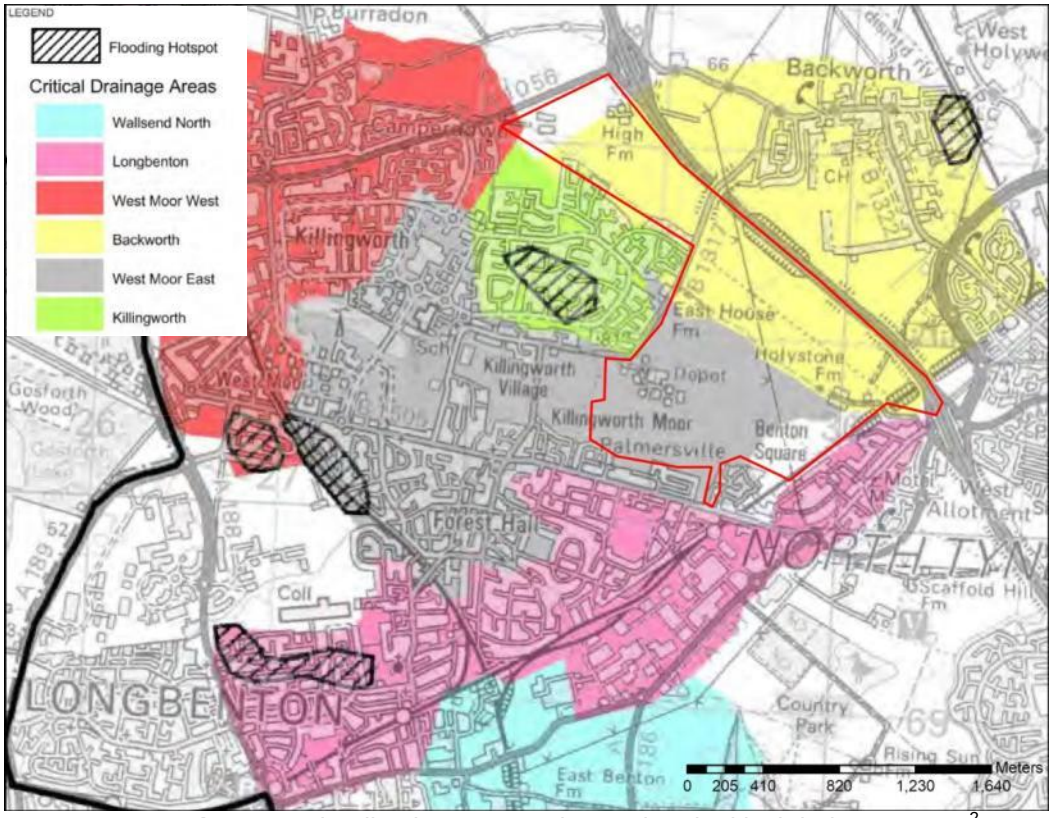


Figure 7: Flooding hotspots and associated critical drainage areas[2]

3.2.10 As a result of the 2012 flooding, NTC has initiated a number of flood alleviation works throughout the Council. The Killingworth & Longbenton Sustainable Surface Water Management Scheme has been developed in partnership by NTC, NWL and the EA. This scheme is currently under development and undergoing public consultation. For further details regarding the works planned for Killingworth & Longbenton and how this may impact development of Killingworth Moor, please refer to the Drainage Strategy section.

3.2.11 Given the surface water ponding predicted in the EA's uFMfSW and historical flooding records the existing site is considered to be at moderate risk from surface water flooding. As the site does contribute to wider catchment surface water flooding issues it is strongly recommended that the post-development run-off should be limited to a reduced rate as practical.

3.3 Groundwater Flood Risk

3.3.1 Groundwater flooding is defined as the emergence of groundwater at the ground surface, or the rising of groundwater into man-made ground, under conditions where the normal range of groundwater levels is exceeded. Groundwater flooding is most likely to occur in low-lying areas underlain by permeable rocks (aquifers).

2

3.3.2 An assessment of groundwater flooding susceptibility undertaken for NTC in 2011 as part of the SWMP identified that parts of Killingworth Moor are at risk of groundwater flooding. Refer to Figure 8 below for further details (the full figure is available in Appendix B).

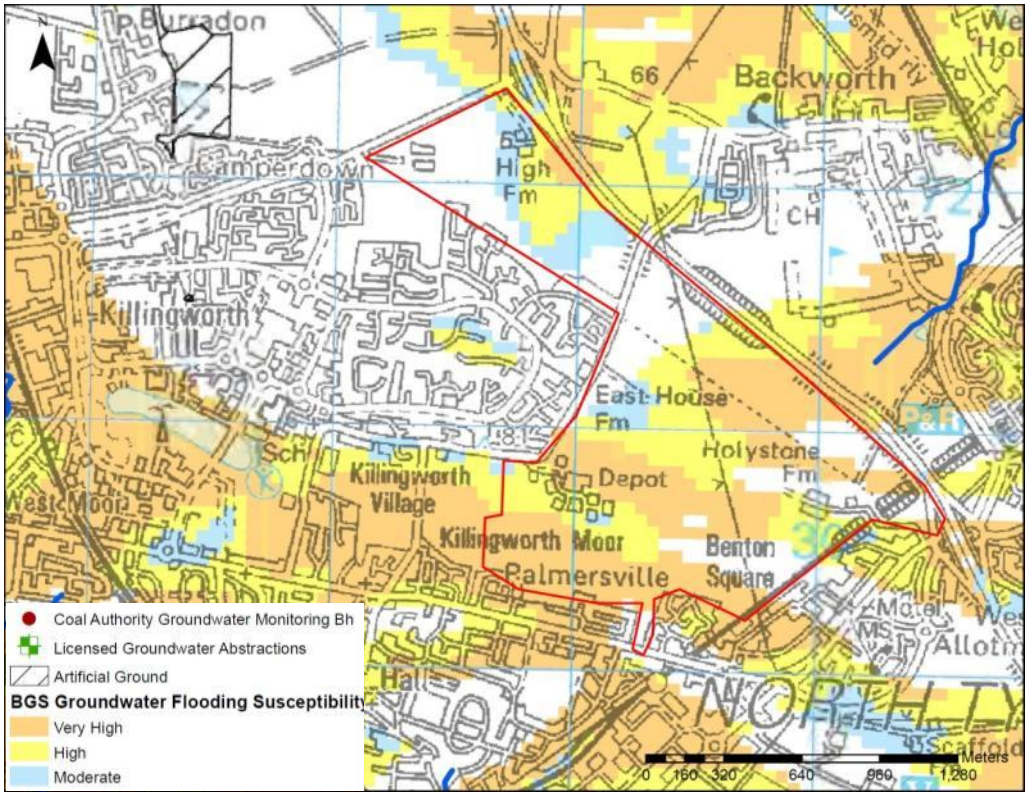


Figure 8: Groundwater flooding susceptibility

3.3.3 The predicted flood susceptibility ratings are from a BGS data set based upon geological and hydrogeological conditions. The BGS data set suggests that susceptibility is mostly associated with the superficial deposits (Glacial Till) as opposed to bedrock geology (largely Pennine Middle Coal Formation).

3.3.4 The 2011 groundwater flooding susceptibility study noted that there was no water level data as part of the study, and as such there is a need to validate the data set.

3.3.5 To provide a high level validation of groundwater flood risk several historical borehole records within the Killingworth Moor site was assessed to review historical depth to groundwater levels:

1. A borehole in the north eastern corner of the site adjacent to the A19 (BGS Reference: NZ27SE90/Q) did not note striking water through the course of its 5.2m depth.
2. A borehole in the south eastern corner of the site (BGS Reference: NZ37SW86/O) also has no records of water strikes to a 4.5m depth.

3. A borehole to the south of the red line boundary (BGS Reference: NZ27SE451) and south of the Forest Hall Letch did strike water at a shallow depth (1.5m below grade).
4. A borehole in the western corner of the site, near the junction of Killingworth Road and West Lane (BGS Reference: NZ27SE578) indicated striking water at 3.35m below the ground surface.

3.3.6 The 2012 North Tyneside SWMP states that no groundwater flooding incidents have been reported to the EA or NTC. Areas of historical surface water flooding have been provided, by the EA and NTC, but it is not known if any of these were caused by groundwater flooding.

3.3.7 The BGS groundwater flooding susceptibility data set indicates that a high proportion of lands within Killingworth Moor are at a high to very high susceptibility to groundwater flooding. This susceptibility to flooding is particularly centred on lands to the south of the B1317. A review of several boreholes spread across the Killingworth Moor lands, tends to support the BGS dataset – as groundwater levels were struck at relatively shallow depths in southern areas of the site. Based upon the inconclusive data available, groundwater flood risk is considered to be moderate to high for the site. It is recommended that the risk of groundwater flooding be investigated at a site-specific FRA level.

3.4 Artificial Sources of Flood Risk

3.4.1 Artificial sources of flooding include reservoirs, canals, lakes and mining abstraction. A review of the EA Reservoir Inundation Maps indicates that the site is not located within an area at risk from reservoir flooding.

3.4.2 Other artificial sources of flooding include canals, lakes or mining abstractions. Killingworth Moor is not located near any of these items, and as such is not at risk from these sources.

4. Development Proposals

4.1 Overview

4.1.1 Killingworth Moor is proposed on land previously identified as safeguarded land, and would contribute some 1,700- 2,000 new homes to the Local Plan. The master plan for the site (from the North Tyneside Local Plan Consultation Draft 2015) proposes that the site will be used to provide a mix of housing tenures, types and sizes alongside new educational facilities through a new primary and secondary school to support the growth delivered by the proposals. An indicative masterplan is shown in Figure 9 below.

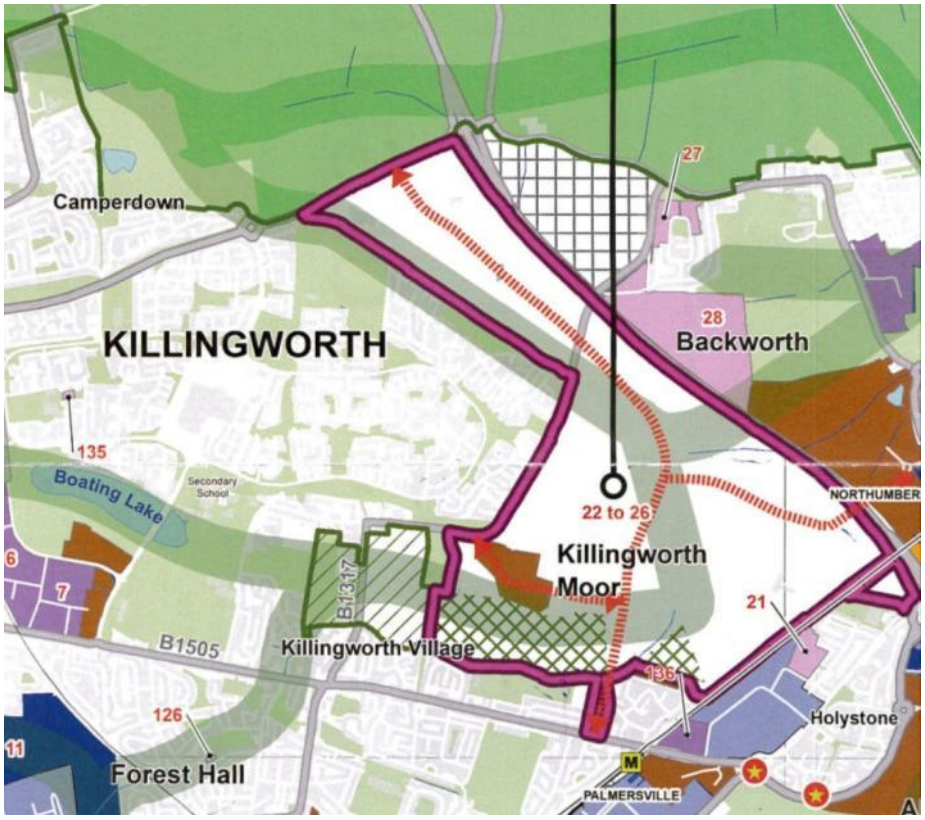


Figure 9: Section of master plan showing Killingworth Moor and surrounding Killingworth area

4.1.2 The indicative master plan proposes the establishment of a buffer around Killingworth Village to prevent Killingworth and Killingworth Village merging with Palmersville and Forest Hall. Plans also include access to open space through the establishment of a green belt extending across the site, with links to surrounding areas.

4.1.3 Draft development proposals / layouts were not available as part of this assessment. As such the following discussion will centre on the proposed master plan and its development mix.

4.2 Development Types & Vulnerability Classification

4.2.1 Killingworth Moor will include a mix of some or all of the following property types:

- New residential homes;
- New educational facilities (primary and secondary schools);
- Public open space / green belt;
- Link roads and other essential infrastructure; and
- Employment land.

4.2.2 As the proposed master plan includes a number of land use types, this results in more than one vulnerability classification for the site. The vulnerability for each potential land use within the site is shown in Table 1.

Table 1: Vulnerability Classification for site development in accordance with Table 2 of the Planning Practice Guidance

Land Use Type	Vulnerability Classification
Residential	More Vulnerable
Educational establishments	More Vulnerable
Public open space	Water-Compatible Development
Transport Infrastructure	Essential Infrastructure
Employment lands	Less Vulnerable

4.3 Suitability for Development

4.3.1 The compatibility for development for each of the land use types (and their associated vulnerability classification) as permitted by the NPPF is provided in Table 2 below.

Table 2: Permitted Development based upon Flood Zones and Flood Vulnerability Classification

Flood Zones	Vulnerability Classification				
	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test Required	✓	✓	✓
Zone 3a	Exception Test Required †	×	Exception Test Required	✓	✓
Zone 3b	Exception Test Required	×	×	×	✓*

Development is appropriate = ✓ Development should not be permitted = ×

† In Flood Zone 3a essential infrastructure should be designed and constructed to remain operational and safe in times of flood.

* In Flood Zone 3b (functional floodplain) essential infrastructure that has to be there and has passed the Exception Test, and water-compatible uses, should be designed and constructed to:

4.3.2 The NPPF states that all of the land uses proposed in the Killingworth Moor master plan, including those classed as 'Essential Infrastructure' are compatible for development within Flood Zone 1. This means the proposed land uses are compatible for development within a large majority of the site.

4.3.3 Predicted fluvial flooding is concentrated around Forest Hall Letch, located along the southern extent of the strategic lands. Within the flooding extents of Flood Zone 3b, only 'Water Compatible' development is permitted.

4.3.4 The North Tyneside Draft Sequential Test indicates that the area located in Flood Zone 3 may be one of the options for site access / egress. If this is the case, the National Planning Practice Guidance specifies that that for 'Essential Infrastructure' to be developed at this location, the Exception Test would be required. It states:

> *In Flood Zone 3b (functional floodplain) essential infrastructure that has to be there and has passed the Exception Test, and water-compatible uses, should be designed and constructed to:*
>
> - *remain operational and safe for users in times of flood;*
> - *result in no net loss of floodplain storage;*
> - *not impede water flows and not increase flood risk elsewhere.*

4.3.5 As a portion of Killingworth Moor is located within Flood Zone 3b and the site contributes to wider surface water flooding issues (as part of a CDA), additional consideration to development was provided through the North Tyneside Local Plan Consultation Draft - Draft Flooding Sequential Test, January 2015. Further details regarding the Sequential Test are provided below.

4.4 Sequential Test

4.4.1 The North Tyneside Draft Flooding Sequential Test for Killingworth Moor specified that the primary means of mitigating flood risk for the site would be through site design to avoid the areas susceptible to fluvial flooding (and where necessary surface water flooding). It recommends avoiding construction of housing in high risk areas of the site (approximately 25% at risk). The remainder of the site could be substituted with less vulnerable uses, such as new public open space. This area could be used for the installation of SuDS features to attenuate surface water on site, before it is discharged.

4.4.2 The North Tyneside Draft Sequential Test concluded that overall whilst there are some flood issues, the level of development forecast for the site has taken into account the level and area to substitute less vulnerable uses. It is likely that this site would pass the Exception Test. As such, taking a sequential approach to development within the Killingworth Moor lands is recommended to ensure compliance with the Draft Sequential Test. Further details regarding proposed flood risk mitigation measures for the site are provided in the following sections.

5. Flood Risk Mitigation and Surface Water Drainage Strategy

5.1 Overview

5.1.1 As previously discussed, the site currently has natural drainage capacity which is in part unmanaged, and extreme rainfall events can contribute to surface water flooding in surrounding areas downstream.

5.1.2 The rolling ball analysis indicates that surface water discharges from the site in four locations:

- Catchment 1 – It is assumed that flows exit the site via a culvert located under the junction of Killingworth Way and the A19.
- Catchment 2 – Overland flows appear to leave the site in two locations: via the Brierdene Burn, and via another unnamed ordinary watercourse to the south. It is assumed that both flowpaths are culverted under the A19.
- Catchment 3 – This catchment discharges surface water from the site via the Forest Hall Letch.

5.1.3 NTC, in collaboration with its partners the EA and NWL, are currently planning a number of modifications to how the wider Killingworth and Longbenton area currently drains. These changes are aimed at mitigating existing flood risk for the wider area. Details regarding the planned flood risk mitigation scheme and changes to drainage infrastructure are provided in the following sections.

5.1.4 A high level drainage strategy has been developed for the site which incorporates available information on the planned flood risk mitigation scheme and changes to the drainage infrastructure. This drainage strategy has been developed to achieve multiple goals, including providing a betterment of flood risk reduction and incorporation of SuDS / green infrastructure in accordance with the goals of local policies. As the next level of detailed design develops, site designers can use the strategic surface water drainage strategy as a guide for designing solutions that are compliant with the strategy and conform to the requirements of NPPF and other applicable policy.

5.2 Planned Flood Risk Mitigation Scheme

5.2.1 To address existing surface water flood risk for the Killingworth and Longbenton area NTC is currently partnering with NWL and the EA on the Killingworth & Longbenton Sustainable Surface Water Management Scheme. The proposed scheme is currently under development and undergoing public consultation.

5.2.2 The following details have been published regarding the proposed scheme[3]:

- The proposed £8 million scheme has been designed to manage surface water in the natural environment rather than using storage tanks and pipes, after the area has suffered from extensive flooding in recent years.
- Water from Killingworth Lake and Longbenton Letch, which currently flows into Northumbrian Water's sewer network, is to be diverted. This will reduce the risk of flooding as sewer pipes will be able to transport higher volumes of wastewater and surface water in times of heavy rainfall.
- The route of Longbenton Letch will be diverted from the sewer network, near Goathland Avenue, into a new underground surface water pipe. This underground, 700 metre pipe, which will mainly run through open land, will transfer flows to Forest Hall Letch.
- Wetland areas will be created along sections of Forest Hall Letch, to provide somewhere for water to go when flows in the watercourse are high.
- To prevent Killingworth Lake from overflowing into Northumbrian Water's sewer network, its surface water area will be increased and water will be transferred by another new underground 340 metre surface water pipe into West Moor Tributary.

5.2.3 As the scheme is currently under development details such as exact location and attenuation volumes for the proposed wetland areas are not available. It is assumed that these flood risk mitigation works are being constructed to manage existing risk, and that any proposed development within Killingworth Moor will need to manage flows discharging from their lands in accordance with applicable national and local policy and guidance.

5.2.4 As the Killingworth & Longbenton Sustainable Surface Water Management Scheme is still under development, it is unknown whether the transfer of flows from the Longbenton Letch to the Forest Hall Letch will result in discharge restrictions from Killingworth Moor to this Letch. Modelling will likely be required as part of the Sustainable Surface Water Management Scheme in order to determine maximum discharge rates from Killingworth Moor given that the Forest Hall Letch will be conveying additional flows as part of the flood mitigation scheme.

5.2.5 It is important to note that the Killingworth & Longbenton Sustainable Surface Water Management Scheme is currently under development and that any of the information above is subject to change. Developers are directed to contact NTC early in any masterplanning activities for Killingworth Moor to ensure compliance with these planned flood risk mitigation works.

[3] Northumbrian Water Limited. 2015. https://www.nwl.co.uk/media-centre/611_5150.aspx

5.3 Drainage Strategy

5.3.1 The sustainable management of surface water runoff has been a major focus whilst developing the drainage strategy. The guidance identified in Section 2, including NPPF and the core masterplanning objectives established at the outset, has been used to set the framework for the consideration of surface water management across Killingworth Moor. This includes:

- Maximising the use of existing topography and the existing drainage regime, whilst also identifying areas where infiltrating SuDS practices may be best suited on the property;
- The use of sustainable attenuation to manage runoff;
- Managing discharge for the lifetime of the development to a betterment over existing runoff rates (including the effects of climate change in the future);
- For the purpose of the drainage strategy, pond locations and capacity/size estimates have been made, to demonstrate sufficient land is set aside in the future to manage surface water runoff; and
- An assessment of the suitability of incorporating infiltrating SuDS practices into the design.

5.3.2 Flood risk and surface water drainage issues have been a key influence throughout the development of the drainage strategy. Killingworth Moor and the surrounding area lie within a CDA, and recent experience of flooding has demonstrated that the surrounding areas can flood under existing (largely Greenfield) conditions at the site. Furthermore, given the proposed Killingworth & Longbenton Sustainable Surface Water Management Scheme, providing betterment over existing conditions was identified as a key priority to ensure flood risk is appropriately mitigated.

5.3.3 Surface water attenuation features were sized based on restricting post-developed flows to less-than-Greenfield runoff rates. As surface water discharge limits from the site were not available, allowable discharge rates were limited to not exceed one half of the existing Greenfield (‘half Greenfield’) runoff rates. The sizing of attenuation features was undertaken based upon managing surface water runoff from the site up to a 1 in 100 year return period (plus climate change) event.

5.4 Existing Runoff Rates

5.4.1 Existing 'Greenfield' runoff rates for Killingworth Moor have been calculated using the FEH Statistical Method. The FEH statistical method correlation formula (revised in 2008) is:

$$QMED = 8.3062(AREAx10)^{0.8510}\ 0.1536^{(1000/SAAR)}\ FARL^{3.4451}\ 0.0460^{BFIHOST\wedge 2}$$

Where:

QMED = Index flood, which is the median of the set of annual maximum flow peaks and is equivalent to approximately the 1 in 2 year flow rate (m^3/s)
AREA = Area (ha)
SAAR =Average Annual Rainfall (mm)
FARL = A measurement of water bodies in the catchment so that their attenuation effects are considered. If the equation is applied to development sites, it is unlikely that FARL will be relevant so this term becomes 1.0
BFIHOST = a measure of base flow runoff

5.4.2 To determine Greenfield runoff rates for the site a SAAR value of 662mm and a BFIHOST value of 0.312 was obtained from the FEH CD.

5.4.3 The volume of runoff generated from a 6 hour 100 year return period event under Greenfield conditions was determined using the following formula:

Greenfield Vol = RD x (AREA x 10 x SPRHOST

Where:

Greenfield Vol (m^3)
RD = Rainfall depth for the 6 hour 100 year return period event (mm)
AREA = Area (ha)
SPRHOST = is the Standard Percentage Runoff coefficient for the SOIL category.

5.4.4 To determine the Greenfield runoff volume from a 6 hour 100 year return period event a rainfall depth of 60.76mm and a SPR value of 39.7% was obtained from the FEH CD.

5.4.5 For Killingworth Moor the area has been divided into three catchments based on existing topography, as per the findings of the rolling ball analysis. These catchments include Catchment 1, outletting in the north east, Catchment 2 discharging to the Brierdene Burn and another unnamed ordinary watercourse to the south and Catchment 3, which drains to the Forest Hall Letch.

5.4.6 To view the catchment sizes and the associated QMED values for each, refer to Table 3.

Table 3: Catchments, contributing drainage areas and greenfield runoff rates

Catchment	Contributing Drainage Area	Greenfield Runoff Rate (Q_{MED})
1	72.3 ha	271 lps
2	44 ha	177 lps
3	94 ha	338 lps
TOTAL	210 ha	786 lps

5.4.1 For further details refer to the calculations in Appendix C.

5.5 Post-Development Options & Runoff Rates

5.5.1 A preliminary drainage strategy that maintains the existing drainage regime has been proposed for managing surface water within Killingworth Moor. Surface water attenuation ponds have been proposed in topographic low areas where existing overland flowpaths discharge from the site. To view the locations of the attenuation ponds, refer to Figure 10.

5.5.2 The volume of each storage area has been sized based on the calculations presented in Appendix C and are considered precautionary as they do not allow for routing or storage during a storm event within the drainage system. The calculations included in Appendix C also do not include Long Term Storage – it is assumed that this will be accommodated as part of the planned development through SuDS or other appropriate measures.

5.5.3 The attenuation features proposed at this stage are predominantly ponds. However, this can be revised when greater details of the development layout and the Killingworth & Longbenton Sustainable Surface Water Management Scheme become available.

5.5.4 As part of the drainage strategy for each catchment, consideration has been given to where water will flow. The underlying concept is for runoff to be managed within the Masterplan in a way that does not put residents within the development at risk and wherever possible reduces flood risk to those off site. This underlying principle is integrated into the layout of the Masterplan and location of the surface water attenuation features.

5.5.5 In compliance with NPPF, all attenuation features have been sized to contain the 1 in 100 year return period flood extent, plus allowance for climate change (30%), over the lifetime of the development on site.

5.5.6 No allowable discharge limits from the site were available at the time of writing this report, so in accordance with the goal of providing a betterment over existing conditions, a target of restricting the outlflows from the site to half-Greenfield rate was established. The allowable discharge rates from the catchments and the betterment over Greenfield runoff rates are summarised in Table 4 below.

Table 4: Allowable discharge rates from the site and corresponding betterment over Greenfield runoff rates

Catchment	Contributing Drainage Area	Greenfield Runoff Rate (Q_{MED})	Allowable Discharge	Reduction in Runoff Rate over Greenfield
1	72.3 ha	271 lps	135.5 lps	50%
2	44 ha	177 lps	88.75 lps	
3	94 ha	338 lps	169.0 lps	
TOTAL	210 ha	786 lps	393 lps	

5.5.7 Table 5 provides a summary of the maximum storage volumes required during the 1 in 100 year plus climate change return period event, discharging at the runoff rates specified in Table 3.

Table 5: Development Attenuation Volumes

Catchment	Required Attenuation Volume (including 30% climate change)
1	19,745 m^3
2	11,880 m^3
3	25,775 m^3
Total	**57,400 m^3**

5.5.8 An indicative plan for Killingworth Moor is shown in Figure 10 below.

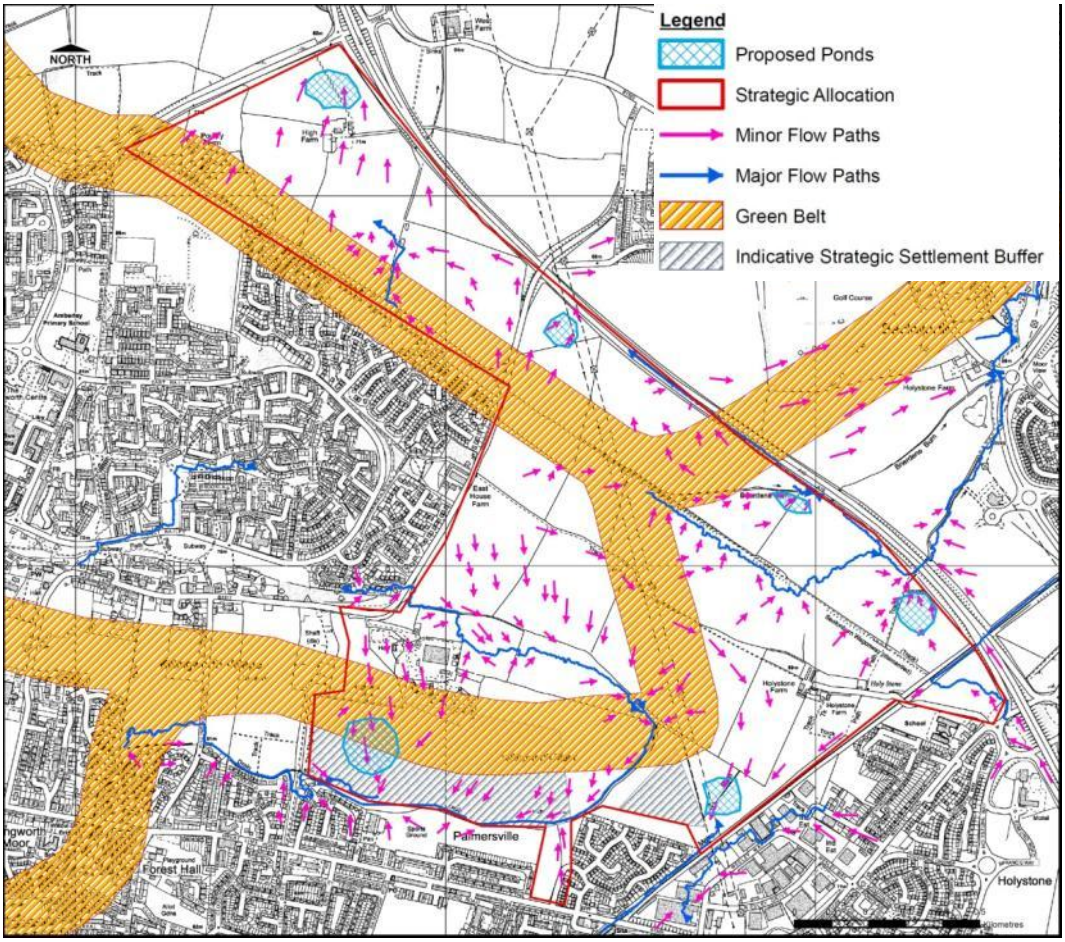


Figure 10: Proposed surface water drainage strategy for Killingworth Moor

5.5.9 For Catchment 1 a small attenuation pond is proposed in the junction of the B1317 and the A19 to manage surface water runoff from the portion of the catchment south of the B1317. Another surface water management pond is proposed in the north eastern corner of the site to manage runoff generated in the lands north of the B1317 prior to discharging from the site.

5.5.10 Two surface water attenuation ponds are also proposed in Catchment 2. One pond is proposed to manage runoff prior to discharging into the Brierdene Burn, and another pond is proposed to attenuate flows entering the ordinary watercourse to the south of the Burn.

5.5.11 In Catchment 3, a large pond is proposed in the south western corner of the site. This pond will minimise land take within the site as its proposed location lies partly within both the Indicative Strategic Settlement Buffer and the Green Belt. The suitability of locating the surface water attenuation pond in this location will need to be verified once further details of the Killingworth & Longbenton Sustainable Surface Water Management Scheme become available. A smaller pond is also proposed to capture overland flows that do not discharge into the Forest Hall Letch.

5.5.12 For all three Catchments the proposed location and size of ponds will need to be verified as part of outline / detailed design, and flowpaths will need to be determined once indicative development layouts are available.

5.5.13 There may be opportunities to accommodate more of the surface water management infrastructure within the Green Belt, however this will need to be assessed as part of outline / detailed design. Incorporating infiltrating SuDS features upstream of the attenuation ponds also has the potential to reduce attenuation storage volumes. Areas where infiltrating SuDS features are best suited for the site are indicated in Figure 11 below.

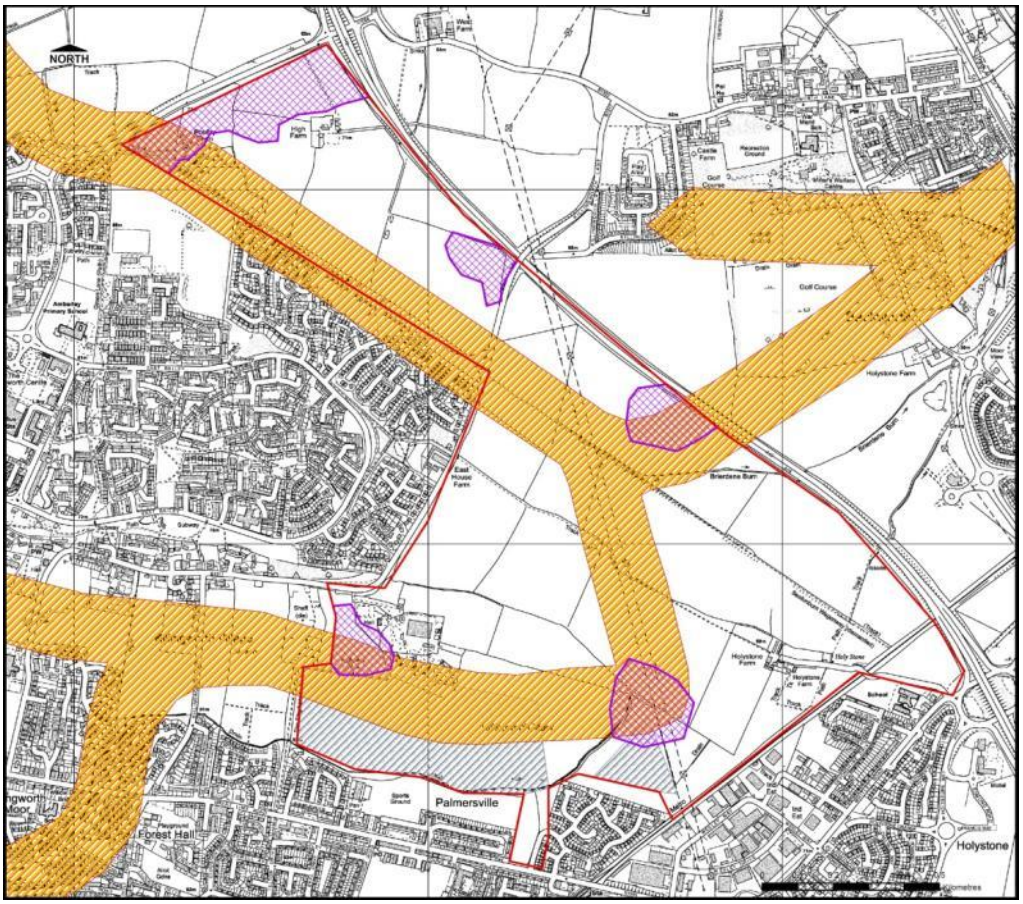


Figure 11: Infiltration SuDS Opportunity Zones

5.5.14 The Infiltrating SuDs Opportunity Zones have been selected to maximise use of the Green Belt, whilst also taking into consideration the findings of the SuDS Suitability Assessment (see following section for further details). It is recommended that the Green Belt be targeted for the integration of surface water management infrastructure / green infrastructure to the greatest extent practical. Catchments 2 and 3 can best utilise the Green Belt given existing topography and flowpaths. Use of Green Belt for Catchment 1 will be challenging given its topography, however the northern portion of the site may be suited for SuDS and presents an opportunity zone for SuDS.

Opportunities & Constraints Summary

5.5.15 Opportunities and constraints associated with the Killingworth Moor drainage strategy are presented in Table 6 below. These opportunities and constraints should be considered when determining the preferred option for the drainage strategy for the site.

Table 6: Opportunities and constraints summary table

Opportunities	Constraints
• SuDS may be integrated within the Green Belt to reduce attenuation storage volumes (pending verification through site investigations) • Indicative Green Belt and Strategic Settlement Buffer provide large area for management of surface water runoff from the site and buffer for accommodation of predicted fluvial flood extents. • Use of SuDS features presents an opportunity for increased biodiversity.	• Use of attenuation ponds adjacent to site outlets will require land outside of the indicative Green Belt and / or Strategic Settlement Buffer. • Proposed pond locations / sizes and discharge locations / flow rates will need to be verified as part of outline and detailed design process and as further details of the Killingworth & Longbenton Sustainable Surface Water Management Scheme become available. • Incorporating surface water management infrastructure in the proposed Green Belt will be challenging in Catchment 1 given the site topography. • Groundwater flood risk is a constraint that needs to be assessed on a site basis to ensure that properties are adequately protected throughout their lifetime.

6. SuDS Suitability Assessment

6.1.1 To assess the suitability of incorporating infiltrating SuDS practices within Killingworth Moor, SuDS Infiltration Mapping data was obtained from BGS.

6.1.2 The SuDS suitability assessment found that Catchment 1 provided the greatest opportunity (and fewest constraints) for the implementation of infiltration SuDS. Both Catchments 1 and 2 had portions of their area marked as having constraints and issues that may make incorporating infiltrating SuDS infeasible or challenging. To view the BGS data and its assessment in detail, please refer to Appendix D.

6.1.3 Given that the BGS data indicates that there are some opportunities for infiltrating SuDS in Killingworth Moor, it is recommended that site investigations be conducted to further assess the suitability of incorporating infiltrating SuDS into the Killingworth Moor masterplan. A geotechnical assessment, including investigation of potential geohazards and most importantly determination of infiltration rates, should be conducted within all catchments (though focused on Catchment 1), to verify the suitability of each catchment.

6.1.4 If detailed site investigations find that infiltrating SuDS are not feasible for part or all of Killingworth Moor, non-infiltrating SuDS practices should be implemented to the greatest extent possible. These practices include green roofs and rainwater harvesting.

7. Summary and Flood Risk Mitigation Recommendations

7.1.1 Capita Property & Infrastructure was commissioned by NTC in April 2015 to develop a strategic flood risk assessment and drainage assessment for Killingworth Moor. Killingworth Moor has been identified in North Tyneside Council's (NTC) 2015 Draft Local Plan as a potential site to accommodate approximately 1,700- 2,000 new homes.

7.1.2 Fluvial flood risk is predicted to be low for a large majority of the site. A small proportion of the site, constrained to the southern boundary of the site is predicted to be at risk of fluvial flooding from the Forest Hall Letch. Approximately 1.33% of the site falls within Flood Zone 2, 0.48% within Flood Zone 3a and 1.06% within Flood Zone 3b.

7.1.3 Groundwater flood risk varies across the site, and is considered to be moderate to high based upon available data. The EA's uFMfSW and historical flooding records indicate that the site is at low to moderate risk from surface water flooding. Killingworth Moor is located within a CDA and contributes to catchment-wide surface water flooding issues.

7.1.4 Development layouts were not available at the time of writing, but a mixture of land uses have been proposed for the site including: residential homes, educational facilities, public open space / green belt, link roads and employment land. The flood risk vulnerability classification of these uses ranges from 'Less Vulnerable' to 'Essential Infrastructure.' The NPPF states that all of these land uses are compatible for development within Flood Zone 1. Construction of Essential Infrastructure within Flood Zone 3 a / b, and construction classified as More Vulnerable within Flood Zone 3a requires the Exception Test.

7.1.5 Killingworth Moor is located in a CDA and contributes to wider surface water issues. As such consideration must be given to surface water flood risk to ensure that development can take place whilst not increasing flood risk at the site and surrounding area.

7.1.6 To address the existing surface water flood risk for the wider area surrounding Killingworth Moor NTC is currently working with NWL and EA on the Killingworth & Longbenton Sustainable Surface Water Management Scheme.

7.1.7 A drainage strategy was developed for the site that took the available information on the Sustainable Surface Water Management Scheme into account. To reduce surface water runoff generated from the site surface water attenuation features were sized based on restricting post-developed flows to half-Greenfield runoff rates. This approach restricted the allowable discharge rate Catchment 1 to 271 lps, Catchment 2 to 177 lps, and Catchment 3 to 338 lps.

7.1.8 The sizing of attenuation features was undertaken based upon managing surface water runoff from the site up to a 1 in 100 year return period (plus climate change) event. In accordance with these criteria, an attenuation storage volume of 19,745 m^3 is proposed for Catchment 1, 11,880 m^3 for Catchment 2 and 25,775 m^3 for Catchment 3.

7.1.9 To accommodate these storage volumes a preliminary drainage strategy was proposed that maximises the use of existing topography and the existing drainage regime.

7.1.10 A SuDS suitability assessment conducted for the site found that there are a number of areas where incorporating infiltrating SuDS may be feasible. These areas were highlighted as Infiltrating SuDS Opportunity Zones within the development. It is recommended that site investigations be conducted to further assess the suitability of incorporating infiltrating SuDS into the Killingworth Moor masterplan.

7.2 Flood risk mitigation & development recommendations:

7.2.1 Below are flood risk mitigation measures to take place as part of development of the Killingworth Moor site:

- The development layout should include the provision for overland flow routes within the layout, so that surface water from the land is channelled into the attenuation features, keeping residents within and around the Killingworth Moor safe during extreme and intense rainfall events.

- SuDS should be incorporated into the development layout to the greatest extent possible. The Infiltrating SuDS Opportunity Zones in Figure 11, the SuDS Infiltration Mapping data (Appendix D) and future site investigations should guide the placement of infiltrating SuDS to the most beneficial locations on site. Non-infiltrating SuDS like rainwater harvesting and green roofs should be used where infiltration is not feasible.

- As a best practice approach, finished floor levels should be raised by 300 mm above finished ground levels to mitigate surface water flood risk. Essential infrastructure and critical electrical systems within buildings should also be adequately raised / protected.

- The development layout must take into consideration the Sequential Approach to development – locating development in areas at lower flood risk – as specified by the North Tyneside Draft Sequential Test. The Exception Test is required for construction of Essential Infrastructure within Flood Zone 3 a / b, and construction classified as More Vulnerable within Flood Zone 3a.

- The development layout must take into consideration the existing sewerage infrastructure on the site. NWL should be consulted early in the master planning process, especially during development of an outline drainage strategy for the site.

- The risk of groundwater flooding be investigated at a site-specific FRA level.

- The EA should be consulted for further recommendations regarding flood risk mitigation.

Appendix A Site Plans and Topography

Appendix B Flood Risk Mapping

Appendix C Site Plans and Topography

Appendix D SuDS Suitability Assessment

To assess the suitability of incorporating infiltrating SuDS practices within Killingworth Moor SuDS Infiltration Mapping data was obtained from BGS. The Infiltration SuDS Map comprises a GIS dataset in four thematic sections which together provide answers to four key questions. The four questions are:

Question 1. Are there any constraints that mean infiltration SuDS should only be used if the potential for and consequences of flooding and geohazards are known?
This step addresses the potential presence of geological and hydrogeological hazards that could be initiated or worsened by infiltrating water to the ground. In such areas, infiltration is not recommended unless a full appraisal of the potential for and consequences of infiltration has been undertaken. Possible hazards include:

i) ground instability resulting from the infiltration of water into rocks that are highly susceptible to landslide or collapse associated with dissolution or shallow mining;
ii) flooding resulting from infiltration into deposits where the water table is shallow and potentially able to rise causing inundation of soakaways or emergence of groundwater at the ground surface, and
iii) made ground of unknown characteristics that may be unstable or potentially contaminated.

Question 2. What is the drainage potential of the subsurface?
The drainage potential of the ground depends on the geology and hydrogeology of the subsurface. This step provides information on the depth to water table, the permeability of superficial deposits, the thickness of superficial deposits and the permeability of the bedrock. Data is also provided on the presence of deposits that lie on a floodplain; in such deposits, groundwater level may respond rapidly to rises in river level causing inundation of subsurface systems.

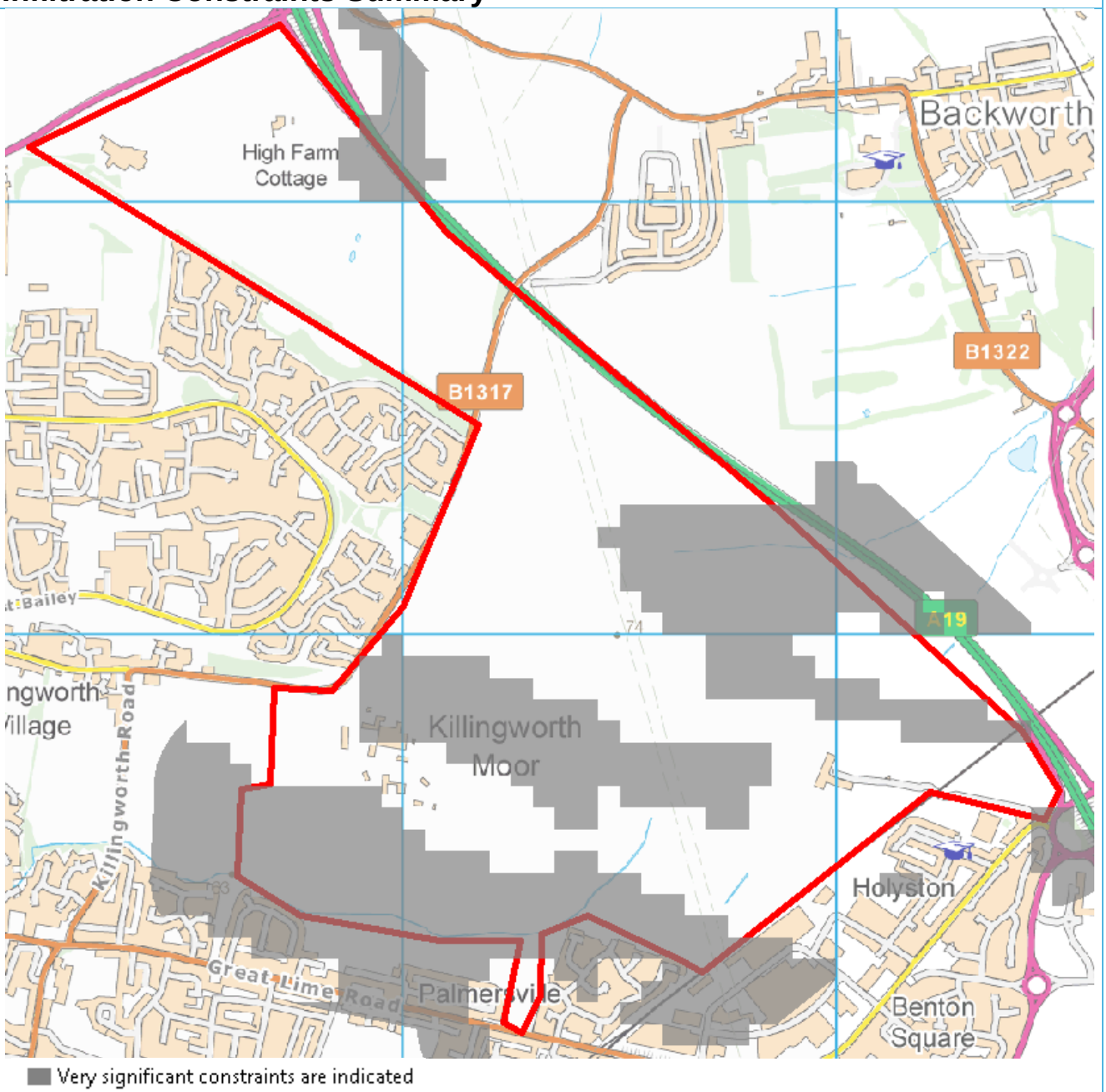
Question 3. Are there any ground stability considerations?
Not all ground instability hazards will preclude the installation of infiltration SuDS, but if present, those hazards should be taken into account during design and construction. Where such hazards are thought to be present, they are highlighted in this step. Hazards considered include soluble rocks, landslides, compressible ground, collapsible ground, shrink-swell clays, running sand and shallow mining (excluding coal mining).

Question 4. Is the groundwater susceptible to deterioration in quality?
When designing SuDS installations the potential impact on groundwater quality should be considered. This step provides information on the EA source protection zone classification, the predominant flow mechanism through the unsaturated zone and on the presence of made ground, which may be contaminated. This information can be used, in part, to determine likely pre-treatment requirements.

The BGS specifies that the SuDS Infiltration Mapping dataset is intended to provide the information required to make a preliminary decision on the extent to which the subsurface at a site is suitable for the installation of infiltration SuDS. The data is not an alternative for a site investigation or an infiltration test.

The Infiltration SuDS Mapping data is analysed on the following pages.

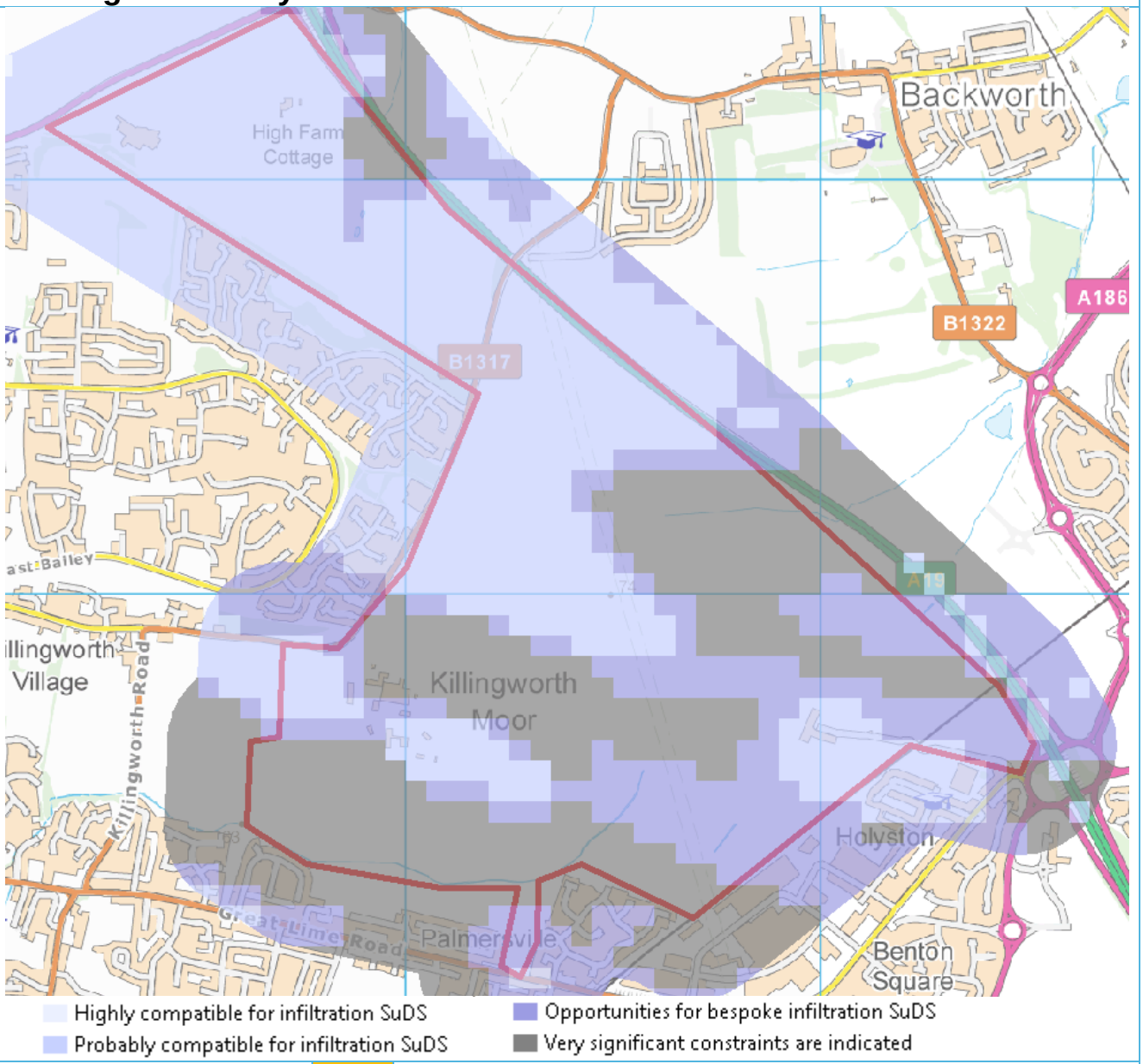
Infiltration Constraints Summary



Are there infiltration constraints where SuDS are proposed?		Varies

Comments	The infiltration constraints layer indicates that there are variable significant constraints that can impact the effectiveness of infiltrating SuDS within Killingworth Moor. These constraints occupy approximately 40% of the site within three distinctive areas. The largest of these areas occupies the south eastern corner of the site (Catchment 3) and largely follows the course of the Forest Hall Letch. The second of the three areas sits parallel to this first layer in a narrow band through the centre of the southern half of the site, and is also largely within Catchment 3. A third area where significant constraints are predicted is within Catchment 2. This area is largely centred around the Brierdene Burn. A small portion of land in the northern half of the site adjacent to High Farm Cottage is also affected. The infiltration constraints summary layer indicates that in these affected locations there is a very significant potential for one or more geohazards associated with infiltration. Any site investigation should consider whether the potential for, or the consequences of infiltration, are significant.

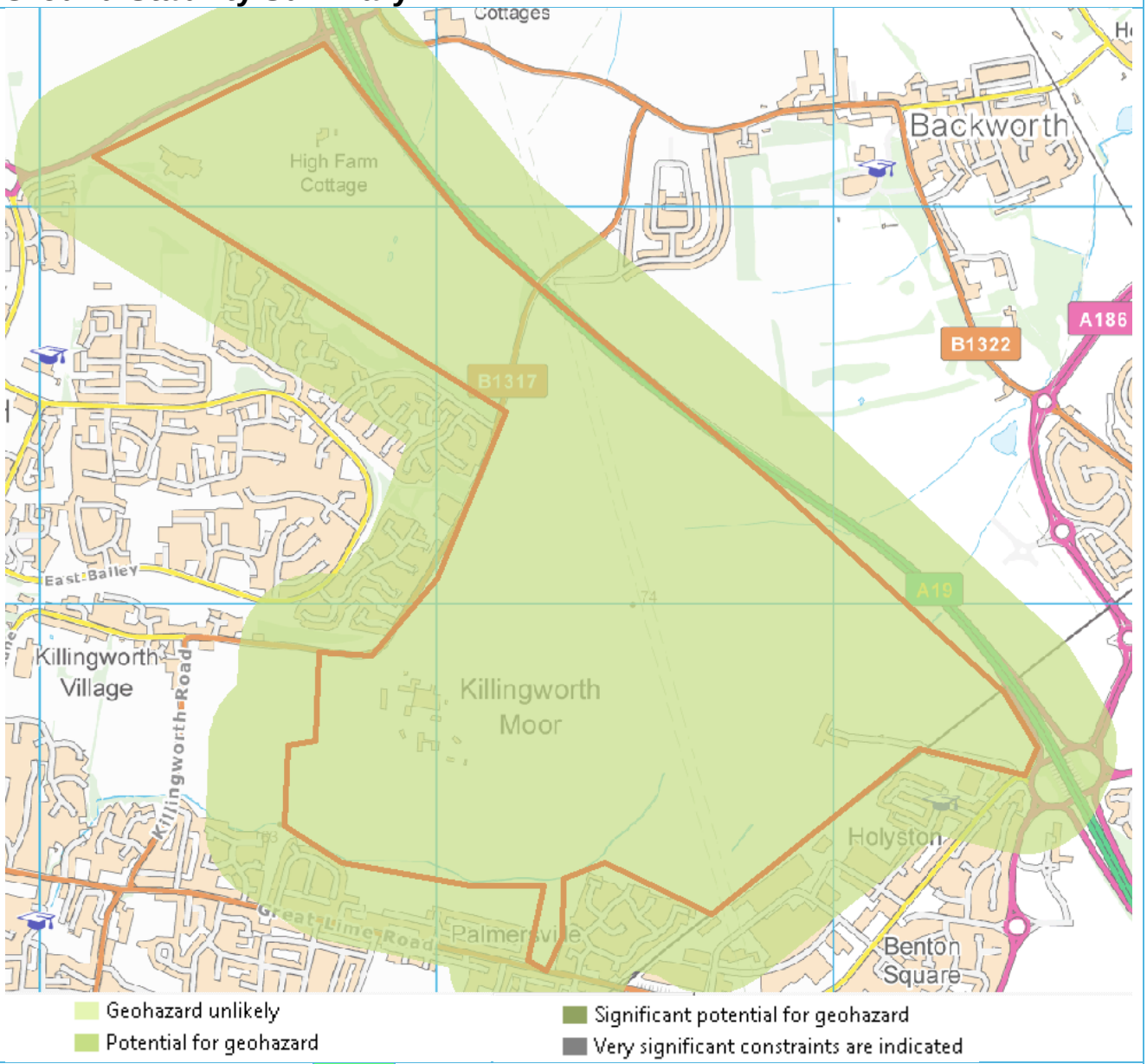
Drainage Summary



Is the subsurface compatible for infiltration SuDS?		Varies

Comments	The Drainage Potential layer provides further details regarding the compatibility of locations for implementing infiltration SuDS. As with the infiltration summary layer in the previous image, it can be seen that approximately 40% of the development site is affected by very significant constraints. The areas where very significant constraints are predicted largely follow the significant constraint areas for the infiltration constraints summary map. For these areas the subsurface is described as having opportunities for bespoke infiltration SuDS. The subsurface is potentially suitable for infiltration SuDS although the design will be influenced by the ground conditions. In these locations, infiltration SuDS may have to be used alongside water storage (in ponds/chambers) and re-use but will require further investigation. Greater opportunities for implementing infiltration SuDS are predicted in the northern portion of the site – in Catchment 1. A large proportion of this area is described as 'probably suitable for infiltration SuDS.' This area should be assessed further, particularly infiltration rates should be quantified via an infiltration/soakaway test.

Ground Stability Summary



Are there any ground stability considerations?		Low to Moderate potential for Geohazard
Comments	The Ground Stability Summary layer provides an indication of a location's potential to be subject to geohazard based on a number of parameters, including landslides, running sand and shallow mining. For Killingworth Moor, it can be seen that the entire site falls within the category "Potential for geohazard". In these locations ground instability problems may be present or anticipated but increased infiltration is unlikely to result in ground instability. The advice states that before installing infiltration SuDS consider the potential for, or the consequences of infiltration impacting ground stability.	

Appendix D

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