From:	[redacted]
To:	Local Dev. Framework
Subject:	CDC Local Plan Representation - 1 of 2
Date:	07 February 2018 12:04:47
Attachments:	image001.jpg APC Local Plan Rep to CDC 07-02-2018 - Re Bentham Rd Ingleton.pdf App I1 - 121701-10 rev A Location Plan.pdf App I2 - Site Plan as Existing Topographical Survey.pdf App I3b - Dwg 16-1069-001 Proposed Site Access.pdf App I4 - Design and Access Statement 05-02-2018.pdf App I5 - Planning Statement - 05-02-2018.pdf App I6 - Transport and Sustainable Access Statement - 31-12-2018.pdf

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Dear sir/madam,

Please see attached Representation and supporting Appendices (attached to this and a second email).

I would be grateful if you would acknowledge receipt.

Kind regards

[redacted]

[redacted] – Bsc (Hons) MRTPI
Managing Director
Addison Planning Consultants Ltd
addison_planning_logo_small

E: - [redacted]
M: - [redacted]
T: - [redacted]
WWW.AddisonPlanning.Com
5B Calls Landing,
36-38 The Calls, Leeds, LS2 7EW
Registered Company Number: 08945769
VAT Registration: 186373672

Addison Planning Consultants Ltd
t: [redacted]
m: [redacted]
e: [redacted]
www: addisonplanning.com

Date: 7th February 2018
Our Ref: APC00002

Planning Policy Team,
Craven District Council,
1 Belle Vue Square,
Skipton,
BD23 1FJ

Dear Sir/Madam,

RE: LOCAL PLAN CONSULTATION – JANUARY 2018: REPRESENTATION IN RELATION TO POLICY SP9 AND SITE ALLOCATION SG025

These Representations have been prepared by Addison Planning Consultants Ltd on behalf of [redacted]. These Representations specifically address the SOUNDNESS of draft Policies SP4 and SP9 in relation to the spatial strategy for Ingleton; and the omission of a proposed Allocation Site under Draft Policy SP9: Strategy for Ingleton – Tier 3.

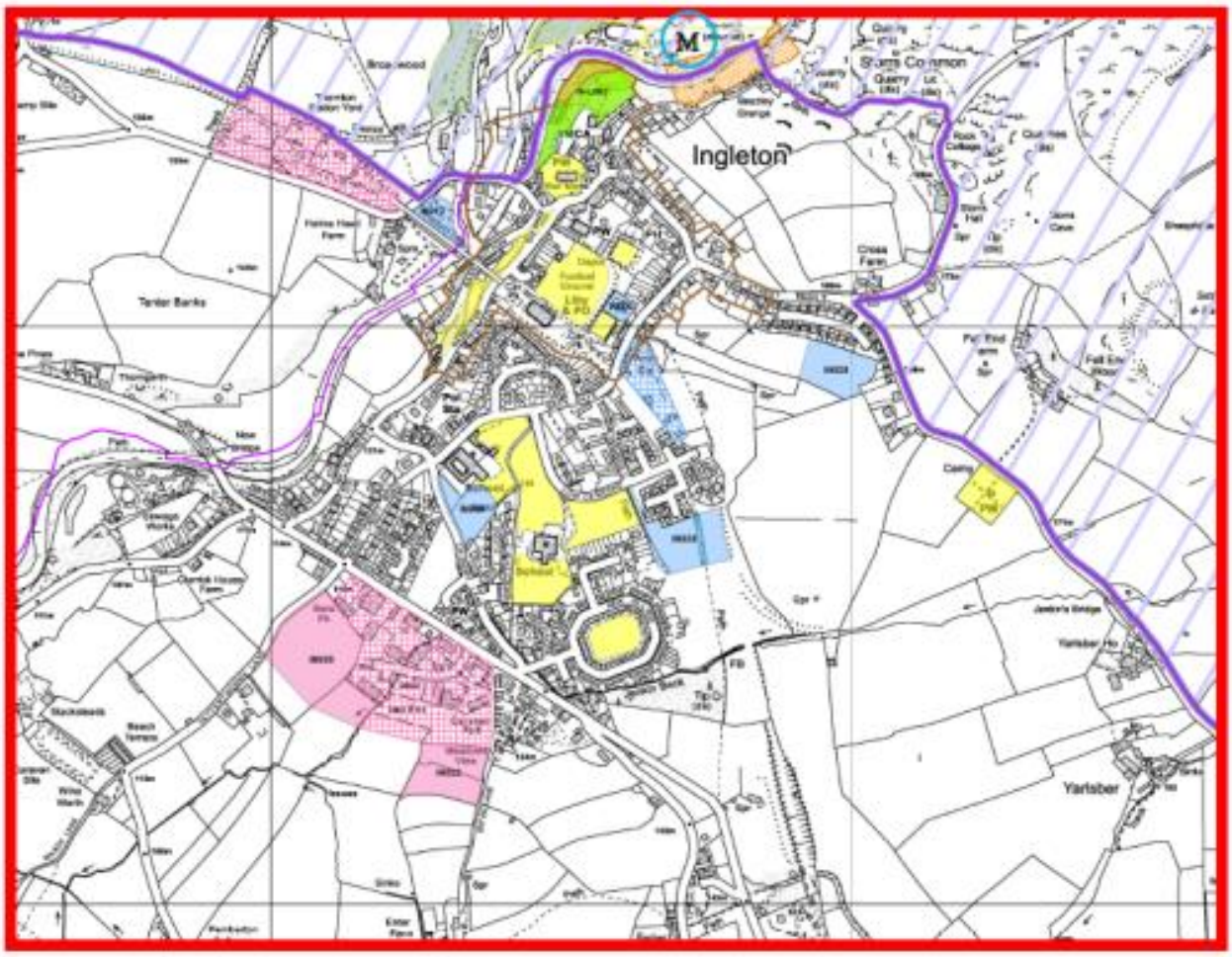
DRAFT POLICY SP4: SPATIAL STRATEGY AND HOUSING GROWTH: - this policy identifies Ingleton as a Tier 3 settlement which is a service centre with a good range of services, shops and facilities. Criterion C states:

"Directing a proportionate level of growth to Glusburn/Crosshills, Gargrave and Ingleton to underpin their roles as Tier 3 settlements (Local Service Centres);"

The Policy also sets out that the anticipated level of growth for Ingleton is 3.5% of the District wide requirement or the equivalent of 8 net dwellings per annum. This is reproduced in more detail at Table 5 p57 which states that the anticipated level of housing growth for Ingleton is 3.5% of the District requirement which equates to 160 dwellings as a minimum requirement for the Plan Period.

The Table states that 32 dwellings have been completed in the period 2012 to Sept 2017 which leaves a residual gross requirement of 143 dwellings (including an allowance of 15 dwellings lost). Allowing for sites with outstanding permission in Ingleton totalling 40 dwellings, the residual minimum housing requirement for Ingleton for the Plan Period is 103 dwellings.

DRAFT POLICY SP9: STRATEGY FOR INGLETON –TIER 3 then identifies 5 sites as proposed Allocations to deliver **exactly 103 dwellings** over the Plan Period. The extract from the draft Proposals Map below shows the five proposed housing sites (coloured light blue). The five draft housing Allocations are labelled with site references: IN06, IN010, IN028, IN029, and IN048.



SOUNDNESS

Policy SP4, in relation to the Spatial Strategy for Ingleton, is not sound because it fails to allocate sufficient housing land to provide a degree of flexibility to ensure housing needs for Ingleton are met over the Plan Period.

Policy SP4 identifies a minimum housing requirement of 143 dwellings over the Plan Period. It then assumes that all 40 dwellings with planning permission will be delivered in the short term. No allowance is made for non-implementation of those 40 dwellings. Similarly, by allocating exactly enough land to meet the minimum residual requirement of 103 dwellings, no allowance is made for any difficulties that may arise with delivering those allocations. The Council, in effect, assumes that 100% of existing permissions and allocations will be delivered – but, that 100% delivery still only delivers enough housing land to meet the **minimum requirement**.

This is not a realistic scenario and will undoubtedly lead to insufficient housing land being delivered in Ingleton to meet housing needs over the Plan Period. The Policy is therefore UNSOUND because it is ineffective and fails to address the evidenced need for housing in Ingleton.

OMISSION SITE

The lack of soundness of Policies SP4 and SP9 in relation to the spatial strategy and housing growth for Ingleton could be addressed through an additional Housing Allocation. The following site located at Bentham Road and the A65 Ingleton can deliver 10 family dwellings (including affordable housing) in the Plan Period.

This site is available, suitable and deliverable as a Housing Allocation, with a willing developer that will deliver housing on receipt of planning permission. Evidence has been prepared to show how the site is deliverable and sustainable. This evidence is included as Appendices with this submission:

App - I1:	Site Location Plan
App - I2:	Site Plan as Existing – Topographical Survey
App - I3a:	Site Layout Plan as Proposed, Elevations, Floorplans and Sections
	121701-01 rev F Site plan
	121701-05 rev A Elevations and floor plans
App I3b:	16-1069-001 Proposed Site Access
App I4:	Design and Access Statement 05-02-2018
App I5:	Planning Statement 05-02-2018
App I6:	Transport and Sustainable Access Statement - 15-12-2017
App I7a:	Tree Survey 05-12-2017
App I7b:	Tree Survey Plan 05-12-2017
App I8:	FRA and Drainage Strategy KRS.0334.001.R.001.A

Appendix 8 is particularly notable as it provides evidence to demonstrate that the Environment Agency Flood Risk Map zoning for the site is erroneous and demonstrates how the site can be delivered without risk to the development or elsewhere.

The SOUNDNESS of Policies SP4 and SP9 in relation to Ingleton could therefore be addressed through the Allocation of this site. Ten additional dwellings will provide a minimum degree of flexibility needed to ensure the spatial strategy and housing needs for Ingleton are met.

I would be grateful if you could acknowledge receipt and confirm the Representations have been duly made.

Kind Regards

MANAGING DIRECTOR
ADDISON PLANNING CONSULTANTS LTD

Peter Harrison Architects

T. [redacted] M. [redacted]

61C Main Street Addingham Near Ilkley Yorkshire LS29 0PD

Land at Ingleton [redacted]

Location Plan

SCALE		DRWG. NO.	REV
1:1250 @ A4	**January 2018**	**121701-10**	**A**

N

KEY TO SYMBOL/ANNOTATION

Symbol	Description
STN	-Survey Station
MH	-Manhole
IC	-Inspection Cover
G	-Gully Grate
SV	-Water Stop Valve
GV	-Gas Stop Valve
MTR	-Water Meter
FH	-Fire Hydrant
BT	-Telecom Cover
CATV	-Cable Television Cover
EC	-Electric Cover
ER	-Earth Rod
TP	-Telegraph Pole
EP	-Electric Pole
LP	-Lamp Post
SP	-Sign Post
Stay	-Stay
DP	-Downpipe
SVP	-Soil & Vent Pipe
TL	-Traffic Light
Post	-Post
CCTV	-Closed Circuit TV Pole
BOL	-Bollard
PB	-Post Box
BS	-Bus Stop
RE	-Rodding Eye
BH	-Borehole
TH	-Trial Hole
OSBM	-Ordnance Survey Bench Mark
RH	-Ridge Height
EH	-Eaves Height
FFL	-Finished Floor Level
TH	-Tree Height
TBL	-Top Boundary Level
WL	-Water Level
THL	-Threshold Level
-	Tree
-	Bush

LINETYPE

- Building
- Wall
- Fence
- Hedge
- Kerb
- Verge
- Foliage
- Gate
- Bank Bottom
- Bank Top

CONTROL STATIONS

Station	Easting	Northing	Level
STN1	368971.731	472674.512	111.117
STN2	369014.044	472650.395	113.623
STN3	368929.664	472667.848	109.979
STN4	368936.424	472712.116	109.014
STN5	368913.419	472648.023	109.574
STN6	368860.286	472599.624	108.663

NOTES

Levels and Co ords related to OSGB36(15) National Datum and grid using GPS

Drawing scale 1:200 when plotted on A0 drawing sheet

REV	DATE	DESCRIPTION	BY
-	-	-	-

PREMIER DESIGN SURVEYS LTD
OFFICE 2
THE OLD BANK CHAMBERS
37 MARKET PLACE
THIRSK
NORTH YORKSHIRE
YO7 1HA
TEL : [redacted]
WWW.PREMIERDESIGNSURVEYS.CO.UK

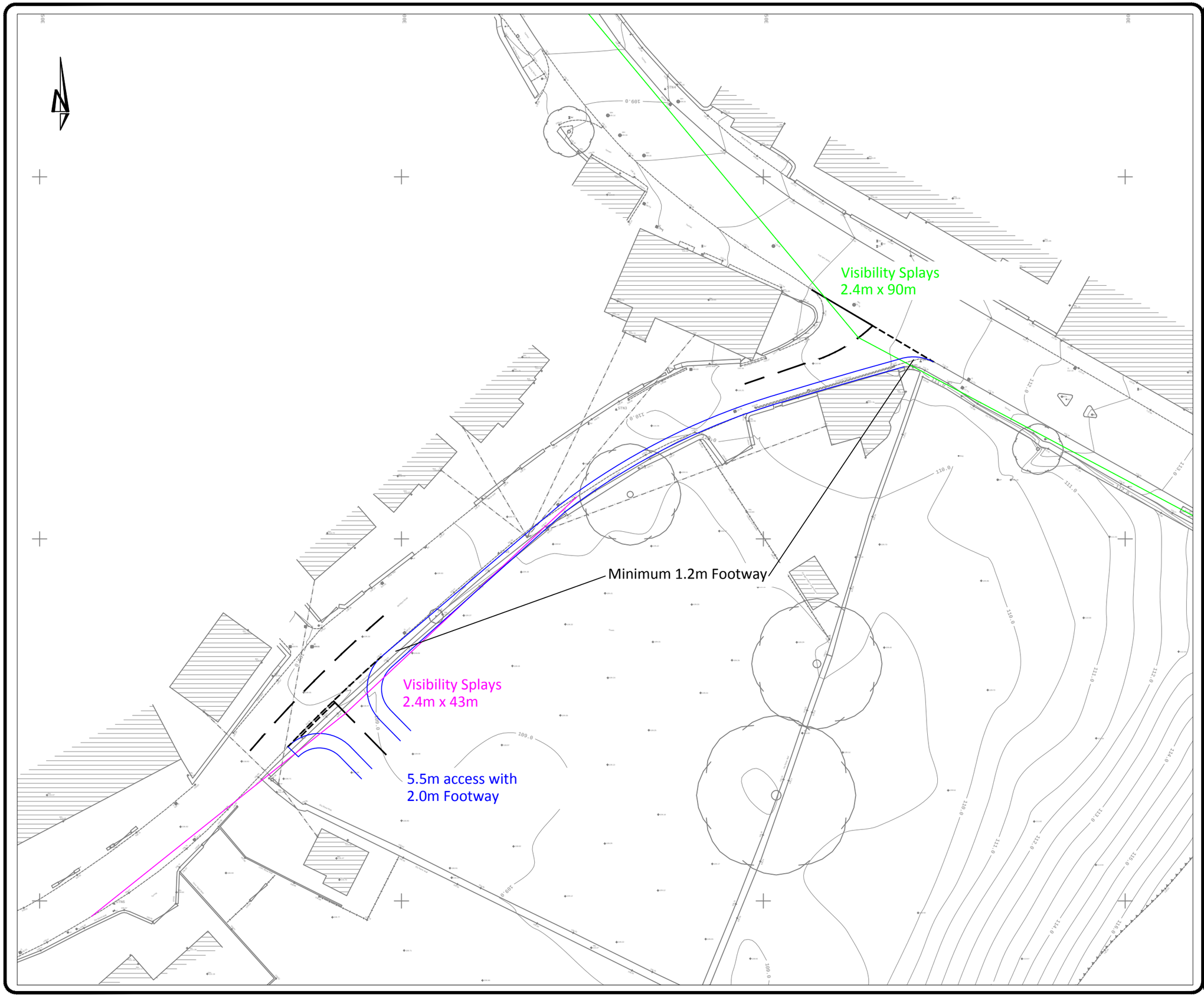
PROJECT
Land off Bentham Road
Ingleton

DRAWING TITLE
Topographical Survey

CLIENT
[redacted]

DRAWN	JR/AC	DATE	08/12/17
CHECKED	JR/AC	SCALE	1:200 @ A0

DRAWING NUMBER 3416-1



Notes:

1. All dimensions are to be checked on site before the commencement of works. Any discrepancies are to be reported to the Architect & Engineer for verification. Figured dimensions only are to be taken from this drawing.

2. This drawing is to be read in conjunction with all relevant Engineers' and Service Engineers' drawings and specifications. This drawing is copyright.

Rev	Date	Description	Ckd	By

Coraiht

Adamson House, Towers Business Park
Wilmslow Road
Manchester
M20 2YY

Tel: [redacted]
Email: [redacted]
Web: www.coraiht.com

Client

[redacted]

Project

Bentham Road, Ingleton

Title

Proposed Site Access

Drawing Status

Job No. 16-1069

Drawn	Checked	Scale at A3	Date	Issue Date
LB	TC	1:1000	12/12/17	-

Drawing No. 001 -

OUTLINE APPLICATION FOR DEVELOPMENT OF TEN DWELLINGS (DETAILS OF ACCESS, APPEARANCE, LAYOUT AND SCALE SUBMITTED)

Design and Access Statement

ON LAND SOUTH OF BENTHAM ROAD, INGLETON, NORTH YORKSHIRE

5th February 2018

CONTENTS

Introduction

1.1 This Design and Access Statement ("Statement") has been prepared by Addison Planning Consultants Ltd on behalf of [redacted] in support of a full Planning Application for:

"OUTLINE APPLICATION FOR DEVELOPMENT OF TEN DWELLINGS (DETAILS OF ACCESS, APPEARANCE, LAYOUT AND SCALE SUBMITTED) ON LAND SOUTH OF BENTHAM ROAD, INGLETON, NORTH YORKSHIRE"

1.2 This report will explain how the scheme design has addressed National and local Planning requirements.

1.3 The application comprises the following information:

I1a: APC Covering Ltr 05-02-2018

I1b: Planning Application Form 05-02-2018

I1c: Site Location Plan

I2: Site Plan as Existing – Topographical Survey

I3a: Site Layout Plan as Proposed, Elevations, Floorplans and Sections

121701-01 rev F Site plan

121701-05 rev A Elevations and floor plans

I3b: 16-1069-001 Proposed Site Access

I4: Design and Access Statement 05-02-2018

I5: Planning Statement 05-02-2018

I6: Transport and Sustainable Access Statement - 15-12-2017

I7a: Tree Survey 05-12-2017

I7b: Tree Survey Plan 05-12-2017

I8: FRA and Drainage Strategy KRS.0334.001.R.001.A

Site Description and Planning History

LOCATION

2.1 The proposed development is located adjacent to the A65 New Road, to the south side of Ingleton. Ingleton is a village and civil parish in the Craven district of North Yorkshire, England. The village is 19 miles from Kendal and 17 miles from Lancaster on the western side of the Pennines.

2.2 The site is approximately 0.36 hectare in size and is situated to the east side of Bentham Road and the south side of New Road (the A65) located to the south of Ingleton:

2.3 The site is enclosed by an existing stone wall along its boundary with Bentham Road, and existing dry-stone walls also delineate its south and eastern boundaries. The site is pasture; three mature trees mark the north and eastern boundaries (the subject of Tree Preservation Orders). The Site location plan submitted with the Application shows the site in more detail.

2.4 Located adjacent to the site on the western side of Bentham Road are existing dwellings. The photograph bellows shows this urban context – the application site is to the left, framed by the dwelling located alongside its southern boundary.

2.5 The main village of Ingleton is located to the north of the application site. The village is well served by existing facilities including shops, primary school and employment premises. These facilities are located within walking distance of the Appeal Site (this is evidenced in I6 - Transport and Sustainable Access Statement).

2.6 The sustainability of the site, having regard to the characteristics of the surrounding area and access to facilities is assessed in detail in Chapter 5 of this Statement.

PLANNING HISTORY

2.7 A review of the Council's Public Access database has been undertaken in relation to the property, although this does not constitute a Land Search and there may be other older planning history relating to the site. This shows:

2.8 The Application site itself has no history of planning applications. In relation to adjacent sites, the following are relevant;

45/2014/14619: Retrospective application for the change of use of part of OS Field 9363 to domestic curtilage. Formation

of new vehicle entrance to highway and new driveway at 10 New Road, Ingleton approved June 2014.

45/2016/17572 | Erection of detached single garage. | 10 New Road Ingleton Carnforth North Yorkshire LA6 3HW approved February 2017.

45/2008/8888: Construction of 4no. Dwellings (Re-submission 45/2007/8093) at Land Adjacent Clarrick Terrace, Ingleton approved January 2009.

The Proposed Development and Supporting Documents

3.1 USE:

The proposed use of the site is to develop a small scheme of ten family dwellings with gardens to meet local housing needs. Seven of the proposed houses would be market dwellings and three of the proposed houses would be Affordable Dwellings delivered on site.

3.2 AMOUNT

Ten dwellings in total are proposed comprising the following housing mix:

1 one-bedroom dwelling (Affordable)

2 two-bedroom dwellings (Affordable)

6 three-bedroom dwellings (Market)

1 four-bedroom dwelling (Market)

3.3 DESIGN AND LAYOUT

The layout has been designed with a single point of access onto Bentham Road. Houses are presented to face onto Bentham Road to create a traditional terrace and street frontage. Views from Bentham Road through the site to the open countryside beyond are created by located an amenity space adjacent to this frame, framed by the existing mature trees.

3.4 SCALE

All of the proposed dwellings are two storeys in height reflecting the character and scale of traditional properties in Ingleton.

3.5 LANDSCAPING

Landscaping details are Reserved for future consideration in this Application. However, the proposed layout indicatively shows new landscaping and planting areas within the site. This includes an area of land to the south of the proposed access which could be readily planted with indigenous species of trees to create a landscaped feature at the site entrance.

3.6 The proposed layout also ensures the existing mature trees within the site, which are the subject of a Tree Preservation Order, are retained. The layout is designed to introduce landscape amenity areas around these trees as features within the scheme.

3.7 APPEARANCE

The new development aspires to respect the local vernacular in terms of scale & façade materials. The scaling, proportions and simplicity of the fenestration patterns to the main façades have been developed to give the site its own identity. Aesthetically the buildings will be traditional quarried random stone with slate effect interlocking tiled roof.

3.8 The use of the stone allows the new development to sit comfortably within the area having picked visual clues and references from the surrounding area, adjacent to and beyond the existing site. The development bears significant relevance to the scale surrounding area whilst also having a modern architectural style.

3.9 ACCESS

The proposed site access is directly off Bentham Road. In order to improve sustainable access to the site, a minimum 1.2m footway is proposed from the site access linking into the existing footway at the A65. Further details are set out in the Transport and Sustainable Access Statement submitted with the Application.

PLANNING STATEMENT

OUTLINE APPLICATION FOR DEVELOPMENT OF TEN DWELLINGS (DETAILS OF ACCESS, APPEARANCE, LAYOUT AND SCALE SUBMITTED) ON LAND SOUTH OF BENTHAM ROAD, INGLETON, NORTH YORKSHIRE

PLANNING PORTAL REFERENCE: PP-06694189

Prepared by [redacted] BSC Hons MRTPI Director,

Addison Planning Consultants Ltd on behalf of

[redacted]

5th February 2018

CONTENTS

REFERENCE DOCUMENTS

CD1 CDC Local Plan 1999
CD2 CDC Publication Draft Local Plan January 2018

QUALIFICATIONS AND EXPERIENCE

1.1 My name is [redacted] and I have been a Chartered Member of the Royal Town Planning Institute since 1993. I hold a degree in Town and Regional Planning and I am Managing Director of Addison Planning Consultants Ltd.

1.2 I have 26 years of experience of working in the field of town planning, including 12 years in local government working in both planning policy and development control and 14 years acting for land owners, developers, occupiers and investors throughout the North of England. My involvement in the property market involves the preparation of complex planning applications, strategic promotion of land and property through the local planning policy system and acting as expert witness at planning appeals.

1.3 My evidence consists of this Statement and a set of Core Documents with the prefix 'CD'. Additional expert evidence in is provided by CoraIHT in relation to highway matters, and KRS Environmental in relation to flood risk and drainage issues.

1.4 My Statement deals with the planning policy context relating to the site and specifically the history of the application site, why the application scheme has been developed and the planning policy context for the proposals. I then consider the planning case for the application scheme.

1.5 **Chapters 2 to 4** introduce the proposal. Chapter 3 describes the site and its environs, and the planning history. Chapter 4 examines the planning policy context for the consideration of the application proposals.

1.6 **Chapter 5** of my Statement examines the planning case for the scheme.

1.7 **Chapter 6** summarises the principal conclusions from Chapters 5.

INTRODUCTION & BACKGROUND INFORMATION

2.1 This Planning Statement has been prepared on behalf of the applicant [redacted] The Application is submitted with details of the Access, Appearance, Layout and Scale for consideration (and Landscaping details reserved).

2.2 The Application submitted to CDC comprises the following details/documents and plans:

I1a: APC Covering Ltr 05-02-2018
I1b: Planning Application Form 05-02-2018
I1c: Site Location Plan
I2: Site Plan as Existing – Topographical Survey
I3a: Site Layout Plan as Proposed, Elevations, Floorplans and Sections
121701-01 rev F Site plan
121701-05 rev A Elevations and floor plans
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I6: Transport and Sustainable Access Statement - 15-12-2017
I7a: Tree Survey 05-12-2017
I7b: Tree Survey Plan 05-12-2017
I8: FRA and Drainage Strategy KRS.0334.001.R.001.A

2.3 The proposal in summary is for 10 dwellings. Specifically, design details have been formulated to enable an understanding of the visual impact of the scheme. The ten dwellings have been carefully designed to reflect the local vernacular and the 'infill' nature of the site. All the dwellings are two-storey in height. Local vernacular design detailing is proposed including local stone to the elevations.

2.4 The proposed use of the site is to develop a small scheme of ten family dwellings with gardens to meet local housing needs. Seven of the proposed houses would be market dwellings and three of the proposed houses would be Affordable Dwellings delivered on site.

2.5 Ten dwellings in total are proposed comprising the following housing mix:
1 one-bedroom dwelling (Affordable)
2 two-bedroom dwellings (Affordable)
6 three-bedroom dwellings (Market)
1 four-bedroom dwelling (Market)

2.6 The layout has been designed with a single point of access onto Bentham Road. Houses are presented to face onto Bentham Road to create a traditional terrace and street frontage. Views from Bentham Road through the site to the open countryside beyond are created by located an amenity space adjacent to this frame, framed by the existing mature trees.

INTRODUCTION & BACKGROUND INFORMATION

2.7 All the proposed dwellings are two storeys in height reflecting the character and scale of traditional properties in Ingleton. The new development aspires to respect the local vernacular in terms of scale & façade materials. The scaling, proportions and simplicity of the fenestration patterns to the main façades have been developed to give the site its own identity. Aesthetically the buildings will be traditional quarried random stone with slate effect interlocking tiled roof.

2.8 The use of the stone allows the new development to sit comfortably within the area having picked visual clues and references from the surrounding area, adjacent to and beyond the existing site. The development bears significant relevance to the scale surrounding area whilst also having a modern architectural style

2.9 In addition, a new pedestrian link from the dwellings to the existing footpath infrastructure of the village is proposed. This will also provide a betterment for the residents of the existing dwellings on Bentham road as current there is no safe pedestrian access to the centre of the village.

2.10 This Planning Statement, read in conjunction with the submitted technical evidence in relation highways, flood risk and drainage demonstrates that the proposal is a sustainable development. This Statement will also refer to the list of documents, plans and correspondence set out as Core Documents (referenced with the pre-fix '**CD'**) as set out on the contents page.

SITE DESCRIPTION AND PLANNING HISTORY

3.1 The proposed development is located adjacent to the A65 New Road, to the south side of Ingleton. Ingleton is a village and civil parish in the Craven district of North Yorkshire, England. The village is 19 miles from Kendal and 17 miles from Lancaster on the western side of the Pennines.

3.2 The site is approximately 0.36 hectare in size and is situated to the east side of Bentham Road and the south side of New Road (the A65) located to the south of Ingleton.

3.3 The site is enclosed by an existing stone wall along its boundary with Bentham Road, and existing dry-stone walls also delineate its south and eastern boundaries. The site is pasture; three mature trees mark the north and eastern boundaries (the subject of Tree Preservation Orders). The Site location plan included with the Application submission shows the site in more detail.

THE SURROUNDING AREA

3.4 Located adjacent to the site on the western side of Bentham Road are existing dwellings. The photograph bellows shows this urban context – the application site is to the left, framed by the dwelling located alongside its southern boundary.

SITE DESCRIPTION AND PLANNING HISTORY

3.5 The main village of Ingleton is located to the north of the application site. The village is well served by existing facilities including shops, primary school and employment premises. These facilities are located within walking distance of the Site (this is evidenced in **I6** - Transport and Sustainable Access Statement).

3.6 The sustainability of the site, having regard to the characteristics of the surrounding area and access to facilities is assessed in detail in Chapter 5 of this Statement.

PLANNING HISTORY

3.7 The following Planning History has been derived from the Council's Public Access database – a full Land Search has not been undertaken and there may therefore be other older planning applications relating to the site.

3.8 The Application site itself has no history of planning applications. In relation to adjacent sites, the following are relevant;

3.9 45/2014/14619: Retrospective application for the change of use of part of OS Field 9363 to domestic curtilage. Formation of new vehicle entrance to highway and new driveway at 10 New Road, Ingleton approved June 2014.

3.10 45/2016/17572 | Erection of detached single garage. | 10 New Road Ingleton Carnforth North Yorkshire LA6 3HW approved February 2017.

3.11 45/2008/8888: Construction of 4no. Dwellings (Re-submission 45/2007/8093) at Land Adjacent Clarrick Terrace, Ingleton approved January 2009.

PLANNING POLICY CONTEXT

RELEVANT ADOPTED PLANNING POLICY

4.1 The Development Plan consists of the saved policies of the Craven District (outside of the Yorkshire Dales National Park) Local Plan which was adopted on 2 July 1999. Most of policies in the Local Plan have expired in anticipation of the adoption of the Local Development Framework (now known as the new Local Plan). A copy of the 1999 Local Plan (extracts of relevant policies) is referenced as **CD1**.

4.2 The Council are likely to consider the following saved Policies as relevant to the consideration of the application proposals:

ENV1: Development in the Open Countryside.

ENV2: Requirements for Development in Open Countryside.

T2: Road Hierarchy

4.3 The Applicant considers that these policies are out of date and cannot be consider any significant weight, if any, in the consideration of the Application. I set out in the next section of my Statement my assessment of the material weight to be attached to these policies.

4.4 Other material considerations to be taken into account include the National Planning Policy Framework (the Framework – March 2012); the planning guidance published in March 2014 to support the Framework; and the Community Infrastructure Levy (CIL) Regulations 2010 (as amended).

SUPPLEMENTARY PLANNING GUIDANCE

4.5 The Council has no Supplementary Planning Guidance of relevance to the Application proposals. In relation to Affordable Housing, the Council produced a document entitled 'Negotiating Affordable Housing October 2015' as a basis for requiring Affordable Housing in new development schemes. This was first adopted by the Council for development management purposes in 2012 (although it has not been the subject of any public consultation). The October 2016 version was the subject of a legal challenge resulting in the 'policy document' being quashed by the Courts in March 2017.

4.6 The Council currently has no saved policy or supplementary guidance in relation to requirements for affordable housing provision.

EMERGING CRAVEN DISTRICT LOCAL PLAN AND EVIDENCE BASE

4.7 The Council is in the process of writing a new Local Plan for the District (outside the Yorkshire Dales National Park), which will replace the saved policies from the 1999 Local Plan. The new Local Plan will contain strategic

PLANNING POLICY CONTEXT

policies and will identify development sites to meet the needs of Craven up to 2035.

4.8 At the time of writing the Publication Draft version of the Local Plan was published for consultation in early January 2018 for a six-week consultation period expiring on the 13th February 2018. The Council will seek to place material weight on its emerging polices, although the Plan is still to be subject to an Examination and consideration of any representations received during the various stages of consultation.

4.9 Emerging policies in the Publication Draft Local Plan likely to be of relevance to the consideration of this Application (subject to an assessment of weighting) are set out below:

- Draft Policy SD1: The Presumption in Favour of Sustainable Development
- Draft Policy SD2: Meeting the Challenge of Climate Change
- Draft Policy SP1: Meeting Housing Need
- Draft Policy SP3: Housing Mix and Density
- Draft Policy SP4: Spatial Strategy and Housing Growth
- Draft Policy SP9: Strategy for Ingleton –Tier 3
- Draft Policy ENV3: Good Design
- Draft Policy ENV6: Flood Risk
- Draft Policy H2: Affordable Housing
- Draft Policy INF1: Planning Obligations
- Draft Policy INF3: Sport, Open Space and Recreation Facilities

4.10 DRAFT POLICY SP1: MEETING HOUSING NEED – this sets out that provision is made for 4,600 net additional dwellings in the plan area over the period 1 April 2012 to 31 March 2032; and that this is a ***minimum provision*** and equates to an annual average housing requirement of 230 net additional dwellings per annum.

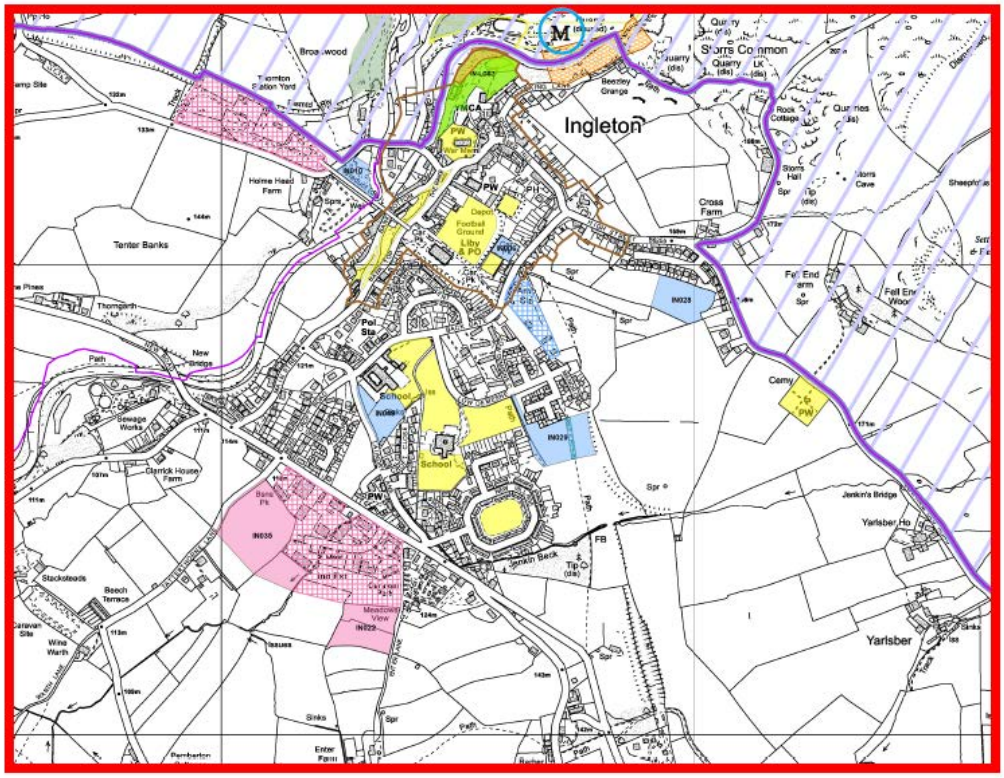
4.11 DRAFT POLICY SP4: SPATIAL STRATEGY AND HOUSING GROWTH: - this policy identifies Ingleton as a Tier 3 settlement which is a service centre with a good range of services, shops and facilities. Criterion C states:

"Directing a proportionate level of growth to Glusburn/Crosshills, Gargrave and Ingleton to underpin their roles as Tier 3 settlements (Local Service Centres);"

PLANNING POLICY CONTEXT

4.12 The Policy also sets out that the anticipated level of growth for Ingleton is 3.5% of the District wide requirement or the equivalent of 8 net dwellings per annum. This is reproduced in more detail at Table 5 p57 which states that the anticipated level of housing growth for Ingleton is 3.5% of the District requirement which equates to 160 dwellings as a minimum requirement for the Plan Period. The Table states that 32 dwellings have been completed in the period 2012 to Sept 2017 which leaves a residual gross requirement of 143 dwellings (including an allowance of 15 dwellings lost). Allowing for sites with outstanding permission in Ingleton totalling 40 dwellings, the residual minimum housing requirement for Ingleton for the Plan Period is 103 dwellings.

4.13 DRAFT POLICY SP9: STRATEGY FOR INGLETON –TIER 3 then identifies 5 sites as proposed Allocations to deliver exactly 103 dwellings over the Plan Period. The extract from the draft Proposals Map below shows the five proposed housing sites (coloured light blue). The five draft housing Allocations are labelled with site references: IN06, IN010, IN028, IN029, and IN048.



4.14 The Application site has not previously been put forward as a potential housing site by the landowners during the earlier stages of preparing the Local Plan (Strategic Housing Land Availability Assessment).

PLANNING POLICY CONTEXT

4.15 DRAFT POLICY H2: AFFORDABLE HOUSING; this draft Policy seeks to ensure proposed residential developments of 11 or more dwellings deliver at least 30% as affordable dwellings on site, or to provide financial contributions in lieu of on-site provision for proposals for between 6 and 10 dwellings in Designated Rural Areas. The Parish of Ingleton is classified as being within a Designated Rural Area.

4.16 DRAFT POLICY INF3: SPORT, OPEN SPACE AND RECREATION FACILITIES: This draft policy seeks developer contributions towards new or enhanced recreation facilities for schemes of between 6 and 10 dwellings in Designated Rural Areas.

4.17 These Policies are at an early stage in the plan making process and will be subject to representations and consideration at an Examination in Public before any significant weight can be attached to them.

ASSESSMENT OF PLANNING CASE

5.1 I consider that the main issue to be considered in the Application is:

(1) Whether the application site is sustainable having regard to accessibility to schools, shops, services and employment; and

5.2 Prior to considering this main issue, I have set out below my assessment of the principle of the proposed residential development having regard to saved Development Plan policies, and the current level of housing need in this District. The level of housing need forms an important material planning consideration having regard to the emphasis placed on the provision of new housing at paragraph 14 and 49 of the NPPF.

THE PRINCIPLE OF DEVELOPMENT

HOUSING NEED AND SUPPLY

5.3 The application site lies outside of but adjacent to the existing development limits of Ingleton as defined in the 1999 Local Plan. The Council considers that saved Local Plan Policies ENV and ENV2 are still relevant to this case.

5.4 The Applicant's case is that Policies ENV1 and ENV2 are out of date and cannot be afforded any material weight in the consideration of the proposals.

5.5 Policy ENV1 seeks to protect the character and quality of the open countryside from being spoilt by sporadic development and restricts development to small scale proposals appropriate for the enjoyment of the scenic qualities of the countryside and other appropriate small-scale development having a rural character and where the proposal clearly benefits the rural economy; helps to maintain or enhance landscape character; is essential for the efficient operation of agriculture or forestry; or is essential to the needs of the rural community.

5.6 Saved LP Policy ENV2 seeks to ensure that any development acceptable in principle under saved policy ENV1 is compatible with the character of the area and does not have an unacceptable impact on the landscape; the design and materials used relate to the setting; that traffic generated can be accommodated satisfactorily and services and infrastructure can be provided without a serious harmful change to the character and appearance of the area.

5.7 That is, both policies seek to control the supply of housing in the District. Given that Policy ENV2 is linked to Policy ENV1 – in so far as Policy ENV2 only relates to proposals acceptable under ENV1 – it follows that if Policy ENV1 is out of date, Policy ENV2 must also be considered as out of date if

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it is determined that the Council cannot demonstrate a 5-year supply of housing land.

5.8 The Council considers (in its Housing Supply monitoring report published in November 2016) it can demonstrate a 5.49-year supply of housing but also states in recent Committee Reports dealing with new housing proposals that the *"existence of a Five-Year Housing Land Supply is not a reason by itself to justify refusal of a planning application*."

5.9 The Applicant's case is that the Council is unable to demonstrate an adequate supply of housing to meet housing needs for the reasons set out below:

5.10 In October 2016, an updated Strategic Housing Market Assessment (SHMA) report was produced by Arc4 Consulting for Craven District Council (CDC). This recommended a full Objectively Assessed Need for Housing (OAN) based on up-to-date evidence of **214 dwellings per annum** for the Craven Housing Market Areas (i.e. across the whole of the local authority area). In the officer's report to the Craven Spatial Planning Sub Committee of 22nd November 2016 it was recommended that this updated OAN should be used as the OAN for the purposes of the Local Plan going forward (i.e. for that part of Craven District outside the Yorkshire Dales National Park Authority area). The officer's report clearly accepts that the new OAN is based on an objective assessment of the latest evidence.

5.11 In contrast, the latest CDC 5 Year Housing Supply Statement (November 2016) appears to entirely ignore this OAN evidence that CDC has commissioned. The statement poses the question: *"could the emerging housing requirement target of 256 dwellings per year in the new draft Local Plan be used to measure the 5-year housing land supply or the housing requirement target of 250 dwellings per year in the now revoked Regional Spatial Strategy, or some other measure?"*

5.12 It then draws on the well-known Hunston judgement to argue that in the absence of an adopted Local Plan with a housing requirement, the need for housing in assessing any five-year housing land supply should be set by *"the most up to date information on objectively assessed housing need in the Department of Communities and Local Government (DCLG) household projections"*.

5.13 This is an incorrect reading of what the National Planning Policy Framework and indeed national Planning Practice Guidance (PPG) were intended to mean. It is widely accepted that there is a distinction between an OAN (which is sometimes styled a "policy off" housing need) and a

ASSESSMENT OF PLANNING CASE

housing requirement (sometimes styled "policy on"). An OAN does not consider factors that may constrain the ability of a local authority to deliver housing need or indeed the aspiration to increase housing growth faster than the OAN figure to meet some economic aspirations. In contrast a housing requirement adopted in a Local Plan may take these factors into account.

5.14 The relevant guidance is set out in PPG para 3-30 that sets out the starting point for assessing a five-year housing land supply, i.e. the need figure that should be used. To quote this at length:

"Housing requirement figures in up-to-date adopted Local Plans should be used as the starting point for calculating the five-year supply. Considerable weight should be given to the housing requirement figures in adopted Local Plans, which have successfully passed through the examination process, unless significant new evidence comes to light. It should be borne in mind that evidence which dates back several years, such as that drawn from revoked regional strategies, may not adequately reflect current needs".

"Where evidence in Local Plans has become outdated and policies in emerging plans are not yet capable of carrying sufficient weight, information provided in the latest full assessment of housing needs should be considered. But the weight given to these assessments should take account of the fact they have not been tested or moderated against relevant constraints. Where there is no robust recent assessment of full housing needs, the household projections published by the Department for Communities and Local Government should be used as the starting point, but the weight given to these should take account of the fact that they have not been tested (which could evidence a different housing requirement to the projection, for example because past events that affect the projection are unlikely to occur again or because of market signals) or moderated against relevant constraints (for example environmental or infrastructure)" [our emphasis added].

5.15 It is quite clear therefore from this guidance what CDC should be doing; it should be using its recent, robust assessment of full housing needs. If there were no such assessment, then the use of DCLG household projections alone would be reasonable as CDC argue. However, because CDC itself has commissioned independent robust OAN evidence this is palpably not the case. In other words, it must use its own consultant's advice on the latest OAN figure.

5.16 Since, the November 2016 Housing Supply Statement was published, the Council has published an updated OAN as part of the Publication Draft

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version of its Local Plan (as described in Section 4 of this Report). As at January 2018, the Council's evidence states that the Full Objectively Assessed Need (FOAN) for housing in the Plan Area is 206 dwellings per annum (or 4120 dwellings 2012 to 2032); and the housing requirement (the policy on figure) is 230 dwellings per annum (or 4600 dwellings 2012 to 2032).

5.17 I set out below the implications for the five-year housing land supply in Craven District of using the proper housing need figure that CDC themselves have adopted in the Publication Draft Local Plan as at January 2018. There are two columns in the table:

• The first column uses the identical approach to that adopted by CDC in the own assessment in November 2016 but using the most up to date published FOAN as set out in the Publication Draft Local Plan. This looks at the backlog over five years to the end of March 2017.

• The second column does the same exercise but uses the Housing Requirement figure set out in the Publication Draft.

CDC Housing Figures from Publication Draft Local Plan – January 2018	**CDC FOAN 206/yr.**	**CDC Housing Requirement**
(a) Housing Requirement 2012 to 2032	4120	4600
(b) Avg Annual Hsg Requirement 1st April 2012 to 31st March 2017	206	230
(c) Five Year Housing Requirement	1030	1150
(d) Total Net Completions Over Backlog Period of 5 years 1st April 2012 to 31st March 2017	710	710
(e) Total Requirement over Backlog Period	1030	1150
(f) Backlog (=e minus f)	320	440
(g) Total Five-Year Housing Requirement 1st April 2017 to 31st March 2022 (=c+f)	1350	1590
(h) 20% Buffer	270	318
(i) Total Five-Year Requirement 1st April 2017 to 31st March 2022 including 20%	1620	1908

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Buffer (=g plus h)		
(j) Avg Annual Housing Requirement 1st April 2017 to 31st March 2022 (=i/5)	324	381
(k) Estimated supply (from Publication Draft Local Plan. *Taken from Table 4 p56 of Publication Draft supply at **1st Oct 2017**	1549*	1549*
(l) Five-year land supply expressed in Years (=k/j)	**4.78 Yrs.**	**4 Yrs.**

5.18 ***CDC's own assessment of its supply states in the Publication Draft Local Plan a figure of 1549 dwellings as at 1st Oct 2017. The Table above uses the usual monitoring period of 31st March – so this CDC figure effectively adds an extra 6 months of supply. The actual supply figure to March 2017 will therefore be considerably less. This has the effect of significantly over estimating supply – which means the expressed 5-year land supply is also over inflated.***

5.19 My evidence has clearly demonstrated that, based simply on the Council's own evidence base on supply and the proper application of the Council's own evidence on OAN, it cannot demonstrate a five-year housing land supply.

5.20 In coming to this conclusion, I have not needed to carry out a detailed site by site assessment of the housing supply that CDC propose that totals 1,549. Such an assessment would be usual in any assessment of five-year housing land supply. This is because, on the Council's own evidence they are so clearly short of having a sufficient supply. At present their five-year supply of housing land would need to increase significantly for CDC to be anywhere near having a sufficient five-year supply of housing land.

5.21 As the relevant policies for the supply of housing are out of date the Applicant's case is that the proposals should be considered in the context of the presumption in favour of sustainable development. The Applicant's case is that the proposal would provide much needed market and affordable housing and the lack of a five-year housing land supply weighs significantly in favour of the proposal.

5.22 Even if I am wrong about the 5-year supply and the weight that should be attached to Policy ENV1 – the Applicant's case is that the proposal would not in any event conflict with that Policy because the appeal site is sustainable (having regard to accessibility to schools, shops, services and

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employment); and because the proposal would not have a significant harmful effect on the landscape and visual character and appearance of the area. These are the two main issues I consider later in my Statement.

5.23 Regarding the principle of development, the Applicant's case is that the proposals accord with the Development Plan in so far as the saved policies are consistent with the NPPF. Having regard to the lack of 5-year land supply for housing, the second part of paragraph 14 of the NPPF is also relevant and the proposals should therefore be approved as there are no adverse impacts of doing so that would significantly and demonstrably outweigh the benefits, when assessed against the policies in the Framework taken as a whole. The following paragraphs set out the Applicant's case as to benefits of the Application scheme and why there are no adverse impacts that would outweigh those benefits.

ECONOMIC BENEFITS

5.24 The proposed development of this site would provide economic benefits associated from new housing developments including the provision of construction jobs and from future residents of the proposed dwellings. In addition, the proposal would provide some social benefits and help to support the vitality of the rural community.

DESIGN, HOUSING MIX AND IMPACT ON NEIGHBOURING PROPERTIES

5.25 Ten dwellings in total are proposed comprising the following housing mix:

1 one-bedroom dwelling (Affordable)

2 two-bedroom dwellings (Affordable)

6 three-bedroom dwellings (Market)

1 four-bedroom dwelling (Market)

5.26 The proposed dwellings are designed to reflect the local vernacular with high quality finishing materials including natural stone. Regarding the proposed mix, the Council's Strategic Housing Market Area Assessment 2016 identifies the need for market and affordable housing. This states at paragraph 7.16 (table 7.3) that predominant need is for three and four-bedroom market dwellings and smaller one/two bed affordable dwellings:

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Table 7.3 Suggested dwelling mix by market and affordable dwellings			
Overall dwelling size mix	**Market (%)**	**Affordable (%)**	**Overall (%)**
1/2 Beds	8.2	86.4	39.4
3 Beds	64.9	12.9	44.0
4 Beds	26.9	1.2	16.6
Total	99.9	100.5	100.0
Base	128	86	214

5.27 The proposed mix of one, two, three and four-bedroom dwellings therefore reflects the evidenced need as set out in the Council SHMAA. The Applicant's case is therefore that the proposal will deliver a wide choice of high quality homes and accords with paragraph 50 of the NPPF; and that the proposal represents good design and accords with Section 7 of the NPPF.

5.28 The Applicant's case is also that the proposals will not adversely affect the residential amenity of existing occupiers adjacent to the application site. Adequate spacing within the layout has been incorporated with neighbouring properties to meet acceptable amenity and separation standards for privacy and light."

ECOLOGY

5.29 Regarding ecology, the Applicant's case is that the additional landscaping proposed, together with a strategy to provide bat/bird boxes and/or bricks to dwellings, will provide an opportunity to enhance biodiversity. The proposal therefore accords with paragraph 118 of the NPPF and that the landscaping strategy will provide a benefit by improving biodiversity in the area.

DRAINAGE AND FLOOD RISK

5.30 The NPPF requires local planning authorities to adopt proactive strategies to mitigate and adapt to climate change taking full account of flood risk, water supply and demand considerations.

5.31 In this regard, the Applicant's case is that the proposals will not increase the risk of flooding either on or off site and that the site can be adequately drained of both surface and foul water.

5.32 Detailed evidence has been prepared and set out in a Flood Risk assessment and Drainage Strategy which demonstrates that the site can be developed without increasing flood risk.

ACCESS AND HIGHWAY IMPACTS

5.33 The Applicants' have undertaken a systematic assessment of the highway/transport implications of the proposals. The evidence provided

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clearly demonstrates that the proposed development will have no material or significant residual impact on traffic or road safety and so passes the test in paragraph 32 of the NPPF.

5.34 The above paragraphs have set out the Applicant's case that the proposals have significant benefits including:

- Delivering much needed market and affordable housing in a District where there is a recognised significant shortage of housing.
- Delivering a wide choice of high quality homes to a high standard of design
- Delivering, through the landscaping strategy, improvements to biodiversity in the area

5.35 The Applicant's case is also that the proposals will not have any significant adverse effect:

- On the residential amenity of existing occupiers adjacent to the site
- On drainage or flood risk
- On access or highway safety

5.36 Having regard to the above, I then consider the two main issues:

ISSUE 1: WHETHER THE APPLICATION SITE IS SUSTAINABLE HAVING REGARD TO ACCESSIBILITY TO SCHOOLS, SHOPS, SERVICES AND EMPLOYMENT

5.37 The Application site is, in fact, located in a highly sustainable location. The existing Local Plan adopted in 1999 recognises Ingleton as a 'Local Service Centre' – refer to paragraph 4.6.3 of **CD1**:

"4.6.3 These local service centres will be given a degree of priority for the development of facilities and smaller scale employment opportunities. They each fulfil an important role in providing local services and shopping facilities to a rural catchment. They also provide a centre for schooling, community facilities and provide local job opportunities, particularly important to those needing part-time work or work close to their homes."

5.38 The emerging Local Plan also classifies Ingleton as a 'Tier 3' settlement with a range of services to which an element of growth is intended to be directed – refer to **CD2**.

5.39 Ingleton is a sustainable settlement with a good range of shops, services, a school and various employment premises and these facilities are within established walking distances. The proposal provides good pedestrian access to these facilities – making it a highly sustainable location for the ten dwellings proposed.

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5.40 The Applicants have provided a Transport Statement which provides technical evidence to justify this conclusion – referenced as Document **I6** with the Application submissions. This addresses the sustainability of the site by assessing the accessibility to it by alternative transport modes starting firstly with public transport and then examining pedestrian accessibility.

5.41 Regarding public transport, the site is well serviced by a frequent bus connecting it to Kirby Lonsdale and Lancaster beyond to the north; and Settle and Skipton to the south. These larger towns have an even greater range of services, schools and employment premises. The bus stops for these services are located ***within 130m direct walking distance of the site***. This evidence is set out and illustrated in more detail in the Transport Statement (Document **I6**).

5.42 Regrading pedestrian accessibility, it is proposed that a new pedestrian footpath is created along Bentham Road to connect to the existing infrastructure along the A65 New Road. This is illustrated on the plans within the Application submission and will provide accessibility to the villages' amenities, services and importantly the existing bus stops. As there is no footpath now, the new path will provide a betterment of the residents of the existing dwellings on Bentham Road.

5.43 The Transport Statement provides evidence (refer to detail at section 3.6 of the Transport Statement - Document **CD1e**) to illustrate that the villages services and amenities are within all established walking distance tolerances:

- Bus Stops (130m / 2 minutes' walk);
- Public House (Masons Arms) (250m / 4 minutes' walk);
- Co-Operative Food / Petrol Station (650m / 8 minutes' walk);
- Ingleton Primary School (750m / 10 minutes' walk);
- Ingleton Evangelical Church (550m / 6 minutes' walk);
- Ingleton Village Centre (800m / 12 minutes' walk);
- Ingleton Pharmacy (1km / 17 minutes' walk); and
- Ingleton Library / Community Centre (800m / 12 minutes' walk).

5.44 In relation to accessibility the Transport Statement summarises that the site is accessible on foot, and with the proposed pedestrian path and crossing point linking to New Road in place, will reduce the requirement for residents to make short car journeys to access local amenities.

5.45 The proposed development is therefore accessible by sustainable travel modes and is well located to make use of the existing public transport links and footways. I conclude that the development proposals are acceptable

ASSESSMENT OF PLANNING CASE

in highways and transportation terms. There are no highways or transportation-related reasons upon which a refusal of the planning application for the proposals would be justified.

SUMMARY AND CONCLUSIONS

6.1 Regarding existing planning policies, the Council is unable to rely on or place any material weight on Policies ENV1 or ENV2 of the Local Plan 1999. This is because the Council has a significant need to deliver new housing in the District as evidenced in its up to date evidence base for the emerging Local Plan. Further, it is unable to demonstrate a sufficient supply of housing sites to meet that identified need (a 5-year supply of housing). The NPPF therefore directs that said policies must be considered out of date and that this development proposal should be considered favourably if it can be demonstrated to be sustainable development.

6.2 The proposal would provide much needed market and affordable housing and the lack of a five-year housing land supply weighs significantly in favour of the proposal.

6.3 The proposals therefore accord with the Development Plan in so far as the saved policies are consistent with the NPPF. Having regard to the lack of 5-year land supply for housing, the second part of paragraph 14 of the NPPF is also relevant and the Application proposals should therefore be approved as there are no adverse impacts of doing so that would significantly and demonstrably outweigh the benefits, when assessed against the policies in the Framework taken as a whole. The Assessment has set out that the proposals will have significant benefits including:

- Delivering much needed market and affordable housing in a District where there is a recognised significant shortage of housing.
- Delivering a wide choice of high quality homes to a high standard of design and in accordance with the recognised need in the SHMAA
- Delivering, through the landscaping strategy, improvements to biodiversity in the area

6.4 The proposals will also not have any significant adverse effect:

- On the residential amenity of existing occupiers adjacent to the site
- On drainage or flood risk
- On access or highway safety

6.5 Turning to the main issue I identified, I have concluded that the application site is in a highly sustainable location having regard to accessibility to schools, shops, services and employment by alternative modes of transport including pedestrians. Planning permission should therefore be granted for this proposal.

Statement of Truth

"The evidence which I have prepared and provide for this Planning Statement is to the best of my knowledge true and has been prepared and is

SUMMARY AND CONCLUSIONS

given in accordance with the guidance of my professional institution and I confirm that the opinions expressed are my true and professional opinions."

Signature: ..... Date: 5th February 2018.....

[redacted] **BSc Hons, MRTPI**

www.coraiht.com

Proposed Residential Development
Bentham Road
Ingleton

Transport Statement

Final Report for:

[redacted]

January 2018

Adamson House
Towers Business Park
Wilmslow Road
Manchester
M20 2YY

Email: [redacted]

Cora IHT Registered in England No 10321930

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1	15th December 2017	1st Issue
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3		

CONTENTS

1.0 INTRODUCTION

1.1 Overview

1.1.1 [redacted] has instructed Cora IHT to prepare a Transport Statement (TS) in support of the planning application for 10 residential units off Bentham Road in Ingleton.

1.1.2 The proposed development is located to the south of the A65 New Road / Bentham Road junction. Ingleton is a village and civil parish in the Craven district of North Yorkshire, England. The site location is illustrated in **Figure 1.1**.

Figure 1.1: Site Location

1.1.3 This TS has been prepared in accordance with National Planning Policy Framework and Planning Policy Guidance: Travel Plans, Transport Assessments and Statements in Decision-Taking. It sets out the transport matters relating to the development site and provides details of the development proposals, including an assessment of the predicted traffic flows, the corresponding impact on the surrounding highway network and matters associated with accessibility and connectivity.

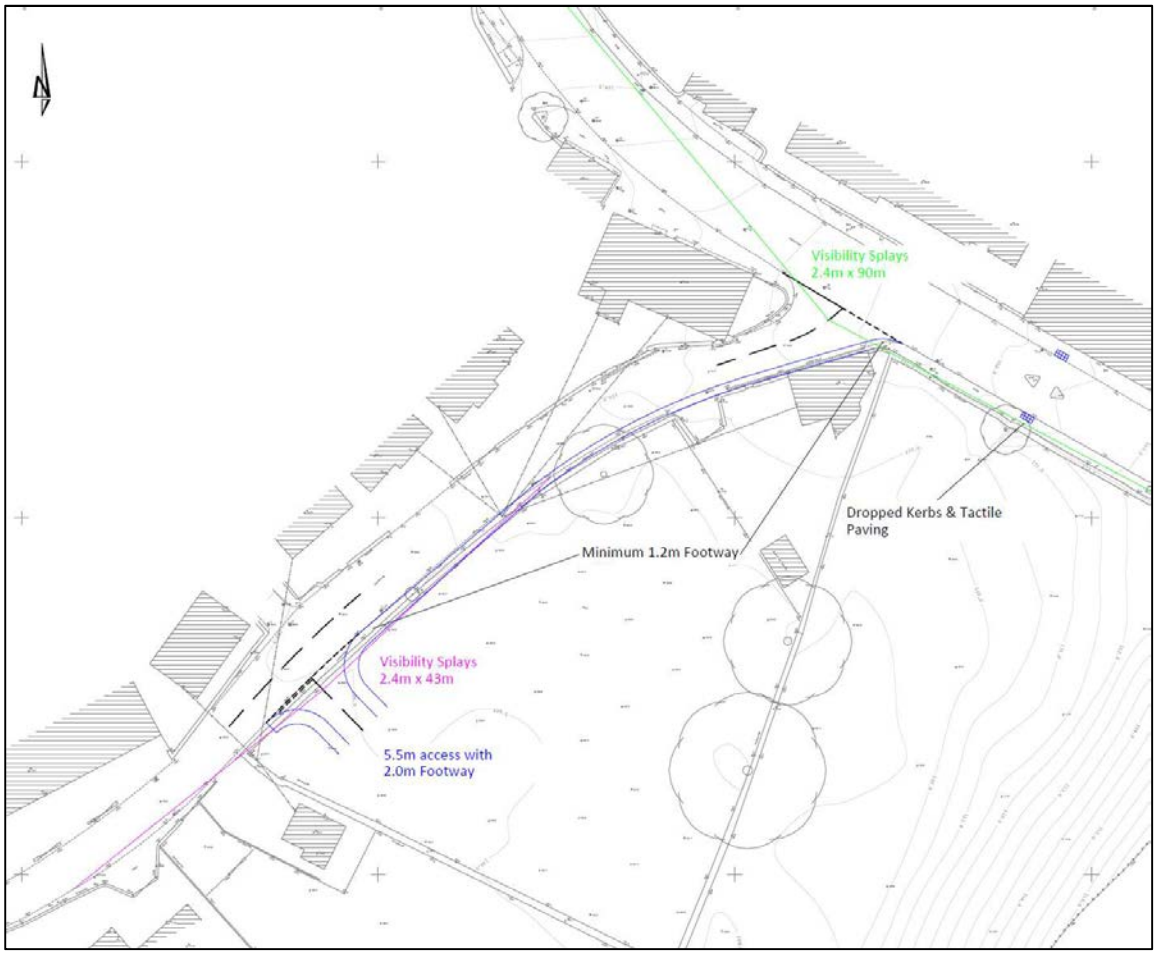
1.2 Proposed Development

1.2.1 The proposed development consists of 10 dwellings with access directly off Bentham Road.

1.2.2 In order to improve sustainable access to the site, a minimum 1.2m footway is proposed from the site access linking into the existing footway at the A65. The existing pedestrian crossing point to the east of the A65 / Bentham Road junction is also to be improved with dropped kerbs and tactile paving.

1.2.3 **Figure 1.2** provides an extract of the proposed access arrangement whilst **Appendix A** provides the full drawing.

Figure 1.2: Site Access



1.2.4 An illustrative site layout is provided in **Appendix B** which indicates one way that the proposed development could be laid out in accordance with current best practice, including to accommodate pedestrians and cyclists.

2.0 Traffic Impact and Accident Assessment

2.1 Development Trips

2.1.1 To identify the trip generation associated with the proposed development, the TRICS database has been utilised. The traffic analysis has been based on up to 20 residential units, the application is for up to 10 dwellings, therefore, this assessment is robust. **Table 2.1** summarises the trip rates and generations associated with the proposed residential development. The TRICS outputs are provided in **Appendix C**.

Table 2.1: Trip Rates and Generation Using TRICS

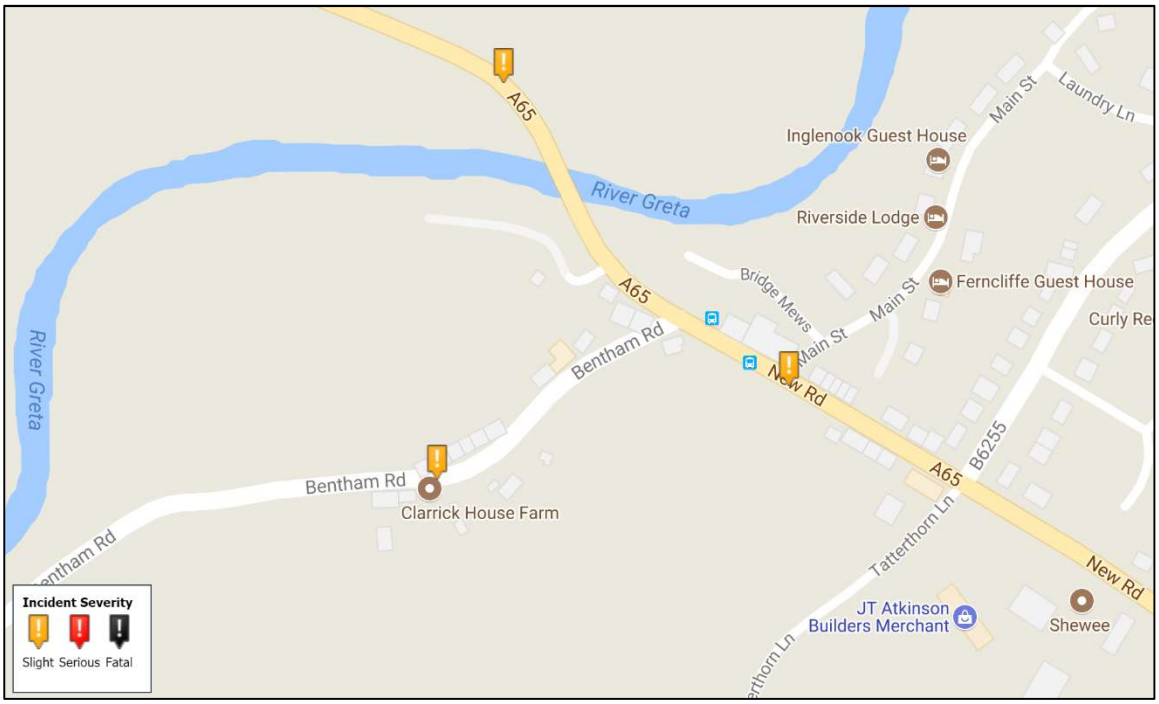
	Morning Peak (08:00-09:00)			Evening Peak (17:00-18:00)		
	Arr	Dep	Total	Arr	Dep	Total
Trip Rates	0.149	0.39	0.539	0.341	0.16	0.501
Proposed Trips	1	4	5	3	2	5

2.1.2 The National Planning Policy Framework [NPPF] (paragraph 32) states that "development should only be prevented or refused on transport grounds where the residual cumulative impacts on development are severe." The proposed development would generate minimal traffic levels, therefore, it can be concluded that it will not have a severe impact on the highway network.

2.2 Accident Analysis

2.2.1 An accident review has been undertaken using the Crashmap website (http://www.crashmap.co.uk) for the period of 2013-2017. **Figure 2.2** shows an extract of the accident plot.

Figure 2.2: Crashmap Accident Plan



2.2.2 As shown from the plan above there has only been 3 slight accident within the local highway network over the 5-year period. There have been no accidents at the A65 New Road / Bentham Road junction. It is concluded that the recorded accident data within the vicinity of the site does not indicate any existing highway safety patterns or problems.

3.0 TRANSPORT POLICY AND ACCESSIBILITY

3.1 Preamble

3.1.1 In order to assess the proposals and develop a transport access strategy for the proposed development, it is necessary to review transport planning guidance, specifically:

- National Planning Policy Framework;
- Travel Plans, Transport Assessments and Statements in Decision-Taking

3.2 National Planning Policy Framework

3.2.1 National Planning Policy Framework [NPPF], March 2012, sets out the government's planning policy and its expectations in terms of the application of this policy. Overall, the policy makes a presumption in favour of sustainable development. According to paragraph 9 of the document, pursuing sustainable development involves seeking positive improvements in the quality of the built, natural and historic environment, as well as in people's quality of life, including (but not limited to):

- making it easier for jobs to be created in cities, towns and villages;
- moving from a net loss of bio-diversity to achieving net gains for nature;
- replacing poor design with better design;
- improving the conditions in which people live, work, travel and take leisure; and
- widening the choice of high quality homes.

3.2.2 Paragraph 17 of the document states that it aims to:

> *'actively manage patterns of growth to make the fullest possible use of public transport, walking and cycling, and focus significant development in locations which are or can be made sustainable'.*

3.2.3 Furthermore, paragraph 32 states that plans and decisions should take account of whether:

- the opportunities for sustainable transport modes have been taken up depending on the nature and location of the site, to reduce the need for major transport infrastructure;
- safe and suitable access to the site can be achieved for all people; and
- improvements can be undertaken within the transport network that cost effectively limit the significant impacts of the development. Development should only be prevented or refused on transport grounds where the residual cumulative impacts of development are severe.

3.3 Travel Plans, Transport Assessments and Statements in Decision-Taking

3.3.1 In March 2014, the Department for Communities and Local Government [DCLG], in conjunction with the Department for Transport [DfT], released advice relating to travel plans, transport assessments and transport statements to support decision making. The document provides advice on when transport assessments and transport statements are required and what they should contain, which is intended to assist stakeholders in determining whether an assessment may be required. If an assessment is required, the level and scope of that assessment is identified within the guidance.

3.3.2 The advice reflects current Government policy relating to promoting a shift from the 'predict and provide' approach to transport planning, to one more focused on sustainability. The document focuses on encouraging environmental sustainability, managing the existing network and mitigating the residual impacts of traffic from development proposals.

3.4 Sustainable Accessibility

3.4.1 The purpose of this section is to outline the accessibility of the site by sustainable modes of transport, including by bicycle. By identifying the accessibility of the site by sustainable modes of transport, appropriate travel plan measures can be identified to promote travel by these modes.

3.5 Access by Bus

3.5.1 The closest bus stops located circa 130m away from the site access near the A65 New Road / Bentham Road junction with further bus stops at Laundry Lane serving the 581. Bus stops are provided in both directions, and are served by the following services:

- 80: Ingleton – Lancaster City Centre; and
- 581 (From Laundry Lane): The Craven – Kirkby Lonsdale (via Skipton and Ingleton).

3.5.2 The 909C "school bus" runs by the site from Kirkby Lonsdale to Settle during term-time.

3.5.3 A map illustrating the location of the bus stops and walking route from the site is provided in **Figure 3.1**, whilst the frequency of the service from the local bus stops to the site is summarised in **Table 3.1**.

Figure 3.1: Bus Stop Location and Walk Route

Table 3.1: Bus Timetable Summary

Service number	Route	Monday - Friday					Saturday	
		First	AM Peak	PM Peak	Last	per day	Peak	per day
80	Ingleton – Lancaster City Centre	07:15	0	0	13:25	4	0	3
	Lancaster City Centre – Ingleton	10:15	0	1	17:15	4	0	4
581	Kirkby Lonsdale – Skipton	07:10	1	1	16:55	8	0	0
	Skipton – Kirkby Lonsdale	09:35	0	1	18:35	8	0	0
Total			**1**	**3**	**-**	**32**	**0**	**7**

3.6 Access on Foot

3.6.1 Walking is the most important mode of travel at a local level and offers the greatest potential to replace short car journeys. The IHT Guidelines for Providing Journeys on Foot (IHT 2000) suggests that the acceptable walking distance to town centres is given as a range, from a desirable 200m to a preferred maximum of 2,000m.

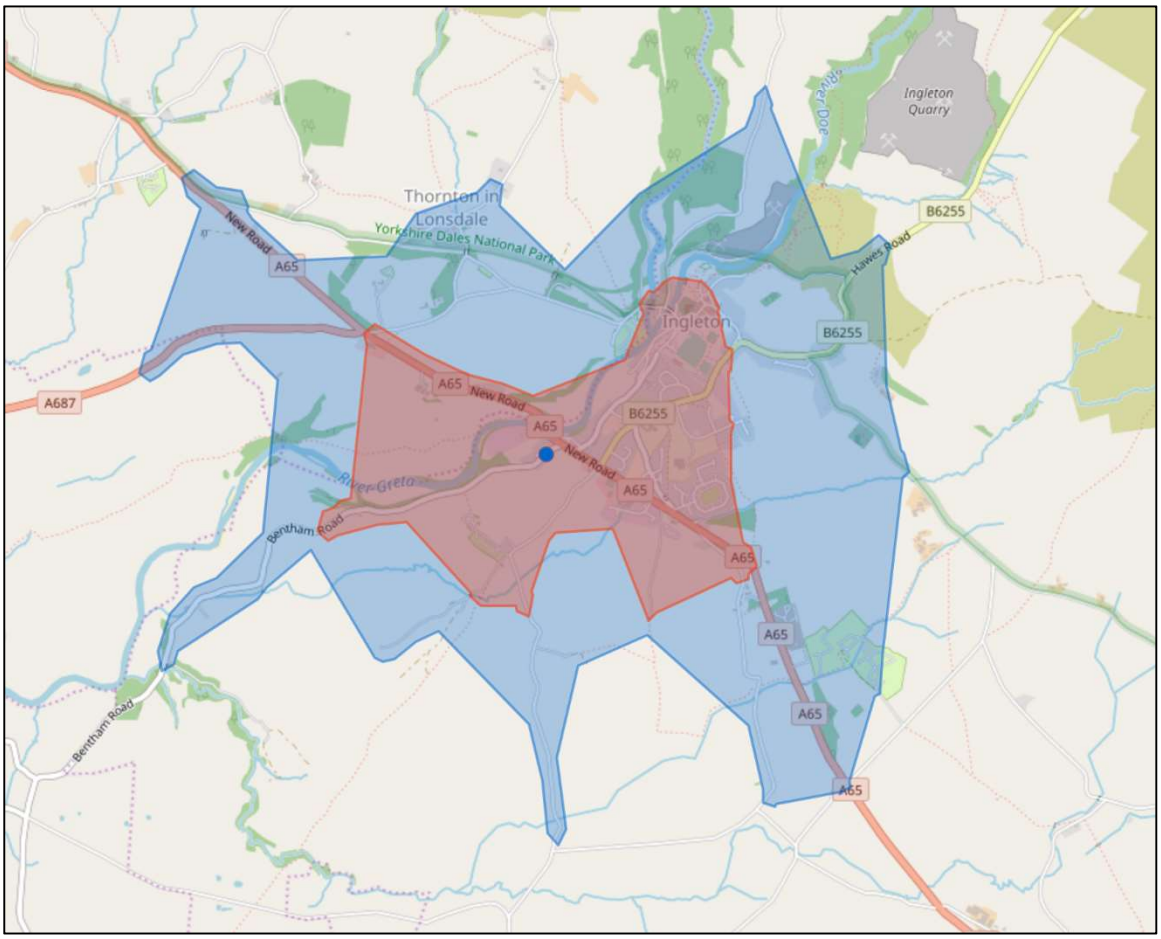
3.6.2 In terms of commuting journeys by foot, the desirable distance is 500m, the acceptable distance is 1,000m and the preferred maximum is 2,000m. However, the distance that people are prepared to walk depends upon many factors; there are obvious physical factors such as age, health and disabilities, along with factors concerning the quality of the route and the environment.

3.6.3 It is proposed that a minimum 1.2m footway is proposed from the site access linking into the existing footway at the A65. This will provide accessibility to the villages' amenities, services and importantly the existing bus stops.

3.6.4 **Figure 3.2** shows the 1km / 2km catchment from the site, which illustrates the areas which lie within a reasonable walking distance.

3.6.5 There are lit footways along both sides of the A65 New Road from the site to the village centre which provides a safe and convenient walking environment.

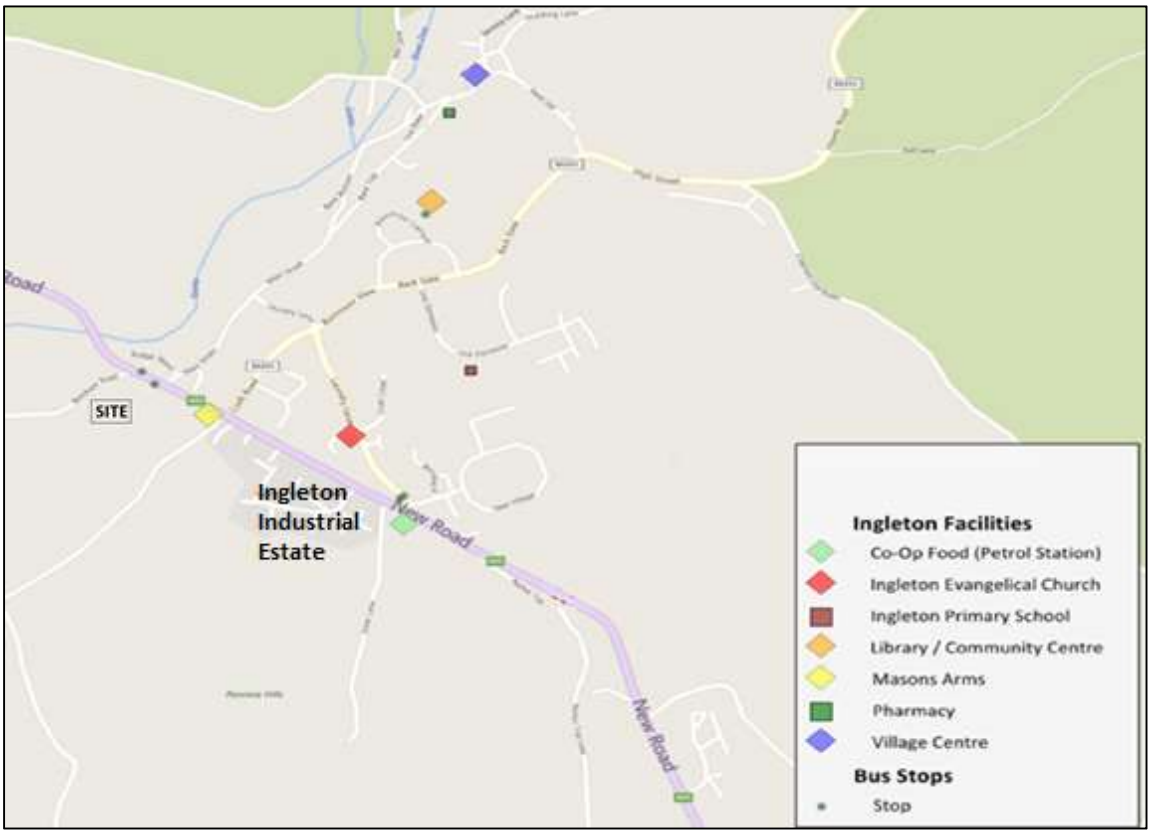
Figure 3.2: 1km / 2km Walking Catchment



3.6.1 The proximity of the site to the local public transport network provides opportunities to travel further afield using linked trips. This enables access to be gained to a variety of local destinations.

3.6.2 **Figure 3.3** illustrates the local facilities within walking distance of the developments.

Figure 3.3: Ingleton Amenities Plan



3.6.3 The Ingleton Industrial Estate is a short walk (450m) from the site. It is a 1.7ha Industrial Estate which one of the largest employment allocations in the northern part of the District with a range of occupiers providing multiple employment opportunities.

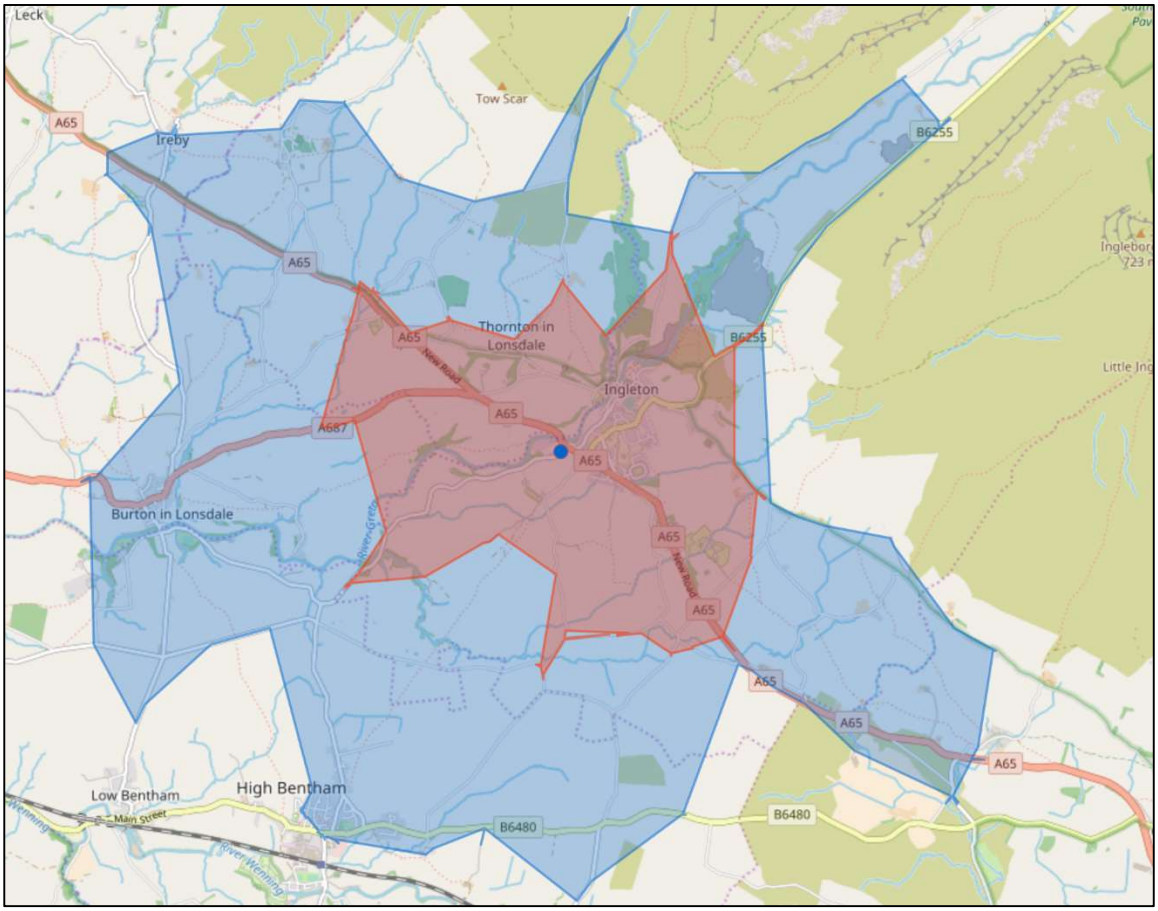
3.6.4 In summary, the site is accessible on foot, and with the proposed pedestrian crossing point linking to New Road in place, will reduce the requirement for residents to make short car journeys to access local amenities.

3.7 Access by Bicycle

3.7.1 It is widely recognised that cycling can act as a substitute for short car journeys, particularly those up to 5km in length. The general topography of area is reasonably flat, which should assist in encouraging visitors of the proposed development to travel by cycle.

3.7.2 **Figure 3.4** presents an extract of the 2.5km / 5km cycle catchment from the site. 5km is equivalent to a typical cycle time of 15-20 minutes, making it an achievable distance for most people.

Figure 3.4: 2.5km / 5km Cycle Catchment

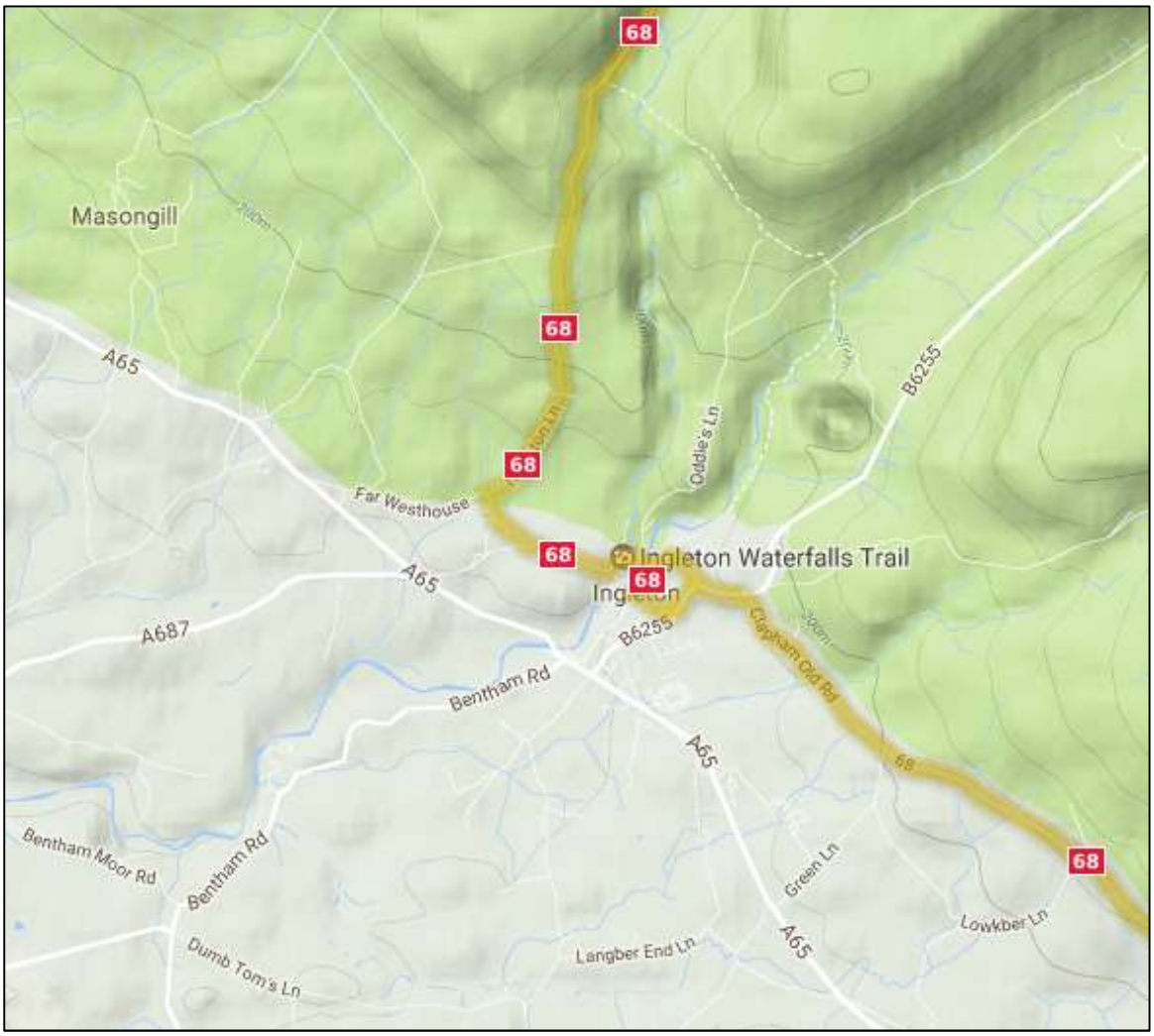


3.7.3 As can be seen from **Figure 3.4**, the whole of Ingleton in addition to the villages of Newby, High Bentham and Burton in Lonsdale are located within 5km of the site, providing additional amenities, facilities, schools and services. Within 5km of the developments the Yorkshire Dales National Park are also accessible.

3.7.4 There is no designated on-road or traffic free cycle routes within the vicinity of the site, however, National Route 68 can be located to the north of the developments, running through the village of Ingleton. Route 68 is known as the Pennine Cycleway. It runs up the spine of England and through three National Parks between Derby and Berwick-upon-Tweed.

3.7.5 **Figure 3.5** illustrates a SUSTRANS map which shows the available on-road and traffic free cycle routes within the development site.

Figure 3.5: SUSTRANS Cycle Map



3.7.6 Cycling would be viable mode of transport for residents living at the site and commuting to work.

3.8 Conclusions

3.8.1 In summary, the proposed development is accessible by sustainable travel modes, and is well located to make use of the existing public transport links and footways. With the proposed pedestrian crossing point linking to New Road in place, will reduce the requirement for residents to make short car journeys to access local amenities.

4.0 SUMMARY AND CONCLUSION

4.1 Summary

4.1.1 [redacted] has instructed Cora IHT to prepare a Transport Statement (TS) in support of the planning application for a residential development off Bentham Road in Ingleton.

4.1.2 The proposed development consists of 10 dwellings with access directly off Bentham Road.

4.1.3 In order to improve sustainable access to the site, a minimum 1.2m footway is proposed from the site access linking into the existing footway at the A65. The existing pedestrian crossing point to the east of the A65 / Bentham Road junction is also to be improved with dropped kerbs and tactile paving.

4.1.4 The National Planning Policy Framework [NPPF] (paragraph 32) states that "development should only be prevented or refused on transport grounds where the residual cumulative impacts on development are severe." The proposed development would generate minimal traffic levels, therefore, it can be concluded that it will not have a severe impact on the highway network.

4.1.5 The recorded accident data within the vicinity of the site does not indicate any existing highway safety patterns or problems.

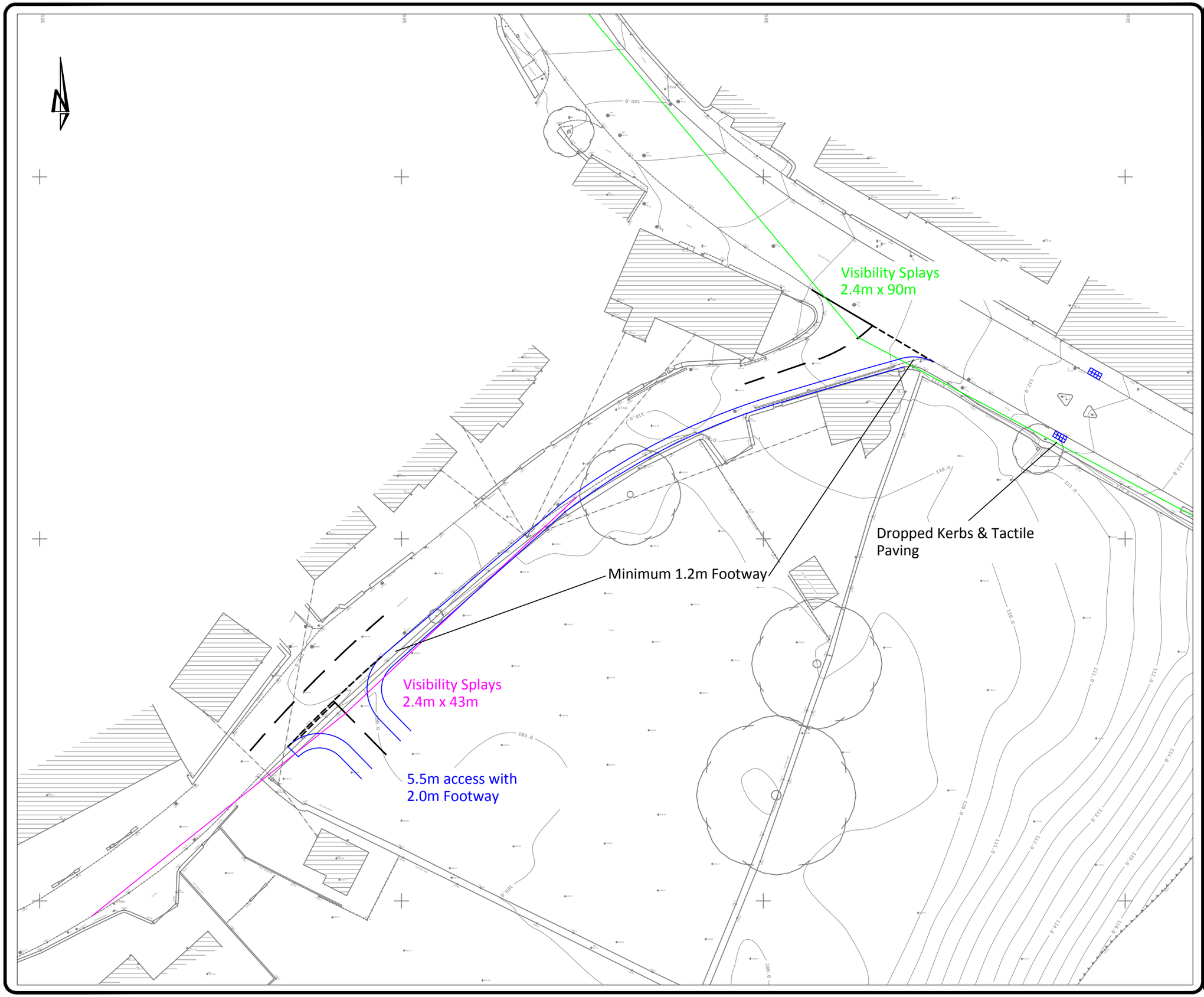
4.1.6 The proposed development is accessible by sustainable travel modes, and is well located to make use of the existing public transport links and footways.

4.2 Conclusion

4.2.1 It is concluded that the development proposals are acceptable in highways and transportation terms. There are no highways or transportation-related reasons upon which a refusal of the planning application for the proposals would be justified.

APPENDICES

APPENDIX A – ACCESS ARRANGEMENT



Notes:

1. All dimensions are to be checked on site before the commencement of works. Any discrepancies are to be reported to the Architect & Engineer for verification. Figured dimensions only are to be taken from this drawing.

2. This drawing is to be read in conjunction with all relevant Engineers' and Service Engineers' drawings and specifications. This drawing is copyright.

Rev	Date	Description	Ckd	By
A	31/01/18	Minor amendments	TC	LB

Adamson House, Towers Business Park
Wilmslow Road
Manchester
M20 2YY

Tel: [redacted]
Email: [redacted]
Web: www.coraliht.com

Client

[redacted]

Project

Bentham Road, Ingleton

Title

Proposed Site Access

Drawing Status

Job No. 16-1069

Drawn	Checked	Scale at A3	Date	Issue Date
LB	TC	1:1000	12/12/17	-

Drawing No. 001 A

APPENDIX B – SITE LAYOUT

Peter Harrison Architects T. [redacted] M. [redacted]

Hill Top Hall Gardens Kildwick Nr. Skipton North Yorkshire BD20 9AF

Land at Ingelton [redacted]

draft site layout

SCALE		DRWG. NO.	REV
1:200 @ A1	January 2018	121701	D

DO NOT SCALE FROM THIS DRAWING. FIGURED DIMENSIONS ONLY ARE TO BE USED.

APPENDIX C – TRICS OUTPUT

Calculation Reference: AUDIT-662801-180115-0150

TRIP RATE CALCULATION SELECTION PARAMETERS:

Land Use : 03 - RESIDENTIAL
Category : A - HOUSES PRIVATELY OWNED
MULTI-MODAL VEHICLES

Selected regions and areas:

02	SOUTH EAST		
	ES	EAST SUSSEX	1 days
	HC	HAMPSHIRE	1 days
	KC	KENT	1 days
	SC	SURREY	1 days
	WS	WEST SUSSEX	1 days
03	SOUTH WEST		
	DC	DORSET	1 days
	DV	DEVON	2 days
	SM	SOMERSET	1 days
	WL	WILTSHIRE	1 days
04	EAST ANGLIA		
	CA	CAMBRIDGESHIRE	1 days
	NF	NORFOLK	3 days
	SF	SUFFOLK	1 days
05	EAST MIDLANDS		
	LN	LINCOLNSHIRE	2 days
06	WEST MIDLANDS		
	SH	SHROPSHIRE	3 days
	ST	STAFFORDSHIRE	1 days
	WK	WARWICKSHIRE	1 days
07	YORKSHIRE & NORTH LINCOLNSHIRE		
	NY	NORTH YORKSHIRE	6 days
	SY	SOUTH YORKSHIRE	1 days
08	NORTH WEST		
	CH	CHESHIRE	2 days
	GM	GREATER MANCHESTER	1 days
	LC	LANCASHIRE	1 days
	MS	MERSEYSIDE	1 days
09	NORTH		
	CB	CUMBRIA	2 days
	DH	DURHAM	1 days
	TW	TYNE & WEAR	1 days
10	WALES		
	PS	POWYS	2 days
	VG	VALE OF GLAMORGAN	1 days

This section displays the number of survey days per TRICS® sub-region in the selected set

Secondary Filtering selection:

This data displays the chosen trip rate parameter and its selected range. Only sites that fall within the parameter range are included in the trip rate calculation.

Parameter:	Number of dwellings
Actual Range:	10 to 98 (units:)
Range Selected by User:	10 to 100 (units:)

Public Transport Provision:
Selection by: Include all surveys

Date Range: 01/01/09 to 27/11/17

This data displays the range of survey dates selected. Only surveys that were conducted within this date range are included in the trip rate calculation.

Selected survey days:

Monday	13 days
Tuesday	7 days
Wednesday	8 days
Thursday	7 days
Friday	6 days

This data displays the number of selected surveys by day of the week.

Selected survey types:

Manual count	41 days
Directional ATC Count	0 days

This data displays the number of manual classified surveys and the number of unclassified ATC surveys, the total adding up to the overall number of surveys in the selected set. Manual surveys are undertaken using staff, whilst ATC surveys are undertaking using machines.

Selected Locations:

Edge of Town Centre	6
Suburban Area (PPS6 Out of Centre)	19
Edge of Town	16

This data displays the number of surveys per main location category within the selected set. The main location categories consist of Free Standing, Edge of Town, Suburban Area, Neighbourhood Centre, Edge of Town Centre, Town Centre and Not Known.

Selected Location Sub Categories:

Residential Zone	37
No Sub Category	4

This data displays the number of surveys per location sub-category within the selected set. The location sub-categories consist of Commercial Zone, Industrial Zone, Development Zone, Residential Zone, Retail Zone, Built-Up Zone, Village, Out of Town, High Street and No Sub Category.

Secondary Filtering selection:

Use Class:

C1	1 days
C3	40 days

This data displays the number of surveys per Use Class classification within the selected set. The Use Classes Order 2005 has been used for this purpose, which can be found within the Library module of TRICS®.

Population within 1 mile:

1,001 to 5,000	3 days
5,001 to 10,000	13 days
10,001 to 15,000	10 days
15,001 to 20,000	6 days
20,001 to 25,000	3 days
25,001 to 50,000	6 days

This data displays the number of selected surveys within stated 1-mile radii of population.

Secondary Filtering selection (Cont.):

Population within 5 miles:

5,001 to 25,000	6 days
25,001 to 50,000	5 days
50,001 to 75,000	4 days
75,001 to 100,000	9 days
100,001 to 125,000	2 days
125,001 to 250,000	8 days
250,001 to 500,000	6 days
500,001 or More	1 days

This data displays the number of selected surveys within stated 5-mile radii of population.

Car ownership within 5 miles:

0.5 or Less	1 days
0.6 to 1.0	13 days
1.1 to 1.5	27 days

This data displays the number of selected surveys within stated ranges of average cars owned per residential dwelling, within a radius of 5-miles of selected survey sites.

Travel Plan:

Yes	3 days
No	38 days

This data displays the number of surveys within the selected set that were undertaken at sites with Travel Plans in place, and the number of surveys that were undertaken at sites without Travel Plans.

PTAL Rating:

No PTAL Present	41 days

This data displays the number of selected surveys with PTAL Ratings.

LIST OF SITES relevant to selection parameters

1 CA-03-A-05 DETACHED HOUSES CAMBRIDGESHIRE
EASTFIELD ROAD

PETERBOROUGH
Suburban Area (PPS6 Out of Centre)
Residential Zone
Total Number of dwellings: 28
Survey date: MONDAY *17/10/16* *Survey Type: MANUAL*

2 CB-03-A-04 SEMI DETACHED CUMBRIA
MOORCLOSE ROAD
SALTERBACK
WORKINGTON
Edge of Town
No Sub Category
Total Number of dwellings: 82
Survey date: FRIDAY *24/04/09* *Survey Type: MANUAL*

3 CB-03-A-05 DETACHED/TERRACED HOUSING CUMBRIA
MACADAM WAY

PENRITH
Edge of Town Centre
Residential Zone
Total Number of dwellings: 50
Survey date: TUESDAY *21/06/16* *Survey Type: MANUAL*

4 CH-03-A-08 DETACHED CHESHIRE
WHITCHURCH ROAD
BOUGHTON HEATH
CHESTER
Suburban Area (PPS6 Out of Centre)
Residential Zone
Total Number of dwellings: 11
Survey date: TUESDAY *22/05/12* *Survey Type: MANUAL*

5 CH-03-A-09 TERRACED HOUSES CHESHIRE
GREYSTOKE ROAD
HURDSFIELD
MACCLESFIELD
Edge of Town
Residential Zone
Total Number of dwellings: 24
Survey date: MONDAY *24/11/14* *Survey Type: MANUAL*

6 DC-03-A-08 BUNGALOWS DORSET
HURSTDENE ROAD
CASTLE LANE WEST
BOURNEMOUTH
Edge of Town
Residential Zone
Total Number of dwellings: 28
Survey date: MONDAY *24/03/14* *Survey Type: MANUAL*

7 DH-03-A-01 SEMI DETACHED DURHAM
GREENFIELDS ROAD

BISHOP AUCKLAND
Suburban Area (PPS6 Out of Centre)
Residential Zone
Total Number of dwellings: 50
Survey date: TUESDAY *28/03/17* *Survey Type: MANUAL*

8 DV-03-A-01 TERRACED HOUSES DEVON
BRONSHILL ROAD

TORQUAY
Suburban Area (PPS6 Out of Centre)
Residential Zone
Total Number of dwellings: 37
Survey date: WEDNESDAY *30/09/15* *Survey Type: MANUAL*

LIST OF SITES relevant to selection parameters (Cont.)

9 DV-03-A-03 TERRACED & SEMI DETACHED DEVON
LOWER BRAND LANE

HONITON
Suburban Area (PPS6 Out of Centre)
Residential Zone
Total Number of dwellings: 70
Survey date: MONDAY *28/09/15* *Survey Type: MANUAL*

10 ES-03-A-02 PRIVATE HOUSING EAST SUSSEX
SOUTH COAST ROAD

PEACEHAVEN
Edge of Town
Residential Zone
Total Number of dwellings: 37
Survey date: FRIDAY *18/11/11* *Survey Type: MANUAL*

11 GM-03-A-10 DETACHED/SEMI GREATER MANCHESTER
BUTT HILL DRIVE
PRESTWICH
MANCHESTER
Edge of Town
Residential Zone
Total Number of dwellings: 29
Survey date: WEDNESDAY *12/10/11* *Survey Type: MANUAL*

12 HC-03-A-19 HOUSES & FLATS HAMPSHIRE
CANADA WAY

LIPHOOK
Suburban Area (PPS6 Out of Centre)
Residential Zone
Total Number of dwellings: 62
Survey date: MONDAY *27/11/17* *Survey Type: MANUAL*

13 KC-03-A-03 MIXED HOUSES & FLATS KENT
HYTHE ROAD
WILLESBOROUGH
ASHFORD
Suburban Area (PPS6 Out of Centre)
Residential Zone
Total Number of dwellings: 51
Survey date: THURSDAY *14/07/16* *Survey Type: MANUAL*

14 LC-03-A-30 SEMI-DETACHED LANCASHIRE
WATSON ROAD

BLACKPOOL
Edge of Town Centre
Residential Zone
Total Number of dwellings: 24
Survey date: FRIDAY *14/06/13* *Survey Type: MANUAL*

15 LN-03-A-03 SEMI DETACHED LINCOLNSHIRE
ROOKERY LANE
BOULTHAM
LINCOLN
Suburban Area (PPS6 Out of Centre)
Residential Zone
Total Number of dwellings: 22
Survey date: TUESDAY *18/09/12* *Survey Type: MANUAL*

16 LN-03-A-04 DETACHED & SEMI-DETACHED LINCOLNSHIRE
EGERTON ROAD

LINCOLN
Edge of Town Centre
Residential Zone
Total Number of dwellings: 30
Survey date: MONDAY *29/06/15* *Survey Type: MANUAL*

17 MS-03-A-03 DETACHED MERSEYSIDE
BEMPTON ROAD
OTTERSPOOL
LIVERPOOL
Suburban Area (PPS6 Out of Centre)
Residential Zone
Total Number of dwellings: 15
Survey date: FRIDAY *21/06/13* *Survey Type: MANUAL*

LIST OF SITES relevant to selection parameters (Cont.)

18 NF-03-A-01 SEMI DET. & BUNGALOWS NORFOLK
YARMOUTH ROAD

CAISTER-ON-SEA
Suburban Area (PPS6 Out of Centre)
Residential Zone
Total Number of dwellings: 27
Survey date: TUESDAY *16/10/12* *Survey Type: MANUAL*

19 NF-03-A-02 HOUSES & FLATS NORFOLK
DEREHAM ROAD

NORWICH
Suburban Area (PPS6 Out of Centre)
Residential Zone
Total Number of dwellings: 98
Survey date: MONDAY *22/10/12* *Survey Type: MANUAL*

20 NF-03-A-03 DETACHED HOUSES NORFOLK
HALING WAY

THETFORD
Edge of Town
Residential Zone
Total Number of dwellings: 10
Survey date: WEDNESDAY *16/09/15* *Survey Type: MANUAL*

21 NY-03-A-08 TERRACED HOUSES NORTH YORKSHIRE
NICHOLAS STREET

YORK
Suburban Area (PPS6 Out of Centre)
Residential Zone
Total Number of dwellings: 21
Survey date: MONDAY *16/09/13* *Survey Type: MANUAL*

22 NY-03-A-09 MIXED HOUSING NORTH YORKSHIRE
GRAMMAR SCHOOL LANE

NORTHALLERTON
Suburban Area (PPS6 Out of Centre)
Residential Zone
Total Number of dwellings: 52
Survey date: MONDAY *16/09/13* *Survey Type: MANUAL*

23 NY-03-A-10 HOUSES AND FLATS NORTH YORKSHIRE
BOROUGHBRIDGE ROAD

RIPON
Edge of Town
No Sub Category
Total Number of dwellings: 71
Survey date: TUESDAY *17/09/13* *Survey Type: MANUAL*

24 NY-03-A-11 PRIVATE HOUSING NORTH YORKSHIRE
HORSEFAIR

BOROUGHBRIDGE
Edge of Town
Residential Zone
Total Number of dwellings: 23
Survey date: WEDNESDAY *18/09/13* *Survey Type: MANUAL*

25 NY-03-A-12 TOWN HOUSES NORTH YORKSHIRE
RACECOURSE LANE

NORTHALLERTON
Edge of Town Centre
Residential Zone
Total Number of dwellings: 47
Survey date: TUESDAY *27/09/16* *Survey Type: MANUAL*

LIST OF SITES relevant to selection parameters (Cont.)

26 NY-03-A-13 TERRACED HOUSES NORTH YORKSHIRE
CATTERICK ROAD
OLD HOSPITAL COMPOUND
CATTERICK GARRISON
Suburban Area (PPS6 Out of Centre)
Residential Zone
Total Number of dwellings: 10
Survey date: WEDNESDAY 10/05/17 Survey Type: MANUAL

27 PS-03-A-01 MIXED HOUSES POWYS
BRYN GLAS

WELSHPOOL
Edge of Town Centre
Residential Zone
Total Number of dwellings: 16
Survey date: MONDAY 11/05/15 Survey Type: MANUAL

28 PS-03-A-02 DETACHED/SEMI-DETACHED POWYS
GUNROG ROAD

WELSHPOOL
Suburban Area (PPS6 Out of Centre)
Residential Zone
Total Number of dwellings: 28
Survey date: MONDAY 11/05/15 Survey Type: MANUAL

29 SC-03-A-04 DETACHED & TERRACED SURREY
HIGH ROAD

BYFLEET
Edge of Town
Residential Zone
Total Number of dwellings: 71
Survey date: THURSDAY 23/01/14 Survey Type: MANUAL

30 SF-03-A-05 DETACHED HOUSES SUFFOLK
VALE LANE

BURY ST EDMUNDS
Edge of Town
Residential Zone
Total Number of dwellings: 18
Survey date: WEDNESDAY 09/09/15 Survey Type: MANUAL

31 SH-03-A-03 DETATCHED SHROPSHIRE
SOMERBY DRIVE
BICTON HEATH
SHREWSBURY
Edge of Town
No Sub Category
Total Number of dwellings: 10
Survey date: FRIDAY 26/06/09 Survey Type: MANUAL

32 SH-03-A-05 SEMI-DETACHED/TERRACED SHROPSHIRE
SANDCROFT
SUTTON HILL
TELFORD
Edge of Town
Residential Zone
Total Number of dwellings: 54
Survey date: THURSDAY 24/10/13 Survey Type: MANUAL

33 SH-03-A-06 BUNGALOWS SHROPSHIRE
ELLESMERE ROAD

SHREWSBURY
Edge of Town
Residential Zone
Total Number of dwellings: 16
Survey date: THURSDAY 22/05/14 Survey Type: MANUAL

34 SM-03-A-01 DETACHED & SEMI SOMERSET
WEMBDON ROAD
NORTHFIELD
BRIDGWATER
Edge of Town
Residential Zone
Total Number of dwellings: 33
Survey date: THURSDAY 24/09/15 Survey Type: MANUAL

LIST OF SITES relevant to selection parameters (Cont.)

35 ST-03-A-06 SEMI-DET. & TERRACED STAFFORDSHIRE
STANFORD ROAD
BLAKENHALL
WOLVERHAMPTON
Edge of Town Centre
No Sub Category
Total Number of dwellings: 17
Survey date: FRIDAY *09/05/14* *Survey Type: MANUAL*

36 SY-03-A-01 SEMI DETACHED HOUSES SOUTH YORKSHIRE
A19 BENTLEY ROAD
BENTLEY RISE
DONCASTER
Suburban Area (PPS6 Out of Centre)
Residential Zone
Total Number of dwellings: 54
Survey date: WEDNESDAY *18/09/13* *Survey Type: MANUAL*

37 TW-03-A-02 SEMI-DETACHED TYNE & WEAR
WEST PARK ROAD

GATESHEAD
Suburban Area (PPS6 Out of Centre)
Residential Zone
Total Number of dwellings: 16
Survey date: MONDAY *07/10/13* *Survey Type: MANUAL*

38 VG-03-A-01 SEMI-DETACHED & TERRACED VALE OF GLAMORGAN
ARTHUR STREET

BARRY
Edge of Town
Residential Zone
Total Number of dwellings: 12
Survey date: MONDAY *08/05/17* *Survey Type: MANUAL*

39 WK-03-A-02 BUNGALOWS WARWICKSHIRE
NARBERTH WAY
POTTERS GREEN
COVENTRY
Edge of Town
Residential Zone
Total Number of dwellings: 17
Survey date: THURSDAY *17/10/13* *Survey Type: MANUAL*

40 WL-03-A-02 SEMI DETACHED WILTSHIRE
HEADLANDS GROVE

SWINDON
Suburban Area (PPS6 Out of Centre)
Residential Zone
Total Number of dwellings: 27
Survey date: THURSDAY *22/09/16* *Survey Type: MANUAL*

41 WS-03-A-05 TERRACED & FLATS WEST SUSSEX
UPPER SHOREHAM ROAD

SHOREHAM BY SEA
Suburban Area (PPS6 Out of Centre)
Residential Zone
Total Number of dwellings: 48
Survey date: WEDNESDAY *18/04/12* *Survey Type: MANUAL*

This section provides a list of all survey sites and days in the selected set. For each individual survey site, it displays a unique site reference code and site address, the selected trip rate calculation parameter and its value, the day of the week and date of each survey, and whether the survey was a manual classified count or an ATC count.

TRIP RATE for Land Use 03 - RESIDENTIAL/A - HOUSES PRIVATELY OWNED
MULTI-MODAL VEHICLES
Calculation factor: 1 DWELLS
BOLD print indicates peak (busiest) period

	ARRIVALS			DEPARTURES			TOTALS		
Time Range	No. Days	Ave. DWELLS	Trip Rate	No. Days	Ave. DWELLS	Trip Rate	No. Days	Ave. DWELLS	Trip Rate
00:00 - 01:00									
01:00 - 02:00									
02:00 - 03:00									
03:00 - 04:00									
04:00 - 05:00									
05:00 - 06:00									
06:00 - 07:00									
07:00 - 08:00	41	35	0.086	41	35	0.286	41	35	0.372
08:00 - 09:00	41	35	0.149	41	35	0.390	41	35	0.539
09:00 - 10:00	41	35	0.150	41	35	0.179	41	35	0.329
10:00 - 11:00	41	35	0.136	41	35	0.148	41	35	0.284
11:00 - 12:00	41	35	0.156	41	35	0.163	41	35	0.319
12:00 - 13:00	41	35	0.173	41	35	0.171	41	35	0.344
13:00 - 14:00	41	35	0.166	41	35	0.173	41	35	0.339
14:00 - 15:00	41	35	0.163	41	35	0.188	41	35	0.351
15:00 - 16:00	41	35	0.252	41	35	0.189	41	35	0.441
16:00 - 17:00	41	35	0.294	41	35	0.176	41	35	0.470
17:00 - 18:00	41	35	0.341	41	35	0.160	41	35	0.501
18:00 - 19:00	41	35	0.228	41	35	0.156	41	35	0.384
19:00 - 20:00									
20:00 - 21:00									
21:00 - 22:00									
22:00 - 23:00									
23:00 - 24:00									
Total Rates:			2.294			2.379			4.673

This section displays the trip rate results based on the selected set of surveys and the selected count type (shown just above the table). It is split by three main columns, representing arrivals trips, departures trips, and total trips (arrivals plus departures). Within each of these main columns are three sub-columns. These display the number of survey days where count data is included (per time period), the average value of the selected trip rate calculation parameter (per time period), and the trip rate result (per time period). Total trip rates (the sum of the column) are also displayed at the foot of the table.

*To obtain a trip rate, the average (mean) trip rate parameter value (TRP) is first calculated for all selected survey days that have count data available for the stated time period. The average (mean) number of arrivals, departures or totals (whichever applies) is also calculated (COUNT) for all selected survey days that have count data available for the stated time period. Then, the average count is divided by the average trip rate parameter value, and multiplied by the stated calculation factor (shown just above the table and abbreviated here as FACT). So, the method is: COUNT/TRP*FACT. Trip rates are then rounded to 3 decimal places.*

Parameter summary

Trip rate parameter range selected:	10 - 98 (units:)
Survey date date range:	01/01/09 - 27/11/17
Number of weekdays (Monday-Friday):	41
Number of Saturdays:	0
Number of Sundays:	0
Surveys automatically removed from selection:	2
Surveys manually removed from selection:	0

This section displays a quick summary of some of the data filtering selections made by the TRICS® user. The trip rate calculation parameter range of all selected surveys is displayed first, followed by the range of minimum and maximum survey dates selected by the user. Then, the total number of selected weekdays and weekend days in the selected set of surveys are show. Finally, the number of survey days that have been manually removed from the selected set outside of the standard filtering procedure are displayed.

TRIP RATE for Land Use 03 - RESIDENTIAL/A - HOUSES PRIVATELY OWNED
MULTI-MODAL TAXIS
Calculation factor: 1 DWELLS
BOLD print indicates peak (busiest) period

	ARRIVALS			DEPARTURES			TOTALS		
Time Range	No. Days	Ave. DWELLS	Trip Rate	No. Days	Ave. DWELLS	Trip Rate	No. Days	Ave. DWELLS	Trip Rate
00:00 - 01:00									
01:00 - 02:00									
02:00 - 03:00									
03:00 - 04:00									
04:00 - 05:00									
05:00 - 06:00									
06:00 - 07:00									
07:00 - 08:00	41	35	0.003	41	35	0.004	41	35	0.007
08:00 - 09:00	41	35	0.006	41	35	0.006	41	35	0.012
09:00 - 10:00	41	35	0.005	41	35	0.003	41	35	0.008
10:00 - 11:00	41	35	0.003	41	35	0.004	41	35	0.007
11:00 - 12:00	41	35	0.003	41	35	0.003	41	35	0.006
12:00 - 13:00	41	35	0.002	41	35	0.001	41	35	0.003
13:00 - 14:00	41	35	0.003	41	35	0.003	41	35	0.006
14:00 - 15:00	41	35	0.003	41	35	0.003	41	35	0.006
15:00 - 16:00	41	35	0.005	41	35	0.006	41	35	0.011
16:00 - 17:00	41	35	0.002	41	35	0.003	41	35	0.005
17:00 - 18:00	41	35	0.003	41	35	0.002	41	35	0.005
18:00 - 19:00	41	35	0.003	41	35	0.004	41	35	0.007
19:00 - 20:00									
20:00 - 21:00									
21:00 - 22:00									
22:00 - 23:00									
23:00 - 24:00									
Total Rates:			0.041			0.042			0.083

This section displays the trip rate results based on the selected set of surveys and the selected count type (shown just above the table). It is split by three main columns, representing arrivals trips, departures trips, and total trips (arrivals plus departures). Within each of these main columns are three sub-columns. These display the number of survey days where count data is included (per time period), the average value of the selected trip rate calculation parameter (per time period), and the trip rate result (per time period). Total trip rates (the sum of the column) are also displayed at the foot of the table.

*To obtain a trip rate, the average (mean) trip rate parameter value (TRP) is first calculated for all selected survey days that have count data available for the stated time period. The average (mean) number of arrivals, departures or totals (whichever applies) is also calculated (COUNT) for all selected survey days that have count data available for the stated time period. Then, the average count is divided by the average trip rate parameter value, and multiplied by the stated calculation factor (shown just above the table and abbreviated here as FACT). So, the method is: COUNT/TRP*FACT. Trip rates are then rounded to 3 decimal places.*

Parameter summary

Trip rate parameter range selected:	10 - 98 (units:)
Survey date date range:	01/01/09 - 27/11/17
Number of weekdays (Monday-Friday):	41
Number of Saturdays:	0
Number of Sundays:	0
Surveys automatically removed from selection:	2
Surveys manually removed from selection:	0

This section displays a quick summary of some of the data filtering selections made by the TRICS® user. The trip rate calculation parameter range of all selected surveys is displayed first, followed by the range of minimum and maximum survey dates selected by the user. Then, the total number of selected weekdays and weekend days in the selected set of surveys are show. Finally, the number of survey days that have been manually removed from the selected set outside of the standard filtering procedure are displayed.

TRIP RATE for Land Use 03 - RESIDENTIAL/A - HOUSES PRIVATELY OWNED
MULTI-MODAL OGVS
Calculation factor: 1 DWELLS
BOLD print indicates peak (busiest) period

	ARRIVALS			DEPARTURES			TOTALS		
Time Range	No. Days	Ave. DWELLS	Trip Rate	No. Days	Ave. DWELLS	Trip Rate	No. Days	Ave. DWELLS	Trip Rate
00:00 - 01:00									
01:00 - 02:00									
02:00 - 03:00									
03:00 - 04:00									
04:00 - 05:00									
05:00 - 06:00									
06:00 - 07:00									
07:00 - 08:00	41	35	0.001	41	35	0.001	41	35	0.002
08:00 - 09:00	41	35	0.005	41	35	0.004	41	35	0.009
09:00 - 10:00	41	35	0.004	41	35	0.004	41	35	0.008
10:00 - 11:00	41	35	0.003	41	35	0.002	41	35	0.005
11:00 - 12:00	41	35	0.003	41	35	0.003	41	35	0.006
12:00 - 13:00	41	35	0.001	41	35	0.001	41	35	0.002
13:00 - 14:00	41	35	0.003	41	35	0.002	41	35	0.005
14:00 - 15:00	41	35	0.001	41	35	0.002	41	35	0.003
15:00 - 16:00	41	35	0.001	41	35	0.001	41	35	0.002
16:00 - 17:00	41	35	0.001	41	35	0.001	41	35	0.002
17:00 - 18:00	41	35	0.002	41	35	0.002	41	35	0.004
18:00 - 19:00	41	35	0.000	41	35	0.000	41	35	0.000
19:00 - 20:00									
20:00 - 21:00									
21:00 - 22:00									
22:00 - 23:00									
23:00 - 24:00									
Total Rates:			0.025			0.023			0.048

This section displays the trip rate results based on the selected set of surveys and the selected count type (shown just above the table). It is split by three main columns, representing arrivals trips, departures trips, and total trips (arrivals plus departures). Within each of these main columns are three sub-columns. These display the number of survey days where count data is included (per time period), the average value of the selected trip rate calculation parameter (per time period), and the trip rate result (per time period). Total trip rates (the sum of the column) are also displayed at the foot of the table.

*To obtain a trip rate, the average (mean) trip rate parameter value (TRP) is first calculated for all selected survey days that have count data available for the stated time period. The average (mean) number of arrivals, departures or totals (whichever applies) is also calculated (COUNT) for all selected survey days that have count data available for the stated time period. Then, the average count is divided by the average trip rate parameter value, and multiplied by the stated calculation factor (shown just above the table and abbreviated here as FACT). So, the method is: COUNT/TRP*FACT. Trip rates are then rounded to 3 decimal places.*

Parameter summary

Trip rate parameter range selected:	10 - 98 (units:)
Survey date date range:	01/01/09 - 27/11/17
Number of weekdays (Monday-Friday):	41
Number of Saturdays:	0
Number of Sundays:	0
Surveys automatically removed from selection:	2
Surveys manually removed from selection:	0

This section displays a quick summary of some of the data filtering selections made by the TRICS® user. The trip rate calculation parameter range of all selected surveys is displayed first, followed by the range of minimum and maximum survey dates selected by the user. Then, the total number of selected weekdays and weekend days in the selected set of surveys are show. Finally, the number of survey days that have been manually removed from the selected set outside of the standard filtering procedure are displayed.

TRIP RATE for Land Use 03 - RESIDENTIAL/A - HOUSES PRIVATELY OWNED
MULTI-MODAL PSVS
Calculation factor: 1 DWELLS
BOLD print indicates peak (busiest) period

	ARRIVALS			DEPARTURES			TOTALS		
Time Range	No. Days	Ave. DWELLS	Trip Rate	No. Days	Ave. DWELLS	Trip Rate	No. Days	Ave. DWELLS	Trip Rate
00:00 - 01:00									
01:00 - 02:00									
02:00 - 03:00									
03:00 - 04:00									
04:00 - 05:00									
05:00 - 06:00									
06:00 - 07:00									
07:00 - 08:00	41	35	0.000	41	35	0.000	41	35	0.000
08:00 - 09:00	41	35	0.001	41	35	0.001	41	35	0.002
09:00 - 10:00	41	35	0.000	41	35	0.000	41	35	0.000
10:00 - 11:00	41	35	0.000	41	35	0.000	41	35	0.000
11:00 - 12:00	41	35	0.001	41	35	0.001	41	35	0.002
12:00 - 13:00	41	35	0.000	41	35	0.000	41	35	0.000
13:00 - 14:00	41	35	0.000	41	35	0.000	41	35	0.000
14:00 - 15:00	41	35	0.000	41	35	0.000	41	35	0.000
15:00 - 16:00	41	35	0.001	41	35	0.001	41	35	0.002
16:00 - 17:00	41	35	0.000	41	35	0.000	41	35	0.000
17:00 - 18:00	41	35	0.000	41	35	0.000	41	35	0.000
18:00 - 19:00	41	35	0.000	41	35	0.000	41	35	0.000
19:00 - 20:00									
20:00 - 21:00									
21:00 - 22:00									
22:00 - 23:00									
23:00 - 24:00									
Total Rates:			0.003			0.003			0.006

This section displays the trip rate results based on the selected set of surveys and the selected count type (shown just above the table). It is split by three main columns, representing arrivals trips, departures trips, and total trips (arrivals plus departures). Within each of these main columns are three sub-columns. These display the number of survey days where count data is included (per time period), the average value of the selected trip rate calculation parameter (per time period), and the trip rate result (per time period). Total trip rates (the sum of the column) are also displayed at the foot of the table.

*To obtain a trip rate, the average (mean) trip rate parameter value (TRP) is first calculated for all selected survey days that have count data available for the stated time period. The average (mean) number of arrivals, departures or totals (whichever applies) is also calculated (COUNT) for all selected survey days that have count data available for the stated time period. Then, the average count is divided by the average trip rate parameter value, and multiplied by the stated calculation factor (shown just above the table and abbreviated here as FACT). So, the method is: COUNT/TRP*FACT. Trip rates are then rounded to 3 decimal places.*

Parameter summary

Trip rate parameter range selected:	10 - 98 (units:)
Survey date date range:	01/01/09 - 27/11/17
Number of weekdays (Monday-Friday):	41
Number of Saturdays:	0
Number of Sundays:	0
Surveys automatically removed from selection:	2
Surveys manually removed from selection:	0

This section displays a quick summary of some of the data filtering selections made by the TRICS® user. The trip rate calculation parameter range of all selected surveys is displayed first, followed by the range of minimum and maximum survey dates selected by the user. Then, the total number of selected weekdays and weekend days in the selected set of surveys are show. Finally, the number of survey days that have been manually removed from the selected set outside of the standard filtering procedure are displayed.

TRIP RATE for Land Use 03 - RESIDENTIAL/A - HOUSES PRIVATELY OWNED
MULTI-MODAL CYCLISTS
Calculation factor: 1 DWELLS
BOLD print indicates peak (busiest) period

	ARRIVALS			DEPARTURES			TOTALS		
Time Range	No. Days	Ave. DWELLS	Trip Rate	No. Days	Ave. DWELLS	Trip Rate	No. Days	Ave. DWELLS	Trip Rate
00:00 - 01:00									
01:00 - 02:00									
02:00 - 03:00									
03:00 - 04:00									
04:00 - 05:00									
05:00 - 06:00									
06:00 - 07:00									
07:00 - 08:00	41	35	0.008	41	35	0.025	41	35	0.033
08:00 - 09:00	41	35	0.002	41	35	0.026	41	35	0.028
09:00 - 10:00	41	35	0.002	41	35	0.008	41	35	0.010
10:00 - 11:00	41	35	0.004	41	35	0.010	41	35	0.014
11:00 - 12:00	41	35	0.003	41	35	0.004	41	35	0.007
12:00 - 13:00	41	35	0.008	41	35	0.005	41	35	0.013
13:00 - 14:00	41	35	0.007	41	35	0.002	41	35	0.009
14:00 - 15:00	41	35	0.005	41	35	0.008	41	35	0.013
15:00 - 16:00	41	35	0.022	41	35	0.003	41	35	0.025
16:00 - 17:00	41	35	0.019	41	35	0.005	41	35	0.024
17:00 - 18:00	41	35	0.023	41	35	0.008	41	35	0.031
18:00 - 19:00	41	35	0.010	41	35	0.007	41	35	0.017
19:00 - 20:00									
20:00 - 21:00									
21:00 - 22:00									
22:00 - 23:00									
23:00 - 24:00									
Total Rates:			0.113			0.111			0.224

This section displays the trip rate results based on the selected set of surveys and the selected count type (shown just above the table). It is split by three main columns, representing arrivals trips, departures trips, and total trips (arrivals plus departures). Within each of these main columns are three sub-columns. These display the number of survey days where count data is included (per time period), the average value of the selected trip rate calculation parameter (per time period), and the trip rate result (per time period). Total trip rates (the sum of the column) are also displayed at the foot of the table.

*To obtain a trip rate, the average (mean) trip rate parameter value (TRP) is first calculated for all selected survey days that have count data available for the stated time period. The average (mean) number of arrivals, departures or totals (whichever applies) is also calculated (COUNT) for all selected survey days that have count data available for the stated time period. Then, the average count is divided by the average trip rate parameter value, and multiplied by the stated calculation factor (shown just above the table and abbreviated here as FACT). So, the method is: COUNT/TRP*FACT. Trip rates are then rounded to 3 decimal places.*

Parameter summary

Trip rate parameter range selected:	10 - 98 (units:)
Survey date date range:	01/01/09 - 27/11/17
Number of weekdays (Monday-Friday):	41
Number of Saturdays:	0
Number of Sundays:	0
Surveys automatically removed from selection:	2
Surveys manually removed from selection:	0

This section displays a quick summary of some of the data filtering selections made by the TRICS® user. The trip rate calculation parameter range of all selected surveys is displayed first, followed by the range of minimum and maximum survey dates selected by the user. Then, the total number of selected weekdays and weekend days in the selected set of surveys are show. Finally, the number of survey days that have been manually removed from the selected set outside of the standard filtering procedure are displayed.

TRIP RATE for Land Use 03 - RESIDENTIAL/A - HOUSES PRIVATELY OWNED
MULTI-MODAL VEHICLE OCCUPANTS
Calculation factor: 1 DWELLS
BOLD print indicates peak (busiest) period

	ARRIVALS			DEPARTURES			TOTALS		
Time Range	No. Days	Ave. DWELLS	Trip Rate	No. Days	Ave. DWELLS	Trip Rate	No. Days	Ave. DWELLS	Trip Rate
00:00 - 01:00									
01:00 - 02:00									
02:00 - 03:00									
03:00 - 04:00									
04:00 - 05:00									
05:00 - 06:00									
06:00 - 07:00									
07:00 - 08:00	41	35	0.100	41	35	0.353	41	35	0.453
08:00 - 09:00	41	35	0.190	41	35	0.571	41	35	0.761
09:00 - 10:00	41	35	0.179	41	35	0.230	41	35	0.409
10:00 - 11:00	41	35	0.170	41	35	0.194	41	35	0.364
11:00 - 12:00	41	35	0.198	41	35	0.200	41	35	0.398
12:00 - 13:00	41	35	0.220	41	35	0.217	41	35	0.437
13:00 - 14:00	41	35	0.199	41	35	0.223	41	35	0.422
14:00 - 15:00	41	35	0.211	41	35	0.235	41	35	0.446
15:00 - 16:00	41	35	0.394	41	35	0.247	41	35	0.641
16:00 - 17:00	41	35	0.413	41	35	0.235	41	35	0.648
17:00 - 18:00	41	35	0.468	41	35	0.207	41	35	0.675
18:00 - 19:00	41	35	0.297	41	35	0.209	41	35	0.506
19:00 - 20:00									
20:00 - 21:00									
21:00 - 22:00									
22:00 - 23:00									
23:00 - 24:00									
Total Rates:			3.039			3.121			6.160

This section displays the trip rate results based on the selected set of surveys and the selected count type (shown just above the table). It is split by three main columns, representing arrivals trips, departures trips, and total trips (arrivals plus departures). Within each of these main columns are three sub-columns. These display the number of survey days where count data is included (per time period), the average value of the selected trip rate calculation parameter (per time period), and the trip rate result (per time period). Total trip rates (the sum of the column) are also displayed at the foot of the table.

*To obtain a trip rate, the average (mean) trip rate parameter value (TRP) is first calculated for all selected survey days that have count data available for the stated time period. The average (mean) number of arrivals, departures or totals (whichever applies) is also calculated (COUNT) for all selected survey days that have count data available for the stated time period. Then, the average count is divided by the average trip rate parameter value, and multiplied by the stated calculation factor (shown just above the table and abbreviated here as FACT). So, the method is: COUNT/TRP*FACT. Trip rates are then rounded to 3 decimal places.*

Parameter summary

Trip rate parameter range selected:	10 - 98 (units:)
Survey date date range:	01/01/09 - 27/11/17
Number of weekdays (Monday-Friday):	41
Number of Saturdays:	0
Number of Sundays:	0
Surveys automatically removed from selection:	2
Surveys manually removed from selection:	0

This section displays a quick summary of some of the data filtering selections made by the TRICS® user. The trip rate calculation parameter range of all selected surveys is displayed first, followed by the range of minimum and maximum survey dates selected by the user. Then, the total number of selected weekdays and weekend days in the selected set of surveys are show. Finally, the number of survey days that have been manually removed from the selected set outside of the standard filtering procedure are displayed.

TRIP RATE for Land Use 03 - RESIDENTIAL/A - HOUSES PRIVATELY OWNED
MULTI-MODAL PEDESTRIANS
Calculation factor: 1 DWELLS
BOLD print indicates peak (busiest) period

	ARRIVALS			DEPARTURES			TOTALS		
Time Range	No. Days	Ave. DWELLS	Trip Rate	No. Days	Ave. DWELLS	Trip Rate	No. Days	Ave. DWELLS	Trip Rate
00:00 - 01:00									
01:00 - 02:00									
02:00 - 03:00									
03:00 - 04:00									
04:00 - 05:00									
05:00 - 06:00									
06:00 - 07:00									
07:00 - 08:00	41	35	0.018	41	35	0.075	41	35	0.093
08:00 - 09:00	41	35	0.055	41	35	0.182	41	35	0.237
09:00 - 10:00	41	35	0.048	41	35	0.067	41	35	0.115
10:00 - 11:00	41	35	0.047	41	35	0.068	41	35	0.115
11:00 - 12:00	41	35	0.054	41	35	0.047	41	35	0.101
12:00 - 13:00	41	35	0.059	41	35	0.048	41	35	0.107
13:00 - 14:00	41	35	0.055	41	35	0.058	41	35	0.113
14:00 - 15:00	41	35	0.059	41	35	0.055	41	35	0.114
15:00 - 16:00	41	35	0.142	41	35	0.080	41	35	0.222
16:00 - 17:00	41	35	0.105	41	35	0.054	41	35	0.159
17:00 - 18:00	41	35	0.109	41	35	0.064	41	35	0.173
18:00 - 19:00	41	35	0.061	41	35	0.044	41	35	0.105
19:00 - 20:00									
20:00 - 21:00									
21:00 - 22:00									
22:00 - 23:00									
23:00 - 24:00									
Total Rates:			0.812			0.842			1.654

This section displays the trip rate results based on the selected set of surveys and the selected count type (shown just above the table). It is split by three main columns, representing arrivals trips, departures trips, and total trips (arrivals plus departures). Within each of these main columns are three sub-columns. These display the number of survey days where count data is included (per time period), the average value of the selected trip rate calculation parameter (per time period), and the trip rate result (per time period). Total trip rates (the sum of the column) are also displayed at the foot of the table.

*To obtain a trip rate, the average (mean) trip rate parameter value (TRP) is first calculated for all selected survey days that have count data available for the stated time period. The average (mean) number of arrivals, departures or totals (whichever applies) is also calculated (COUNT) for all selected survey days that have count data available for the stated time period. Then, the average count is divided by the average trip rate parameter value, and multiplied by the stated calculation factor (shown just above the table and abbreviated here as FACT). So, the method is: COUNT/TRP*FACT. Trip rates are then rounded to 3 decimal places.*

Parameter summary

Trip rate parameter range selected:	10 - 98 (units:)
Survey date date range:	01/01/09 - 27/11/17
Number of weekdays (Monday-Friday):	41
Number of Saturdays:	0
Number of Sundays:	0
Surveys automatically removed from selection:	2
Surveys manually removed from selection:	0

This section displays a quick summary of some of the data filtering selections made by the TRICS® user. The trip rate calculation parameter range of all selected surveys is displayed first, followed by the range of minimum and maximum survey dates selected by the user. Then, the total number of selected weekdays and weekend days in the selected set of surveys are show. Finally, the number of survey days that have been manually removed from the selected set outside of the standard filtering procedure are displayed.

TRIP RATE for Land Use 03 - RESIDENTIAL/A - HOUSES PRIVATELY OWNED
MULTI-MODAL BUS/TRAM PASSENGERS
Calculation factor: 1 DWELLS
BOLD print indicates peak (busiest) period

	ARRIVALS			DEPARTURES			TOTALS		
Time Range	No. Days	Ave. DWELLS	Trip Rate	No. Days	Ave. DWELLS	Trip Rate	No. Days	Ave. DWELLS	Trip Rate
00:00 - 01:00									
01:00 - 02:00									
02:00 - 03:00									
03:00 - 04:00									
04:00 - 05:00									
05:00 - 06:00									
06:00 - 07:00									
07:00 - 08:00	41	35	0.003	41	35	0.013	41	35	0.016
08:00 - 09:00	41	35	0.003	41	35	0.010	41	35	0.013
09:00 - 10:00	41	35	0.002	41	35	0.007	41	35	0.009
10:00 - 11:00	41	35	0.004	41	35	0.008	41	35	0.012
11:00 - 12:00	41	35	0.006	41	35	0.005	41	35	0.011
12:00 - 13:00	41	35	0.010	41	35	0.008	41	35	0.018
13:00 - 14:00	41	35	0.004	41	35	0.001	41	35	0.005
14:00 - 15:00	41	35	0.006	41	35	0.004	41	35	0.010
15:00 - 16:00	41	35	0.007	41	35	0.006	41	35	0.013
16:00 - 17:00	41	35	0.011	41	35	0.004	41	35	0.015
17:00 - 18:00	41	35	0.011	41	35	0.006	41	35	0.017
18:00 - 19:00	41	35	0.014	41	35	0.001	41	35	0.015
19:00 - 20:00									
20:00 - 21:00									
21:00 - 22:00									
22:00 - 23:00									
23:00 - 24:00									
Total Rates:			0.081			0.073			0.154

This section displays the trip rate results based on the selected set of surveys and the selected count type (shown just above the table). It is split by three main columns, representing arrivals trips, departures trips, and total trips (arrivals plus departures). Within each of these main columns are three sub-columns. These display the number of survey days where count data is included (per time period), the average value of the selected trip rate calculation parameter (per time period), and the trip rate result (per time period). Total trip rates (the sum of the column) are also displayed at the foot of the table.

*To obtain a trip rate, the average (mean) trip rate parameter value (TRP) is first calculated for all selected survey days that have count data available for the stated time period. The average (mean) number of arrivals, departures or totals (whichever applies) is also calculated (COUNT) for all selected survey days that have count data available for the stated time period. Then, the average count is divided by the average trip rate parameter value, and multiplied by the stated calculation factor (shown just above the table and abbreviated here as FACT). So, the method is: COUNT/TRP*FACT. Trip rates are then rounded to 3 decimal places.*

Parameter summary

Trip rate parameter range selected:	10 - 98 (units:)
Survey date date range:	01/01/09 - 27/11/17
Number of weekdays (Monday-Friday):	41
Number of Saturdays:	0
Number of Sundays:	0
Surveys automatically removed from selection:	2
Surveys manually removed from selection:	0

This section displays a quick summary of some of the data filtering selections made by the TRICS® user. The trip rate calculation parameter range of all selected surveys is displayed first, followed by the range of minimum and maximum survey dates selected by the user. Then, the total number of selected weekdays and weekend days in the selected set of surveys are show. Finally, the number of survey days that have been manually removed from the selected set outside of the standard filtering procedure are displayed.

TRIP RATE for Land Use 03 - RESIDENTIAL/A - HOUSES PRIVATELY OWNED
MULTI-MODAL TOTAL RAIL PASSENGERS
Calculation factor: 1 DWELLS
BOLD print indicates peak (busiest) period

	ARRIVALS			DEPARTURES			TOTALS		
Time Range	No. Days	Ave. DWELLS	Trip Rate	No. Days	Ave. DWELLS	Trip Rate	No. Days	Ave. DWELLS	Trip Rate
00:00 - 01:00									
01:00 - 02:00									
02:00 - 03:00									
03:00 - 04:00									
04:00 - 05:00									
05:00 - 06:00									
06:00 - 07:00									
07:00 - 08:00	41	35	0.000	41	35	0.013	41	35	0.013
08:00 - 09:00	41	35	0.000	41	35	0.003	41	35	0.003
09:00 - 10:00	41	35	0.000	41	35	0.001	41	35	0.001
10:00 - 11:00	41	35	0.000	41	35	0.001	41	35	0.001
11:00 - 12:00	41	35	0.000	41	35	0.001	41	35	0.001
12:00 - 13:00	41	35	0.000	41	35	0.001	41	35	0.001
13:00 - 14:00	41	35	0.000	41	35	0.000	41	35	0.000
14:00 - 15:00	41	35	0.001	41	35	0.001	41	35	0.002
15:00 - 16:00	41	35	0.000	41	35	0.000	41	35	0.000
16:00 - 17:00	41	35	0.000	41	35	0.001	41	35	0.001
17:00 - 18:00	41	35	0.004	41	35	0.001	41	35	0.005
18:00 - 19:00	41	35	0.004	41	35	0.000	41	35	0.004
19:00 - 20:00									
20:00 - 21:00									
21:00 - 22:00									
22:00 - 23:00									
23:00 - 24:00									
Total Rates:			0.009			0.023			0.032

This section displays the trip rate results based on the selected set of surveys and the selected count type (shown just above the table). It is split by three main columns, representing arrivals trips, departures trips, and total trips (arrivals plus departures). Within each of these main columns are three sub-columns. These display the number of survey days where count data is included (per time period), the average value of the selected trip rate calculation parameter (per time period), and the trip rate result (per time period). Total trip rates (the sum of the column) are also displayed at the foot of the table.

*To obtain a trip rate, the average (mean) trip rate parameter value (TRP) is first calculated for all selected survey days that have count data available for the stated time period. The average (mean) number of arrivals, departures or totals (whichever applies) is also calculated (COUNT) for all selected survey days that have count data available for the stated time period. Then, the average count is divided by the average trip rate parameter value, and multiplied by the stated calculation factor (shown just above the table and abbreviated here as FACT). So, the method is: COUNT/TRP*FACT. Trip rates are then rounded to 3 decimal places.*

Parameter summary

Trip rate parameter range selected:	10 - 98 (units:)
Survey date date range:	01/01/09 - 27/11/17
Number of weekdays (Monday-Friday):	41
Number of Saturdays:	0
Number of Sundays:	0
Surveys automatically removed from selection:	2
Surveys manually removed from selection:	0

This section displays a quick summary of some of the data filtering selections made by the TRICS® user. The trip rate calculation parameter range of all selected surveys is displayed first, followed by the range of minimum and maximum survey dates selected by the user. Then, the total number of selected weekdays and weekend days in the selected set of surveys are show. Finally, the number of survey days that have been manually removed from the selected set outside of the standard filtering procedure are displayed.

TRIP RATE for Land Use 03 - RESIDENTIAL/A - HOUSES PRIVATELY OWNED
MULTI-MODAL COACH PASSENGERS
Calculation factor: 1 DWELLS
BOLD print indicates peak (busiest) period

	ARRIVALS			DEPARTURES			TOTALS		
Time Range	No. Days	Ave. DWELLS	Trip Rate	No. Days	Ave. DWELLS	Trip Rate	No. Days	Ave. DWELLS	Trip Rate
00:00 - 01:00									
01:00 - 02:00									
02:00 - 03:00									
03:00 - 04:00									
04:00 - 05:00									
05:00 - 06:00									
06:00 - 07:00									
07:00 - 08:00	41	35	0.000	41	35	0.000	41	35	0.000
08:00 - 09:00	41	35	0.000	41	35	0.001	41	35	0.001
09:00 - 10:00	41	35	0.000	41	35	0.000	41	35	0.000
10:00 - 11:00	41	35	0.000	41	35	0.000	41	35	0.000
11:00 - 12:00	41	35	0.000	41	35	0.000	41	35	0.000
12:00 - 13:00	41	35	0.000	41	35	0.000	41	35	0.000
13:00 - 14:00	41	35	0.000	41	35	0.000	41	35	0.000
14:00 - 15:00	41	35	0.000	41	35	0.000	41	35	0.000
15:00 - 16:00	41	35	0.001	41	35	0.000	41	35	0.001
16:00 - 17:00	41	35	0.000	41	35	0.000	41	35	0.000
17:00 - 18:00	41	35	0.000	41	35	0.000	41	35	0.000
18:00 - 19:00	41	35	0.000	41	35	0.000	41	35	0.000
19:00 - 20:00									
20:00 - 21:00									
21:00 - 22:00									
22:00 - 23:00									
23:00 - 24:00									
Total Rates:			0.001			0.001			0.002

This section displays the trip rate results based on the selected set of surveys and the selected count type (shown just above the table). It is split by three main columns, representing arrivals trips, departures trips, and total trips (arrivals plus departures). Within each of these main columns are three sub-columns. These display the number of survey days where count data is included (per time period), the average value of the selected trip rate calculation parameter (per time period), and the trip rate result (per time period). Total trip rates (the sum of the column) are also displayed at the foot of the table.

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Parameter summary

Trip rate parameter range selected:	10 - 98 (units:)
Survey date date range:	01/01/09 - 27/11/17
Number of weekdays (Monday-Friday):	41
Number of Saturdays:	0
Number of Sundays:	0
Surveys automatically removed from selection:	2
Surveys manually removed from selection:	0

This section displays a quick summary of some of the data filtering selections made by the TRICS® user. The trip rate calculation parameter range of all selected surveys is displayed first, followed by the range of minimum and maximum survey dates selected by the user. Then, the total number of selected weekdays and weekend days in the selected set of surveys are show. Finally, the number of survey days that have been manually removed from the selected set outside of the standard filtering procedure are displayed.

TRIP RATE for Land Use 03 - RESIDENTIAL/A - HOUSES PRIVATELY OWNED
MULTI-MODAL PUBLIC TRANSPORT USERS
Calculation factor: 1 DWELLS
BOLD print indicates peak (busiest) period

	ARRIVALS			DEPARTURES			TOTALS		
Time Range	No. Days	Ave. DWELLS	Trip Rate	No. Days	Ave. DWELLS	Trip Rate	No. Days	Ave. DWELLS	Trip Rate
00:00 - 01:00									
01:00 - 02:00									
02:00 - 03:00									
03:00 - 04:00									
04:00 - 05:00									
05:00 - 06:00									
06:00 - 07:00									
07:00 - 08:00	41	35	0.003	41	35	0.026	41	35	0.029
08:00 - 09:00	41	35	0.003	41	35	0.015	41	35	0.018
09:00 - 10:00	41	35	0.002	41	35	0.008	41	35	0.010
10:00 - 11:00	41	35	0.004	41	35	0.008	41	35	0.012
11:00 - 12:00	41	35	0.006	41	35	0.006	41	35	0.012
12:00 - 13:00	41	35	0.010	41	35	0.010	41	35	0.020
13:00 - 14:00	41	35	0.004	41	35	0.001	41	35	0.005
14:00 - 15:00	41	35	0.007	41	35	0.005	41	35	0.012
15:00 - 16:00	41	35	0.008	41	35	0.006	41	35	0.014
16:00 - 17:00	41	35	0.011	41	35	0.005	41	35	0.016
17:00 - 18:00	41	35	0.015	41	35	0.006	41	35	0.021
18:00 - 19:00	41	35	0.018	41	35	0.001	41	35	0.019
19:00 - 20:00									
20:00 - 21:00									
21:00 - 22:00									
22:00 - 23:00									
23:00 - 24:00									
Total Rates:			0.091			0.097			0.188

This section displays the trip rate results based on the selected set of surveys and the selected count type (shown just above the table). It is split by three main columns, representing arrivals trips, departures trips, and total trips (arrivals plus departures). Within each of these main columns are three sub-columns. These display the number of survey days where count data is included (per time period), the average value of the selected trip rate calculation parameter (per time period), and the trip rate result (per time period). Total trip rates (the sum of the column) are also displayed at the foot of the table.

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Parameter summary

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Number of weekdays (Monday-Friday):	41
Number of Saturdays:	0
Number of Sundays:	0
Surveys automatically removed from selection:	2
Surveys manually removed from selection:	0

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TRIP RATE for Land Use 03 - RESIDENTIAL/A - HOUSES PRIVATELY OWNED
MULTI-MODAL TOTAL PEOPLE
Calculation factor: 1 DWELLS
BOLD print indicates peak (busiest) period

	ARRIVALS			DEPARTURES			TOTALS		
Time Range	No. Days	Ave. DWELLS	Trip Rate	No. Days	Ave. DWELLS	Trip Rate	No. Days	Ave. DWELLS	Trip Rate
00:00 - 01:00									
01:00 - 02:00									
02:00 - 03:00									
03:00 - 04:00									
04:00 - 05:00									
05:00 - 06:00									
06:00 - 07:00									
07:00 - 08:00	41	35	0.129	41	35	0.479	41	35	0.608
08:00 - 09:00	41	35	0.250	41	35	0.794	41	35	1.044
09:00 - 10:00	41	35	0.232	41	35	0.314	41	35	0.546
10:00 - 11:00	41	35	0.225	41	35	0.280	41	35	0.505
11:00 - 12:00	41	35	0.261	41	35	0.257	41	35	0.518
12:00 - 13:00	41	35	0.297	41	35	0.279	41	35	0.576
13:00 - 14:00	41	35	0.265	41	35	0.284	41	35	0.549
14:00 - 15:00	41	35	0.281	41	35	0.303	41	35	0.584
15:00 - 16:00	41	35	0.566	41	35	0.336	41	35	0.902
16:00 - 17:00	41	35	0.548	41	35	0.299	41	35	0.847
17:00 - 18:00	41	35	0.615	41	35	0.284	41	35	0.899
18:00 - 19:00	41	35	0.386	41	35	0.261	41	35	0.647
19:00 - 20:00									
20:00 - 21:00									
21:00 - 22:00									
22:00 - 23:00									
23:00 - 24:00									
Total Rates:			4.055			4.170			8.225

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Number of weekdays (Monday-Friday):	41
Number of Saturdays:	0
Number of Sundays:	0
Surveys automatically removed from selection:	2
Surveys manually removed from selection:	0

This section displays a quick summary of some of the data filtering selections made by the TRICS® user. The trip rate calculation parameter range of all selected surveys is displayed first, followed by the range of minimum and maximum survey dates selected by the user. Then, the total number of selected weekdays and weekend days in the selected set of surveys are show. Finally, the number of survey days that have been manually removed from the selected set outside of the standard filtering procedure are displayed.

From:	[redacted]
To:	Local Dev. Framework
Subject:	RE: CDC Local Plan Representation - 2 of 2
Date:	07 February 2018 12:05:48
Attachments:	image001.jpg App I7 - Tree Survey 05-12-2017.pdf App I7b - Tree Survey Plan 05-12-2017.pdf App I8 - FRA and Drainage Strategy KRS.0334.001.R.001.A.PDF

[redacted] – Bsc (Hons) MRTPI
Managing Director
Addison Planning Consultants Ltd
addison_planning_logo_small
E: - [redacted]
M: - [redacted]
T: - [redacted]
WWW.AddisonPlanning.Com
5B Calls Landing,
36-38 The Calls, Leeds, LS2 7EW
Registered Company Number: 08945769
VAT Registration: 186373672

From: [redacted]
Sent: 07 February 2018 12:03
To: 'localplan@cravendc.gov.uk' <localplan@cravendc.gov.uk>
Subject: CDC Local Plan Representation - 1 of 2

Dear sir/madam,
Please see attached Representation and supporting Appendices (attached to this and a second email).
I would be grateful if you would acknowledge receipt.
Kind regards
[redacted]

[redacted] – Bsc (Hons) MRTPI
Managing Director
Addison Planning Consultants Ltd

E: - [redacted]
M: - [redacted]
T: - [redacted]
WWW.AddisonPlanning.Com
5B Calls Landing,
36-38 The Calls, Leeds, LS2 7EW
Registered Company Number: 08945769
VAT Registration: 186373672

[redacted] F.Arbor.A.

ARBORICULTURAL CONSULTANT

SURVEY DETAILS FOR TREES AT

LAND SOUTH OF BENTHAM ROAD, INGLETON

Issued to: Addison Planning

05 December 2017

Prepared by: [redacted]

Phone/Fax [redacted]

Email : [redacted]

Note:

All tree surgery and felling works detailed should be carried out to a standard, the minimum of which is specified in BS3998:2010 Tree Work - Recommendations.

Contractors should be suitably qualified and experienced to an acceptable standard. They should also be aware that if during operations any defects become apparent that would not have been immediately obvious to the Consultant, that such defects should be notified immediately and confirmed in writing within a reasonable period.

All observations and recommendations only relate to the site and the trees as they were at the time of inspection. Should severe climatic or environmental events or changes take place, it may be necessary to reassess the situation so as to ensure an acceptable and continuing level of safety.

Should the inspection have taken place during the dormant season, this will have simplified the inspection of the high crowns and canopies. It will not have been possible however to ascertain either leaf size, colour or density which, can be classic indicators of stress or root associated disorders.

The survey has also been prepared in the knowledge that some form of development may occur on the site. As such, some of the recommendations put forward could be considered unnecessary were the site simply left as it presently exists.

Furthermore, should development be approved, it may be necessary to reassess and amend this document upon completion of all construction operations to ensure that trees, properties and people can all safely co-exist.

All tree numbers refer to those indicated on the attached site drawing. Dimensions of any trees off site may have been estimated if access was not possible.

The report unless stated otherwise, is of a preliminary nature in that the trees were not climbed but inspected from ground level, and no soil or timber samples have been taken for analysis.

A copy of the Consultant's General Conditions of Contract are attached. These form the basis upon which all services and information are provided.

KEY:

Tree No. - Tree Number – to be recorded on tree survey plan where necessary.

Species – common and scientific names, where possible.

Height – overall height of the tree in metres

Stem Dia - Stem diameter – in millimetres at 1.5m above adjacent ground level (on sloping ground to be taken on the upslope side of the tree base) or immediately above the root flare for multi stemmed trees.

Branch spread – in metres taken at the four cardinal points to derive an accurate representation of the crown (to be recorded on the tree survey plan where necessary).

Height of cc - Height of crown clearance – in metres above adjacent ground level to inform on ground clearance, crown stem ratio and shading). Where considered desirable, first significant branch and direction of growth e.g. 2.4-N

Age class – young (Y), Middle aged (MA), mature (M), over mature (OM) & veteran (V).

Physiological condition – e.g. good (g), fair (f), poor (p) & dead (d).

Structural condition – e.g. collapsing, the presence of decay and any physical defect.

Preliminary management recommendations – including further investigations of suspected defects that require more detailed assessment and potential for wildlife habitat.

ERC - Estimated remaining contribution – in years, <10, 10+, 20+, 40+.

Cat grade - Category grade – U or A to C (see Table 1) to be recorded in plan on the tree survey plan where appropriate.

RPA – Root protection area calculated from BS5837:2012 Trees in Relation to Design, Demolition and Construction – Recommendations in sq/m's. Where indicated, dimensions of radius of circle or sides of square based around centre point of trunk calculated for design purposes.

RP – Remedially prune: remove significant dead wood, basal & epicormic shoots, broken, crossing and rubbing branches etc and undertake light reshaping if necessary to improve form and balance/ abate actual or potential nuisance. Ensure adequate clearances over highway (5.2m) and footpath (2.4m)

- estimated dimensions (e.g. for off-site or otherwise inaccessible trees where accurate data cannot be recovered).

Table 1 **Cascade chart for tree quality assessment**

Category and definition	Criteria (including subcategories where appropriate)			Identification on plan
Trees unsuitable for retention (see Note)				
Category U Those in such a condition that they cannot realistically be retained as living trees in the context of the current land use for longer than 10 years	• Trees that have a serious, irremediable, structural defect, such that their early loss is expected due to collapse, including those that will become unviable after removal of other category U trees (e.g. where, for whatever reason, the loss of companion shelter cannot be mitigated by pruning) • Trees that are dead or are showing signs of significant, immediate, and irreversible overall decline • Trees infected with pathogens of significance to the health and/or safety of other trees nearby, or very low quality trees suppressing adjacent trees of better quality *NOTE Category U trees can have existing or potential conservation value which it might be desirable to preserve; see **4.5.7**.*			See Table 2
	1 Mainly arboricultural qualities	**2 Mainly landscape qualities**	**3 Mainly cultural values, including conservation**	
Trees to be considered for retention				
Category A **Trees of high quality** with an estimated remaining life expectancy of at least 40 years	Trees that are particularly good examples of their species, especially if rare or unusual; or those that are essential components of groups or formal or semi-formal arboricultural features (e.g. the dominant and/or principal trees within an avenue)	Trees, groups or woodlands of particular visual importance as arboricultural and/or landscape features	Trees, groups or woodlands of significant conservation, historical, commemorative or other value (e.g. veteran trees or wood-pasture)	See Table 2
Category B **Trees of moderate quality** with an estimated remaining life expectancy of at least 20 years	Trees that might be included in category A, but are downgraded because of impaired condition (e.g. presence of significant though remediable defects, including unsympathetic past management and storm damage), such that they are unlikely to be suitable for retention for beyond 40 years; or trees lacking the special quality necessary to merit the category A designation	Trees present in numbers, usually growing as groups or woodlands, such that they attract a higher collective rating than they might as individuals; or trees occurring as collectives but situated so as to make little visual contribution to the wider locality	Trees with material conservation or other cultural value	See Table 2
Category C **Trees of low quality** with an estimated remaining life expectancy of at least 10 years, or young trees with a stem diameter below 150 mm	Unremarkable trees of very limited merit or such impaired condition that they do not qualify in higher categories	Trees present in groups or woodlands, but without this conferring on them significantly greater collective landscape value; and/or trees offering low or only temporary/transient landscape benefits	Trees with no material conservation or other cultural value	See Table 2

Inspector: [redacted]

Site: Land South of Bentham Road, Ingleton

Date of Inspection: 4th December 2017

Tree No.	Species	H'gt.	Stem Dia.	Branch Spread		H'gt of C.C.	1st Branch @	Age Class	PC	Structural Condition	Preliminary Management Recommendations	ERC	Cat Grade	RPA Sq.m's	RPA Circle of Radii / m's
T1	Oak	18	650	N E S W	8 8.5 8.9 9	2	3NE	M	F	Low canopy over highway. One broken/failed limb at 6m over highway. Minor occluded & partially occluded pruning wounds to stem. Reasonable vitality. Minor old branch stumps and dead wood present all typical of species. Decurrent form.	Undertake remedial pruning to include crown lift over highway. Monitor.	20+	B2	191.16	7.8
T2	Sycamore	17.5	875	N E S W	10 11 11.5 9.5	3	5N	M	F	Well balanced. Slightly low vitality but reasonable for tree of this size and age. Minor old branch stumps and dead wood present all typical of species. Very close to wall and causing early displacement. Canopy close to adjacent garage under construction.	Undertake remedial pruning to include drawing back canopy from adjacent garage. Monitor.	20+	B2	346.41	10.5
T3	Ash	17.5	975	N E S W	11 10.6 11 12.2	2		M	F	Very close to adjacent dry stone wall and causing major displacement. Several long laterals to North and West with potential for failure - some limb shedding already occurred and decay present. Relatively low vitality. Minor old branch stumps and dead wood present all typical of species. Stem bifs at 1+m with included bark union.	Limited potential but could be retained for short period with reduction and reshaping of scaffold limbs to North and West to improve form and balance. Undertake remedial pruning to remaining canopy. Monitor. Repair wall to give clearance to tree.	10+	C2	430.11	11.7

[redacted] F.Arbor.A

ARBORICULTURAL CONSULTANT

General Conditions of Contract

1. DEFINITIONS

In these Conditions:

"Consultant" means [redacted] F.Arbor.A.

"Contract" means the contract for the provision of Services.

"Employer" means the person whose request for the provision of the Services is accepted by the Consultant or who accepts a written quotation of the Consultant.

"Site" means the area in which the Services are to be carried out as specified in writing to the Consultant prior to his commencing the provision of the Services.

"Services" means the services of arboricultural consultant to be supplied to the Employer by the Consultant in accordance with these Conditions.

2. BASIS OF THE CONTRACT

The consultant shall provide to the Employer and the Employer shall accept the Services in accordance with any written quotation of the Consultant which is accepted by the Employer or any request to provide services of the Employer which is accepted by the Consultant to appropriate British Standards and within a reasonable time. Time shall not be of the essence of the Contract. These conditions shall govern the Contract to the exclusion of any other terms and conditions and no variation to these Conditions shall be binding unless agreed between the Employer and the Consultant. No variation of the Services will be made without prior agreement in writing between the Employer and the Consultant. (The Consultant's employees or agents are not authorised to make any representations concerning the Services unless confirmed by the Consultant in writing.)

3. THE CONSULTANT SHALL:

a) be entitled to subcontract assign or transfer any or all of the Contract without informing the Employer. The Consultant shall be responsible for its obligations under the Contract where sub-contracting takes place.

b) be responsible for making good at his own cost any damage caused as a result solely of his own work.

c) on completion of the Contract leave the site reasonably clean and tidy from his own work.

4. THE EMPLOYER SHALL:

a) be responsible for ensuring that the Consultant is notified of all Tree Preservation or Conservation Area Orders, Private Covenants, the need for Felling Licences, or Planning Legislation that is applicable to the Contract.

b) be responsible for ensuring that the Consultant is notified of all springs, wells, service pipes and cables, sewage or land drains, or any other hazards or obstructions which are not discoverable upon immediate visual inspection of the surface of the site. Any breach of this responsibility shall entitle the Consultant to make a reasonable charge for any additional work caused by such hazards or obstructions.

5. CONTRACT PRICES

The price for the Services shall not include Value Added Tax which the Employer shall be additionally liable to pay to the Consultant. The price which the Employer shall be liable to pay shall be determined by reference to the Consultants hourly charge rate current at the date of completion of the Services. In addition the Employer shall be liable to reimburse the Consultant for such expenses as may reasonably and properly be incurred by him in the performance of the services as Consultant. Written details of the Consultant's hourly charge rate will be provided to the Employer on written request by the Employer.

6. METHOD OF PAYMENT

a) Subject to any special terms agreed in writing between the Employer and the Consultant the Consultant shall be entitled to invoice the Employer for the price of the Services on or at any time after the Services have been completed.

b) The Employer undertakes to pay the Consultant within 28 days of the date of the Consultant's invoice. The time of payment of the price shall be of the essence of the Contract.

c) Failure by the Employer to make payment on the due date, will entitle the Consultant to interest on the amount unpaid at 3% per annum above the base rate of Barclays Bank plc from time to time until payment in full is made and will further enable the Consultant to cancel the contract or suspend any further provision of Services to the Employer.

d) If the Consultant fails to perform the Services for any reason other than any cause beyond the Consultant's reasonable control or the Employer's fault and the Consultant is accordingly liable to the Employer, the Consultant's liability shall be limited to the excess (if any) of the cost to the Employer (in the cheapest available market) of services to replace those not completed over the price of the Services.

7. DISPUTES

a) Where disputes arising from the Contract cannot be resolved by the Employer and the Consultant, then an independent single arbitrator agreeable to both parties (or in default of agreement nominated on the application of either party by the Chairman of the Professional Committee of the Arboricultural Association for the time being) shall be employed.

b) The losing party will pay the resulting costs, unless otherwise decided by the arbitrator.

c) The Contract shall be governed by the Laws of England.

8. THE SITE

Access

i) The Consultant will have free and reasonable access within the Site. Any areas that are to be excluded from this should be notified in writing to the Consultant prior to the date on which the Services are commenced.

ii) The Employer shall ensure that the Consultant has access to private areas outside the site reasonably necessary in order that the Services can be carried out.

iii) The Employer shall indemnify the Consultant against any liability incurred by the Consultant (of whatsoever nature) due to his having entered on private areas without permission of the owner when the Employer has stated free access has been negotiated.

9. LIABILITY

a) The Consultant shall not be liable to the Employer or be deemed to be in breach of the Contract by reason of any delay in performing the Services, if the delay or failure was due to any cause beyond the Consultant's reasonable control. Without prejudice to the generality of the foregoing, the following shall be regarded as causes beyond the Consultant's reasonable control:

i) Act of God, explosion, flood, tempest, fire or accident;

ii) acts, restrictions, regulations, bye-laws, prohibitions or measures of any kind on the part of any governmental, parliamentary or local authority;

iii) strikes, lock-outs or other industrial actions or trade disputes.

b) The Consultant shall not be responsible or liable for any work undertaken as a result of recommendations by the Consultant unless, or until, such work is carried out and both supervised and approved by the Consultant.

10. QUOTATION

a) Any quotation given by the Consultant to the Employer shall remain open for acceptance for 30 days from the date of such quotation and thereafter lapses automatically.

b) Acceptance of such quotation involves acceptance of these conditions.It should be noted that any attempted or actual cancellation thereof by the Employer may involve the Employer in a claim for recovery by the Consultant of any loss or expense incurred as a result.

c) The Consultant is the owner of the copyright existing in any such quotation and it shall not be copied without the prior written consent of the Consultant. Any reproduction before obtaining the Consultant's consent constitutes an infringement of copyright and a breach of the Contract entitling the Consultant inter alia to rescind the Contract and rendering the Employer liable for payment of damages.

11. INSOLVENCY OF EMPLOYER

This clause applies if:

a) the employer makes any voluntary arrangement with its creditors or becomes subject to an administration order or (being an individual or firm) becomes bankrupt or (being a company) goes into liquidation (otherwise than for the purposes of amalgamation or reconstruction); or

b) an encumbrancer takes possession, or a receiver is appointed, of any of the property or assets of the Employer; or

c) the Employer ceases, or threatens to cease, to carry on business; or

d) the Consultant reasonably apprehends that any of the events mentioned above is about to occur in relation to the Employer and notifies the Employer accordingly.

If this clause applies then without prejudice to any other right or remedy available to the Consultant, the Consultant shall be entitled to cancel the Contract or suspend any further provision of Services under the Contract without any liability to the Employer, and if the services have been completed but not paid for the price shall become immediately due and payable notwithstanding any previous agreement or arrangement to the contrary.

12. OWNERSHIP/COPYRIGHT

The Consultant is the owner of the copyright in any report tender documentation and/or recommendations and all associated information submitted to the Employer by the Consultant. The report recommendations tender documentation and all associated information submitted to the Employer shall not be copied without prior written consent of the Consultant. Any reproduction before obtaining the Consultant's consent constitutes an infringement of copyright and a breach of the Contract entitling the Consultant, inter alia, to rescind the Contract and rendering the Employer liable for payment of damages.

13. GENERAL

a) Any notice required or permitted to be given by either party to the other under these Conditions shall be in writing addressed to that other party at its registered office or principal place of business or such other address as may at the relevant time have been notified pursuant to this provision to the party giving notice.

b) No waiver by the Consultant of any breach of the Contract by the Employer shall be considered as a waiver of any subsequent breach of the same or any other provision.

c) If any provision of these conditions is held by any competent authority to be invalid or unenforceable in whole or in part the validity of the other provisions of these Conditions and the remainder of the provision in question shall not be affected thereby.

d) The headings in these Conditions are for convenience only and shall not affect their interpretation.

N

0 5 10 15 20 25 m

Scale 1:500

General Notes

LEGEND

AREA

GROUP

HEDGE

WOOD

TRUNK LOCATION

TREE SHADE (24 hr)

A1 AREA REFERENCE

G1 GROUP REFERENCE

H1 HEDGE REFERENCE

T1 TREE REFERENCE

W1 WOOD REFERENCE

B2 CATEGORY GRADE

TREE CANOPY GRADES

CATEGORY A

CATEGORY B

CATEGORY C

CATEGORY U

ROOT PROTECTION AREA

No.	Revision/Issue	Date

[redacted] F.Arbor.A.

ARBORICULTURAL CONSULTANT

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Project Name and Address

Land South of Bentham Road, Ingleton

Drawn By	Checked
www.YourCad.co.uk	IT

Date: December 2017

Scale: 1:500 @ A1

Land to the south of Bentham Road, Ingleton

NPPF: Flood Risk Assessment

For [redacted]

KRS.0334.001.R.001.A

January 2018

www.krsenvironmental.com

[redacted]

CONTACT DETAILS

KRS Environmental Ltd
The Media Centre
7 Northumberland Street
Huddersfield
West Yorkshire
HD1 1RL

Mob: [redacted]
Tel: [redacted]
Email: [redacted]
Web: krsenvironmental.com

Land to the south of Bentham Road, Ingleton	
Project	NPPF: Flood Risk Assessment
Client	[redacted]
Status	Final
Prepared by	[redacted] BSc (Hons), MSc, MCIWEM
Date	January 2018

Disclaimer:

This report has been produced by KRS Environmental Limited within the terms of the contract with the client and taking account of the resources devoted to it by agreement with the client.

We disclaim any responsibility to the client and others in respect of any matters outside the scope of the above.

This report is confidential to the client and we accept no responsibility of whatsoever nature to third parties to whom this report, or any part thereof, is made known. Any such party relies on the report at their own risk.

CONTENTS

TABLES

EXECUTIVE SUMMARY

A residential development, would be expected to remain dry in all but the most extreme conditions. Providing the recommendations made in this FRA are instigated, flood risk from all sources would be minimised, the consequences of flooding are acceptable, and the development would be in accordance with the requirements of the NPPF.

The site has been shown to be located outside of the 1 in 100 year, 1 in 100 year (+30%), 1 in 200 year and 1 in 1000 year flood outlines. The adoption of a SUDS Strategy for the site will further reduce the risk of flooding to the site and off-site locations.

This FRA demonstrates that the proposed development would be operated with minimal risk from flooding, would not increase flood risk elsewhere and is compliant with the requirements of the NPPF. The development should not therefore be precluded on the grounds of flood risk.

1.0 INTRODUCTION

1.1 Background

This Flood Risk Assessment (FRA) has been prepared by KRS Environmental Limited at the request of [redacted] to support a planning application for the proposed development on Land to the south of Bentham Road, Ingleton. This FRA includes an assessment of the existing and proposed surface and foul water drainage of the site.

This FRA has been carried out in accordance with guidance contained in the National Planning Policy Framework (NPPF)[1] and associated Planning Practice Guidance[2]. This FRA identifies and assesses the risks of all forms of flooding to and from the development and demonstrates how these flood risks will be managed so that the development remains safe throughout the lifetime, taking climate change into account.

It is recognised that developments which are designed without regard to flood risk may endanger lives, damage property, cause disruption to the wider community, damage the environment, be difficult to insure and require additional expense on remedial works. The development design should be such that future users will not have difficulty obtaining insurance or mortgage finance, or in selling all or part of the development, as a result of flood risk issues.

1.2 National Planning Policy Framework (NPPF)

One of the key aims of the NPPF is to ensure that flood risk is taken into account at all stages of the planning process; to avoid inappropriate development in areas at risk of flooding and to direct development away from areas of highest risk.

It advises that where new development is exceptionally necessary in areas of higher risk, this should be safe, without increasing flood risk elsewhere, and where possible, reduce flood risk overall.

A risk based approach is adopted at stages of the planning process, applying a source pathway receptor model to planning and flood risk. To demonstrate this, an FRA is required and should include:

- whether a proposed development is likely to be affected by current or future flooding from all source;
- whether it will increase flood risk elsewhere;
- whether the measures proposed to deal with these effects and risks are appropriate;
- if necessary provide the evidence to the Local Planning Authority (LPA) that the Sequential Test can be applied; and
- whether the development will be safe and pass part c) of the Exception Test if this is appropriate.

[1] Department for Communities and Local Government (2012) National Planning Policy Framework.
[2] Communities and Local Government (2014) Planning Practice Guidance - Flood Risk and Coastal Change.

1.3 Report Structure

This FRA has the following report structure:

- Section 2 details the sources of information that have been consulted;
- Section 3 describes the location area and the existing and proposed development;
- Section 4 outlines the flood risk to the existing and proposed development;
- Section 5 details the sequential and exception tests;
- Section 6 describes the existing water networks within the vicinity of the site;
- Section 7 outlines the proposed foul water drainage for the site;
- Section 8 details the proposed surface water drainage for the site and assesses the potential impacts of the proposed development on surface water drainage;
- Section 9 describes the risk manage methods used to mitigate all sources of flood risk; and
- Section 10 presents a summary and conclusions.

[redacted]

2.0 SOURCES OF INFORMATION

2.1 Discussion with Regulators

Consultation and discussions with the relevant regulators have been undertaken during this FRA including the Environment Agency, the Local Planning Authority (LPA), the Lead Local Flood Authority (LLFA), and Sewerage Undertakers.

2.1.1 Environment Agency

The Flood and Water Management Act 2010 gives the Environment Agency a strategic overview role for all forms of flooding and coastal erosion. They also have direct responsibility for the prevention, mitigation and remediation of flood damage for main rivers and coastal areas. The Environment Agency is the statutory consultee with regards to flood risk and planning.

Environment Agency Standing Advice and the NPPF has been consulted and reviewed during this FRA. This has confirmed the level of FRA required and that a surface water drainage assessment is to be undertaken. Information regarding the current flood risk at the application site, local flood defences and flood water levels has been obtained from the Environment Agency. The Environment Agency has confirmed that they hold no modelled information for this area (see Appendix 1).

2.1.2 Craven District Council

Craven District Council is the LPA. Planning guidance written by Craven District Council regarding flood risk was consulted to assess the mitigation policies in place. These documents include the Local Development Framework and the Local Plan. The Craven District Council Strategic Flood Risk Assessment (SFRA) which covers the site has been reviewed.

2.1.3 North Yorkshire County Council

North Yorkshire County Council is the LLFA and has responsibilities for 'local flood risk', which includes surface runoff, groundwater and ordinary watercourses. Planning guidance written by the North Yorkshire County Council regarding flood risk was consulted to assess the mitigation policies in place. The North Yorkshire County Council Preliminary Flood Risk Assessment (PFRA) which covers the site has been reviewed.

Correspondence has been received from [redacted] Flood Risk Management Project Engineer at North Yorkshire County Council (see Appendix 2). The following was confirmed:

- North Yorkshire County Council SuDS Design Guidance - https://www.northyorks.gov.uk/sites/default/files/fileroot/Environment%20and%20waste/Flooding/SuDS_design_guidance.pdf
- Historic data regarding flooding and Drainage issues within the area
    - The proposed site location is situated within Flood Zone 2 and 3, a Medium - High risk of flooding from rivers and sea.
    - The proposed site location has a low risk of surface water flooding.
    - North Yorkshire County Council, in its capacity as Lead Local Flood Authority holds no records of internal property flooding at the site location or in the local area. It must

be noted that this does not mean to say that flooding has not occurred as flooding can often go unreported to authorities.

  - We are aware of substantial flooding incidents upstream & downstream of the site due to capacity issues in local sewers, watercourses, culverts and overland flows. We have received significantly increased levels of complaints over recent years from concerned residents affected by, and threatened by flooding from these sources. It is the owner/developer's responsibility to reduce flood risk where possible using NPPF.

- Any council sewers within the area

  - North Yorkshire County Council, in its capacity as Lead Local Flood Authority does not hold this information

- Advice with regards to the disposal of the surface water from the site (i.e. the use of SUDs or surface water drainage system)

  - Please see our SuDS Design Guidance, link above. This document outlines the LLFA's requirements with regards to surface water management on site.

  - It should be noted that any proposed developments with high flood risk from river and surface water must demonstrate how they will mitigate the risk for both on site and off site properties. No flooding can occur on site up to and including the 1 in 30 year storm event plus Climate Change and Urban Creep, and no flooding can occur within properties and infrastructure up to an including the 1 in 100 year storm event plus climate change, plus urban creep. Please see our SuDS Design Guidance, referenced above.

- It would be expected that the Flood Risk Assessment addresses the flood risk to the site, and existing properties in the vicinity.

- It must be demonstrated that any development in this area will not increase flood risk and try to improve the drainage where possible.

- It should be made clear within the FRA and scheme proposals how you wish to mitigate flood risk and compensate for any loss of floodplain as the site is located within Flood Zone 3, the functional floodplain.

- It should be made clear that the proposals do not increase flood risk on or off site and must not obstruct the natural flow of water from other developments.

- Finished Floor Levels should be set above the 1 in 100 year plus climate change flood level with an additional 300mm freeboard above the flood level.

- Property Level Resilience should be implemented wherever possible in developments in high flood risk zones, this could include, but is not limited to the measures noted in the Communities and Local Government Document 'Improving the Flood Performance of New Buildings - Flood Resilient Construction: For example, this document may note the use of flood doors where appropriate and the raising of/non-raising of sockets which would limit the disruption that a flood would cause to a property

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/7730/flood_performance.pdf

2.1.3 United Utilities

United Utilities is responsible for the disposal of waste water and supply of clean water for this area. Information with regards to sewer and water main flooding contained within the Craven District Council SFRA and the North Yorkshire County Council PFRA have been consulted as part of this FRA. All Water Companies have a statutory obligation to maintain a register of properties/areas which are at risk of flooding from the public sewerage system, and this is shown on the DG5 Flood Register.

A Pre-Planning Sewerage Enquiry has been undertaken with United Utilities to ascertain their views on the availability of the public sewer network and any restrictions which would be imposed on the proposed development and includes a sewer plan (see Appendix 3). United Utilities have made the following comments:

'We have carried out an assessment of your application which is based on the information provided; this pre development advice will be valid for 12 months.

Foul water

Foul water will be allowed to drain to the public combined/ foul sewer network.

Surface Water

Surface water from this site must drain to soak away or some other form of infiltration system. However, if ground conditions confirm in writing that this is not a viable solution, all surface water can drain to the 300mm diameter surface water sewer on New Road at a maximum pass forward flow of 6.5 l/s for any storm event.

Connection Application

Although we may discuss and agree discharge points & rates in principle, please be aware that you will have to apply for a formal sewer connection. This is so that we can assess the method of construction, Health & Safety requirements and to ultimately inspect the connection when it is made. Details of the application process and the form itself can be obtained from our website by following the link below

http://www.unitedutilities.com/connecting-public-sewer.aspx

Sewer Adoption Agreement

You may wish to offer the proposed new sewers for adoption. United Utilities assess adoption application based on Sewers adoption 6th Edition and for any pumping stations our company addenda document. Please refer to link below to obtain further guidance and application pack:

http://www.unitedutilities.com/sewer-adoption.aspx'

3.0 LOCATION & DEVELOPMENT DESCRIPTION

3.1 Site Location

The site is located on Land to the south of Bentham Road, Ingleton (see Figure 1). The National Grid Reference (NGR) of the site is 368928, 472626.

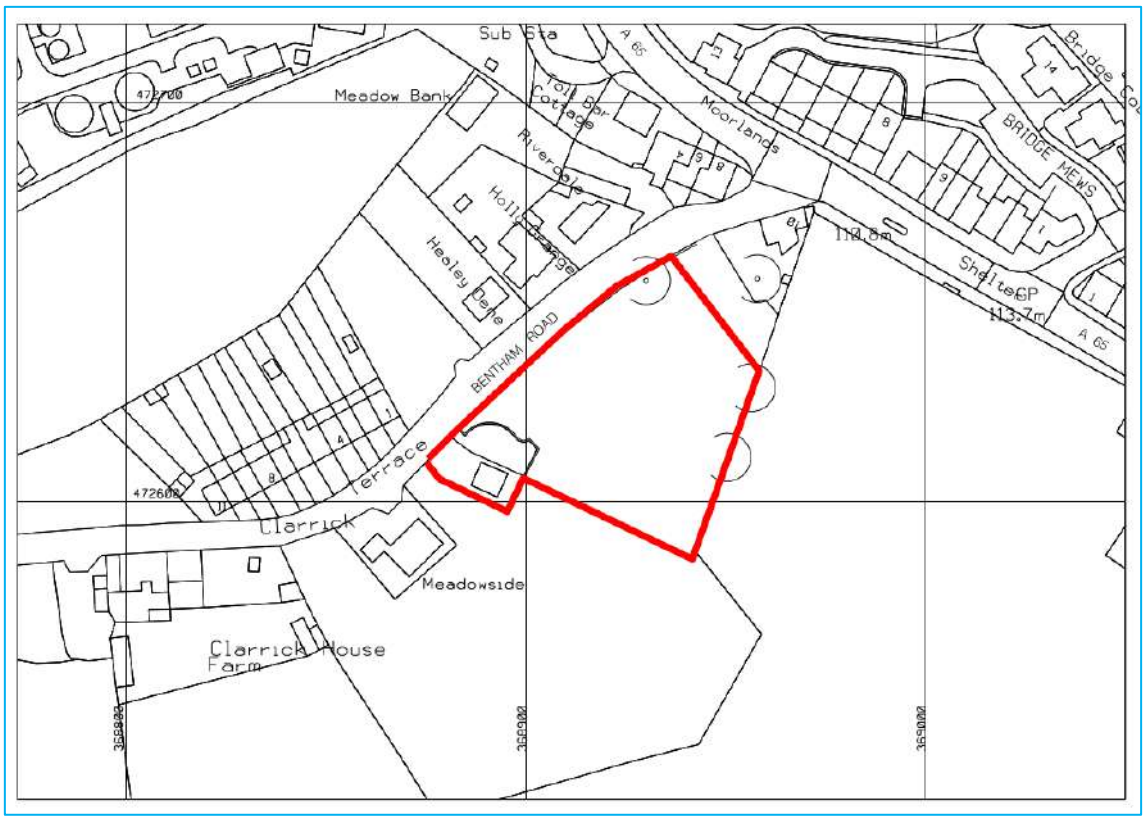


Figure 1 - Site Location

3.2 Existing Development

The site comprises a greenfield development and is currently vacant land.

3.3 Proposed Development

It is understood that the proposals are for a residential development of approximately 10 units with gardens (see Appendix 4). Further details with regard to the proposed development can be found in the accompanying information submitted with the planning application.

3.4 Topographic Survey

A site topographic survey was undertaken in December 2017 (see Appendix 5). The site is reasonably flat. The minimum ground level is 109.05 above Ordnance Datum (mAOD) and the maximum ground level is 109.97mAOD.

3.5 Catchment Hydrology

The River Greta is located approximately 250m to the north of the site and the Jenkin Beck is located approximately 500m to the south east of the site. There are no other watercourses located on, or within, the vicinity of the site.

3.6 Geology

The British Geological Survey (BGS) Map indicates that the bedrock underlying the site consists of the Pennine Coal Measures Group and Warwickshire Group (undifferentiated) - siltstone and sandstone with subordinate mudstone. Sedimentary bedrock formed approximately 272 to 319 million years ago in the Permian and Carboniferous Periods. Local environment previously dominated by swamps, estuaries and deltas. The superficial deposits consist of Alluvium - clay, sand and gravel. Superficial deposits formed up to 2 million years ago in the Quaternary Period. Local environment previously dominated by rivers (U).

Much of the catchment upstream of the site lies on limestone partly covered by deposits of Till. Peat soils are also common in the upstream catchment.

3.7 Groundwater

The Environment Agency aquifer designation data shows that the bedrock and superficial deposits are designated as a Secondary A Aquifer. These are permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.

3.8 Groundwater Source Protection Zones

The site is not located within an Environment Agency Groundwater Source Protection Zone.

3.9 Soil

Information from the National Soil Resource Institute[3] details the site area as being situated on slowly permeable seasonally wet acid loamy and clayey soils with impeded drainage. The Flood Studies Report WRAP soil map classification is type 5 Soils of wet uplands: i) with peaty or humose surface horizons and impermeable layers at shallow depth; ii) deep raw peat associated with gentle upland slopes or basin sites; and iii) bare rock cliffs and screes; iv) shallow, permeable rocky soils on steep slopes.

3.10 Permeability/Infiltration Rate

In determining the future surface runoff from the site, the potential of using infiltration devices has been considered. The deposits will have a permeability which is spatially variable but likely to permit moderate infiltration with areas which are likely to be free-draining.

The depth of any soakaway should not normally exceed 2.00m and will not intersect the water table. A minimum of 1.00 unsaturated zone will be maintained between the base of any soakaway and the maximum seasonal water table. Whilst the permeability and infiltration rate of the site should ideally be confirmed by a site investigation into the hydrogeology of the site, the ground conditions suggest infiltration techniques such as soakaways may work and may provide a suitable option at the site.

If an infiltration system is proposed, it is recommended that a series of infiltration/soakaway tests are carried out on site to BRE Digest 365 Guidelines to confirm the assumptions made in the calculations.

[3] https://www.landis.org.uk/soilscapes/

Such work is beyond the scope of this FRA, but should be undertaken to inform the detailed drainage strategy for the site.

4.0 FLOOD RISK

4.1 Sources of Flooding

All sources of flooding have been considered, these are: fluvial (river) flooding, tidal (coastal) flooding, groundwater flooding, surface water (pluvial) flooding, sewer flooding and flooding from artificial drainage systems/infrastructure failure.

4.2 Environment Agency Flood Zones

A review of the Environment Agency's Flood Zones indicates that the site is located within Flood Zones 2 and 3 and therefore has a 'medium to high probability' of fluvial flooding as shown in Figure 2. Flood Zone 2 has between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) in any year and Flood Zone 3 has a 1 in 100 or greater annual probability of river flooding (>1%) in any year.

The Environment Agency Flood Zones are precautionary. They do not take account of flood defence infrastructure (which can be breached, overtopped or may not be in existence for the lifetime of the development). It therefore represents a worst-case scenario of flooding. The Flood Zones only represent fluvial and tidal flooding; they do not consider flooding from other sources. Nor do they take account of climate change.

At this location the Flood Zone extents have been derived from broad scale national modelling; JFLOW. The Environment Agency acknowledges that the JFLOW method is a generalised, and coarse modelling approach and as such the outlines produced by JFLOW can only be taken as a rough guide.

The Environment Agency Flood Zones and acceptable development types are explained in Table 1. Table 1 shows that some development types are generally acceptable in Flood Zones 2 and 3.

Figure 2 – Environment Agency Flood Zones

Table 1 - Environment Agency Flood Zones and Appropriate Land Use

Flood Zone	Probability	Explanation	Appropriate Land Use
Zone 1	Low	Less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%)	All development types generally acceptable
Zone 2	Medium	Between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% 0.1%) in any year	Most development type are generally acceptable
Zone 3a	High	A 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year	Some development types not acceptable
Zone 3b	'Functional Floodplain'	Land where water has to be flow or be stored in times of flood. SFRAs should identify this zone (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1% flood, or at another probability to be agreed between the LPA and the Environment Agency, including water conveyance routes)	Some development types not acceptable

4.3 Craven District Council SFRA Flood Zones

The Craven District Council Level 1 SFRA further delineates Flood Zone 3 and shows that areas of the site are located within Flood Zone 3a with a 1 in 100 or greater annual probability of river flooding (>1%) in any year, see Figure 3. The site is not located within Flood Zone 3b 'Functional Floodplain'.

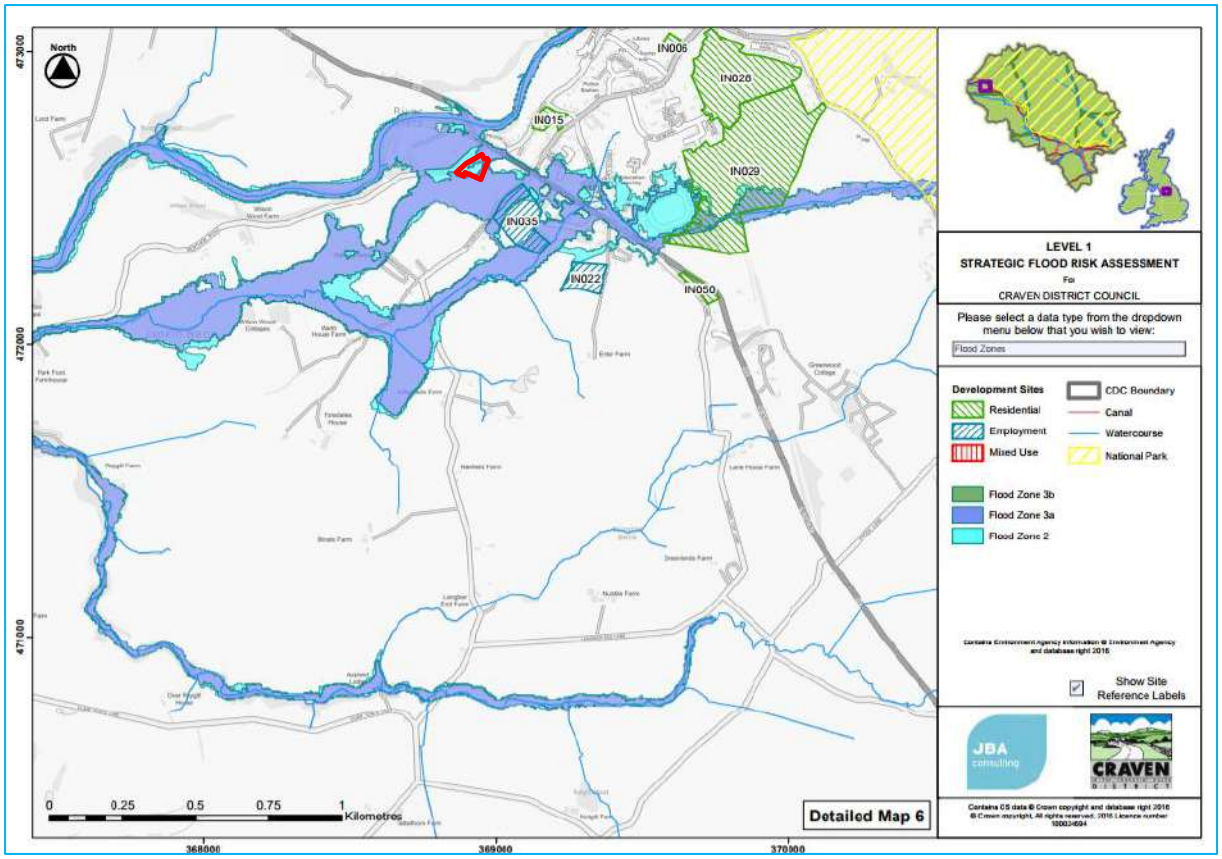


Figure 3 - Craven District Council SFRA Flood Zones

4.4 Flood Risk Vulnerability

In the Planning Practice Guidance to the NPPF appropriate uses have been identified for the Flood Zones. Applying the Flood Risk Vulnerability Classification in the Planning Practice Guidance to the NPPF, the proposed development is classified as 'more vulnerable'.

Table 2 of this report and the Planning Practice Guidance to the NPPF state that 'more vulnerable' uses are appropriate within Flood Zones 2 and 3 after the completion of a satisfactory FRA.

Table 2 - Flood Risk Vulnerability and Flood Zone 'Compatibility'

Flood Risk Vulnerability classification	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Zone 1	✓	✓	Yes	✓	✓
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.

4.5 Historic Flooding

The Environment Agency has confirmed that the site has not historically flooded and the Craven District Council Level 1 SFRA confirms that the site has not historically flooded (see Figure 4). There are no records of anecdotal information of flooding at the site. The British Hydrological Society "Chronology of British Hydrological Events[4]" has no information on flooding within the vicinity of the site. No other historical records of flooding for the site have been recorded. Therefore, it has been assumed that the site has not flooded in the recent past.

However, it is understood that areas within the vicinity of the site has flooded recently such as areas of New Road being flooded due to bridge surcharging during the July 2015 flood event. Flooding occurred within Ingleton as a result of a convective storm on the 19th July 2015.

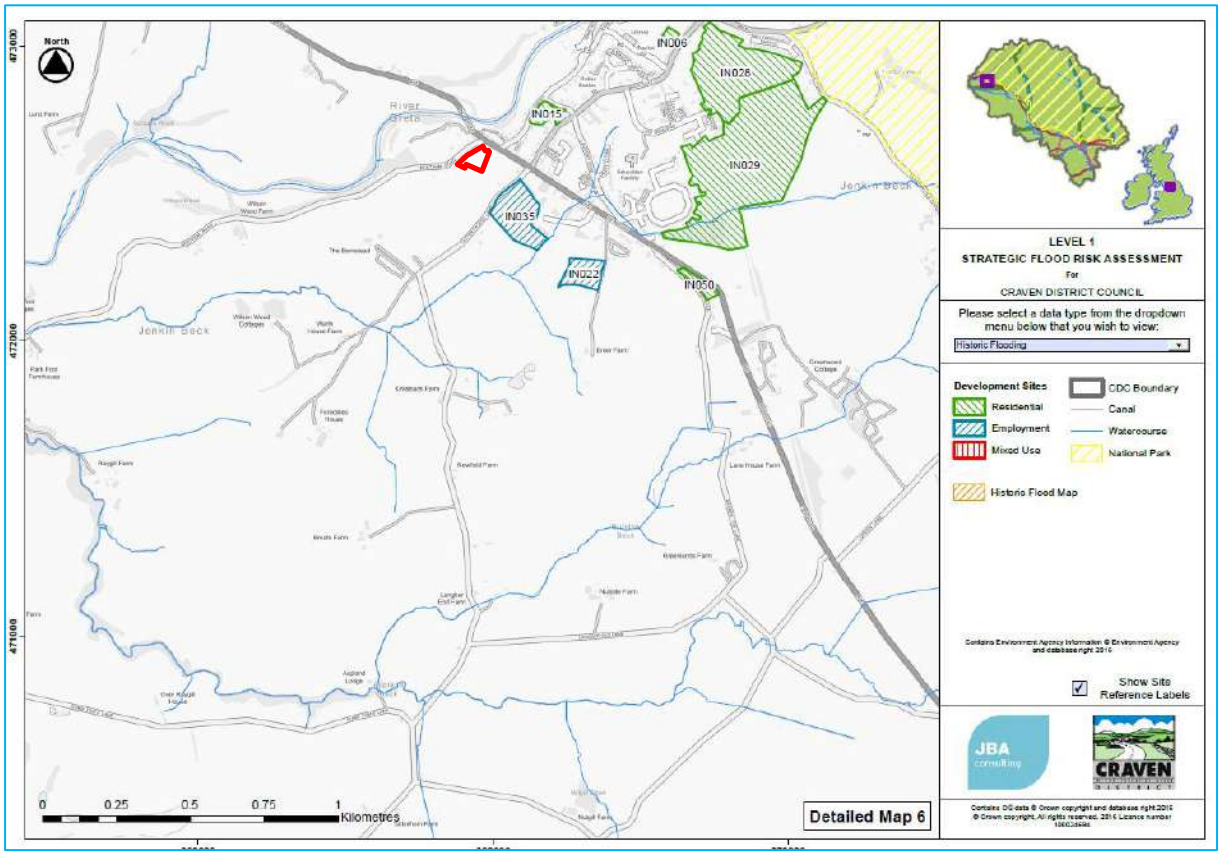


Figure 4 - Craven District Council SFRA Historical Flooding

4.6 Existing and Planned Flood Defence Measures

A review of the Environment Agency Flood Zone map (see Figure 2) Craven District Council SFRA flood defence map (see Figure 5) have confirmed that the site is not protected by any formal or informal flood defence measures.

[4] http://www.dundee.ac.uk/geography/cbhe/

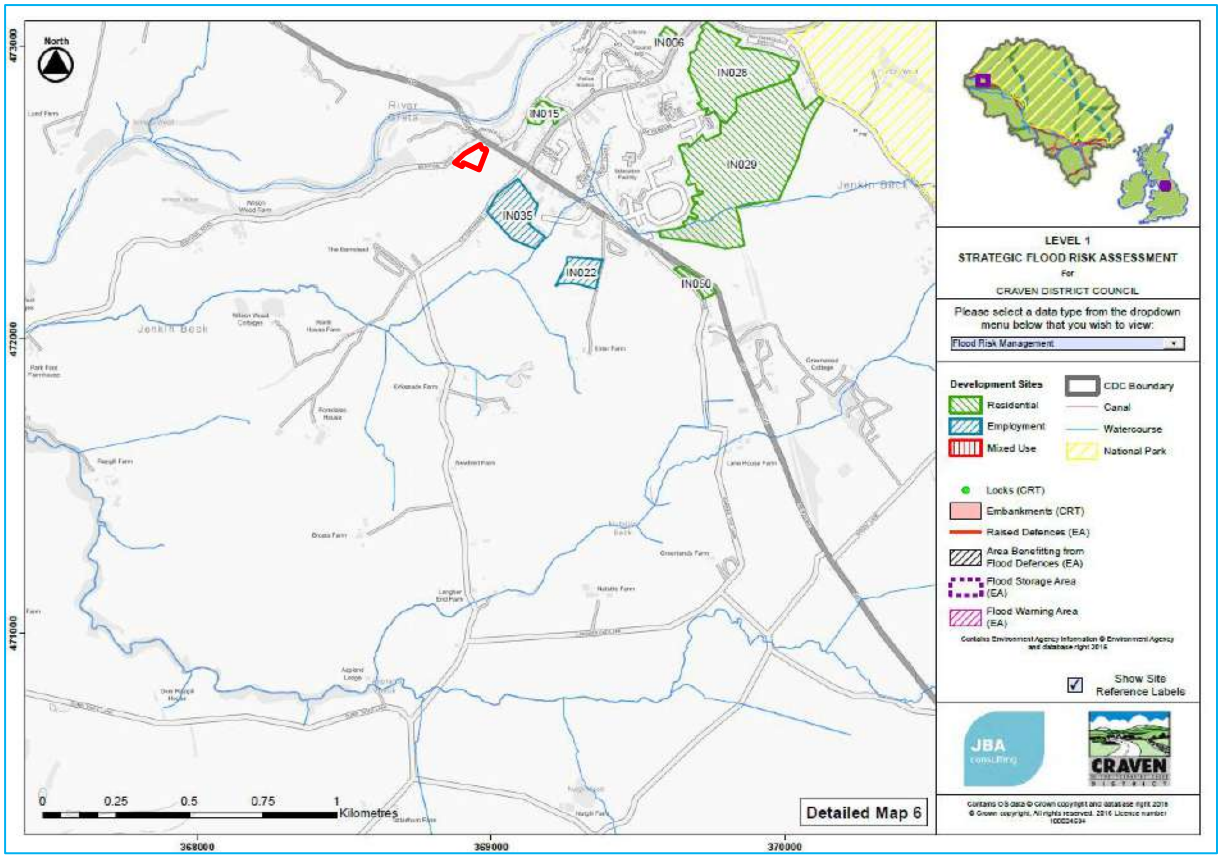


Figure 5 - Craven District Council SFRA Flood Defences

4.7 Climate Change

Projections of future climate change, in the UK, indicate more frequent, short-duration, high intensity rainfall and more frequent periods of long duration rainfall. Guidance included within the NPPF recommends that the effects of climate change are incorporated into FRA. Recommended precautionary sensitivity ranges for peak rainfall intensities and peak river flows are outlined in the associated Planning Practice Guidance to the NPPF[5].

Table 3 show peak river flow allowances by river basin district. The flood risk assessments: climate change allowances guidance recommends that for 'more vulnerable' uses in Flood Zones 2 and 3 that the higher central and upper end allowances are used. Therefore, the 1 in 100 year (+30%) water level has been used as the design flood level.

Table 3 - Peak River Flow Allowances by River Basin District (use 1961 to 1990 baseline)

River basin district	Allowance category	2015 to 2039	2040 to 2059	2060 to 2115
Humber	Upper end	+ 20%	+ 30%	+ 50%
	Higher central	+ 15%	+ 20%	+ 30%
	Central	+ 10%	+ 15%	+ 20%

[5] https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#high-allowances.

4.8 Fluvial Flooding

River Greta

The River Greta is located approximately 250m to the north of the site. The site is protected by higher ground between the site and the River Greta. Ground levels rise to approximately 108mAOD between the site and the River Greta. The topography of the floodplains within the vicinity of the site is flat and the mechanisms of flooding are not complex. The actual risk of flooding caused by overtopping of the river bank during a fluvial flood event on the River Greta will be reduced compared to the extent of flooding shown in the Environment Agency Flood Zones.

It is important to understand the hydrological nature of the River Greta due to its implications on fluvial flood risk at the site. Such an investigation was undertaken using 'industry standard' techniques such as the Centre for Ecology and Hydrology (CEH) Flood Estimation Handbook (FEH) web service, and the Revitalised Rainfall Runoff Method 2 (ReFH2). These methods are based on robust hydrological modelling techniques and are described in the Flood Estimation Handbook (FEH).

Catchment descriptors from the FEH web service have been used to infer the physical nature of the catchment and its possible response to a rainfall event. Table 4 sets out the catchment descriptors for the study catchment upstream of the site (see Figure 6). The catchment boundary has been checked against the OS mapping and no changes are necessary.

The catchment area is 60.34km^2, the SPRHOST value (Standard Percentage Runoff) is 49.68 and indicates a moderately permeable catchment. Approximately 49.68% of the rainfall will contribute to direct runoff rather than be stored and reflects the underlying geology. The BFIHOST value (Baseflow Index) is 0.3380 indicates a baseflow responsive catchment to rainfall and the SAAR6190 (Standard Average Annual Rainfall) value is high at 1686mm a year. The URBEXT1990 value is 0.0420 and therefore, the catchment is moderately urbanised. There are no river flow or level gauges within the upstream catchment.

The geology of much of the catchment of the River Greta is dominated by limestone. This can affect the flow characteristics of the river because limestone can be highly permeable and include large surface and subsurface features such as fractures, sinkholes and caves that promote subsurface movement of water. The degree of influence of these features on river flow depends on rainfall characteristics. Extreme rainfall can overwhelm the subsurface pathways leading to flooding.

The River Greta has a gravel bed which includes large boulders, the River Greta is a mountain river where the flow regime will include infrequent but significant high flows. The catchment descriptors were used to calculate the design flow on River Greta, using the ReFH2 Method. Table 5 shows that the peak flows for the River Greta range from 67.80m^3/s for the 1 in 20 year event to 287.53m^3/s for the 1 in 1000 year event (see Appendix 6).

Climate change allowances must be taken into account over the whole lifetime of the development (see Table 3). Therefore, the peak river flows for the 1 in 100 year event have been increased by 20%, 30% and 50% to account for the effects of climate change in accordance with the Planning Practice Guidance to the NPPF.

Table 4 - FEH Catchment Descriptors

Parameter	Value
Outlet	368950, 472750
NGR	SD 68950 72750
Area	60.34 km²
Altbar	388 m
Aspbar	185 degrees
Aspvar	0.12
Bfihost	0.3380
CentroidEasting	372,657 m
CentroidNorthing	478,287 m
Dplbar	9.14 km
Dpsbar	153.30 m/km
Farl	0.9990
Fpext	0.0469
Fpdbar	0.626 cm
Fploc	0.869
Ldp	17.65 km
Propwet	0.620
Rmed1H	11.9 mm
Rmed1D	54.0 mm
Rmed2D	71.2 mm
Saar6190	1,686 mm
Saar4170	1,675 mm
Sprhost	49.68 %
Urbconc1990	0.0420
Urbext1990	0.0046
Urbloc1990	0.0220
Urbconc2000	0.7290
Urbext2000	0.0070
Urbloc2000	0.2010
CatchmentRainC	-0.024
CatchmentRainD1	0.459
CatchmentRainD2	0.399
CatchmentRainD3	0.375
CatchmentRainE	0.289
CatchmentRainF	2.556
GridRainD1	0.432
GridRainD2	0.354
GridRainD3	0.372
GridRainC	-0.024
GridRainE	0.287

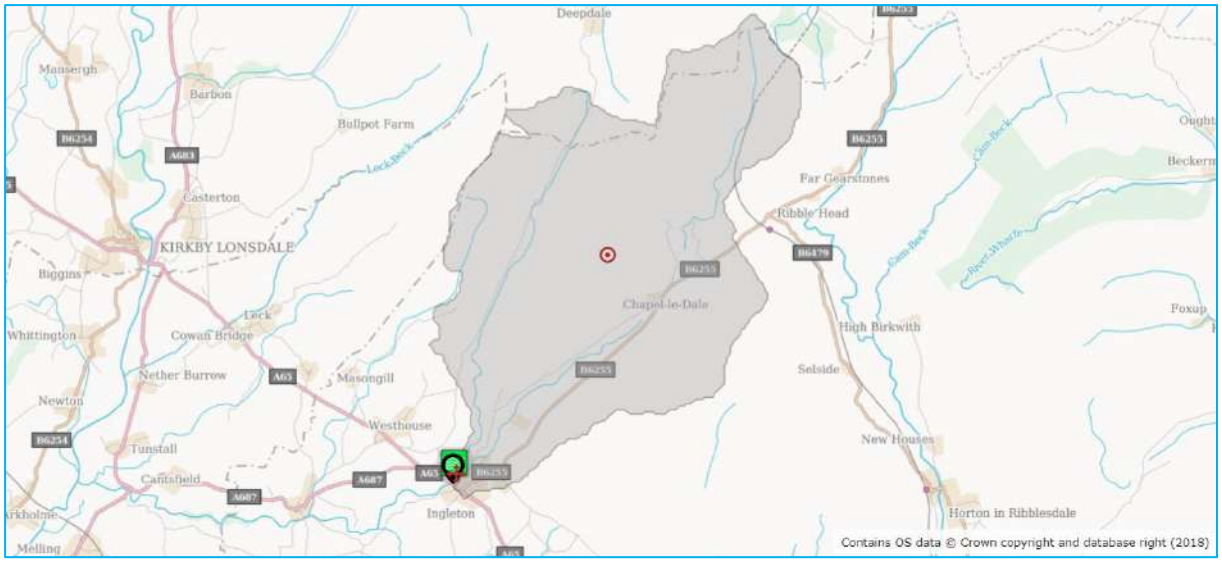


Figure 6 - River Greta Upstream Catchment as shown on the FEH web service

Table 5 - Peak Flows for the River Greta

Return Period (yrs)	Peak Discharge (m^3/s)
2	67.80
20	115.79
50	138.58
75	150.87
100	160.92
100 + 20%	193.10
100 + 30%	209.20
100 + 50%	241.38
1000	287.53

Figures 7 to 9 show cross sections of the River Greta created using the Environment Agency's 2m LiDAR Digital Terrain Model (DTM) and Figure 10 shows the cross sections locations. The cross sections are representative of the channel in the reach adjacent, upstream and downstream of the site.

The cross sections show that the site is located at over 109mAOD while the left hand bank of the River Greta is at approximately 101mAOD, there are low spots in the left hand bank at approximately 99mAOD just upstream of New Bridge. However, the ground level of New Road is a minimum of 109mAOD between the site and the River Greta therefore, it is unlikely that any floodwater that overtops the left hand river bank upstream of New Bridge will flow to the site due to the high levels of New Road between the site and the River Greta.

The ground level of Bentham Road is a minimum of 108mAOD between the site and the River Greta therefore, it is unlikely that any floodwater that overtops the left hand river bank downstream of the New Bridge will flow to the site due to the high levels of Bentham between the site and the River Greta.

The 'normal' water level of the River Greta is approximately 98.11mAOD. The site is approximately 11m above the 'normal' water level of the River Greta.

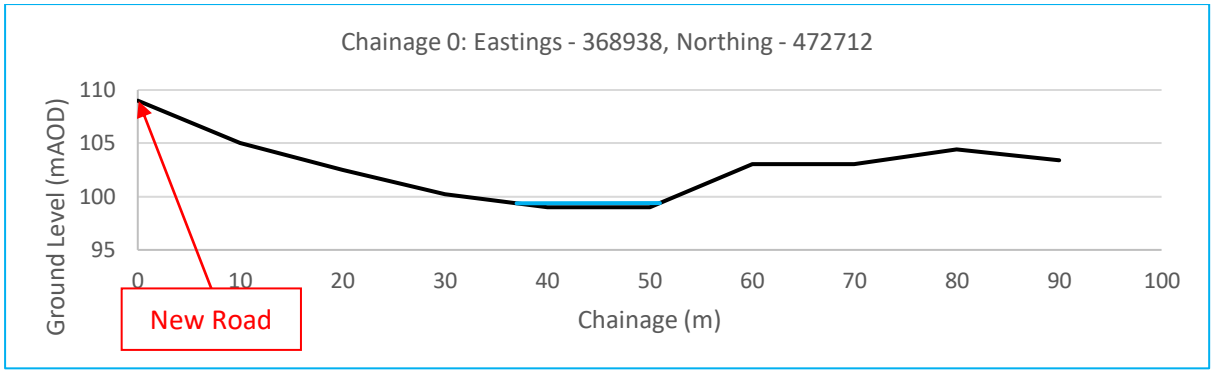


Figure 7 - Cross section 4 of the River Greta just upstream of New Bridge

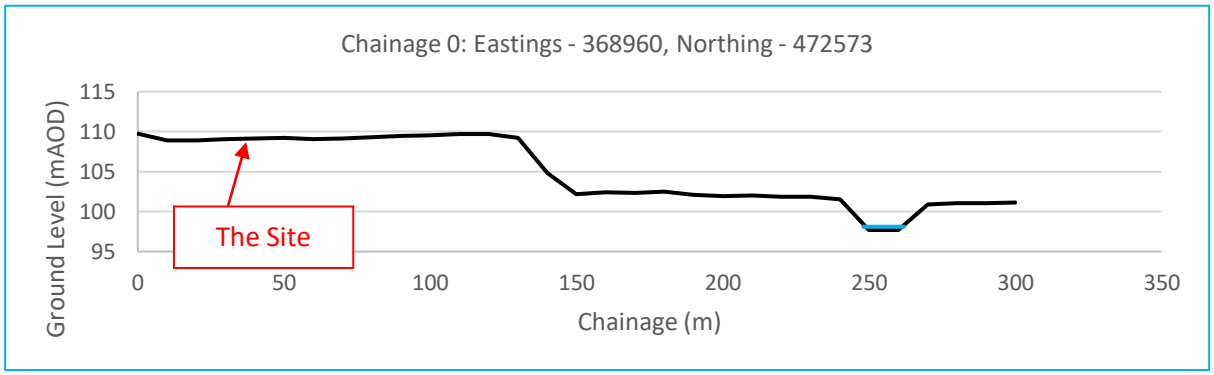


Figure 8 - Cross section 2 from the site to the River Greta

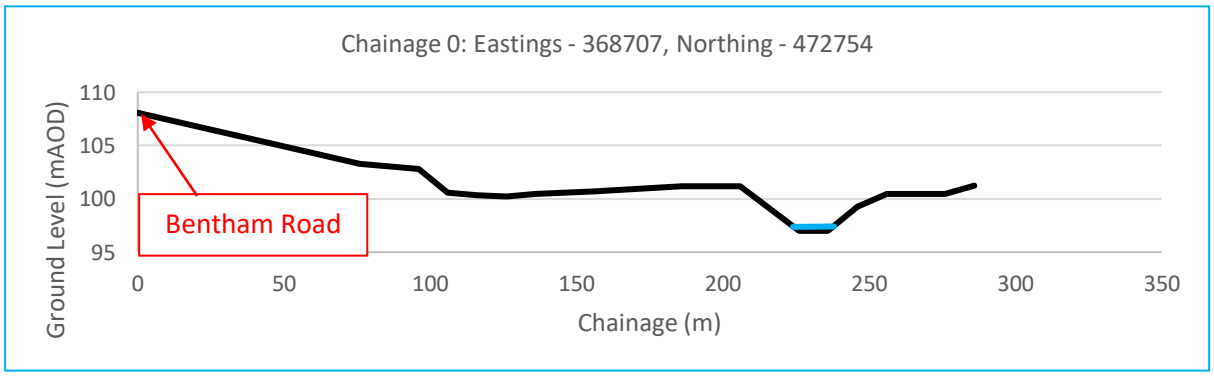


Figure 9 - Cross section 1 of the River Greta downstream of the site

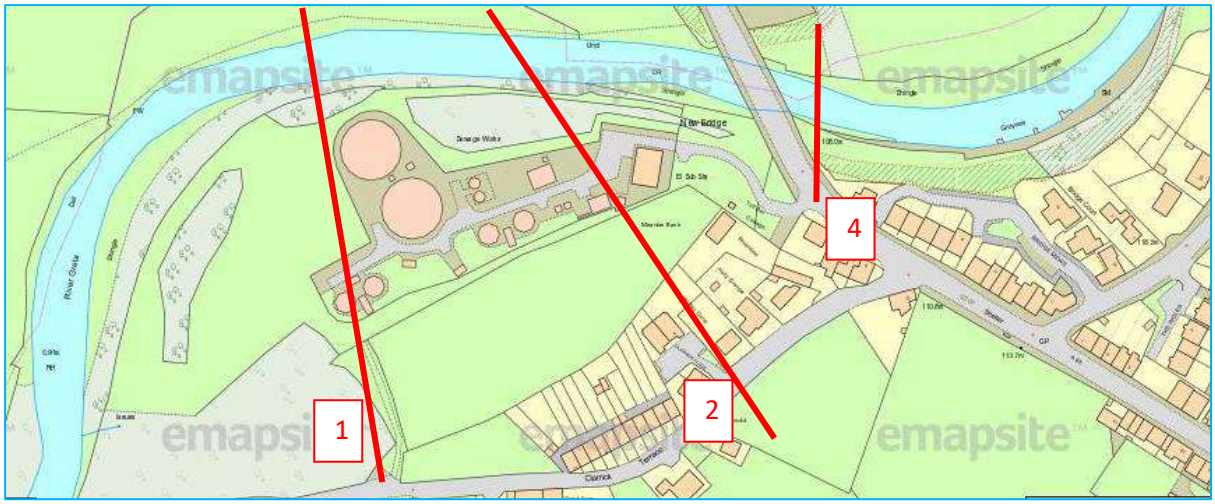


Figure 10 - Cross section locations

The minimum cross section of the River Greta near the site is 20.00m wide and 2.00m deep (based on site measurements). The bankfull capacity of the channel has been calculated using the following Manning's equation.

$$V = \frac{R^{0.67} x S^{0.5}}{n}$$

Where:

V = velocity (m/s)
R = (Cross Sectional Area of channel)/ (Wetted Perimeter)
S = Slope
n = Manning's Coefficient of Roughness

Table 6 shows that the bankfull capacity of the River Greta is approximately 169.04m^3/s. When comparing the bankfull capacity of the River Greta (see Table 6) with the flood flows generated within the watercourse catchment (see Table 5) it can be seen that the watercourse channel has a bankfull capacity of approximately the 1 in 100 year event. Any event greater than the bankfull capacity of 169.04m^3/s may cause flooding.

Table 6 - Bankfull Capacity (Manning's Equation)

Width (m)	Depth (m)	R	S	Manning's n	Bankfull Capacity (m^3/s)
20.00	1.80	1.501	0.02	0.04	169.04

A steady state HEC-RAS model of River Greta has been developed from the cross sections and using the ReFH2 Method peak flows shown in Table 5 as the upstream inflows. Given the short length of the River Greta that passes to the east of the site, only one inflow location in the model has been included, a short distance upstream of the site.

To ensure the runoff from the entire catchment is taken into account and flood flows are not underestimated, it is intended to calculate peak flows for the full catchment to the downstream limit of the site. The New Bridge just upstream of the site has been included within the HEC-RAS model as these may pose constrictions to flow. Therefore, the model results are a precautionary and conservative representation of the flood risk at the site.

A Manning's n roughness coefficient value of 0.040 has been used for the river channel and a value of 0.035 has been used for the floodplain. Table 7 shows the maximum modelled water levels for the River Greta (see Appendix 7).

Table 7 - Maximum Water Levels (mAOD)

Return Period (yrs)	Cross Section			
	4	3 - New Bridge	2	1
100	101.50	101.09	100.28	99.14
100 + 20%	101.73	101.31	100.46	99.36
100 + 30%	101.84	101.41	100.54	99.46
100 + 50%	102.05	101.60	100.70	99.65
1000	102.31	101.89	100.90	99.90

Sensitivity Analysis

The results of the sensitivity analyses give an indication of the level of confidence that can be placed in the water level estimates obtained from computational hydraulic modelling. This is most important in circumstances where it has not been possible to calibrate the model for observed events, as in this case. The sensitivity analyses also give an indication of how the results may vary due to seasonal changes in vegetative growth, variations in the estimate of peak flows and variations in the coefficients of hydraulic structures.

The following parameters were varied one at a time to assess their sensitivity on the flood levels.

- Manning's 'n' roughness coefficient values +/- 20%

The sensitivity of the model water levels to channel and floodplain roughness was checked by varying the adopted Manning's 'n' roughness values. Manning's 'n' roughness values were uniformly increased by 20% for the first run and uniformly decreased by 20% for the second run (see Table 8).

A 20 % increase in Manning's 'n' roughness values resulted in an increase in water levels at the site of between 0.00m and 0.37m during the design event which is the 1 in 100 year (+30%) event and an increase of between 0.00m and 0.40m during the 1 in 1000 year event (see Appendix 8). Conversely, a 20 % decrease in Manning's 'n' roughness values resulted in a decrease of between 0.00m and 0.15m during the design event which is the 1 in 100 year (+30%) event and a decrease of between 0.00m and 0.06m during the 1 in 1000 year event (see Appendix 7).

These results show that the model is not very sensitive to changes in the Manning's 'n' roughness values, is behaving normally and therefore shows confidence in the model results.

[redacted]

Table 8 - Sensitivity Analysis Modelled Water Levels (mAOD)

Return Period (yrs)	Cross Section											
	4			3 - New Bridge			2			1		
	Baseline	+ 20%	- 20%	Baseline	+ 20%	- 20%	Baseline	+ 20%	- 20%	Baseline	+ 20%	- 20%
100	101.50	101.56	101.43	101.09	101.31	101.09	100.28	100.59	100.05	99.14	99.14	99.14
100 + 20%	101.73	101.81	101.66	101.31	101.56	101.31	100.46	100.82	100.30	99.36	99.36	99.36
100 + 30%	101.84	101.92	101.77	101.41	101.68	101.41	100.54	100.91	100.42	99.46	99.46	99.46
100 + 50%	102.05	102.13	101.98	101.60	101.87	101.60	100.70	101.08	100.63	99.65	99.65	99.65
1000	102.31	102.38	102.25	101.89	102.04	101.86	100.90	101.30	100.90	99.90	99.90	99.90

The 1 in 100 year (+30%) water level has been used as the design flood level which has been modelled at 101.84mAOD. The 1 in 1000 year water level has been modelled at 101.89mAOD. The site minimum ground level is 109.97mAOD therefore, the site will not be inundated with floodwater for all events up to and including the 1 in 1000 year event from the River Greta. The New Bridge is shown to not surcharge for all events up to and including the 1 in 1000 year event.

It should be taken into account that at this location the Flood Zone extents have been derived from broad scale national modelling; JFLOW, as shown in Figure 2. The Environment Agency acknowledges that the JFLOW method is a generalised, and coarse modelling approach and as such the outlines produced by JFLOW can only be taken as a rough guide. Therefore, the modelled water levels discussed above provide a much more robust estimate of the flood risk posed by the River Greta at this location than the Environment Agency Flood Zones shown in Figure 2.

Figure 11 shows the JBA Comprehensive River Flood Map for the site and this confirms that the site is located outside of the River Greta flood outlines for all events up to and including the 1 in 1000 year event. The flood outlines and corresponding water levels are similar to the water levels predicted using the HEC-RAS model.

The JBA Comprehensive River Flood Map has been developed using an updated version of JFLOW and a LiDAR 5m resolution DTM for the undefended scenario. Figure 11 shows the flood risk posed to the site in more detail than the Environment Agency Flood Zones shown in Figure 2. The actual risk of fluvial flooding is much reduced compared to the Environment Agency Flood Zones.

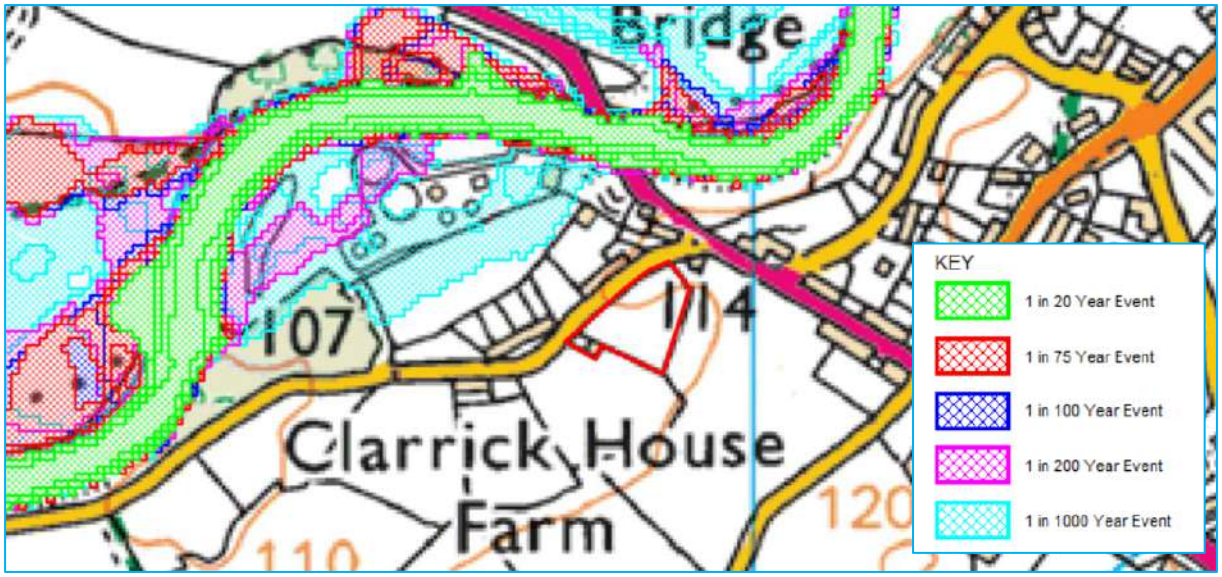


Figure 11 - JBA Comprehensive River Flood Map

Residual flood risk of failure or blockage (complete or partial) of New Bridge

An assessment of the residual flood risk of failure or blockage (complete or partial) of New Bridge has been undertaken (see Figure 12). Blockage of such a feature can occur through a number of different mechanisms:

Large debris in watercourse

If large pieces of rubbish or natural debris are allowed to collect in the channel these can be washed downstream during episodes of high flow and then become lodged either in the bridge entrance of internally within a bridge. This in itself will reduce the bridge capacity, but would also allow smaller pieces of debris to become trapped and then further reduce the bridge capacity.

The potential for this mechanism to be realised depends upon the availability of debris and the frequency with which the watercourse is cleared. In this case, there are similar sized bridges/culverts upstream of the site on which any large debris is likely to become lodged and the availability of suitable sized debris is limited due to the nature of the catchment. Given this there is limited potential for a blockage of this type to occur at the bridges.

Sedimentation

Over long periods of natural sedimentation along with additional sediment loading and other geomorphological changes caused by human actions can result in siltation within bridges that will then reduce the bridge capacity. There is no reason to expect significant sediment loading. It should also be noted that such problems typically impact smaller bridges and it is unlikely that sedimentation will significantly impact conveyance in this case.

Bridge or channel collapse

A collapse of the bridges would block flows and could lead to water backing up and flooding areas of the site. This is likely to occur where bridges are old and in poor repair however, the bridges are not in need of repair and are regularly maintained. If a partial blockage or failure of the bridges were to occur the capacity of the bridges would be exceeded and localised flooding may occur. However, this will be of a minor nature due to the low flows and topography of the area.

The bridges are large, well maintained and is structurally sound therefore the probability of a bridge collapsing, and/or a blockage is low. Due to the large size of the bridges it is unlikely that the maximum flows for the River Greta will surcharge at the bridge entrances.

Figure 12 - New Bridge River Greta (©Google 2017)

If a partial blockage or failure of the bridge were to occur, it is unlikely that the capacity of the bridges would be exceeded. If a complete blockage or failure of the bridge were to occur, which is highly unlikely, flooding of the River Greta would occur. However, this will be of a minor nature due to the low flows and topography of the area. Therefore, it can be seen that flooding of the site from surcharging of the bridges is unlikely especially. On the rare occasion that the capacity of the bridges is exceeded, the water then spills from the bridge inlet and follows the contours of the surrounding area.

Flood risk to the site from the River Greta can be considered to be limited. Any overbank flow would follow the contours of the surrounding area and would flow directly to the west rather than flowing towards the site. The flood risk can also be considered to be limited due to the difference in elevations. The ground levels of the site are located approximately 8m above the 'normal' water level of the River Greta.

It can be concluded that fluvial flood risk from the River Greta poses a very low risk to the site. Therefore, the risk of flooding from fluvial flooding is considered to be **not significant**.

Jenkin Beck

The Jenkin Beck is located approximately 500m to the south east of the site and is protected by higher ground between the site and Jenkin Beck. Ground levels rise to approximately 120mAOD between the site and Jenkin Beck.

Jenkin Beck is classified as non-main river and OS Mapping shows that the catchment area is to the north east of the site and the Ingleborough area. The beck upstream of the site has a catchment area of approximately 5.00km² and is predominantly rural runoff. However, as the catchment is generally the upland hills to the south of Ingleborough the runoff is likely to be rapid and flashy.

The Jenkin Beck is a narrow channel varying from 1.40m to 2.70m wide upstream of the site (see Figure 13) and the Jenkin Beck is approximately 0.90m deep however, there are several small bridges that span Jenkin Beck.

Figure 13 - Jenkin Beck adjacent to New Village/Brookacre (©Google 2017)

One most significant bridge is where the beck passes beneath New Village/Brookacre, as shown in Figure 13, where the bed to bridge soffit height is approximately 0.45m. It is considered that this bridge would constrict flows and during more extreme flood events would result in the bridge deck being overtopped and floodwater flowing onto New Road. It is likely that any overtopping of this bridge deck would result in New Road being flooded upstream of the site. From the video footage taken during July 2015 flood event it appears that the beck overtopped at bridges resulting in New Road being flooded.

The Environment Agency Flood Zone map in Figure 2 shows flood water overtopping the bank top level upstream of the site and then flowing onto New Road and Tatterthorne Lane and inundating the site.

The Environment Agency surface water flood map is representative of the fluvial flood risk from Jenkin Beck. The medium risk surface water flood outline is representative of the 1 in 100 year flood event and the low risk surface water flood outline is representative of the 1 in 1000 year event as shown below in Figure 14. The surface water flood map assumes that the channel capacity of the beck is 1 in 2 years. Therefore, the flood map is highly conservative. The flood map shows that the site remains dry and is not flooded during the 1 in 100 year and 1 in 1000 year events from the Jenkin Beck.

It should be taken into account that at this location the Flood Zone extents have been derived from broad scale national modelling; JFLOW, as shown in Figure 2. The Environment Agency acknowledges that the JFLOW method is a generalised, and coarse modelling approach and as such the outlines produced by JFLOW can only be taken as a rough guide.

Figure 15 shows the JBA Comprehensive River and Surface Water Flood Map for the site and this confirms that the site is located outside of the Jenkin Beck flood outlines for all events up to and including the 1 in 1000 year event. This flood map has been developed using an updated version of JFLOW and a LiDAR 5m resolution DTM for the undefended scenario. Figures 14 and 15 shows the flood risk posed to the site in more detail than the Environment Agency Flood Zones shown in Figure 2.

The 1 in 100 year (+30%) water level is the design event however, as this is not available the 1 in 200 year water level has been used as the design flood level and by comparing the 1 in 200 year flood outline with the LiDAR Data it has been shown that the 1 in 200 year event has a water level of 108.92mAOD near to the site with a water depth of less than 0.30m. The modelled water levels discussed above provide a much more robust estimate of the flood risk posed by the Jenkin Beck at this location than the Environment Agency Flood Zones shown in Figure 2. The actual risk of fluvial flooding is much reduced compared to the Environment Agency Flood Zones.

Figure 14 - Environment Agency Surface Water Flood Map

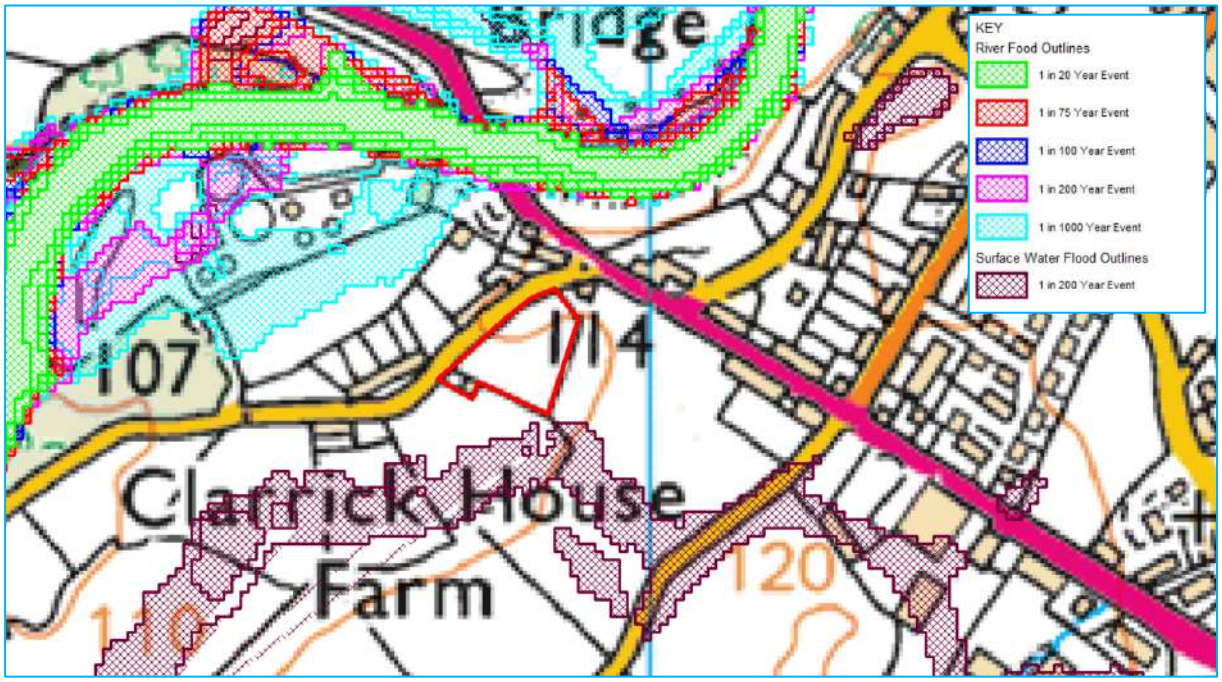


Figure 15 - JBA Comprehensive River and Surface Water Flood Map

Flood risk to the site from the Jenkin Beck can be considered to be limited. Any overbank flow would follow the contours of the surrounding area and would flow directly to the east rather than flowing towards the site. The flood risk can also be considered to be limited due to the difference in elevations. The ground levels of the site are located approximately 2.00m above the normal water level of the Jenkin Beck.

It can be concluded that fluvial flood risk from the Jenkin Beck poses a low risk to the site. Therefore, the risk of flooding from fluvial flooding is considered to be of **low significance**. The risk of fluvial flooding will be further managed and mitigated by using a number of property level protection measures to manage and reduce the overall flood risk at the site (see Section 9.0).

4.9 Tidal Flooding

The site is not located within the vicinity of tidal flooding sources and the risk of tidal flooding is considered to be **not significant**. Flooding from these sources has not been considered further within this FRA.

4.10 Groundwater Flooding

Groundwater flooding tends to occur sporadically in both location and time. When groundwater flooding does occur, it tends to mostly affect low-lying areas, below surface infrastructure and buildings (for example, tunnels, basements and car parks) underlain by permeable rocks (aquifers).

The site is underlain by permeable chalk layers. Rainfall will soak into the chalk and may emerge again in the base flow of streams and rivers or as springs. Figure 16 shows that the site has between a 25% to 50% susceptibility to groundwater flooding. However, no below surface infrastructure and buildings are proposed for the site, as such the site is not considered to be at risk of flooding from rising/high groundwater. Any risk would be mitigated by the adoption of the SUDS Strategy for the site and provided the buildings are set above the back of the footway of the adjacent carriageway to enable the full capacity of any secondary flood conveyance to be utilised, the risk of flooding from groundwater flooding is considered to be of **low significance**. The risk of flooding will be further managed and mitigated by using a number of property level protection measures to manage and reduce the overall flood risk at the site (see Section 9.0).

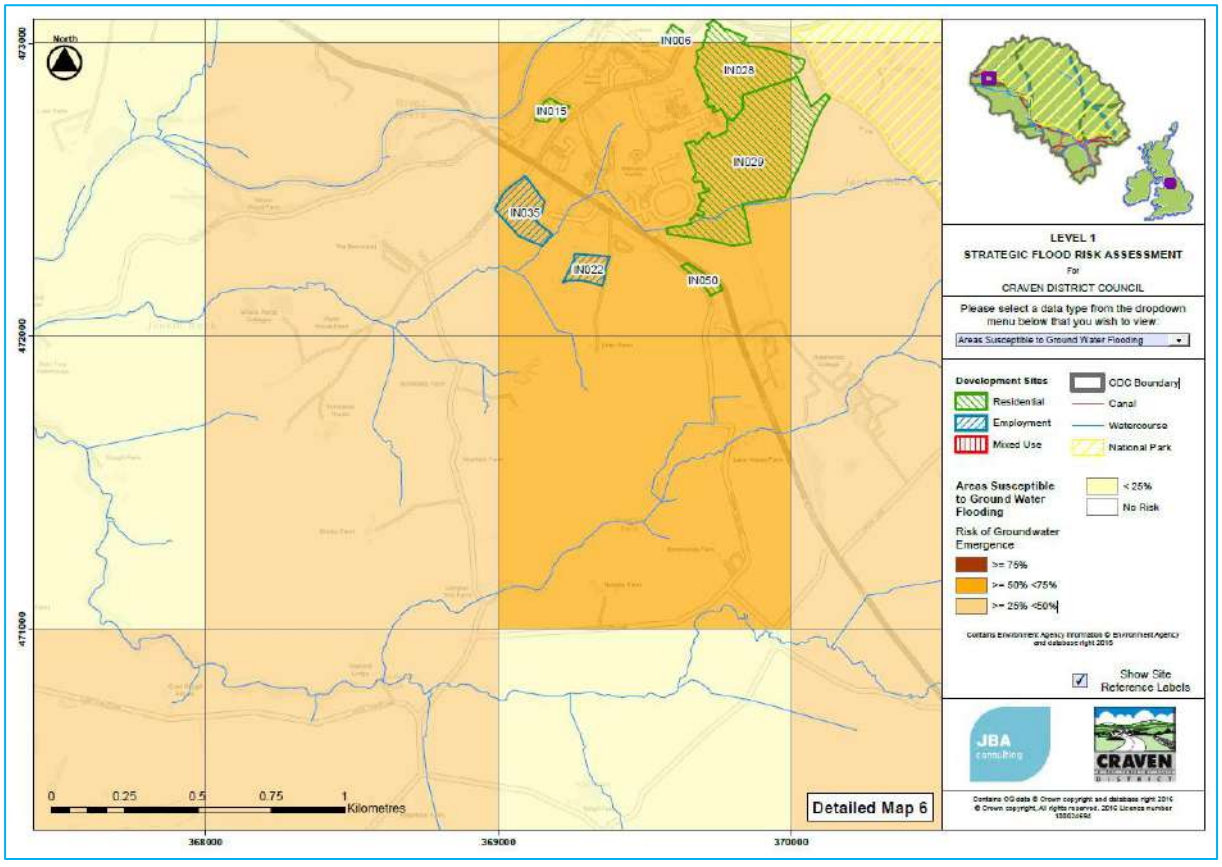


Figure 16 - Craven District Council SFRA Areas Susceptible to Groundwater Flooding

4.11 Surface Water (pluvial) Flooding

The site is not situated near to large areas of poor permeability or areas with the geology and/or topography which may result in surface water flooding. The site surroundings are relatively flat and there are no large catchments that would tend to generate surface water runoff towards the site. Surface water flow flooding tends to occur sporadically in both location and time such surface water flows would tend to be confined to the streets around the development.

The Environment Agency Surface Water flood map shows that the site has a very low risk of surface water flooding (see Figure 14) with a chance of flooding of less than 1 in 1000 (0.1%) years. This has been confirmed within the Craven District Council SFRA (see Figure 17) and JBA Comprehensive Surface Water Flood map (see Figure 15).

Any risk will be further mitigated by the adoption of the SUDS Strategy for the site and provided the buildings are set above the back of the footway of the adjacent carriageway to enable the full capacity of any secondary flood conveyance to be utilised. Therefore, the risk of flooding from surface water flooding is considered to be of **low significance**. The risk of flooding will be further managed and mitigated by using a number of property level protection measures to manage and reduce the overall flood risk at the site (see Section 9.0).

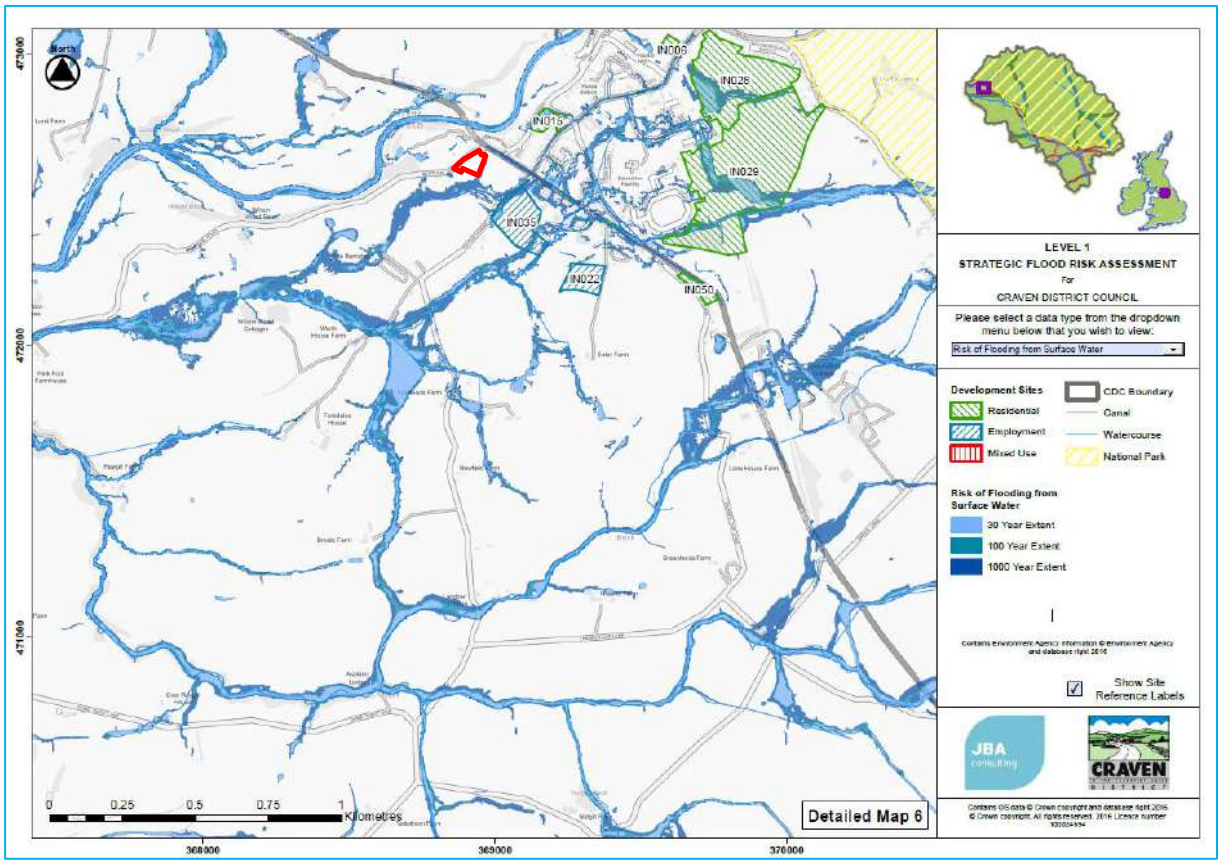


Figure 17 - Craven District Council SFRA Surface Water Flooding

4.12 Sewer Flooding

Sewer flooding occurs when urban drainage networks become overwhelmed and maximum capacity is reached. This can occur if there is a blockage in the network causing water to back up behind it or if the sheer volume of water draining into the system is too great to be handled. Sewer flooding tends

to occur sporadically in both location and time such flood flows would tend to be confined to the streets around the development.

There are no existing sewers located within the vicinity of the site. Given the design parameters normally used for drainage design in recent times and allowing for some deterioration in the performance of the installed systems, which are likely to have been in place for many years, an appropriate flood risk probability from this source could be assumed to have a return period in the order of 1 in 10 to 1 in 20 years. The provision of adequate level difference between the ground floors and adjacent ground level would reduce the annual probability of damage to property from this source to 1 in 100 years or less.

Sewer flooding poses a flood risk to the site however, this will be mitigated by the adoption of the surface water management strategy for the site and provided the buildings are set above the back of the footway of the adjacent carriageway to enable the full capacity of any secondary flood conveyance to be utilised. Therefore, the risk of flooding from sewer flooding is considered to be **not significant**. Therefore, flooding from these sources has not been considered further within this FRA.

4.13 Flooding from Artificial Drainage Systems/Infrastructure Failure

There are no other nearby artificial water bodies, water channels and artificial drainage systems that could be considered a flood risk to the site. The Environment Agency Reservoir flood map shows that the site is not at risk of reservoir flooding (see Figure 18). The risk of flooding from artificial drainage systems/infrastructure failure is considered to be **not significant**. Therefore, flooding from these sources has not been considered further within this FRA.

Figure 18 - Environment Agency Reservoir Flood Map

4.14 Effects of the Development on Flood Risk

The site has been shown to be located outside of the 1 in 100 year, 1 in 100 year (+30%) and 1 in 1000 year flood outlines. Therefore, there will be no net loss of floodplain storage capacity. The overall direction of the movement of water will be maintained within the developed site and surrounding area. The conveyance routes (flow paths) will not be blocked or obstructed. The topography of the site will not be altered therefore; the overland flow routes will not be altered. The proposed development proposes minimal new structures and will therefore allow floodwater to pass through the site with no effect on the conveyance routes.

4.15 Site Specific Flood Risk Assessment

A summary of the sources of flooding and a review of the risk posed by each source at the site is shown in Table 9.

Table 9 - Risk Posed by Flooding Sources

Sources of Flooding	Potential Flood Risk	Potential Source	Probability
Fluvial Flooding	Yes	Jenkin Beck	Low
Tidal Flooding	No	None Reported	None
Groundwater Flooding	No	None Reported	None
Surface Water Flooding	Yes	Poor Permeability	Low
Sewer Flooding	No	None Reported	None
Flooding from Artificial Drainage Systems/Infrastructure Failure	No	None Reported	None

The site is located within Flood Zones 2 and 3 and therefore has a 'medium to high probability' of fluvial flooding. However, at this location the Flood Zone extents have been derived from broad scale national modelling; JFLOW. The Environment Agency acknowledges that the JFLOW method is a generalised, and coarse modelling approach and as such the outlines produced by JFLOW can only be taken as a rough guide. The site is unlikely to flood except in extreme conditions. The primary, but unlikely, flood risk to the site is posed by fluvial flooding however, the site has no history of flooding.

River Greta

HEC-RAS modelling of the River Greta shows that the 1 in 100 year (+30%) water level is 101.84mAOD and the 1 in 1000 year water level is 101.89mAOD. The site minimum ground level is 109.97mAOD therefore, the site will not be inundated with floodwater for all events up to and including the 1 in 1000 year event from the River Greta. The New Bridge is shown to not surcharge for all events up to and including the 1 in 1000 year event.

The modelled water levels discussed above provide a much more robust estimate of the flood risk posed by the River Greta at this location than the Environment Agency Flood Zones. The JBA Comprehensive River Flood Map for the site confirms that the site is located outside of the River Greta flood outlines for all events up to and including the 1 in 1000 year event. The flood outlines and corresponding water levels are similar to the water levels predicted using the HEC-RAS model. The actual risk of fluvial flooding is much reduced compared to the Environment Agency Flood Zones. It can be concluded that fluvial flood risk from the River Greta poses a very low risk to the site. Therefore, the risk of flooding from fluvial flooding is considered to be **not significant**.

Jenkin Beck

The Environment Agency surface water flood map is representative of the fluvial flood risk from Jenkin Beck. The medium risk surface water flood outline is representative of the 1 in 100 year flood event and the low risk surface water flood outline is representative of the 1 in 1000 year event. The surface water flood map assumes that the channel capacity of the beck is 1 in 2 years. Therefore, the flood map is highly conservative. The flood map shows that the site remains dry and is not flooded during the 1 in 100 year and 1 in 1000 year events from the Jenkin Beck.

The JBA Comprehensive River and Surface Water Flood Map for the site confirm that the site is located outside of the Jenkin Beck flood outlines for all events up to and including the 1 in 1000 year event.

The above shows the flood risk posed to the site in more detail than the Environment Agency Flood Zones.

The 1 in 200 year water level has been used as the design flood level and by comparing the 1 in 200 year flood outline with the LiDAR Data it has been shown that the 1 in 200 year event has a water level of 108.92mAOD near to the site with a water depth of less than 0.30m. The modelled water levels discussed above provide a much more robust estimate of the flood risk posed by the Jenkin Beck at this location than the Environment Agency Flood Zones. The actual risk of fluvial flooding is much reduced compared to the Environment Agency Flood Zones.

It can be concluded that fluvial flood risk from the Jenkin Beck poses a low risk to the site. Therefore, the risk of flooding from fluvial flooding is considered to be of **low significance**. A number of secondary flooding sources have been identified which may pose a **low significant** risk to the site. These are:

- Groundwater Flooding
- Surface Water Flooding

The flooding sources will only inundate the site to a relatively low water depth and water velocity, will only last a short period of time, in very extreme cases and will not have an impact on the whole of the proposed development site. The risk from this source will be further mitigated by using a number of property level protection measures to manage and reduce the overall flood risk at the site (see Section 9.0).

The application is for a new, suitable flood-resilient design. The exposure of people and property will be reduced and minimised compared to existing site conditions. The chance of flooding each year is low each year. This takes into account the effect of any flood defences that may be located within the vicinity of the site as well property level protection measures.

The proposed development will have no impact on flood risk and the overall direction of the movement of water will be maintained within the developed site and surrounding area. There will no net loss in flood storage capacity. The conveyance routes (flow paths) will not be blocked or obstructed. The topography of the site will not be altered therefore; the overland flow routes will not be altered.

In conclusion, the site has been shown to be located outside of the 1 in 100 year, 1 in 100 year (+30%) and 1 in 1000 year flood outlines and a 'more vulnerable' use is appropriate at this location.

5.0 SEQUENTIAL APPROACH

5.1 Sequential Test

The risk-based Sequential Test in accordance with the NPPF aims to steer new development to areas at the lowest probability of flooding (i.e. Flood Zone 1). The planning applicant should state why there is no alternative available to them to develop.

It is impractical to suggest that there are more suitable locations for this development elsewhere. This is the only site in the ownership of the client and therefore the only site available to them to develop. The cost of buying a similar site and the cost to construct a similar development would make it uneconomical. The site proposals cannot be located in another site elsewhere. There are no alternative sites available to develop with a comparable size for residential uses within Ingleton.

No 'reasonably available' alternative sites have been identified within the sites identified for residential uses within the Ingleton area. The sites are already developed and are not available to construct the site proposals.

The Council's objectives are to sustain and enhance the vitality and viability of the region, and to ensure a wide range of businesses to which people have easy access by a range of transport therefore, improving the overall quality of life. This is underpinned by the quality of the physical environment, social well-being and economic and environmental improvements. The Council seeks to grant permission for developments that add to the vitality and viability of the region.

This site will help to regenerate the region and will help to deliver these objectives. This will site will help encourage economic impetus that will in turn help deliver a stronger service function and mix of housing uses.

The site proposals remain consistent with the relevant planning policies and are not at odds with the current use of the site and can only enhance and preserve the residential base which currently exists. The wider area surrounding the proposed development site is affected by a very similar, and in many cases, higher risk of flooding. The application is for a new, suitable flood-resilient design. The exposure of people and property will be minimised.

Flood risk at the site will be further mitigated by using a number of property level protection measures to manage and reduce the overall flood risk at the site. The proposed development will improve the sites resilience, resistance to flooding and by using property level protection measures to protect the site from flooding the vulnerability of the site will be improved.

Incidentally, the level of identified need for houses means that it is not a simple case of development on this site or on an alternative site. The Council continues to assess potential sites, in addition to this site. Whilst flood risk is a significant material planning consideration and the LPA will continue to seek to minimise flood risk and identify development sites at the lowest risk of flooding - suitable, available and viable sites for housing is scarce. Those sites that meet the criteria, subject to gaining planning permission, need to be brought forward to help meet the identified need.

It can be seen that in the short term at least it will be difficult to achieve housing targets due to market conditions such that developers are unwilling to develop sites where the rate of house sales remain at relatively low levels. Additionally, in the present housing climate there is an increased risk of delays to building completions.

Historically, a significant proportion of housing development across the district has come forward on 'windfall' sites comprising small infill sites, changes of use and conversions. Given the compelling

evidence of historic completion rates and expected future trends of housing delivery sites suitable for 'windfall' sites, it is clear therefore that 'windfall' site such as this site will remain an important element of the provision of the required new houses. It is therefore clear that the subject site and many other 'windfall' sites will be required if the Council is to have any chance of meeting its 5 year land supply of housing.

Similar developments on any site outside a Flood Zone will not offer any advantage vis-a-vis flooding. Consequently, application of the Sequential Test demonstrates that there is no measurable advantage to constructing the proposed housing elsewhere.

Application of the Sequential Test requires that there are other suitable sites available that offer less risk in terms of flooding. Development of this site with the floor levels proposed provides greater safety for the occupants than a similar site immediately adjacent to the flood risk area with levels marginally above the design flood risk level.

Hence this proposal provides greater protection to occupants than might be afforded by another notional site. Consequently, the Sequential Test would suggest that this site is one to which development should be moved to, rather than one from which it should directed away from.

From the above it is shown that there are overriding sustainability reasons for the development to be granted planning permission. The development proposals should therefore be considered by the LPA to satisfy the Sequential Test as set out in the NPPF.

5.2 Exception Test

For the Exception Test to be passed:

a) It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA.

The key emphasis of the NPPF is to achieve sustainable development. The NPPF provides the following aims under the umbrella of sustainable development.

1. Building a strong, competitive economy
2. Ensuring the vitality of town centres
3. Supporting a prosperous rural economy
4. Promoting sustainable transport
5. Supporting high quality communications infrastructure
6. Delivering a wide choice of high quality homes
7. Requiring good design
8. Promoting healthy communities
9. Protecting Green Belt land
10. Meeting the challenge of climate change, flooding and coastal change
11. Conserving and enhancing the natural environment
12. Conserving and enhancing the historic environment
13. Facilitating the sustainable use of mineral

The site is sustainable and within walking distance of the local community and services. The development of the site will improve the appearance of the site and make a positive contribution to as well as providing much a needed home in a highly sustainable location well-served by public transport and close to local facilities including schools.

The Councils' policies make clear for the need to focus on new development in locations which are accessible and sustainable, making use of existing infrastructure and community facilities and services.

There is an important need within this area for affordable housing, which is suitable for a wide variety of people.

The added material benefit is the contribution that this site will make to the Councils' housing supply position in full compliance with the emerging strategic housing policy. There is an identified need for residential uses to meet future housing needs and accordingly there is a sound and strong planning reason for bringing the site forward.

These outcomes will provide wider sustainability benefits to the community that outweigh flood risk and will deliver considerably wider sustainability benefits than could conceivably only be achieved through use of the site for residential purposes. The development proposals should therefore be considered by the Council to satisfy the first condition of the Exceptions Test as set out in the NPPF.

b) A FRA must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible, reducing flood risk overall.

This FRA has demonstrated that the development will be safe, without increasing flood risk elsewhere.

The development proposals should therefore be considered by the LPA to satisfy the Exception Test as set out in the NPPF.

6.0 EXISTING DRAINAGE NETWORKS

6.1 Introduction

This section details the existing water network infrastructure within and adjacent to the site. The existing water network has been identified and assessed using a number of techniques including correspondence with United Utilities and a topographic survey.

It is recognised that developments that are designed without regards to the foul and surface water sewers are likely to result in increased impact on existing off-site service provision. In addition, it is possible that substantial services cross the site, which may have associated easements.

Understanding the impact of existing services and potential reinforcement can be helpful in determining development areas of the scheme and also associated costs. In addition, any foul and/or surface water strategy may also require an understanding of the existing capacity.

6.2 Existing Sewers

A sewer plan has been received from United Utilities (see Appendix 3). United Utilities public foul, surface water and combined sewers are located to the east and west of the site. United Utilities has no duty to keep records of private sewers, and there are no comprehensive records kept elsewhere.

United Utilities has confirmed that the existing foul and surface water sewers will not be affected by building over proposals and easements as the sewers do not cross the site. However, it is highly recommended that site investigation of any proposed working area is undertaken to establish whether any unmapped public or private sewers and lateral drains are in existence.

6.3 Foul Water Capacity Assessment

United Utilities has confirmed that foul water will be allowed to drain to the public combined/ foul sewer network.

7.0 PROPOSED FOUL WATER DRAINAGE

7.1 Foul Water Drainage Strategy

In relation to foul drainage, pre-application discussions were undertaken with United Utilities. Development of the site will take place with separate systems for foul and surface water drainage. The separate system will extend to the public sewer. Foul water will drain to the public combined/foul sewer network.

Using the information on the depth and arrangement of the existing sewers it has been assumed that gravity drainage is possible. However, it would be prudent to undertake further detailed surveys to verify the inverts, depth and arrangement of the existing public sewer.

7.2 Conditions

The public sewer network is for domestic sewage purposes. This generally means foul water for domestic purposes and, where suitable surface water or combined sewer is available, surface water from the roofs of buildings together with surface water from paved areas of land appurtenant to those buildings. Land and highway drainage have no right of connection to the public sewer network. No land drainage can be connected/discharged to the public sewer.

At a last resort, highway drainage may be accepted under certain circumstances. If SUDS are not a viable option, there are no watercourses or highway drains available and if capacity is available within the public sewer network, highway drainage discharge to the public sewer network may be permitted. In this event, the developer may be required to enter into a formal agreement with United Utilities under Section 115 Water Industry Act 1991 to discharge non-domestic flows into the public sewer network.

Roof water should not pass through the traditional 'stage' or full retention type of interceptor/separator. It is good drainage practice for any interceptor/separator to be located upstream of any on-site balancing, storage or other means of flow attenuation that may be required.

Car parking areas are to be drained using road type gullies. Surface water runoff from communal parking (greater than 800m^2 or more than 50 car parking spaces) and hardstanding must pass through an adequately sized Class B oil, petrol and grit interceptor/separator a before discharge to the public sewer network. Roof water will not pass through the traditional 'stage' of full retention type of interceptor/separator. The interceptor/separator will be located upstream of any on-site balancing, storage or other means of flow attenuation.

7.3 Application to make connections

The developer will write to United Utilities requesting an application form that will be duly completed and returned. No works on the public sewer will be carried out until a letter of consent is received from United Utilities.

7.4 Adoption Agreements

Prospective adoptable sewers and pumping stations will be designed and in constructed in accordance with 'Sewers for Adoption' 7th Edition as supplemented by United Utilities' requirements, pursuant to an agreement under Section 104 of the Water Industry Act 1991. An application to enter into a Section 104 agreement must be made in writing prior to any works commencing on site.

8.0 PROPOSED SURFACE WATER DRAINAGE

8.1 Surface Water Runoff Overview

It is recognised that consideration of flood issues should not be confined to the floodplain. The alteration of natural surface water flow patterns through developments can lead to problems elsewhere in the catchment, particularly flooding downstream. For example, replacing vegetated areas with roofs, roads and other paved areas can increase both the total and the peak flow of surface water runoff from the development site. Changes of land use on previously developed land can also have significant downstream impacts where the existing drainage system may not have sufficient capacity for the additional drainage.

A SUDS Strategy for the site proposals has been developed to manage and reduce the flood risk posed by the surface water runoff from the site. An assessment of the surface water runoff rates has been undertaken, in order to determine the surface water options and attenuation requirements for the site. The assessment considers the impact of the development compared to current conditions. Therefore, the surface water attenuation requirement for the developed site can be determined and reviewed against existing arrangements.

The surface water drainage arrangements for any development site should be such that the volumes and peak flow rates of surface water leaving a developed site are no greater than the rates prior to the proposed development, unless specific off-site arrangements are made and result in the same net effect.

It should be acknowledged that the satisfactory collection, control and discharge of surface water runoff are now a principle planning and design consideration. This is reflected in recently implemented guidance and the National Sustainable Drainage Systems (SUDS) Standards.

8.2 Climate change

Projections of future climate change, in the UK, indicate more frequent, short-duration, high intensity rainfall and more frequent periods of long duration rainfall. Guidance included within the NPPF recommends that the effects of climate change are incorporated into Flood Risk Assessments. Recommended precautionary sensitivity ranges for peak rainfall intensities and peak river flows are outlined in the associated Planning Practice Guidance to the NPPF[6].

The recommended national precautionary sensitivity range for peak rainfall intensity are summarised in Table 10.

Table 10 - Peak Rainfall Intensity Allowance in Small and Urban Catchment (use 1961 to 1990 baseline)

Parameter	2010 to 2039	2040 to 2059	2060 to 2115
Upper end	+ 10%	+ 20%	+ 40%
Central	+ 5%	+ 10%	+ 20%

[6] Communities and Local Government (2014) Planning Practice Guidance - Flood Risk and Coastal Change.

8.3 Discharge of Surface Water

There are three possible options to discharge the surface water runoff in accordance with requirement H3 of the Building Regulations, this hierarchy is also promoted within the NPPF. Rainwater shall discharge to one of the following, listed in order of priority:

- an adequate soakaway or some other adequate infiltration system; or, where that is not reasonably practicable,
- a watercourse; or where that is not reasonably practicable,
- a sewer.

It is necessary to identify the most appropriate method of controlling and discharging surface water. The design should seek to improve the local runoff profile by using systems that can either attenuate runoff and reduce peak flow rates or positively impact on the existing surface water runoff.

8.3.1 Soakaway/Infiltration System

In determining the future surface runoff from the site, the potential of using infiltration devices has been considered. As no site geotechnical information on the permeability and infiltration rate at the site has been acquired at this stage it is not possible to comment definitively upon the suitability of infiltration based systems. However, an overview of the general ground conditions may be used to gauge if there is potential for their application.

Whilst the permeability and infiltration rate of the site should ideally be confirmed by a site investigation into the hydrogeology of the site, the ground conditions suggest infiltration techniques such as soakaways may work and may provide a suitable option at the site.

If an infiltration system is proposed, it is recommended that a series of infiltration/soakaway tests are carried out on site to BRE Digest 365 Guidelines to confirm the assumptions made in the calculations. Such work is beyond the scope of this FRA, but should be undertaken to inform the detailed drainage strategy for the site.

8.3.2 Watercourse

Should infiltration be found to be unsuitable, the next option is discharge to a watercourse. There are no watercourses located within the vicinity of the site. Therefore, it will not be possible to discharge surface water runoff from the site into a watercourse. If required, this option should be explored further at the detailed design state.

8.3.3 Sewer

In the event that discharge of surface water via infiltration or discharge to a watercourse is deemed unsuitable, then discharge to the public sewer would be possible. All surface water runoff that cannot be discharged via infiltration will be managed on site and discharged to a surface water sewer. United Utilities has confirmed that:

'… if ground conditions confirm in writing that this is not a viable solution, all surface water can drain to the 300mm diameter surface water sewer on New Road at a maximum pass forward flow of 6.5 l/s for any storm event'.

8.4 Site Areas

The site comprises a greenfield development and is currently vacant land. It is understood that the proposals are for a residential development with approximately 10 units with gardens. The incorporation of gardens and landscaped areas will allow a proportion of the rainfall to infiltrate into the soil substrate.

The site comprises a piece of land covering an area of approximately 3.52ha. The impermeable areas within the proposed development will cover an area of approximately 2.40ha, the increase in impermeable areas will lead to an increase in surface water runoff rate and volumes. If the surface water runoff from the developed site is not attenuated this would generate higher surface water runoff post-development. If uncontrolled, this could in turn increase the risk of flooding to the site and off-site locations. The required attenuation storage could be provided by a variety of means these are discussed below.

8.5 Greenfield Runoff Rates

An estimation of surface water runoff is required to permit effective site water management and prevent any increase in flood risk to off-site receptors. In accordance with The SUDS Manual, the Greenfield runoff from the site has been calculated using the IoH124 method. Table 11 shows the IoH 124 method Greenfield run off rates for the proposed impermeable area of 2.40ha (see Appendix 10). QBAR has been calculated to be 24.66 litres/second.

The method used for calculating the runoff complies with the NPPF, as well as the new Defra non-statutory technical standards for SUDS, and assumes that the excess runoff associated with the proposed development (plus an allowance for future climate change) will need to be managed by the proposed SUDS Strategy.

Table 11 - IoH 124 Method Greenfield Runoff Rates

Return Period (yrs)	Runoff Rate (l/s)
1	20.96
QBAR	24.66
30	41.42
100	51.78

8.6 SUDS and Water Quality

Current guidance promotes sustainable water management through the use of SUDS. SUDS measures should be used to control the surface water runoff from the proposed development site therefore, managing the flood risk to the site and surrounding areas from surface water runoff.

A hierarchy of techniques is identified[7]:

1. **Prevention** – the use of good site design and housekeeping measures on individual sites to prevent runoff and pollution (e.g. minimise areas of hard standing).

2. **Source Control** – control of runoff at or very near its source (such as the use of rainwater harvesting, permeable paving, soakaways and/or green roofs).

[7] CIRIA (2004) Report C609, Sustainable Drainage Systems – Hydraulic, Structural and Water Quality advice.

3. **Site Control** – management of water from several sub-catchments (including routing water from roofs and car parks to one/several large soakaways for the whole site, swales and/or infiltration trenches).

4. **Regional Control** – management of runoff from several sites, typically in a detention pond, basins, tanks and/or wetland.

It is generally accepted that the implementation of SUDS as opposed to conventional drainage systems, provides several benefits by:

- reducing peak flows to watercourses or sewers and potentially reducing the risk of flooding downstream;
- reducing the volumes and frequency of water flowing directly to watercourses or sewers from developed sites;
- improving water quality over conventional surface water sewers by removing pollutants from diffuse pollutant sources;
- reducing potable water demand through rainwater harvesting;
- improving amenity through the provision of public open spaces and wildlife habitat; and
- replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.

The most appropriate attenuation system will need to satisfy three main characteristics, firstly, provide the required volume of storage, secondly, minimise the loss of developable land and thirdly, where possible provide local amenity.

The application of the SUDS Manual requires that the runoff from sites is not only restricted to meet the Greenfield runoff characteristics but also that SUDS systems are utilised to improve the quality of the runoff prior to outfall to watercourses. The SUDS Manual and Environment Agency guidance applies a sustainability hierarchy to the various types of SUDS systems, this is summarised in Table 12.

Table 12 - Sustainability Hierarchy

Most Sustainable	SUDS Technique	Flood Reduction	Pollution Reduction	Landscape & Wildlife
	Living Roofs	✓	✓	✓
	Basins and ponds - Constructed wetlands - Balancing ponds - Detention basins - Retention ponds	✓	✓	✓
	Filter strips and swales	✓	✓	✓
	Infiltration Devices - Soakaways	✓	✓	✓
	Permeable Surfaces and Filter Drains - Gravelled areas - Solid paving blocks - Permeable paving	✓	✓	
Least Sustainable	**Tanked systems** - Over-sized pipes/tanks - Cellular storage	✓		

Systems at the top of the hierarchy provide a combination of attenuation, treatment and ecology and are deemed the most sustainable options. There are always specific scenarios where systems are more suitable than others and at this stage it is not possible to guide the development towards a particular strategy.

In addition to the above hierarchy the SUDS Manual identifies the number of treatment trains or SUDS devices through which flow should pass from various point sources of runoff (see Table 13). This is designed to ensure that the receiving watercourses are not put at risk of pollution by new development therefore; accordingly, two treatment trains will be used on this site.

Table 13 - Number of Treatment Train Components (assuming effective pre-treatment is in place)

Runoff Catchment Characteristic	Receiving Watercourse Sensitivity		
	Low	Medium	High
Roof only	1	1	1
Residential roads Parking areas Commercial zones	2	2	3
Refuse collection Industrial areas Loading bays Lorry parks Highways	3	3	4

The usual approach is to consider the 'SUDS train' where each of the above options are considered in turn until a suitable solution is found. Thus, source control techniques such as soakaways, rainwater harvesting and/or infiltration trenches, if suitable on a site, are considered preferable to permeable conveyance and passive treatment systems such as tanks or ponds. The various options are considered in outline below.

8.6.1 Source Control

(i) Soakaways

Soakaways are buried rings or tanks filled with rubble or stone and allow gradual infiltration of collected runoff from impermeable areas into the surrounding soil. They require relatively permeable strata below a site to allow percolation and the reduction in runoff is achieved by the volume of percolation and the available storage volume. An assessment of their suitability requires the characteristics of the sub-soils or the geology to confirm the infiltration rate or vertical permeability.

At this stage it is proposed that the roof drainage from the site could discharge to house soakaways. The soakaways would be sized according to on the site infiltration rates obtained during infiltration/soakaway tests. If the soakaways are sized for example the 1 in 10 year event an overflow would discharge water to another SUDS feature during events larger than the 1 in 10 year event. Table 14 shows the soakaway characteristics required such that the 1 in 100 year (+40%) event can be fully discharged. This is based on an infiltration rate of 0.02m/hr.

The BRE365 calculation procedure for a concrete ring soakaway with a void ratio of 63% (i.e. 95% for the concrete ring and 30% for the surrounding pit) within the Masterdrain Drainage Software was used to demonstrate that the proposed surface water runoff volumes can be viably accommodated on site and drained by infiltration during the 1 in 10, 1 in 30, and 1 in 100 year storms with a 40% allowance for climate change assuming a roof area of 55m^2 per house (see Appendix 11). It should be noted that some of the houses are smaller than this, so this is a conservative estimate. The required half emptying time of 24 hours for each of the design storms is met and therefore this method of storm water disposal is appropriate for use on this site.

Soakaways could also be located within the landscaped areas and public open space to provide the required volumes of surface water storage if the capacities of the house soakaways are exceeded. If an infiltration system is proposed, it is recommended that a series of infiltration/soakaway tests are carried out on site to BRE Digest 365 Guidelines to confirm the assumptions made in the calculations.

Table 14 - BRE365 Concrete Ring Soakaway Calculations

Return Period (years)	Impermeable Area (m^2)	Ring Diameter (mm)	Side Length (m)	Depth (m)	Required Volume (m^3)	Actual Volume (m^3)
10 +40%	55	1200	2.40	1.50	3.40	6.10
30 +40%					4.40	6.10
100 +40%					5.90	6.10

(ii) Permeable Paving

The use of permeable paving can often be considered for pedestrian or car parking areas but not for heavy traffic areas such as roadways where the heavy loading could damage the paving infrastructure. Permeable paving also depends on having permeable underlying strata. The permeable paving can either discharge via infiltration or discharge to cellular storage.

Permeable paving will provide storage for the first 5mm (interception storage) as a minimum. It is should be noted that any permeable paving system to be installed by a developer must have an infiltration rate of at least 30mm/hr (0.03m/hr) to avoid ponding on the surface before it reaches the natural soil (permeable paving systems generally would have an infiltration rate in excess of 30mm/hr).

These systems also encourage biological treatment of flow and extraction of oils and heavy metals from the runoff. Treatment processes that occur within the surface structure and the geotextile layers include:

- Filtration
- Absorption
- Biodegradation
- Sedimentation

Land take is reduced as storage is located under car parks and access roads. However, maintenance is potentially a long-term issue and the possibility of the paving being damaged, dug up and not properly reinstated or not regularly swept could lead to compromising the future capacity of the system.

This system will negate the need for a separate collection system such as kerbs and gullies. It will also assist in reducing the flood profile of the site by significantly attenuating the run off from the development within the sub base material. There is no specific amenity provided by the system other than enabling other areas to be utilised for development rather than potentially sterilizing areas with an easement for a sewer or stand-off for a basin.

It is most likely that permeable paving will be utilised within the driveways/car parking areas of the dwellings. Provided that this is laid onto a thick open-graded sub-base, this provide sufficient storage for the runoff before discharge via infiltration or to cellular storage such that the 1 in 100 year (+40%) event can be fully discharged (see Table 15 and Appendix 12). This is based on an infiltration rate of 0.02m/hr and assuming a roof area of 55m^2 per house. It should be noted that some of the houses are smaller than this, so this is a conservative estimate. The infiltration volume exceeds the total runoff volume. Minimal storage is required, therefore a minimum construction thickness of 375mm should be used.

Table 15 - Permeable Paving 1 in 100 Year (+40%) Event

Parameter	Value
Area draining to permeable paving	30m^2
Permeable paving area	30m^2
Mean rain intensity	16.70m/hr
Total rainfall volume	3.002m^3
Total runoff volume	2.852m^3
Mean discharge rate	0.167l/s
Infiltration volume	Infiltration volume exceeds the total runoff volume

(iii) Rainwater Harvesting

The reuse of water from roofed areas to provide grey (non-potable) water for flushing WCs within buildings can reduce storm runoff without the need for treatment or oil separators since the risk of spillage or contamination is low. Such a facility could be practical depending on the available water volumes. Rain water is held in off-line storage tanks at or about roof level from where a gravity feed is used to supplement the standard water supply. This would not include the hardstanding areas at ground level such as roads and car parking areas which would require a pumped system to return

water to roof level and this is considered impractical. Over the course of a year a grey water system will reduce the volume of water entering the storm water disposal system and could be considered.

Such a system would require one or more tanks at roof level and under optimum conditions these would be kept as near as full as possible to ensure a reliable water supply. For the purposes of a worst-case design scenario it is assumed that the tanks would be full at the start of an extreme rainfall event and hence all storm rainfall would enter the surface water drainage system rather than grey water storage. Whilst there may be merit in including such a scheme in the overall designs these are not considered appropriate in the SUDS assessment.

(iv) Water Butts

Water butts are the most common means of harvesting rainwater for garden use. They are small, off-line storage devices that are designed to capture and store roof runoff. They are a simple water conservation technique that can contribute to sustainable water management for developed areas. In general water butts do not provide water quality treatment.

A water butt collects rainwater from roofs via an inlet that is connected to the roof down-pipe. Water butts are manufactured in a wide variety of sizes and can consist of inter-connectable units. During wet periods, water butts are often full, resulting in little or no attenuation or reduction in outflow rates or volumes. However, water butts can be designed to attenuate runoff by using a throttled overflow system with excess water discharge to the drainage system or soakaway. Water butts will be used to provide betterment but not as the primary system and have therefore not been included within any storage volume calculations. A rainwater harvesting water butt is included within the design of the site which will reduce the amount of water within the site and catchment area. One large water butt per dwelling will be used which will provide 0.35m^3 of water storage.

(v) Green Roofs

A green roof is a multi-layered system that covers the top of a building with soil and vegetation and which can provide a degree of rain storm attenuation and a reduction in site runoff. These can either be extensive roofs which are low maintenance with a 25-125 mm soil layer in which a variety of hardy drought tolerant low plants are grown, or intensive roofs with trees and planters which impose a greater load on the roof structure but are more suitable in certain circumstances. Green roofs can be used to reduce the volume and rate of runoff so that other SUDS techniques in the scheme can be significantly reduced in size.

As the buildings will not have flat roofs and the application of green roofs in a domestic scenario is limited due to on-going maintenance and access requirements of any system therefore, this is not a practical option and is therefore not considered further.

8.6.2 Site Control - Permeable Conveyance Systems

Permeable conveyance systems can take the form of infiltration trenches, swales or filter strips at road margins where surface runoff from roads, car parking areas and also roof drainage can be directed. Used to collect water directly from linear systems, percolate the flow, attenuate and then discharge the flow to either a traditional system or a secondary SUDS device.

The use of these systems is more suited to linear applications such as roads as the typical cross section is relatively small and longer runs are required to provide attenuation volume. Land take can be relatively small in comparison to other systems and both types perform well in improving water quality. They are also ideally suited for disposal of water via secondary infiltration.

It is likely that these features could be utilised as the first treatment train and as part of the site collection and conveyance system.

(i) Infiltration Trench

Infiltration trenches are essentially linear soakaways which allows water to infiltrate into the soils as it is transported to a disposal point. There is space available on this site to provide a long length of infiltration trench.

(ii) Swales

Swales are open wide trapezoidal channels across a site which allows water to infiltrate into the soils as it is transported to a disposal point. There is space available on this site to provide a long length of swale.

(iii) Filter Strips

Filter strips will be smaller in plan area than a swale although the swale can be landscaped to be incorporated in to the verge of the carriageway, combining two functions. There is space available on this site to provide a long length of swale and it is likely that these will provide a suitable means of surface water disposal.

Other options include canals and rills.

8.6.3 Passive Treatment Systems

Where ground conditions prevent the use of infiltration, such as on ground that may be impermeable or contaminated, SUDS methods that are designed not to infiltrate can be considered. Passive treatment systems can include a pond, wetland, tank or a basin on the lower parts of a site. These will reduce peak flows, but not the volume of runoff, and slow down flows before disposal to a surface water drainage system. These may provide a suitable SUDS solution for this site and options are therefore considered in outline below.

The provision of suitable storage on site to mitigate the flood risk resulting from the development of the site will be a key factor in the evolution of the site development layout. The provision of large volumes of attenuation, as is likely in this case, can be achieved by a number of methods; however, not all systems can be assessed in direct comparison.

One of the aims of the NPPF is to provide not only flood risk mitigation but also to maximise additional gains such as improvements in runoff quality and provision of amenity and bio-diversity. Systems incorporating these features are often termed SUDS and it is the requirement of NPPF that these are considered as the primary means of collection, control and disposal for storm water as close to source as possible.

The principle applied in the design of storage is to limit the discharge rate of surface water runoff from the developed site for events of similar frequency of occurrence to the same peak rate of runoff as that which takes place from a greenfield site prior to development.

Table 16 shows the volume of storage required for the proposed development estimated using the Masterdrain Drainage Software for the 1 in 1, 1 in 30 and 1 in 100 year events, with a 40% allowance for climate change (increase in peak rainfall) assuming the proposed impermeable area of 2.40ha with 6.50l/s used as the limiting discharge rate before discharge to the surface water public sewers (see Appendix 13). Therefore, the surface water runoff from the developed site will be no greater than existing. The proposed surface water runoff from the site will be limited to greenfield runoff rates and the corresponding required storage provided on site.

Table 16 - Storage Volume

Return Period (years)	Limiting Discharge Rate (l/s)	Volume (m^3)
1 + 40%	6.50	27
30 + 40%		92
100 + 40%		135

This volume may be reduced by implementing a complex control at the outfall which would increase the rate of discharge from the site for events above the 1 in 30 year event. During the detailed design stage, the system could be designed to attenuate to the 1 in 2, 1 in 30 and 1 in 100 year events, in accordance with the Interim Code of Practice for SUDS. This should be explored at detailed design stage and agreed with the LPA, LLFA and Environment Agency. This volume of attenuation storage could be provided by a variety of means these are discussed below.

(i) Ponds and Basins

The nature of these systems is such that the runoff from the development can be treated by biological action and stilling to significantly improve the quality of water discharged from the system.

Basins also provide large areas of open space that can be developed for recreational uses or as new habitats for wildlife. Both systems do, however, take up significant amounts of developable land and have residual maintenance and liability issues attached to their implementation.

In this case, the topography of the site would permit the use of these systems with careful integration of landscaping and earthworks. Due to the small size of the site this option is not practical for the site.

(ii) Storage Tanks

Hard engineered tank storage systems have traditionally been used for attenuation structures for the past decade and are often specified where large volumes of storage are required (>200m^3) and available space is an issue. These could be located underneath the roads and paved areas.

These systems have no inherent water treatment properties bar potential sedimentation of the attenuated flow and offer no additional amenity benefits. In some cases, the easement to the tank or culvert is such that a significant portion of land area is sterilized from development and certain planting.

There are also significant costs associated with these systems in production, transportation and installation. However, once installed the long-term maintenance of the system is relatively low. With a proven record of successful installation, tanks and culverts are regularly adopted by water authorities across the country, albeit with a large associated easement that will sterilise that portion of the site.

In this case, the site conditions would permit the use of these systems with careful integration. The site layout allows for approximately 135m^3 of storage tanks under the highways located on the site. The oversized drainage network would be used to attenuate any excess flows over and above the house soakaway capacity and/or permeable paving.

(iii) Oversized Drainage Network

A further option on storage and attenuation would be the use of an oversized drainage network designed to act as inline storage, rather than a tank or pond, to provide the required storage volume underground. These could be located underneath the roads and paved areas.

As the diameter of larger pipes readily available is limited the applicability of these types of systems is more suited to <200m^3 of attenuation. Above this volume the length of pipe required is excessive and difficult to suitably fit into a normal site layout. There is no intrinsic amenity provided by the use of this system neither is there any specific level of run-off treatment over and above that of a standard pipe and gully system.

However, due to their traditional nature, the adoption of these types of systems by water authorities is straightforward and does not require any specialist input. The pipes are generally available direct from suppliers with little or no lead in time and the satisfactory long-term performance of these systems is well documented.

This option could be used in combination with other SUDS elements to provide the required storage volume. The site layout allows for approximately 135m^3 of oversized drainage network under the highways located on the site. The oversized drainage network would be used to attenuate any excess flows over and above the house soakaway capacity and/or permeable paving.

(iv) Cellular Storage

Large volumes of storage can be provided under grassed and lightly trafficked areas by using proprietary plastic cellular systems. This will maximise the developable area of the site. These could be located underneath the roads and paved areas.

There is no specific mechanism within the system designed to treat flow, but extended detention times will allow sedimentation reducing the suspended solids within the discharge. There is no creation of amenity by the installation of these types of systems, indeed by maintaining access to the system small areas may need to be reserved.

If the developable footprint is tight, then these systems may be advantageous however to ensure adoptability it is recommended that the use of these systems is discussed with the adopting authority as they are not always preferred.

There would be room to install cellular storage under the drive way areas to provide the storage volume required. This will require the new drainage network to divert flow from the impermeable buildings and parking areas to this cellular storage facility. This could also be drained via permeable pavement surfaces.

The site layout allows for cellular storage under the highways located on the site. The site layout allows for approximately 135m^3 of cellular storage. Cellular storage would be used to attenuate any excess flows over and above the house soakaway capacity and/or permeable paving. The cellular storage would be used to attenuate any excess flows over and above the house soakaway capacity and/or permeable paving.

(v) Surface Storage

The use of roads, public areas and even landscaped areas as additional storage is becoming a widely accepted form of attenuation. Water spilling from drainage systems can be collected via roads and kerbs and channelled to lower lying areas where it would be stored until the capacity in the existing system returns. These systems have the advantage of requiring little additional infrastructure merely detailing of the proposed roads and grassed areas.

As these systems will only be used in extreme events when the adopted drainage system is exceeded (>1 in 30 years), they provide a very efficient way of catering for these events rather than providing permanent capacity. There is no inherent water treatment capability in this system or any particular increase in amenity; however, the costs associated with this provision are relatively small. It is

recommended that these systems are only used in emergency circumstances or for events greater than the 1 in 30 year event.

8.7 Proposed SUDS Strategy

The objective of this SUDS Strategy is to ensure that a sustainable drainage solution can be achieved which reduces the peak discharge rate to manage and reduce the flood risk posed by the surface water runoff from the site. At this stage a detailed surface water drainage design has not been undertaken, however it is necessary to demonstrate that the surface water from the proposed development can be discharged safety and sustainably. The SUDS Strategy takes into account the following principles:

- No increase in the volume or runoff rate of surface water runoff from the site.
- No increase in flooding to people or property off-site as a result of the development.
- No surface water flooding of the site.
- The proposals take into account a 40% increase in rainfall intensity due to climate change during the next 100 years which is the lifetime of the development

For all development, a hierarchical approach to surface water management. This approach has been adopted within this SUDS Strategy with infiltration being utilised wherever possible. If discharge via infiltration is not possible the surface water will be discharge to public surface water sewers. The site layout allows for at least a two stage SUDS treatment train to allow for improvement in water quality.

In line with adopting a 'management train' it is recommended that water is managed as close to source as possible. This will reduce the size and cost of infrastructure further downstream and also shares the maintenance burden more equitably. It is therefore recommended that each plot provides its own attenuation, and one stage of treatment. This may be in the form of:

- Water Butts for each dwelling.
- Permeable paving of all driveways and car parking areas.
- House soakaways for each dwelling.
- Filter strips, infiltration trenches, swales.
- Cellular storage below the permeable paving, if required.
- Oversized pipes/cellular storage/storage tanks, if required.
- For larger events in other areas such as car-parking and landscaping, provided that it will not cause damage or prevent access.

The Outline SUDS Strategy is shown in Figure 19. The precise nature and form of the SUDS system will be influenced by the type of the dwellings on the site, so some flexibility should be offered, providing proposals are robust and adequate plans for their maintenance made. Each plot may discharge into the drainage system.

If ground permeability is poor then surface features such as filter strips, canals and rills, swales etc. would be required for conveying surface water runoff. Some pipework would invariably be required for road crossings and flow control purposes.

The remainder of the site that is not formally drained, i.e. gardens and areas of open space, will be permeable (grass). The majority of rainwater falling on these areas will soak into the ground. Surface

water runoff would be directed to the drainage system through drainage gullies located around the perimeter of the buildings and through contouring of the hardstanding areas.

As a consequence of limiting the rate of discharge from the site, at times of heavy rainfall the volume of water leaving the site will be significantly less than that draining from it. In order to prevent this water backing up in the system and causing flooding, the surface water will be discharged by infiltration methods (e.g. soakaways, permeable paving etc.) however; if this is not possible 135m^3 of attenuation storage will be incorporated into the site layout with discharge limited to 6.50l/s for all events up to and including the 1 in 100 year (+40%) rainfall event. Therefore, the surface water runoff from the developed site will be no greater than existing.

This volume may be reduced when moderate infiltration is taken into account. The volume is dependent on the values assumed for infiltration. Local site-specific investigations and testing will improve this estimate and refine the volumes for infiltration.

The size of this attenuation storage has been calculated such that the proposed development has the capacity to accommodate the 1 in 100 year rainfall event including a 30% increase in rainfall intensity that is predicted to occur as a result of climate change. Consequently, all areas drained have been designed to accommodate a 100 year (+40% climate change) storm event.

This restriction will provide significant flood mitigation benefits to existing third-party property and land downstream of the site that may be potentially at risk from flooding. These methods will reduce peak flows, the volume of runoff, and slow down flows and will provide a suitable SUDS solution for this site.

SUDS features may be integrated into the landscape forming a harmonious whole, which will have a visually pleasing affect. Paths may be constructed to enable access for both maintenance and recreation, with surface finishes that are durable, and in keeping with the surroundings. Street furniture may be used to enhance enjoyment of the space. Visual clutter such as signposts and fences which prevent access to the space and make it less inviting may be avoided. Careful barrier planting and use of aquatic benches and shallow slopes will reduce health and safety risks.

Planting should use a variety of native species of local provenance to ensure opportunities for biodiversity and sustain habitat within the development. A range of habitats may be created using SUDS features such as ponds, with aquatic benches for marginal planting, areas for natural wetland and meadow planting. Features should aim to mimic equivalent natural features, following natural drainage paths and fitting in with site contours, with natural elongated sinuous forms where possible. SUDS features may also be managed for wildlife for example by encouraging flowering plants, changing mowing regimes to allow plants to set seeds, and leaving them over winter as a food source. Carrying out grass cuts, and removing from site may also improve biodiversity of landscaped areas. However, such management regimes are likely to differ from normal regimes and may need additional equipment, training and agreement from the maintaining authority to implement.

More traditional or conventional drainage structures are likely to be required as part of the proposed development: collecting runoff where source control is not practical, conveying water within the site, or providing additional attenuation storage underground. In certain areas within the proposed development, gullies or linear drains may be the most practical option, when whole-life issues are considered: such as operation, maintenance, and change of use.

At this stage a detailed surface water drainage design has not been undertaken, however it is necessary to demonstrate that the surface water from the proposed development can be discharged safety and sustainably. It is proposed that a planning condition can be adopted to cover the detailed design of the surface water runoff from the site. It is proposed that the detailed drainage design of the final scheme would be secured by a planning condition attached to any planning permission

granted and agreed with the Environment Agency, United Utilities, the LLFA and the LPA prior to works commencing.

The adoption of a SUDS Strategy for the site represents an enhancement from the current conditions as the current surface water runoff from the site is uncontrolled, untreated, unmanaged and unmitigated. In adopting these principles, it has been demonstrated that a scheme can be developed that does not increase the risk of flooding to adjacent properties and development further downstream.

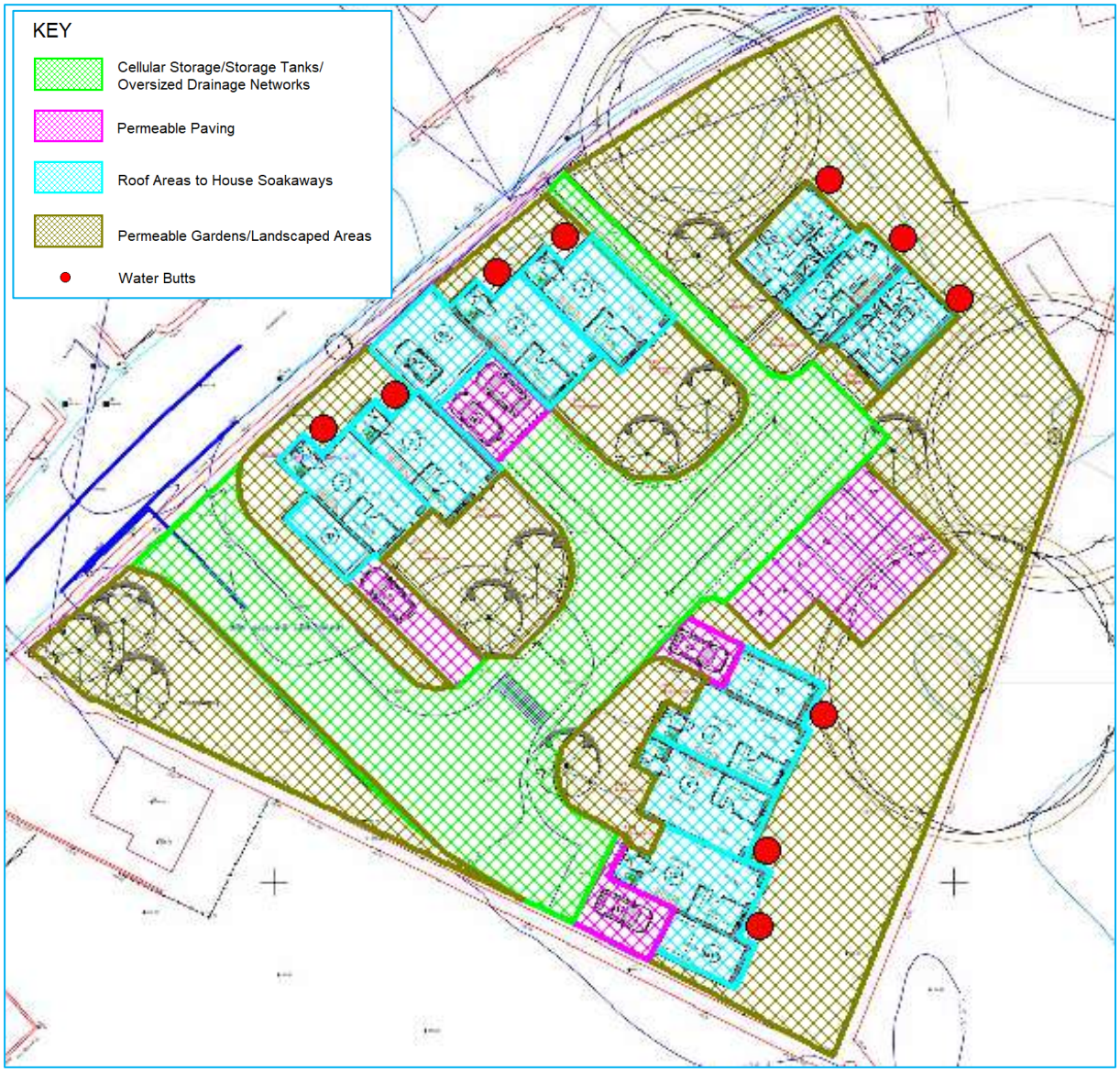


Figure 19 - Outline SUDS Strategy

8.8 Designing for Local Drainage System Failure/Design Exceedance

When considering residual risk, it is necessary to make predictions as to the impacts of a storm event that exceeds the design event, or the impact of a failure of the local drainage system. The SUDS Strategy applies a safe and sustainable approach to discharging rainfall runoff from the site and this reduces the risk of flooding however, it Is not possible to completely remove the risk. This section of the FRA is therefore associated with the way the residual risk is managed.

As part of the SUDS Strategy it must be demonstrated that the flooding of property would not occur in the event of local drainage system failure and/or design exceedance. It is not economically viable or sustainable to build a drainage system that can accommodate the most extreme events. Consequently, the capacity of the drainage system may be exceeded on rare occasions, with excess water flowing above ground[8].

The attenuation requirements have been designed to accommodate the 1 in 100 year storm event plus climate change (+40%). The design of the site layout provides an opportunity to manage this local drainage system failure/exceedance flow and ensure that indiscriminate flooding of property does not occur.

There will not be an extensive sewerage network on the proposed development site and therefore any potential exceedance flooding would be from the sewers and lateral drains connecting the properties to the underground storage areas. It is very unlikely that a catastrophic failure would occur. An exceedance or blockage event of the sewers would not affect the proposed buildings because the finished floor level will be raised above surrounding ground levels, ensuring any exceedance flooding would not affect the buildings. Exceedance flows would be contained within the highways and within the site and would flow to the lower ground levels where the public open space is located. It is not considered that there is an increased risk to the properties on the site or located adjacent to the site.

In particular, the landscaped areas will include preferential flow paths that convey water away from buildings. Surface water runoff would be directed to the drainage system through drainage gullies located around the perimeter of the buildings and through contouring of the hardstanding areas.

When considering the impacts of a storm event that exceeds the 1 in 100 year (+40%) event, there is a safety factor, even under the design event conditions. It should also be noted that additional storage is provided within the manholes, pipes and drainage gullies which will provide betterment over and above the 1 in 100 year (+40%) event. Consequently, if this event were to be exceeded there is additional capacity with the system to accommodate this. If this freeboard was to be exceeded the consequences would be similar, if not less than for the local drainage system failure. Consequently, the impact of an exceedance event is not considered to represent any significant flood hazard.

The above manages and mitigates the flood risk from surface water runoff to the proposed properties from surface water runoff generated by the site development and to offsite locations as well the risk from surface water runoff generated offsite.

8.9 Operation and Maintenance Requirements

The following maintenance schedules are based on The SUDS Manual, for standard maintenance regimes. However, planting and maintenance regimes may be changed to enhance bio-diversity. In order for any surface water drainage system to operate as originally intended, it is necessary to ensure that it is adequately maintained throughout its lifetime. For residential developments, this is generally taken as 100 years. Therefore, over the lifetime of a development there is strong possibility that the system could either fail or its performance be reduced if it is not correctly maintained. This is even more important when SUDS form part of the SUDS Strategy compared to traditional piped networks.

The surface water drainage scheme will be installed and fully operational before occupation of the site occurs. The surface water drainage scheme will be regularly maintained. The key maintenance requirements are regular inspection of silt traps, manholes, pipework and pre-treatment devices, with removal of sediment and debris as required.

[8] CIRIA (2006) Designing for exceedance in urban drainage – good practice.

Regular inspection and maintenance is required to ensure the effective long-term operation of below ground modular storage systems. Maintenance responsibility for the system will be placed with the owner of the dwellings who will employ responsible organisations when required. Specific maintenance needs of the system will be monitored, and maintenance schedules adjusted to suit requirements.

Preventative measures will be taken rather than corrective measures. Preventative maintenance ensures both the condition monitoring and life-extending tasks are carried out at scheduled regular intervals, ensuring failure and regular repair of the system is avoided.

The operational and maintenance requirements are shown in Table 17.

Table 17 - Operational and maintenance requirements

Maintenance schedule	Required action	Frequency
Soakaways		
Regular maintenance	Inspect for sediment and debris in pre-treatment components and floor of inspection tube or chamber and inside of concrete manhole rings	Annually
	Cleaning of gutters and any filters on downpipes	Annually (or as required based on inspections)
	Trimming any roots that may be causing blockages	Annually (or as required)
Occasional maintenance	Remove sediment and debris from pre-treatment components and floor or inspection tube or chamber and inside of concrete manhole rings	Annually (or as required based on inspections)
Remedial actions	Reconstruct soakaway and/or replace or clean void fill, if performance deterioration or failure occurs	As required
	Replacement or clogged geotextiles	As required
Monitoring	Inspect silt traps and note rate of sediment accumulation	Monthly in the 1st year and then annually
	Check soakaway to ensure emptying is occurring	Annually
Permeable Paving		
Regular maintenance	Brushing and vacuuming (standard cosmetic sweep over whole pavement)	Once a year, after autumn leaf fall, or reduced frequency as required, based on site specific observations of clogging or manufacturers recommendations – pay particular attention to areas where water runs onto permeable surface from adjacent impermeable areas as this area is most likely to collect most sediment

Occasional maintenance	Stabilise and mow contributing and adjacent areas	As required
	Removal of weed	As required – once per year on less frequency used pavements
Remedial actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50mm of the level of the paving	As required
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users	As required
	Rehabilitation of surface and upper sub-structure	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)
Monitoring	Initial inspection	Monthly for three months after installation
	Inspect for evidence of poor operation and/or weed growth – if required take remedial action	3 monthly, 48 hours after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually
Infiltration trenches/swales/filter strips		
Regular maintenance	Inspect and identify any areas that are not operating correctly, if required take remedial action	Monthly for three months then annually
	Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
	For systems where rainfall infiltrates into the tank from above, check surface or filter for blockage by sediment, algae or other matter, remove and replace surface infiltration medium as necessary	Annually
	Remove sediment from pretreatment structures and/or internal forebays	Annually, or as required
Remedial actions	Repair/rehabilitate inlets, outlets, overflows and vents	As required
Monitoring	Inspect all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed	Annually

	Survey inside of tank for sediment build-up and remove if necessary	Every 5 years or as required
Oversized pipes/cellular storage/storage tanks		
Regular maintenance	Inspect and identify any areas that are not operating correctly, if required take remedial action	Monthly for three months then annually
	Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
	For systems where rainfall infiltrates into the tank from above, check surface or filter for blockage by sediment, algae or other matter, remove and replace surface infiltration medium as necessary	Annually
	Remove sediment from pre-treatment structures and/or internal forebays	Annually, or as required
Remedial actions	Repair/rehabilitate inlets, outlets, overflows and vents	As required
Monitoring	Inspect all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed	Annually
	Survey inside of tank for sediment build-up and remove if necessary	Every 5 years or as required

9.0 RISK MANAGEMENT

9.1 Introduction

The flood risk at this location is considered suitable for 'more vulnerable' developments within the NPPF. In this flood zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area through the layout, form of the development and the use of flood mitigation measures including SUDS techniques.

The flooding sources will be mitigated on the site by using a number of techniques, and mitigation strategies to manage and reduce the overall flood risk at the site. This will ensure the development will be safe and there is:

- Minimal risk to life;
- Minimal disruption to people living and working in the area;
- Minimal potential damage to property;
- Minimal impact of the proposed development on flood risk generally; and;
- Minimal disruption to natural heritage.

9.2 Sequential Approach

The sequential approach has been applied within the site by locating the most vulnerable elements of the development in the lowest risk areas. The most vulnerable use, the dwellings, are situated on the higher part of the site at a lower risk of flooding with the more flood-compatible uses such as the garden/landscaped areas being situated in the lower part of the site at a higher risk of flooding.

9.3 Finished Floor Level

The finished floor levels should be located 300mm above the 1 in 200 year water level for the Jenkin Brook which is 108.92mAOD at 109.32mAOD. It is recognised however that owing to limited headroom constraints, massing, planning policy and Building Regulations it is considered impractical to raise the finished floor levels further. Therefore, in order to mitigate against this, it is recommended that the occupants of the proposed dwelling sign up to receive flood warnings from the Environment Agency and implement a flood evacuation plan to a safe area away from the building during times of flood. It is also proposed that flood protection measures are employed within the building design to reduce the overall risk to the occupants. This is discussed below.

A combination of resistance (proofing) and resilience measures will be included to provide protection above the 1 in 100 year (+30%) event. This is discussed below.

9.4 First Floor Accommodation

Accommodation will be located on the first floor as well as the ground floor of the site. This will allow occupants to retreat to higher floor levels if needed. The levels of the first floor will be located a minimum of 2.50m above the ground floor finished floor level well above any flood water levels.

This provides a 'safe haven' above any flood water levels. This will enable rapid escape should flooding occur which is unlikely. The upper floors are accessed via internal stairs and are sufficient in size to safely house all occupants of the dwelling. The 'safe haven' will only be required in very extreme events or if a flood warning has not been received.

9.5 Sleeping Accommodation

All sleeping will be located on the first floor, the first floors will be located a minimum of 2.50m above the ground floor finished floor level well above any flood water levels.

9.6 Flood Resistance

Flood risk can be mitigated through the design of the building. Flood resistance measures are measures that help resist floodwaters entering a property (airbrick covers are an example of a flood resistance measure). Flood resistant measures will be used, including:

- The walls of the properties will be thick.
- Sealant will be used around external doors and windows.
- All windows will be located a minimum of 500mm above the ground levels.
- All external doors and windows will be constructed from hard wearing materials.

These factors will prevent water entering the properties and make the properties more resistant to seepage.

9.7 Flood Resilience

Flood resilience measures are designed in such a way as to reduce the cost and time required to reinstate the property should it be flooded (tiled floors are an example of a flood resilience measure).

The properties will be constructed in such a way that although floodwater may enter the building, elements that are damaged by flood water can be easily repaired or replaced. This is a form of flood resilience. They are suitable as no other measure is practicable. Robust materials and finishes will be used, including:

- all electrics wiring, switches, sockets, socket outlets etc. to be located a minimum of 600mm above the 1 in 200 year water level for the Jenkin Brook of 108.92mAOD at 109.52mAOD; and
- fit non-return valves/anti flow valves at last point of inspection chamber before connection to drains.

A proprietary damp-proof membrane system will be used that is bonded to the slab rather than below the insulation and installed in accordance with the manufacturer's requirements will be used. Cavity walls with polyisocyanurate (PIR) rigid closed-cell insulation that retains structural integrity and have low moisture take will be used. Plasterboard will be fixed horizontally, with water resistant plaster at lower levels.

Fixings will be galvanized/stainless steel/copper (no mild steel to be used - cause rust/staining or walls). Hardcore and binding will have good compaction to reduce the risk of settlement and consequential cracking.

9.8 Flood Warning and Evacuation Plan

A Flood Warning and Evacuation Plan will be developed. Sensible precautions would include raising electrical items, irreplaceable items and sentimental items off the ground or where possible moving them to a higher floor, rolling up carpets and rugs and turning off utilities. In addition, consider what actions you would take should the property need to be evacuated including access and egress routes

and preparing a flood kit in advance containing warm clothing, medication, a torch, food and wellingtons.

The Flood Warning and Evacuation Plan is a 'living' document and therefore should be periodically reviewed and updated to provide advice and guidance to occupants in the event of an extreme flood. The Flood Warning and Evacuation Plan will therefore reduce the vulnerability of the occupants to flooding and makes them aware of the mechanisms of flooding at the site.

The site is located in a flood risk area therefore; the dwellings will participate in the Environment Agency flood warning telephone service. The site will register contact details with the Environment Agency' Flood Warnings Service (Floodline 0845 988 1188) in order to receive Flood Alerts

The Environment Agency operate a free flood warning service providing alerts by phone, text or email when flooding is anticipated providing an opportunity for owners to take necessary precautions, giving enough time for the building to be safely evacuated and mitigation measures to be put in place.

All occupants of the site will be made aware of the Environment Agency Floodline telephone number and the Flood Warning Codes and their meaning. The owner of the property will carry out the role of Flood Warden for the site and ensure they have an understanding of the flood mechanisms of the site and will ensure that the safety of the occupants and visitors will not be compromised.

The Environment Agency uses Flood Warnings Codes. They can be issued in any order, usually ending with an 'all clear'. They are issued by the Environment Agency through their website and Floodline. The flood warning will be passed onto the occupiers and visitors of the site verbally, by telephone and/or in person. It will be ensured that everyone receives the flood warnings when required.

The likelihood of a rapid river level rise and possible rapid inundation of urban areas posing a risk to life is considered to be minimal. This is primarily due to the large system and upper contributing catchment area which allows the Environment Agency, with its current flood warning system, to provide forewarning of two (2) days of a pending flood event.

The site is located within a low risk area where the onset of flooding is very gradual (many hours) as per Flood Risk Assessment Guidance for New Development Phase 2, R&D Technical Report FD2320/TR2. The speed of inundation and rate of floodwater rise would be low.

In order for the following evacuation procedures to be effective:

- The dwelling will participate in the Environment Agency flood warning telephone service.
- The flood warning will be passed onto the occupants and visitors of the site verbally, by telephone and/or in person. It will be ensured that everyone receives the flood warnings when required.

9.9 Safe Access and Egress Route

The NPPF requires that, where required, safe access and escape is available to/from new developments in flood risk areas. Access routes should be such that occupants can safely access and exit their dwellings in design flood conditions. These routes must also provide the emergency services with access to the development during a flood event and enable flood defence authorities to carry out any necessary duties during the period of flood.

The site has been shown to be located outside of the 1 in 100 year, 1 in 100 year (+30%) and 1 in 1000 year flood outlines therefore, safe access and egress can be maintained for all events up to and

including the 1 in 100 year (+30%) event in accordance with the NPPF and Environment Agency guidance.

The Safe Access and Egress Routes shown in Figure 20 indicates the exit route that all people (i.e. occupants and visitors) on site should follow once a flood warning has been received. People should make their way to areas outside of the flood zone via Bentham Road to the north east.

Facilities such as community centres, shops etc. are located within the vicinity of the site which may be used in the event of a flood event. There may also be large areas than those shown in Figure 8 that are flood free located nearer and within the vicinity of the site. In the event of a Flood Warning, vital belongings, including waterproof clothing, necessary medication and essentials for infants and children will be collected. It should be ensured that all occupiers and visitors to the site are accounted for, and then exit the site using the route shown in Figure 20.

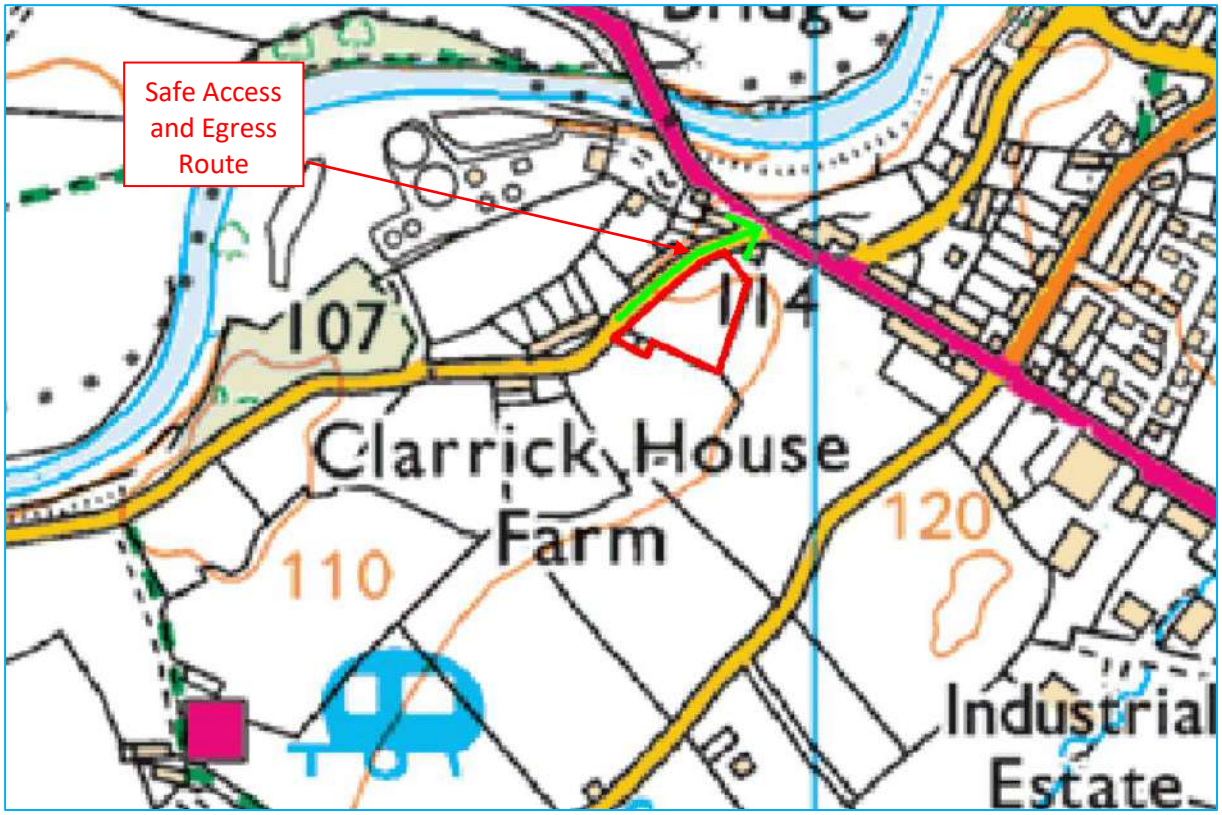


Figure 20 - Safe Access and Egress Route

9.10 Flooding Consequences

The mitigation measures detailed above show that the flood risk can be effectively managed and therefore the consequences of flooding are acceptable.

10.0 SUMMARY AND CONCLUSIONS

10.1 Introduction

This report presents an FRA in accordance with the NPPF for the proposed development on Land to the south of Bentham Road, Ingleton and includes an assessment of the existing and proposed surface and foul water drainage of the site.

This FRA identifies and assesses the risks of all forms of flooding to and from the development and demonstrates how these flood risks will be managed so that the development remains safe throughout the lifetime, taking climate change into account.

10.2 Flood Risk

The site is located within Flood Zones 2 and 3 and therefore has a 'medium to high probability' of fluvial flooding. However, at this location the Flood Zone extents have been derived from broad scale national modelling; JFLOW. The Environment Agency acknowledges that the JFLOW method is a generalised, and coarse modelling approach and as such the outlines produced by JFLOW can only be taken as a rough guide. The site is unlikely to flood except in extreme conditions. The primary, but unlikely, flood risk to the site is posed by fluvial flooding however, the site has no history of flooding.

River Greta

HEC-RAS modelling of the River Greta shows that the 1 in 100 year (+30%) water level is 101.84mAOD and the 1 in 1000 year water level is 101.89mAOD. The site minimum ground level is 109.97mAOD therefore, the site will not be inundated with floodwater for all events up to and including the 1 in 1000 year event from the River Greta. The New Bridge is shown to not surcharge for all events up to and including the 1 in 1000 year event.

The modelled water levels discussed above provide a much more robust estimate of the flood risk posed by the River Greta at this location than the Environment Agency Flood Zones. The JBA Comprehensive River Flood Map for the site confirms that the site is located outside of the River Greta flood outlines for all events up to and including the 1 in 1000 year event. The flood outlines and corresponding water levels are similar to the water levels predicted using the HEC-RAS model. The actual risk of fluvial flooding is much reduced compared to the Environment Agency Flood Zones. It can be concluded that fluvial flood risk from the River Greta poses a very low risk to the site. Therefore, the risk of flooding from fluvial flooding is considered to be **not significant**.

Jenkin Beck

The Environment Agency surface water flood map is representative of the fluvial flood risk from Jenkin Beck. The medium risk surface water flood outline is representative of the 1 in 100 year flood event and the low risk surface water flood outline is representative of the 1 in 1000 year event. The surface water flood map assumes that the channel capacity of the beck is 1 in 2 years. Therefore, the flood map is highly conservative. The flood map shows that the site remains dry and is not flooded during the 1 in 100 year and 1 in 1000 year events from the Jenkin Beck.

The JBA Comprehensive River and Surface Water Flood Map for the site confirm that the site is located outside of the Jenkin Beck flood outlines for all events up to and including the 1 in 1000 year event. The above shows the flood risk posed to the site in more detail than the Environment Agency Flood Zones.

The 1 in 200 year water level has been used as the design flood level and by comparing the 1 in 200 year flood outline with the LiDAR Data it has been shown that the 1 in 200 year event has a water level of 108.92mAOD near to the site with a water depth of less than 0.30m. The modelled water levels discussed above provide a much more robust estimate of the flood risk posed by the Jenkin Beck at this location than the Environment Agency Flood Zones. The actual risk of fluvial flooding is much reduced compared to the Environment Agency Flood Zones.

It can be concluded that fluvial flood risk from the Jenkin Beck poses a low risk to the site. Therefore, the risk of flooding from fluvial flooding is considered to be of **low significance**. A number of secondary flooding sources have been identified which may pose a **low significant** risk to the site. These are:

- Groundwater Flooding
- Surface Water Flooding

The flooding sources will only inundate the site to a relatively low water depth and water velocity, will only last a short period of time, in very extreme cases and will not have an impact on the whole of the proposed development site. The risk from this source will be further mitigated by using a number of property level protection measures to manage and reduce the overall flood risk at the site.

The application is for a new, suitable flood-resilient design. The exposure of people and property will be reduced and minimised compared to existing site conditions. The chance of flooding each year is low each year. This takes into account the effect of any flood defences that may be located within the vicinity of the site as well property level protection measures.

The proposed development will have no impact on flood risk and the overall direction of the movement of water will be maintained within the developed site and surrounding area. There will no net loss in flood storage capacity. The conveyance routes (flow paths) will not be blocked or obstructed. The topography of the site will not be altered therefore; the overland flow routes will not be altered.

In conclusion, the site has been shown to be located outside of the 1 in 100 year, 1 in 100 year (+30%) and 1 in 1000 year flood outlines and a 'more vulnerable' use is appropriate at this location.

10.3 Sequential Approach

The development proposals should be considered by the LPA to satisfy the Sequential and Exception Tests as set out in the NPPF.

10.4 Foul Water Drainage Strategy

Development of the site will take place with separate systems for foul and surface water drainage. The separate system will extend to the public sewer. Foul water will drain to the public combined/foul sewer network.

Using the information on the depth and arrangement of the existing sewers it has been assumed that gravity drainage is possible. However, it would be prudent to undertake further detailed surveys to verify the inverts, depth and arrangement of the existing public sewer.

10.5 SUDS Strategy

The SUDS Strategy ensures that a sustainable drainage solution can be achieved which reduces the peak discharge rate to manage and reduce the flood risk posed by the surface water runoff from the site. At this stage a detailed surface water drainage design has not been undertaken, however it is

necessary to demonstrate that the surface water from the proposed development can be discharged safety and sustainably. The SUDS Strategy takes into account the following principles:

- No increase in the volume or runoff rate of surface water runoff from the site.
- No increase in flooding to people or property off-site as a result of the development.
- No surface water flooding of the site.
- The proposals take into account a 40% increase in rainfall intensity due to climate change during the next 100 years which is the lifetime of the development

For all development, a hierarchical approach to surface water management. This approach has been adopted within this SUDS Strategy with infiltration being utilised wherever possible. If discharge via infiltration is not possible the surface water will be discharge to public surface water sewers. The site layout allows for at least a two stage SUDS treatment train to allow for improvement in water quality.

In line with adopting a 'management train' it is recommended that water is managed as close to source as possible. This will reduce the size and cost of infrastructure further downstream and also shares the maintenance burden more equitably. It is therefore recommended that each plot provides its own attenuation, and one stage of treatment. This may be in the form of:

- Water Butts for each dwelling.
- Permeable paving of all driveways and car parking areas.
- House soakaways for each dwelling.
- Filter strips, infiltration trenches, swales.
- Cellular storage below the permeable paving, if required.
- Oversized pipes/cellular storage/storage tanks, if required.
- For larger events in other areas such as car-parking and landscaping, provided that it will not cause damage or prevent access.

The Outline SUDS Strategy is shown in Figure 20. The precise nature and form of the SUDS system will be influenced by the type of the dwellings on the site, so some flexibility should be offered, providing proposals are robust and adequate plans for their maintenance made. Each plot may discharge into the drainage system.

If ground permeability is poor then surface features such as filter strips, canals and rills, swales etc. would be required for conveying surface water runoff. Some pipework would invariably be required for road crossings and flow control purposes.

The remainder of the site that is not formally drained, i.e. gardens and areas of open space, will be permeable (grass). The majority of rainwater falling on these areas will soak into the ground. Surface water runoff would be directed to the drainage system through drainage gullies located around the perimeter of the buildings and through contouring of the hardstanding areas.

As a consequence of limiting the rate of discharge from the site, at times of heavy rainfall the volume of water leaving the site will be significantly less than that draining from it. In order to prevent this water backing up in the system and causing flooding, the surface water will be discharged by infiltration methods (e.g. soakaways, permeable paving etc.) however; if this is not possible 135m^3 of

attenuation storage will be incorporated into the site layout with discharge limited to 6.50l/s for all events up to and including the 1 in 100 year (+40%) rainfall event. Therefore, the surface water runoff from the developed site will be no greater than existing.

This volume may be reduced when moderate infiltration is taken into account. The volume is dependent on the values assumed for infiltration. Local site-specific investigations and testing will improve this estimate and refine the volumes for infiltration.

The size of this attenuation storage has been calculated such that the proposed development has the capacity to accommodate the 1 in 100 year rainfall event including a 30% increase in rainfall intensity that is predicted to occur as a result of climate change. Consequently, all areas drained have been designed to accommodate a 100 year (+40% climate change) storm event.

This restriction will provide significant flood mitigation benefits to existing third-party property and land downstream of the site that may be potentially at risk from flooding. These methods will reduce peak flows, the volume of runoff, and slow down flows and will provide a suitable SUDS solution for this site.

SUDS features may be integrated into the landscape forming a harmonious whole, which will have a visually pleasing affect. Paths may be constructed to enable access for both maintenance and recreation, with surface finishes that are durable, and in keeping with the surroundings. Street furniture may be used to enhance enjoyment of the space. Visual clutter such as signposts and fences which prevent access to the space and make it less inviting may be avoided. Careful barrier planting and use of aquatic benches and shallow slopes will reduce health and safety risks.

Planting should use a variety of native species of local provenance to ensure opportunities for biodiversity and sustain habitat within the development. A range of habitats may be created using SUDS features such as ponds, with aquatic benches for marginal planting, areas for natural wetland and meadow planting. Features should aim to mimic equivalent natural features, following natural drainage paths and fitting in with site contours, with natural elongated sinuous forms where possible. SUDS features may also be managed for wildlife for example by encouraging flowering plants, changing mowing regimes to allow plants to set seeds, and leaving them over winter as a food source. Carrying out grass cuts, and removing from site may also improve biodiversity of landscaped areas. However, such management regimes are likely to differ from normal regimes and may need additional equipment, training and agreement from the maintaining authority to implement.

More traditional or conventional drainage structures are likely to be required as part of the proposed development: collecting runoff where source control is not practical, conveying water within the site, or providing additional attenuation storage underground. In certain areas within the proposed development, gullies or linear drains may be the most practical option, when whole-life issues are considered: such as operation, maintenance, and change of use.

At this stage a detailed surface water drainage design has not been undertaken, however it is necessary to demonstrate that the surface water from the proposed development can be discharged safety and sustainably. It is proposed that a planning condition can be adopted to cover the detailed design of the surface water runoff from the site. It is proposed that the detailed drainage design of the final scheme would be secured by a planning condition attached to any planning permission granted and agreed with the Environment Agency, United Utilities, the LLFA and the LPA prior to works commencing.

The adoption of a SUDS Strategy for the site represents an enhancement from the current conditions as the current surface water runoff from the site is uncontrolled, untreated, unmanaged and unmitigated. In adopting these principles, it has been demonstrated that a scheme can be developed

that does not increase the risk of flooding to adjacent properties and development further downstream.

10.6 Risk Management

The flooding sources will be managed and mitigated on the site by using a number of techniques, and mitigation strategies to manage and reduce the overall flood risk at the site, this will ensure the development will be safe. Measured used:

Sequential Approach: The sequential approach has been applied within the site by locating the most vulnerable elements of the development in the lowest risk areas. The most vulnerable use, the dwellings, are situated on the higher part of the site at a lower risk of flooding with the more flood-compatible uses such as the garden/landscaped areas being situated in the lower part of the site at a higher risk of flooding.

Finished Floor Level: The finished floor levels should be located 300mm above the 1 in 200 year water level for the Jenkin Brook which is 108.92mAOD at 109.32mAOD. It is recognised however that owing to limited headroom constraints, massing, planning policy and Building Regulations it is considered impractical to raise the finished floor levels further. Therefore, in order to mitigate against this, it is recommended that the occupants of the proposed dwelling sign up to receive flood warnings from the Environment Agency and implement a flood evacuation plan to a safe area away from the building during times of flood. It is also proposed that flood protection measures are employed within the building design to reduce the overall risk to the occupants. This is discussed below.

A combination of resistance (proofing) and resilience measures will be included to provide protection above the 1 in 100 year (+30%) event. This is discussed below.

First Floor Accommodation: Accommodation will be located on the first floor as well as the ground floor of the site. This will allow occupants to retreat to higher floor levels if needed. The levels of the first floor will be located a minimum of 2.50m above the ground floor finished floor level well above any flood water levels.

This provides a 'safe haven' above any flood water levels. This will enable rapid escape should flooding occur which is unlikely. The upper floors are accessed via internal stairs and are sufficient in size to safely house all occupants of the dwelling. The 'safe haven' will only be required in very extreme events or if a flood warning has not been received.

Sleeping Accommodation: All sleeping will be located on the first floor; the first floors will be located a minimum of 2.50m above the ground floor finished floor level well above any flood water levels.

Flood Resistance: Flood risk can be mitigated through the design of the building. Flood resistance measures are measures that help resist floodwaters entering a property (airbrick covers are an example of a flood resistance measure). Flood resistant measures will be used, including:

- The walls of the properties will be thick.
- Sealant will be used around external doors and windows.
- All windows will be located a minimum of 500mm above the ground levels.
- All external doors and windows will be constructed from hard wearing materials.

These factors will prevent water entering the properties and make the properties more resistant to seepage.

Flood Resilience: Robust materials and finishes will be used, including:

- all electrics wiring, switches, sockets, socket outlets etc. to be located a minimum of 600mm above the 1 in 200 year water level for the Jenkin Brook of 108.92mAOD at 109.52mAOD; and

- fit non-return valves/anti flow valves at last point of inspection chamber before connection to drains.

A proprietary damp-proof membrane system will be used that is bonded to the slab rather than below the insulation and installed in accordance with the manufacturer's requirements will be used. Cavity walls with polyisocyanurate (PIR) rigid closed-cell insulation that retains structural integrity and have low moisture take will be used. Plasterboard will be fixed horizontally, with water resistant plaster at lower levels.

Fixings will be galvanized/stainless steel/copper (no mild steel to be used - cause rust/staining or walls). Hardcore and binding will have good compaction to reduce the risk of settlement and consequential cracking.

Flood Warning and Evacuation Plan: A Flood Warning and Evacuation Plan will be developed. The Flood Warning and Evacuation Plan is a 'living' document and therefore should be periodically reviewed and updated to provide advice and guidance to occupants in the event of an extreme flood. The Flood Warning and Evacuation Plan will therefore reduce the vulnerability of the occupants to flooding and makes them aware of the mechanisms of flooding at the site.

The site is located in a flood risk area therefore; the dwellings will participate in the Environment Agency flood warning telephone service. The site will register contact details with the Environment Agency' Flood Warnings Service (Floodline 0845 988 1188) in order to receive Flood Alerts

Safe Access and Egress Route: The site has been shown to be located outside of the 1 in 100 year, 1 in 100 year (+30%) and 1 in 1000 year flood outlines therefore, safe access and egress can be maintained for all events up to and including the 1 in 100 year (+30%) event in accordance with the NPPF and Environment Agency guidance.

The Safe Access and Egress Routes indicates the exit route that all people (i.e. occupants and visitors) on site should follow once a flood warning has been received. People should make their way to areas outside of the flood zone via Bentham Road to the north east.

10.7 Conclusion

In conclusion, a residential development, would be expected to remain dry in all but the most extreme conditions. Providing the recommendations made in this FRA are instigated, flood risk from all sources would be minimised, the consequences of flooding are acceptable, and the development would be in accordance with the requirements of the NPPF.

The site has been shown to be located outside of the 1 in 100 year, 1 in 100 year (+30%), 1 in 200 year and 1 in 1000 year flood outlines. The adoption of a SUDS Strategy for the site will further reduce the risk of flooding to the site and off-site locations.

This FRA demonstrates that the proposed development would be operated with minimal risk from flooding, would not increase flood risk elsewhere and is compliant with the requirements of the NPPF. The development should not therefore be precluded on the grounds of flood risk.

APPENDIX 1 – Environment Agency Correspondence

[redacted]

From: CMBLNC Info Requests [redacted]
Sent: 20 December 2017 11:28
To: [redacted]
Subject: CL69823SR

Dear [redacted]

Enquiry regarding land at Ingleton

Thank you for your enquiry which was received on 30 November 2017.

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

Unfortunately we do not have any detailed modelling at this location and so we are unable to provide a product 4. The Environment Agency has no record of previous flooding in this area and we have no flood defences.

Please refer to 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

[redacted]

[redacted]
Customers and Engagement Officer, Cumbria and Lancashire
Environment Agency | Ghyll Mount, Gillan Way, Penrith 40 Business Park, Penrith, Cumbria, CA11 9BP

[redacted]

Creating a better place for people and wildlife

From: [redacted]
Sent: 30 November 2017 10:01
To: Enquiries, Unit [redacted]
Subject: Land at Ingleton

Dear Sir/Madam,

RE: Land at Ingleton 171130/jf02

I have been commissioned by my client to undertake a Flood Risk Assessment for the site shown above. I have attached a site location plan.

I wish to obtain Product 4: Detailed Flood Risk Assessment Map for the site.

If you have any queries do not hesitate to contact me.

Regards,

[redacted] | Director
BSc, MSc, MCIWEM
KRS Environmental Ltd

[redacted]
W: krsenvironmental.com

P **Think about the environment, only print this email if you need to.**

APPENDIX 2 – North Yorkshire County Council Correspondence

[redacted]

From: [redacted]

Sent: 18 January 2018 15:44
To: [redacted]
Subject: RE: Land to the south of Bentham Road, Ingleton
Attachments: FRA Enquiry - Land to the south of Bentham Road, Ingleton SW.pdf; FRA Enquiry - Land to the south of Bentham Road, Ingleton.pdf

Good afternoon,

Thank you for your enquiry in relation to flood risk at Bentham Road, Ingleton. Please see below the information you have request.

North Yorkshire County Council SuDS Design Guidance - https://www.northyorks.gov.uk/sites/default/files/fileroot/Environment%20and%20waste/Flooding/SuDS_design_guidance.pdf

- **Historic data regarding flooding and Drainage issues within the area**

The proposed site location is situated within Flood Zone 2 and 3, a Medium - High risk of flooding from rivers and sea (see attached)
The proposed site location has a low risk of surface water flooding (see attached)

North Yorkshire County Council, in its capacity as Lead Local Flood Authority holds no records of internal property flooding at the site location or in the local area. It must be noted that this does not mean to say that flooding has not occurred as flooding can often go unreported to authorities.
We are aware of substantial flooding incidents upstream & downstream of the site due to capacity issues in local sewers, watercourses, culverts and overland flows. We have received significantly increased levels of complaints over recent years from concerned residents affected by, and threatened by flooding from these sources. It is the owner/developer's responsibility to reduce flood risk where possible using NPPF.

- **Any council sewers within the area**

North Yorkshire County Council, in its capacity as Lead Local Flood Authority does not hold this information

- **Advice with regards to the disposal of the surface water from the site (i.e. the use of SUDs or surface water drainage system)**

Please see our SuDS Design Guidance, link above. This document outlines the LLFA's requirements with regards to surface water management on site.

It should be noted that any proposed developments with high flood risk from river and surface water must demonstrate how they will mitigate the risk for both on site and off site properties. No flooding can occur on site up to and including the 1 in 30 year storm event plus Climate Change and Urban Creep, and no flooding can occur within properties and infrastructure up to an including the 1 in 100 year storm event plus climate change, plus urban creep. Please see our SuDS Design Guidance, referenced above.

- It would be expected that the Flood Risk Assessment addresses the flood risk to the site, and existing properties in the vicinity.
- It must be demonstrated that any development in this area will not increase flood risk and try to improve the drainage where possible.
- It should be made clear within the FRA and scheme proposals how you wish to mitigate flood risk and compensate for any loss of floodplain as the site is located within Flood Zone 3, the functional floodplain.

- It should be made clear that the proposals do not increase flood risk on or off site and must not obstruct the natural flow of water from other developments.
- Finished Floor Levels should be set above the 1 in 100 year plus climate change flood level with an additional 300mm freeboard above the flood level.
- Property Level Resilience should be implemented wherever possible in developments in high flood risk zones, this could include, but is not limited to the measures noted in the Communities and Local Government Document 'Improving the Flood Performance of New Buildings - Flood Resilient Construction: For example, this document may note the use of flood doors where appropriate and the raising of/non-raising of sockets which would limit the disruption that a flood would cause to a property https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/7730/flood_performance.pdf

I hope this attends to the information your require however if you require any more information, please do not hesitate to contact me

Kind regards

[redacted]
Flood Risk Management Project Engineer
North Yorkshire County Council
County Hall – Northallerton - DL7 8AH

[redacted]

North Yorkshire County Council

From: [redacted]
Sent: 05 January 2018 09:22
To: floodriskmanagement
Subject: Land to the south of Bentham Road, Ingleton

Dear Sir/Madam,

I am are undertaking a Flood Risk Assessment for a residential development on Land to the south of Bentham Road, Ingleton. I have attached a site location plan and propose site layout plan and the grid reference is 368928, 472626.

It would be useful if you could advise us of any historic data regarding flooding and drainage issues within this area. If you know of any council sewers within the area and any advice with regards to the disposal of the surface water from the site would also be much appreciated (i.e. the use of SUDs or surface water drainage system). Any other pertanent advice with regards to flood risk and drainage would also be much appreciated.

If you have any queries do not hesitate to contact me.

Regards,

[redacted] | Director
BSc, MSc, MCIWEM

KRS Environmental Ltd

[redacted]

Please think about the environment, only print this email if you need to.

APPENDIX 3 – United Utilities Correspondence

United Utilites Water Limited

Property Searches
Ground Floor Grasmere House
Lingley Mere Business Park
Great Sankey
Warrington
WA5 3LP

Telephone [redacted]

[redacted]

KRS Environmental Limited
3 Princes Square
Princes Street
Montgomery
Powys
SY15 6PZ

Your Ref:	INGLETON
Our Ref:	1353907
Date:	16/1/2018

FAO:

Dear Sirs

Location:

I acknowledge with thanks your request dated 16/01/18 for information on the location of our services.

Please find enclosed plans showing the approximate position of our apparatus known to be in the vicinity of this site.

The enclosed plans are being provided to you subject to the United Utilities terms and conditions for both the wastewater and water distribution plans which are shown attached.

If you are planning works anywhere in the North West, please read our access statement before you start work to check how it will affect our network.
http://www.unitedutilities.com/work-near-asset.aspx.

I trust the above meets with you requirements and look forward to hearing from you should you need anything further.

If you have any queries regarding this matter please telephone us on [redacted]

Yours Faithfully,

[redacted]

[redacted]
Property Searches Manager

TERMS AND CONDITIONS - WASTERWATER & WATER DISTRIBUTION PLANS

These provisions apply to the public sewerage, water distribution and telemetry systems (including sewers which are the subject of an agreement under Section 104 of the Water Industry Act 1991 and mains installed in accordance with the agreement for the self-construction of water mains) (UUWL apparatus) of United Utilities Water Limited "(UUWL)".

TERMS AND CONDITIONS:

1. This Map and any information supplied with it is issued subject to the provisions contained below, to the exclusion of all others and no party relies upon any representation, warranty, collateral contract or other assurance of any person (whether party to this agreement or not) that is not set out in this agreement or the documents referred to in it.
2. This Map and any information supplied with it is provided for general guidance only and no representation, undertaking or warranty as to its accuracy, completeness or being up to date is given or implied.
3. In particular, the position and depth of any UUWL apparatus shown on the Map are approximate only and given in accordance with the best information available. The nature of the relevant system and/or its actual position may be different from that shown on the plan and UUWL is not liable for any damage caused by incorrect information provided save as stated in section 199 of the Water Industry Act 1991. UUWL strongly recommends that a comprehensive survey is undertaken in addition to reviewing this Map to determine and ensure the precise location of any UUWL apparatus. The exact location, positions and depths should be obtained by excavation trial holes.
4. The location and position of private drains, private sewers and service pipes to properties are not normally shown on this Map but their presence must be anticipated and accounted for and you are strongly advised to carry out your own further enquiries and investigations in order to locate the same.
5. The position and depth of UUWL apparatus is subject to change and therefore this Map is issued subject to any removal or change in location of the same. The onus is entirely upon you to confirm whether any changes to the Map have been made subsequent to issue and prior to any works being carried out.
6. This Map and any information shown on it or provided with it must not be relied upon in the event of any development, construction or other works (including but not limited to any excavations) in the vicinity of UUWL apparatus or for the purpose of determining the suitability of a point of connection to the sewerage or other distribution systems.
7. No person or legal entity, including any company shall be relieved from any liability howsoever and whensoever arising for any damage caused to UUWL apparatus by reason of the actual position and/or depths of UUWL apparatus being different from those shown on the Map and any information supplied with it.
8. If any provision contained herein is or becomes legally invalid or unenforceable, it will be taken to be severed from the remaining provisions which shall be unaffected and continue in full force and affect.
9. This agreement shall be governed by English law and all parties submit to the exclusive jurisdiction of the English courts, save that nothing will prevent UUWL from bringing proceedings in any other competent jurisdiction, whether concurrently or otherwise.

Extract from Map of Public Sewers

The position of the underground apparatus shown on this plan is approximate only and is given in accordance with the best information currently available.

The actual positions may be different from those shown on the plan and private pipes, sewers or drains may not be recorded.

United Utilities Water will not accept liability for any loss or damage caused by the actual position being different from those shown. Crown copyright and database rights [2016] Ordnance Survey 100022432.

X368934 Y472626

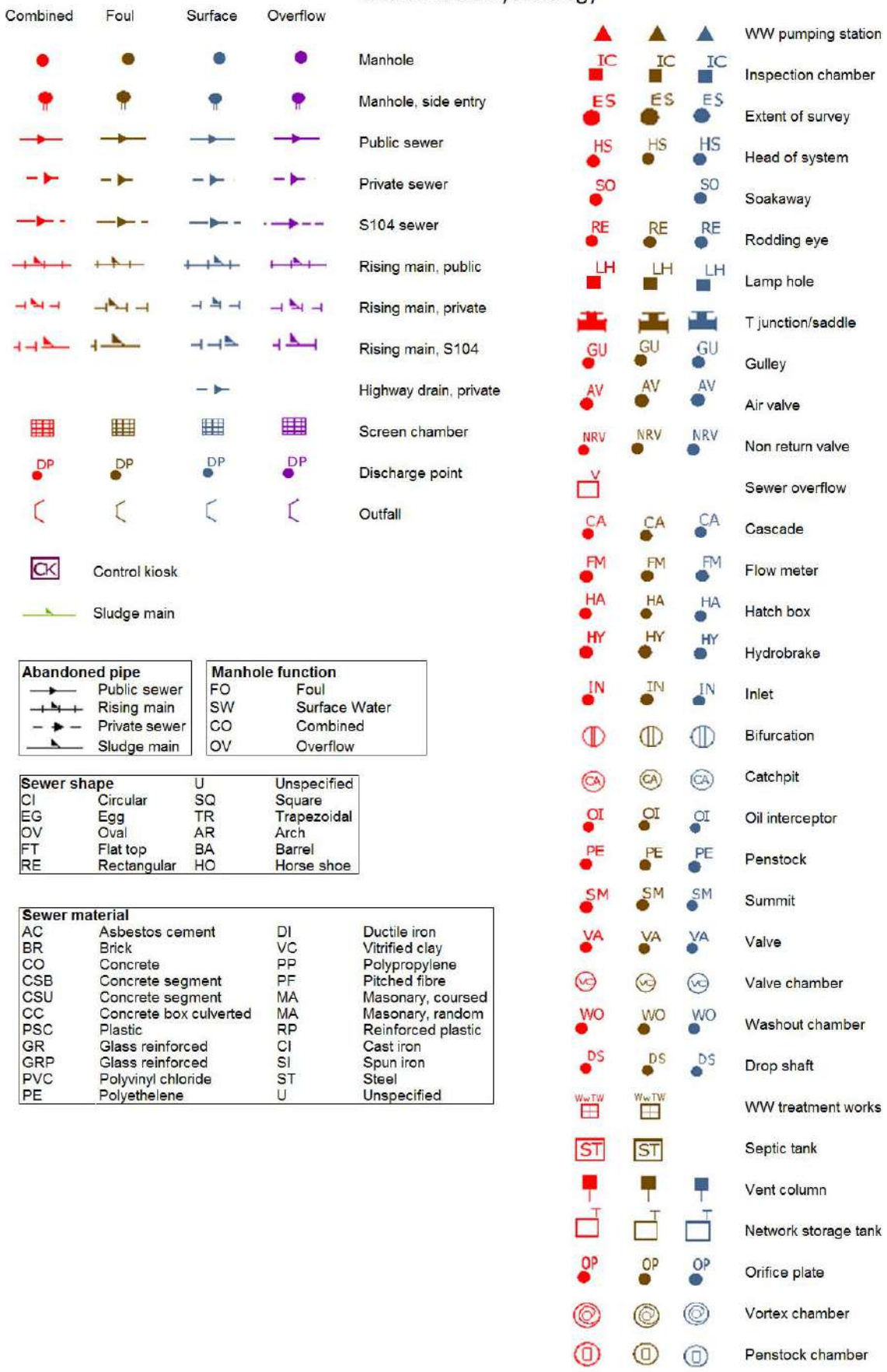
Printed By: Property Searches Date: 16/01/2018

DO NOT SCALE

Approximate Scale: 1:1250

United Utilities
helping life flow smoothly

Wastewater Symbology



Abandoned pipe	
	Public sewer
	Rising main
	Private sewer
	Sludge main

Manhole function	
FO	Foul
SW	Surface Water
CO	Combined
OV	Overflow

Sewer shape			
CI	Circular	U	Unspecified
EG	Egg	SQ	Square
OV	Oval	TR	Trapezoidal
FT	Flat top	AR	Arch
RE	Rectangular	BA	Barrel
		HO	Horse shoe

Sewer material			
AC	Asbestos cement	DI	Ductile iron
BR	Brick	VC	Vitrified clay
CO	Concrete	PP	Polypropylene
CSB	Concrete segment	PF	Pitched fibre
CSU	Concrete segment	MA	Masonary, coursed
CC	Concrete box culverted	MA	Masonary, random
PSC	Plastic	RP	Reinforced plastic
GR	Glass reinforced	CI	Cast iron
GRP	Glass reinforced	SI	Spun iron
PVC	Polyvinyl chloride	ST	Steel
PE	Polyethelene	U	Unspecified

[redacted]

From: [redacted]
Sent: 10 January 2018 10:13
To: [redacted]
Cc: Wastewater Developer Services
Subject: 10 dwellings on land to the South of Bentham Road, Ingleton LA6 3HZ (Grid 368928, 472626) - UU reference: 4200019404

Dear [redacted]

10 dwellings on land to the South of Bentham Road, Ingleton LA6 3HZ (Grid 368928, 472626)
UU reference: 4200019404

We have carried out an assessment of your application which is based on the information provided; this pre development advice will be valid for 12 months.

Foul water
Foul water will be allowed to drain to the public combined/ foul sewer network.

Surface Water
Surface water from this site must drain to soak away or some other form of infiltration system. However, if ground conditions confirm in writing that this is not a viable solution, all surface water can drain to the 300mm diameter surface water sewer on New Road at a maximum pass forward flow of 6.5 l/s for any storm event.

Connection Application
Although we may discuss and agree discharge points & rates in principle, please be aware that you will have to apply for a formal sewer connection. This is so that we can assess the method of construction, Health & Safety requirements and to ultimately inspect the connection when it is made. Details of the application process and the form itself can be obtained from our website by following the link below
http://www.unitedutilities.com/connecting-public-sewer.aspx

Sewer Adoption Agreement
You may wish to offer the proposed new sewers for adoption. United Utilities assess adoption application based on Sewers adoption 6th Edition and for any pumping stations our company addenda document. Please refer to link below to obtain further guidance and application pack:
http://www.unitedutilities.com/sewer-adoption.aspx

Water Supply Enquiry
If you have any query about water supply, please contact the water supply team at [redacted]

Please be aware that on site drainage must be designed in accordance with Building Regulations, National Planning Policy, Planning Conditions and local flood authority guidelines, we would recommend that you laise and make suitable agreements with the relevant statutory bodies.

Should you have any query, please feel free to contact me.

Many thanks.

Regards,

[redacted]
Wastewater Development Engineer

Developer Services and Planning Team
Operational Services
United Utilities
[redacted]
unitedutilities.com

From: [redacted]
Sent: 22 December 2017 09:51
To: Wastewater Developer Services [redacted]
Subject: Land to the South of Bentham Road, Ingleton

Hi,
Please can you undertake a Pre-Development Enquiry request for the site shown above.

plan of and topographic survey of the site. The site is on Land to the South of Bentham Road, Ingleton. I have attacehed the available drawings.).
The grid reference is 368928, 472626. The postcode is LA6 3HZ.

The site consists of a greenfield site and it is proposed to built approximately 10 houses on the site.

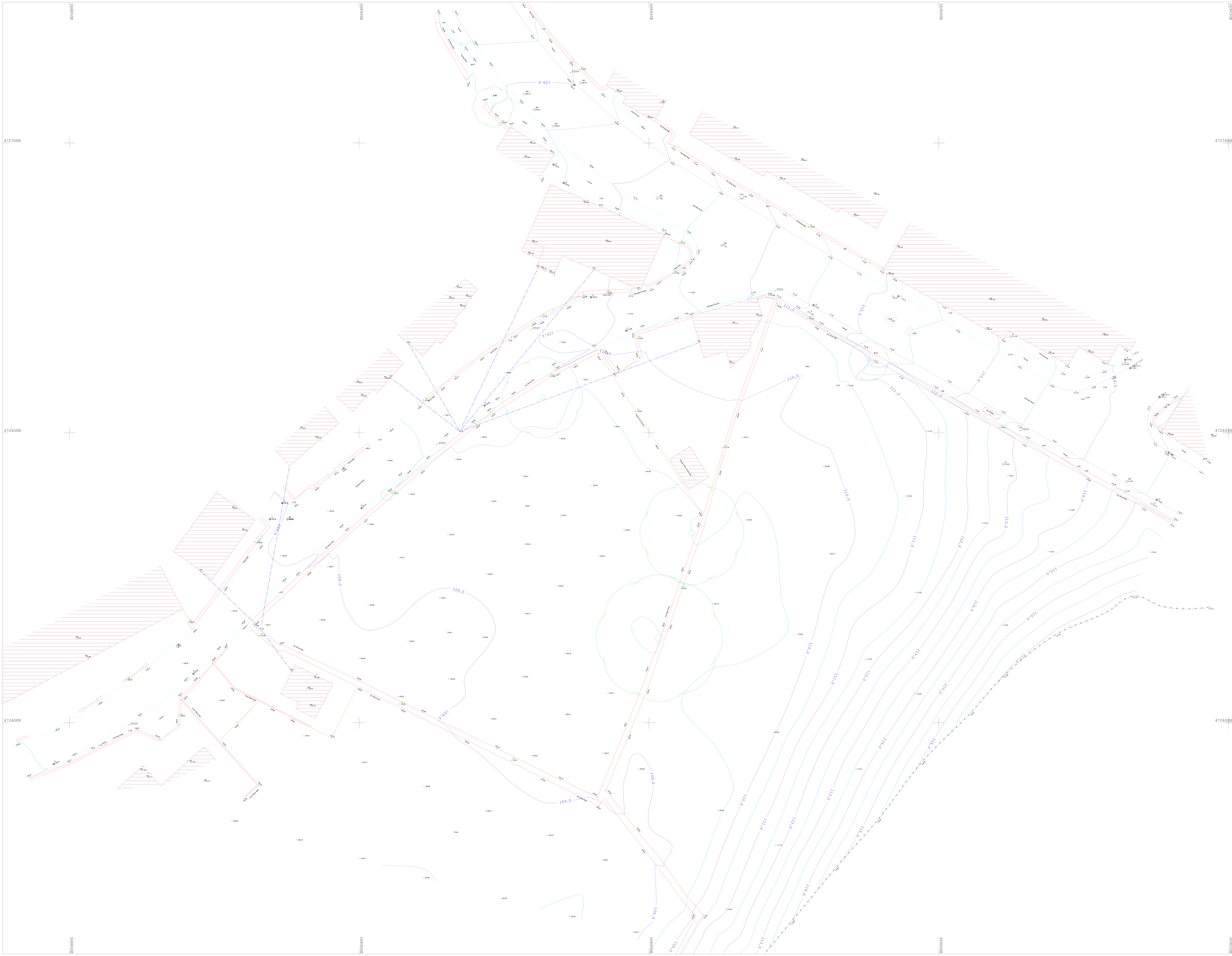
Please can you confirm whether the proposed site can continue to discharge into the public sewer network and any allowable discharge rates.

If you have any queries do not hesitate to contact me.

Regards,

[redacted] | Director
BSc, MSc, MCIWEM
KRS Environmental Ltd

[redacted]
W: krsenvironmental.com



KEY TO SYMBOL/ANNOTATION

STN	-Survey Station
MH	-Manhole
IC	-Inspection Cover
G	-Gully Grate
SV	-Water Stop Valve
GV	-Gas Stop Valve
MTR	-Water Meter
FH	-Fire Hydrant
BT	-Telecom Cover
CATV	-Cable Television Cover
EC	-Electric Cover
ER	-Earth Rod
TP	-Telegraph Pole
EP	-Electric Pole
LP	-Lamp Post
SP	-Sign Post
Stay	-Stay
DP	-Downpipe
SVP	-Soil & Vent Pipe
TL	-Traffic Light
Post	-Post
CCTV	-Closed Circuit TV Pole
BOL	-Bollard
PB	-Post Box
BS	-Bus Stop
RE	-Rodding Eye
BH	-Borehole
TH	-Trial Hole
OSBM	-Ordnance Survey Bench Mark
RH	-Ridge Height
EH	-Eaves Height
FFL	-Finished Floor Level
TH	-Tree Height
TBL	-Top Boundary Level
WL	-Water Level
THL	-Threshold Level
-	Tree
-	Bush

LINETYPE

- Building
- Wall
- Fence
- Hedge
- Kerb
- Verge
- Foliage
- Gate
- Bank Bottom
- Bank Top

CONTROL STATIONS

Station	Easting	Northing	Level
STN1	368971.731	472674.512	111.117
STN2	369014.044	472650.395	113.623
STN3	368929.664	472667.848	109.979
STN4	368936.424	472712.116	109.014
STN5	368913.419	472648.023	109.574
STN6	368860.286	472599.624	108.663

NOTES

Levels and Co ords related to OSGB36(15) National Datum and grid using GPS

Drawing scale 1:200 when plotted on A0 drawing sheet

REV.	DATE	DESCRIPTION	BY
-	-	-	-

PREMIER DESIGN SURVEYS LTD
OFFICE 2
THE OLD BANK CHAMBERS
37 MARKET PLACE
THIRSK
NORTH YORKSHIRE
YO7 1HA
TEL [redacted]
WWW.PREMIERDESIGNSURVEYS.CO.UK

PROJECT
Land off Bentham Road
Ingleton

DRAWING TITLE
Topographical Survey

CLIENT
[redacted]

DRAWN	JR/AC	DATE	08/12/17
CHECKED	JR/AC	SCALE	1:200 @ A0

DRAWING NUMBER
3416-1

APPENDIX 6 – River Greta ReFH2 Method Peak Flow Calculations

UK Design Flood Estimation

Generated on 16 January 2018 10:59:42 by User
Printed from the ReFH Flood Modelling software package, version 2.2.6029.28099

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

Site details Checksum: 674E-CEE5

Site name: FEH_Catchment_Descriptors_368950_472750

Easting: 368950

Northing: 472750

Country: England, Wales or Northern Ireland

Catchment Area (km²): 60.34

Using plot scale calculations: No

Site description: None

Model run: 2 year

Summary of results

Rainfall - FEH 2013 (mm):	37.39	Total runoff (ML):	1125.08
Total Rainfall (mm):	30.68	Total flow (ML):	2231.94
Peak Rainfall (mm):	5.98	Peak flow (m³/s):	67.81

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.
** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH 2013 model)

Name	Value	User-defined?
Duration (hh:mm:ss)	06:30:00	No
Timestep (hh:mm:ss)	00:30:00	No
SCF (Seasonal correction factor)	0.89	No
ARF (Areal reduction factor)	0.92	No
Seasonality	Winter	n/a

Loss model parameters

Name	Value	User-defined?
Cini (mm)	128.19	No
Cmax (mm)	236.27	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	2.38	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	5.92	No
BL (hr)	32.44	No
BR	0.99	No

Urbanisation parameters

Name	Value	User-defined?
Urban area (km^2)	0.66	No
Urbext 2000	0.01	No
Impervious runoff factor	0.7	No
Imperviousness factor	0.3	No
Tp scaling factor	0.5	No
Sewered area (km^2)	0.00	Yes
Sewer capacity (m^3/s)	0.00	Yes

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	0.546	0.000	0.297	0.000	5.921	5.921
00:30:00	0.845	0.000	0.463	0.149	5.831	5.980
01:00:00	1.305	0.000	0.720	0.677	5.748	6.425
01:30:00	2.004	0.000	1.120	1.793	5.678	7.471
02:00:00	3.056	0.000	1.740	3.805	5.632	9.437
02:30:00	4.593	0.000	2.689	7.197	5.626	12.823
03:00:00	5.981	0.000	3.636	12.418	5.684	18.102
03:30:00	4.593	0.000	2.894	20.075	5.836	25.911
04:00:00	3.056	0.000	1.975	29.870	6.114	35.985
04:30:00	2.004	0.000	1.316	40.360	6.539	46.899
05:00:00	1.305	0.000	0.866	49.877	7.108	56.985
05:30:00	0.845	0.000	0.565	56.710	7.793	64.503
06:00:00	0.546	0.000	0.367	59.267	8.540	67.807
06:30:00	0.000	0.000	0.000	57.835	9.286	67.122
07:00:00	0.000	0.000	0.000	53.588	9.981	63.569
07:30:00	0.000	0.000	0.000	47.657	10.590	58.247
08:00:00	0.000	0.000	0.000	41.104	11.096	52.201
08:30:00	0.000	0.000	0.000	34.681	11.499	46.180
09:00:00	0.000	0.000	0.000	28.588	11.801	40.389
09:30:00	0.000	0.000	0.000	23.070	12.011	35.080
10:00:00	0.000	0.000	0.000	18.120	12.138	30.258
10:30:00	0.000	0.000	0.000	13.671	12.193	25.865
11:00:00	0.000	0.000	0.000	9.749	12.184	21.933
11:30:00	0.000	0.000	0.000	6.464	12.120	18.585
12:00:00	0.000	0.000	0.000	3.960	12.014	15.973
12:30:00	0.000	0.000	0.000	2.278	11.877	14.156
13:00:00	0.000	0.000	0.000	1.220	11.722	12.942
13:30:00	0.000	0.000	0.000	0.583	11.556	12.139
14:00:00	0.000	0.000	0.000	0.226	11.386	11.612
14:30:00	0.000	0.000	0.000	0.053	11.214	11.267
15:00:00	0.000	0.000	0.000	0.000	11.043	11.043
15:30:00	0.000	0.000	0.000	0.000	10.874	10.874
16:00:00	0.000	0.000	0.000	0.000	10.707	10.707
16:30:00	0.000	0.000	0.000	0.000	10.544	10.544
17:00:00	0.000	0.000	0.000	0.000	10.382	10.382

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
17:30:00	0.000	0.000	0.000	0.000	10.224	10.224
18:00:00	0.000	0.000	0.000	0.000	10.067	10.067
18:30:00	0.000	0.000	0.000	0.000	9.913	9.913
19:00:00	0.000	0.000	0.000	0.000	9.762	9.762
19:30:00	0.000	0.000	0.000	0.000	9.612	9.612
20:00:00	0.000	0.000	0.000	0.000	9.465	9.465
20:30:00	0.000	0.000	0.000	0.000	9.321	9.321
21:00:00	0.000	0.000	0.000	0.000	9.178	9.178
21:30:00	0.000	0.000	0.000	0.000	9.038	9.038
22:00:00	0.000	0.000	0.000	0.000	8.899	8.899
22:30:00	0.000	0.000	0.000	0.000	8.763	8.763
23:00:00	0.000	0.000	0.000	0.000	8.629	8.629
23:30:00	0.000	0.000	0.000	0.000	8.497	8.497
24:00:00	0.000	0.000	0.000	0.000	8.367	8.367
24:30:00	0.000	0.000	0.000	0.000	8.239	8.239
25:00:00	0.000	0.000	0.000	0.000	8.113	8.113
25:30:00	0.000	0.000	0.000	0.000	7.989	7.989
26:00:00	0.000	0.000	0.000	0.000	7.867	7.867
26:30:00	0.000	0.000	0.000	0.000	7.747	7.747
27:00:00	0.000	0.000	0.000	0.000	7.628	7.628
27:30:00	0.000	0.000	0.000	0.000	7.512	7.512
28:00:00	0.000	0.000	0.000	0.000	7.397	7.397
28:30:00	0.000	0.000	0.000	0.000	7.283	7.283
29:00:00	0.000	0.000	0.000	0.000	7.172	7.172
29:30:00	0.000	0.000	0.000	0.000	7.062	7.062
30:00:00	0.000	0.000	0.000	0.000	6.954	6.954
30:30:00	0.000	0.000	0.000	0.000	6.848	6.848
31:00:00	0.000	0.000	0.000	0.000	6.743	6.743
31:30:00	0.000	0.000	0.000	0.000	6.640	6.640
32:00:00	0.000	0.000	0.000	0.000	6.539	6.539
32:30:00	0.000	0.000	0.000	0.000	6.439	6.439
33:00:00	0.000	0.000	0.000	0.000	6.340	6.340
33:30:00	0.000	0.000	0.000	0.000	6.243	6.243
34:00:00	0.000	0.000	0.000	0.000	6.148	6.148
34:30:00	0.000	0.000	0.000	0.000	6.054	6.054
35:00:00	0.000	0.000	0.000	0.000	5.961	5.961

Appendix

Catchment descriptors

Name	Value	User-defined value used?
Area (km²)	60.34	No
ALTBAR	388	No
ASPBAR	185	No
ASPVAR	0.12	No
BFIHOST	0.34	No
DPLBAR (km)	9.14	No
DPSBAR (mkm-¹)	153.3	No
FARL	1	No
LDP	17.65	No
PROPWET (mm)	0.62	No
RMED1H	11.9	No
RMED1D	54	No
RMED2D	71.2	No
SAAR (mm)	1686	No
SAAR4170 (mm)	1675	No
SPRHOST	49.68	No
Urbext2000	0.01	No
Urbext1990	0	No
URBCONC	0.73	No
URBLOC	0.2	No
Urban Area (km²)	0.66	No
DDF parameter C	-0.02	No
DDF parameter D1	0.46	No
DDF parameter D2	0.4	No
DDF parameter D3	0.37	No
DDF parameter E	0.29	No
DDF parameter F	2.56	No
DDF parameter C (1km grid value)	-0.02	No
DDF parameter D1 (1km grid value)	0.43	No
DDF parameter D2 (1km grid value)	0.35	No
DDF parameter D3 (1km grid value)	0.37	No
DDF parameter E (1km grid value)	0.29	No
DDF parameter F (1km grid value)	2.46	No

UK Design Flood Estimation

Generated on 16 January 2018 10:59:56 by User
Printed from the ReFH Flood Modelling software package, version 2.2.6029.28099

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

Site details Checksum: 674E-CEE5

Site name: FEH_Catchment_Descriptors_368950_472750

Easting: 368950

Northing: 472750

Country: England, Wales or Northern Ireland

Catchment Area (km²): 60.34

Using plot scale calculations: No

Site description: None

Model run: 20 year

Summary of results

Rainfall - FEH 2013 (mm):	61.73	Total runoff (ML):	1986.21
Total Rainfall (mm):	50.65	Total flow (ML):	3928.86
Peak Rainfall (mm):	9.88	Peak flow (m³/s):	115.80

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.
** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH 2013 model)

Name	Value	User-defined?
Duration (hh:mm:ss)	06:30:00	No
Timestep (hh:mm:ss)	00:30:00	No
SCF (Seasonal correction factor)	0.89	No
ARF (Areal reduction factor)	0.92	No
Seasonality	Winter	n/a

Loss model parameters

Name	Value	User-defined?
Cini (mm)	128.19	No
Cmax (mm)	236.27	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	2.38	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	5.92	No
BL (hr)	32.44	No
BR	0.99	No

Urbanisation parameters

Name	Value	User-defined?
Urban area (km^2)	0.66	No
Urbext 2000	0.01	No
Impervious runoff factor	0.7	No
Imperviousness factor	0.3	No
Tp scaling factor	0.5	No
Sewered area (km^2)	0.00	Yes
Sewer capacity (m^3/s)	0.00	Yes

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	0.901	0.000	0.491	0.000	5.921	5.921
00:30:00	1.396	0.000	0.767	0.246	5.832	6.078
01:00:00	2.154	0.000	1.200	1.121	5.753	6.873
01:30:00	3.308	0.000	1.882	2.973	5.694	8.667
02:00:00	5.045	0.000	2.959	6.328	5.675	12.003
02:30:00	7.582	0.000	4.649	12.019	5.722	17.742
03:00:00	9.875	0.000	6.418	20.875	5.876	26.751
03:30:00	7.582	0.000	5.207	34.056	6.190	40.246
04:00:00	5.045	0.000	3.599	51.162	6.723	57.885
04:30:00	3.308	0.000	2.418	69.740	7.513	77.252
05:00:00	2.154	0.000	1.599	86.867	8.559	95.426
05:30:00	1.396	0.000	1.047	99.476	9.815	109.292
06:00:00	0.901	0.000	0.680	104.610	11.190	115.799
06:30:00	0.000	0.000	0.000	102.608	12.571	115.178
07:00:00	0.000	0.000	0.000	95.454	13.865	109.319
07:30:00	0.000	0.000	0.000	85.139	15.011	100.150
08:00:00	0.000	0.000	0.000	73.582	15.978	89.559
08:30:00	0.000	0.000	0.000	62.170	16.758	78.928
09:00:00	0.000	0.000	0.000	51.309	17.359	68.667
09:30:00	0.000	0.000	0.000	41.472	17.794	59.267
10:00:00	0.000	0.000	0.000	32.655	18.083	50.738
10:30:00	0.000	0.000	0.000	24.726	18.241	42.966
11:00:00	0.000	0.000	0.000	17.714	18.283	35.997
11:30:00	0.000	0.000	0.000	11.814	18.226	30.040
12:00:00	0.000	0.000	0.000	7.276	18.092	25.368
12:30:00	0.000	0.000	0.000	4.204	17.902	22.106
13:00:00	0.000	0.000	0.000	2.256	17.677	19.934
13:30:00	0.000	0.000	0.000	1.080	17.432	18.512
14:00:00	0.000	0.000	0.000	0.420	17.177	17.597
14:30:00	0.000	0.000	0.000	0.099	16.918	17.017
15:00:00	0.000	0.000	0.000	0.001	16.660	16.661
15:30:00	0.000	0.000	0.000	0.000	16.405	16.405
16:00:00	0.000	0.000	0.000	0.000	16.154	16.154
16:30:00	0.000	0.000	0.000	0.000	15.907	15.907
17:00:00	0.000	0.000	0.000	0.000	15.664	15.664

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
17:30:00	0.000	0.000	0.000	0.000	15.424	15.424
18:00:00	0.000	0.000	0.000	0.000	15.188	15.188
18:30:00	0.000	0.000	0.000	0.000	14.956	14.956
19:00:00	0.000	0.000	0.000	0.000	14.727	14.727
19:30:00	0.000	0.000	0.000	0.000	14.502	14.502
20:00:00	0.000	0.000	0.000	0.000	14.280	14.280
20:30:00	0.000	0.000	0.000	0.000	14.062	14.062
21:00:00	0.000	0.000	0.000	0.000	13.847	13.847
21:30:00	0.000	0.000	0.000	0.000	13.635	13.635
22:00:00	0.000	0.000	0.000	0.000	13.426	13.426
22:30:00	0.000	0.000	0.000	0.000	13.221	13.221
23:00:00	0.000	0.000	0.000	0.000	13.019	13.019
23:30:00	0.000	0.000	0.000	0.000	12.820	12.820
24:00:00	0.000	0.000	0.000	0.000	12.624	12.624
24:30:00	0.000	0.000	0.000	0.000	12.431	12.431
25:00:00	0.000	0.000	0.000	0.000	12.240	12.240
25:30:00	0.000	0.000	0.000	0.000	12.053	12.053
26:00:00	0.000	0.000	0.000	0.000	11.869	11.869
26:30:00	0.000	0.000	0.000	0.000	11.687	11.687
27:00:00	0.000	0.000	0.000	0.000	11.509	11.509
27:30:00	0.000	0.000	0.000	0.000	11.333	11.333
28:00:00	0.000	0.000	0.000	0.000	11.159	11.159
28:30:00	0.000	0.000	0.000	0.000	10.989	10.989
29:00:00	0.000	0.000	0.000	0.000	10.821	10.821
29:30:00	0.000	0.000	0.000	0.000	10.655	10.655
30:00:00	0.000	0.000	0.000	0.000	10.492	10.492
30:30:00	0.000	0.000	0.000	0.000	10.332	10.332
31:00:00	0.000	0.000	0.000	0.000	10.174	10.174
31:30:00	0.000	0.000	0.000	0.000	10.018	10.018
32:00:00	0.000	0.000	0.000	0.000	9.865	9.865
32:30:00	0.000	0.000	0.000	0.000	9.714	9.714
33:00:00	0.000	0.000	0.000	0.000	9.565	9.565
33:30:00	0.000	0.000	0.000	0.000	9.419	9.419
34:00:00	0.000	0.000	0.000	0.000	9.275	9.275
34:30:00	0.000	0.000	0.000	0.000	9.133	9.133
35:00:00	0.000	0.000	0.000	0.000	8.993	8.993

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
35:30:00	0.000	0.000	0.000	0.000	8.856	8.856
36:00:00	0.000	0.000	0.000	0.000	8.720	8.720
36:30:00	0.000	0.000	0.000	0.000	8.587	8.587
37:00:00	0.000	0.000	0.000	0.000	8.456	8.456
37:30:00	0.000	0.000	0.000	0.000	8.326	8.326
38:00:00	0.000	0.000	0.000	0.000	8.199	8.199
38:30:00	0.000	0.000	0.000	0.000	8.074	8.074
39:00:00	0.000	0.000	0.000	0.000	7.950	7.950
39:30:00	0.000	0.000	0.000	0.000	7.828	7.828
40:00:00	0.000	0.000	0.000	0.000	7.709	7.709
40:30:00	0.000	0.000	0.000	0.000	7.591	7.591
41:00:00	0.000	0.000	0.000	0.000	7.475	7.475
41:30:00	0.000	0.000	0.000	0.000	7.360	7.360
42:00:00	0.000	0.000	0.000	0.000	7.248	7.248
42:30:00	0.000	0.000	0.000	0.000	7.137	7.137
43:00:00	0.000	0.000	0.000	0.000	7.028	7.028
43:30:00	0.000	0.000	0.000	0.000	6.920	6.920
44:00:00	0.000	0.000	0.000	0.000	6.814	6.814
44:30:00	0.000	0.000	0.000	0.000	6.710	6.710
45:00:00	0.000	0.000	0.000	0.000	6.608	6.608
45:30:00	0.000	0.000	0.000	0.000	6.507	6.507
46:00:00	0.000	0.000	0.000	0.000	6.407	6.407
46:30:00	0.000	0.000	0.000	0.000	6.309	6.309
47:00:00	0.000	0.000	0.000	0.000	6.213	6.213
47:30:00	0.000	0.000	0.000	0.000	6.118	6.118
48:00:00	0.000	0.000	0.000	0.000	6.024	6.024

Appendix

Catchment descriptors

Name	Value	User-defined value used?
Area (km²)	60.34	No
ALTBAR	388	No
ASPBAR	185	No
ASPVAR	0.12	No
BFIHOST	0.34	No
DPLBAR (km)	9.14	No
DPSBAR (mkm-¹)	153.3	No
FARL	1	No
LDP	17.65	No
PROPWET (mm)	0.62	No
RMED1H	11.9	No
RMED1D	54	No
RMED2D	71.2	No
SAAR (mm)	1686	No
SAAR4170 (mm)	1675	No
SPRHOST	49.68	No
Urbext2000	0.01	No
Urbext1990	0	No
URBCONC	0.73	No
URBLOC	0.2	No
Urban Area (km²)	0.66	No
DDF parameter C	-0.02	No
DDF parameter D1	0.46	No
DDF parameter D2	0.4	No
DDF parameter D3	0.37	No
DDF parameter E	0.29	No
DDF parameter F	2.56	No
DDF parameter C (1km grid value)	-0.02	No
DDF parameter D1 (1km grid value)	0.43	No
DDF parameter D2 (1km grid value)	0.35	No
DDF parameter D3 (1km grid value)	0.37	No
DDF parameter E (1km grid value)	0.29	No
DDF parameter F (1km grid value)	2.46	No

UK Design Flood Estimation

Generated on 16 January 2018 11:00:07 by User
Printed from the ReFH Flood Modelling software package, version 2.2.6029.28099

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

Site details Checksum: 674E-CEE5

Site name: FEH_Catchment_Descriptors_368950_472750

Easting: 368950

Northing: 472750

Country: England, Wales or Northern Ireland

Catchment Area (km^2): 60.34

Using plot scale calculations: No

Site description: None

Model run: 50 year

Summary of results

Rainfall - FEH 2013 (mm):	72.40	Total runoff (ML):	2395.63
Total Rainfall (mm):	59.40	Total flow (ML):	4742.85
Peak Rainfall (mm):	11.58	Peak flow (m^3/s):	138.59

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.
** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH 2013 model)

Name	Value	User-defined?
Duration (hh:mm:ss)	06:30:00	No
Timestep (hh:mm:ss)	00:30:00	No
SCF (Seasonal correction factor)	0.89	No
ARF (Areal reduction factor)	0.92	No
Seasonality	Winter	n/a

Loss model parameters

Name	Value	User-defined?
Cini (mm)	128.19	No
Cmax (mm)	236.27	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	2.38	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	5.92	No
BL (hr)	32.44	No
BR	0.99	No

Urbanisation parameters

Name	Value	User-defined?
Urban area (km^2)	0.66	No
Urbext 2000	0.01	No
Impervious runoff factor	0.7	No
Imperviousness factor	0.3	No
Tp scaling factor	0.5	No
Sewered area (km^2)	0.00	Yes
Sewer capacity (m^3/s)	0.00	Yes

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	1.057	0.000	0.576	0.000	5.921	5.921
00:30:00	1.637	0.000	0.902	0.288	5.832	6.121
01:00:00	2.526	0.000	1.414	1.316	5.755	7.071
01:30:00	3.880	0.000	2.224	3.493	5.702	9.195
02:00:00	5.917	0.000	3.515	7.445	5.694	13.139
02:30:00	8.893	0.000	5.560	14.167	5.765	19.932
03:00:00	11.582	0.000	7.741	24.675	5.962	30.636
03:30:00	8.893	0.000	6.328	40.410	6.349	46.759
04:00:00	5.917	0.000	4.395	60.954	6.998	67.952
04:30:00	3.880	0.000	2.962	83.388	7.957	91.346
05:00:00	2.526	0.000	1.963	104.203	9.226	113.430
05:30:00	1.637	0.000	1.286	119.674	10.752	130.426
06:00:00	1.057	0.000	0.837	126.164	12.424	138.588
06:30:00	0.000	0.000	0.000	124.001	14.108	138.109
07:00:00	0.000	0.000	0.000	115.538	15.690	131.228
07:30:00	0.000	0.000	0.000	103.172	17.095	120.267
08:00:00	0.000	0.000	0.000	89.238	18.283	107.521
08:30:00	0.000	0.000	0.000	75.439	19.246	94.685
09:00:00	0.000	0.000	0.000	62.288	19.992	82.281
09:30:00	0.000	0.000	0.000	50.379	20.538	70.918
10:00:00	0.000	0.000	0.000	39.707	20.906	60.612
10:30:00	0.000	0.000	0.000	30.106	21.114	51.220
11:00:00	0.000	0.000	0.000	21.608	21.182	42.791
11:30:00	0.000	0.000	0.000	14.442	21.131	35.573
12:00:00	0.000	0.000	0.000	8.914	20.985	29.899
12:30:00	0.000	0.000	0.000	5.158	20.770	25.928
13:00:00	0.000	0.000	0.000	2.771	20.512	23.284
13:30:00	0.000	0.000	0.000	1.328	20.230	21.557
14:00:00	0.000	0.000	0.000	0.516	19.934	20.450
14:30:00	0.000	0.000	0.000	0.122	19.634	19.756
15:00:00	0.000	0.000	0.000	0.001	19.335	19.335
15:30:00	0.000	0.000	0.000	0.000	19.039	19.039
16:00:00	0.000	0.000	0.000	0.000	18.748	18.748
16:30:00	0.000	0.000	0.000	0.000	18.461	18.461
17:00:00	0.000	0.000	0.000	0.000	18.179	18.179

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
17:30:00	0.000	0.000	0.000	0.000	17.901	17.901
18:00:00	0.000	0.000	0.000	0.000	17.627	17.627
18:30:00	0.000	0.000	0.000	0.000	17.357	17.357
19:00:00	0.000	0.000	0.000	0.000	17.092	17.092
19:30:00	0.000	0.000	0.000	0.000	16.830	16.830
20:00:00	0.000	0.000	0.000	0.000	16.573	16.573
20:30:00	0.000	0.000	0.000	0.000	16.320	16.320
21:00:00	0.000	0.000	0.000	0.000	16.070	16.070
21:30:00	0.000	0.000	0.000	0.000	15.824	15.824
22:00:00	0.000	0.000	0.000	0.000	15.582	15.582
22:30:00	0.000	0.000	0.000	0.000	15.344	15.344
23:00:00	0.000	0.000	0.000	0.000	15.109	15.109
23:30:00	0.000	0.000	0.000	0.000	14.878	14.878
24:00:00	0.000	0.000	0.000	0.000	14.650	14.650
24:30:00	0.000	0.000	0.000	0.000	14.426	14.426
25:00:00	0.000	0.000	0.000	0.000	14.206	14.206
25:30:00	0.000	0.000	0.000	0.000	13.988	13.988
26:00:00	0.000	0.000	0.000	0.000	13.774	13.774
26:30:00	0.000	0.000	0.000	0.000	13.564	13.564
27:00:00	0.000	0.000	0.000	0.000	13.356	13.356
27:30:00	0.000	0.000	0.000	0.000	13.152	13.152
28:00:00	0.000	0.000	0.000	0.000	12.951	12.951
28:30:00	0.000	0.000	0.000	0.000	12.753	12.753
29:00:00	0.000	0.000	0.000	0.000	12.558	12.558
29:30:00	0.000	0.000	0.000	0.000	12.366	12.366
30:00:00	0.000	0.000	0.000	0.000	12.177	12.177
30:30:00	0.000	0.000	0.000	0.000	11.990	11.990
31:00:00	0.000	0.000	0.000	0.000	11.807	11.807
31:30:00	0.000	0.000	0.000	0.000	11.626	11.626
32:00:00	0.000	0.000	0.000	0.000	11.449	11.449
32:30:00	0.000	0.000	0.000	0.000	11.273	11.273
33:00:00	0.000	0.000	0.000	0.000	11.101	11.101
33:30:00	0.000	0.000	0.000	0.000	10.931	10.931
34:00:00	0.000	0.000	0.000	0.000	10.764	10.764
34:30:00	0.000	0.000	0.000	0.000	10.599	10.599
35:00:00	0.000	0.000	0.000	0.000	10.437	10.437

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
35:30:00	0.000	0.000	0.000	0.000	10.278	10.278
36:00:00	0.000	0.000	0.000	0.000	10.120	10.120
36:30:00	0.000	0.000	0.000	0.000	9.966	9.966
37:00:00	0.000	0.000	0.000	0.000	9.813	9.813
37:30:00	0.000	0.000	0.000	0.000	9.663	9.663
38:00:00	0.000	0.000	0.000	0.000	9.515	9.515
38:30:00	0.000	0.000	0.000	0.000	9.370	9.370
39:00:00	0.000	0.000	0.000	0.000	9.226	9.226
39:30:00	0.000	0.000	0.000	0.000	9.085	9.085
40:00:00	0.000	0.000	0.000	0.000	8.946	8.946
40:30:00	0.000	0.000	0.000	0.000	8.810	8.810
41:00:00	0.000	0.000	0.000	0.000	8.675	8.675
41:30:00	0.000	0.000	0.000	0.000	8.542	8.542
42:00:00	0.000	0.000	0.000	0.000	8.411	8.411
42:30:00	0.000	0.000	0.000	0.000	8.283	8.283
43:00:00	0.000	0.000	0.000	0.000	8.156	8.156
43:30:00	0.000	0.000	0.000	0.000	8.031	8.031
44:00:00	0.000	0.000	0.000	0.000	7.909	7.909
44:30:00	0.000	0.000	0.000	0.000	7.788	7.788
45:00:00	0.000	0.000	0.000	0.000	7.668	7.668
45:30:00	0.000	0.000	0.000	0.000	7.551	7.551
46:00:00	0.000	0.000	0.000	0.000	7.436	7.436
46:30:00	0.000	0.000	0.000	0.000	7.322	7.322
47:00:00	0.000	0.000	0.000	0.000	7.210	7.210
47:30:00	0.000	0.000	0.000	0.000	7.100	7.100
48:00:00	0.000	0.000	0.000	0.000	6.991	6.991
48:30:00	0.000	0.000	0.000	0.000	6.884	6.884
49:00:00	0.000	0.000	0.000	0.000	6.779	6.779
49:30:00	0.000	0.000	0.000	0.000	6.675	6.675
50:00:00	0.000	0.000	0.000	0.000	6.573	6.573
50:30:00	0.000	0.000	0.000	0.000	6.473	6.473
51:00:00	0.000	0.000	0.000	0.000	6.374	6.374
51:30:00	0.000	0.000	0.000	0.000	6.276	6.276
52:00:00	0.000	0.000	0.000	0.000	6.180	6.180
52:30:00	0.000	0.000	0.000	0.000	6.086	6.086
53:00:00	0.000	0.000	0.000	0.000	5.993	5.993

Appendix

Catchment descriptors

Name	Value	User-defined value used?
Area (km²)	60.34	No
ALTBAR	388	No
ASPBAR	185	No
ASPVAR	0.12	No
BFIHOST	0.34	No
DPLBAR (km)	9.14	No
DPSBAR (mkm-¹)	153.3	No
FARL	1	No
LDP	17.65	No
PROPWET (mm)	0.62	No
RMED1H	11.9	No
RMED1D	54	No
RMED2D	71.2	No
SAAR (mm)	1686	No
SAAR4170 (mm)	1675	No
SPRHOST	49.68	No
Urbext2000	0.01	No
Urbext1990	0	No
URBCONC	0.73	No
URBLOC	0.2	No
Urban Area (km²)	0.66	No
DDF parameter C	-0.02	No
DDF parameter D1	0.46	No
DDF parameter D2	0.4	No
DDF parameter D3	0.37	No
DDF parameter E	0.29	No
DDF parameter F	2.56	No
DDF parameter C (1km grid value)	-0.02	No
DDF parameter D1 (1km grid value)	0.43	No
DDF parameter D2 (1km grid value)	0.35	No
DDF parameter D3 (1km grid value)	0.37	No
DDF parameter E (1km grid value)	0.29	No
DDF parameter F (1km grid value)	2.46	No

UK Design Flood Estimation

Generated on 16 January 2018 11:00:19 by User
Printed from the ReFH Flood Modelling software package, version 2.2.6029.28099

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

Site details Checksum: 674E-CEE5

Site name: FEH_Catchment_Descriptors_368950_472750

Easting: 368950

Northing: 472750

Country: England, Wales or Northern Ireland

Catchment Area (km²): 60.34

Using plot scale calculations: No

Site description: None

Model run: 75 year

Summary of results

Rainfall - FEH 2013 (mm):	77.96	Total runoff (ML):	2616.52
Total Rainfall (mm):	63.96	Total flow (ML):	5183.57
Peak Rainfall (mm):	12.47	Peak flow (m³/s):	150.88

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.
** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH 2013 model)

Name	Value	User-defined?
Duration (hh:mm:ss)	06:30:00	No
Timestep (hh:mm:ss)	00:30:00	No
SCF (Seasonal correction factor)	0.89	No
ARF (Areal reduction factor)	0.92	No
Seasonality	Winter	n/a

Loss model parameters

Name	Value	User-defined?
Cini (mm)	128.19	No
Cmax (mm)	236.27	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	2.38	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	5.92	No
BL (hr)	32.44	No
BR	0.99	No

Urbanisation parameters

Name	Value	User-defined?
Urban area (km^2)	0.66	No
Urbext 2000	0.01	No
Impervious runoff factor	0.7	No
Imperviousness factor	0.3	No
Tp scaling factor	0.5	No
Sewered area (km^2)	0.00	Yes
Sewer capacity (m^3/s)	0.00	Yes

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	1.138	0.000	0.621	0.000	5.921	5.921
00:30:00	1.762	0.000	0.972	0.310	5.832	6.143
01:00:00	2.720	0.000	1.526	1.418	5.756	7.173
01:30:00	4.178	0.000	2.405	3.765	5.705	9.470
02:00:00	6.371	0.000	3.809	8.030	5.704	13.734
02:30:00	9.575	0.000	6.047	15.294	5.787	21.081
03:00:00	12.470	0.000	8.455	26.675	6.006	32.682
03:30:00	9.575	0.000	6.937	43.773	6.432	50.206
04:00:00	6.371	0.000	4.830	66.162	7.144	73.306
04:30:00	4.178	0.000	3.260	90.681	8.193	98.874
05:00:00	2.720	0.000	2.162	113.501	9.581	123.082
05:30:00	1.762	0.000	1.418	130.541	11.252	141.793
06:00:00	1.138	0.000	0.923	137.792	13.084	150.876
06:30:00	0.000	0.000	0.000	135.567	14.932	150.499
07:00:00	0.000	0.000	0.000	126.414	16.670	143.083
07:30:00	0.000	0.000	0.000	112.949	18.215	131.164
08:00:00	0.000	0.000	0.000	97.732	19.524	117.256
08:30:00	0.000	0.000	0.000	82.642	20.587	103.228
09:00:00	0.000	0.000	0.000	68.251	21.412	89.663
09:30:00	0.000	0.000	0.000	55.220	22.018	77.237
10:00:00	0.000	0.000	0.000	43.542	22.428	65.970
10:30:00	0.000	0.000	0.000	33.036	22.664	55.700
11:00:00	0.000	0.000	0.000	23.733	22.747	46.480
11:30:00	0.000	0.000	0.000	15.878	22.699	38.577
12:00:00	0.000	0.000	0.000	9.811	22.546	32.357
12:30:00	0.000	0.000	0.000	5.681	22.318	27.999
13:00:00	0.000	0.000	0.000	3.054	22.043	25.097
13:30:00	0.000	0.000	0.000	1.463	21.740	23.203
14:00:00	0.000	0.000	0.000	0.569	21.423	21.992
14:30:00	0.000	0.000	0.000	0.134	21.101	21.235
15:00:00	0.000	0.000	0.000	0.001	20.779	20.780
15:30:00	0.000	0.000	0.000	0.000	20.461	20.461
16:00:00	0.000	0.000	0.000	0.000	20.148	20.148
16:30:00	0.000	0.000	0.000	0.000	19.840	19.840
17:00:00	0.000	0.000	0.000	0.000	19.536	19.536

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
17:30:00	0.000	0.000	0.000	0.000	19.238	19.238
18:00:00	0.000	0.000	0.000	0.000	18.943	18.943
18:30:00	0.000	0.000	0.000	0.000	18.654	18.654
19:00:00	0.000	0.000	0.000	0.000	18.368	18.368
19:30:00	0.000	0.000	0.000	0.000	18.087	18.087
20:00:00	0.000	0.000	0.000	0.000	17.811	17.811
20:30:00	0.000	0.000	0.000	0.000	17.538	17.538
21:00:00	0.000	0.000	0.000	0.000	17.270	17.270
21:30:00	0.000	0.000	0.000	0.000	17.006	17.006
22:00:00	0.000	0.000	0.000	0.000	16.746	16.746
22:30:00	0.000	0.000	0.000	0.000	16.490	16.490
23:00:00	0.000	0.000	0.000	0.000	16.238	16.238
23:30:00	0.000	0.000	0.000	0.000	15.989	15.989
24:00:00	0.000	0.000	0.000	0.000	15.745	15.745
24:30:00	0.000	0.000	0.000	0.000	15.504	15.504
25:00:00	0.000	0.000	0.000	0.000	15.267	15.267
25:30:00	0.000	0.000	0.000	0.000	15.033	15.033
26:00:00	0.000	0.000	0.000	0.000	14.803	14.803
26:30:00	0.000	0.000	0.000	0.000	14.577	14.577
27:00:00	0.000	0.000	0.000	0.000	14.354	14.354
27:30:00	0.000	0.000	0.000	0.000	14.134	14.134
28:00:00	0.000	0.000	0.000	0.000	13.918	13.918
28:30:00	0.000	0.000	0.000	0.000	13.705	13.705
29:00:00	0.000	0.000	0.000	0.000	13.496	13.496
29:30:00	0.000	0.000	0.000	0.000	13.289	13.289
30:00:00	0.000	0.000	0.000	0.000	13.086	13.086
30:30:00	0.000	0.000	0.000	0.000	12.886	12.886
31:00:00	0.000	0.000	0.000	0.000	12.689	12.689
31:30:00	0.000	0.000	0.000	0.000	12.495	12.495
32:00:00	0.000	0.000	0.000	0.000	12.304	12.304
32:30:00	0.000	0.000	0.000	0.000	12.115	12.115
33:00:00	0.000	0.000	0.000	0.000	11.930	11.930
33:30:00	0.000	0.000	0.000	0.000	11.748	11.748
34:00:00	0.000	0.000	0.000	0.000	11.568	11.568
34:30:00	0.000	0.000	0.000	0.000	11.391	11.391
35:00:00	0.000	0.000	0.000	0.000	11.217	11.217

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
35:30:00	0.000	0.000	0.000	0.000	11.045	11.045
36:00:00	0.000	0.000	0.000	0.000	10.876	10.876
36:30:00	0.000	0.000	0.000	0.000	10.710	10.710
37:00:00	0.000	0.000	0.000	0.000	10.546	10.546
37:30:00	0.000	0.000	0.000	0.000	10.385	10.385
38:00:00	0.000	0.000	0.000	0.000	10.226	10.226
38:30:00	0.000	0.000	0.000	0.000	10.070	10.070
39:00:00	0.000	0.000	0.000	0.000	9.916	9.916
39:30:00	0.000	0.000	0.000	0.000	9.764	9.764
40:00:00	0.000	0.000	0.000	0.000	9.615	9.615
40:30:00	0.000	0.000	0.000	0.000	9.468	9.468
41:00:00	0.000	0.000	0.000	0.000	9.323	9.323
41:30:00	0.000	0.000	0.000	0.000	9.180	9.180
42:00:00	0.000	0.000	0.000	0.000	9.040	9.040
42:30:00	0.000	0.000	0.000	0.000	8.901	8.901
43:00:00	0.000	0.000	0.000	0.000	8.765	8.765
43:30:00	0.000	0.000	0.000	0.000	8.631	8.631
44:00:00	0.000	0.000	0.000	0.000	8.499	8.499
44:30:00	0.000	0.000	0.000	0.000	8.369	8.369
45:00:00	0.000	0.000	0.000	0.000	8.241	8.241
45:30:00	0.000	0.000	0.000	0.000	8.115	8.115
46:00:00	0.000	0.000	0.000	0.000	7.991	7.991
46:30:00	0.000	0.000	0.000	0.000	7.869	7.869
47:00:00	0.000	0.000	0.000	0.000	7.748	7.748
47:30:00	0.000	0.000	0.000	0.000	7.630	7.630
48:00:00	0.000	0.000	0.000	0.000	7.513	7.513
48:30:00	0.000	0.000	0.000	0.000	7.398	7.398
49:00:00	0.000	0.000	0.000	0.000	7.285	7.285
49:30:00	0.000	0.000	0.000	0.000	7.174	7.174
50:00:00	0.000	0.000	0.000	0.000	7.064	7.064
50:30:00	0.000	0.000	0.000	0.000	6.956	6.956
51:00:00	0.000	0.000	0.000	0.000	6.850	6.850
51:30:00	0.000	0.000	0.000	0.000	6.745	6.745
52:00:00	0.000	0.000	0.000	0.000	6.642	6.642
52:30:00	0.000	0.000	0.000	0.000	6.540	6.540
53:00:00	0.000	0.000	0.000	0.000	6.440	6.440

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
53:30:00	0.000	0.000	0.000	0.000	6.342	6.342
54:00:00	0.000	0.000	0.000	0.000	6.245	6.245
54:30:00	0.000	0.000	0.000	0.000	6.149	6.149
55:00:00	0.000	0.000	0.000	0.000	6.055	6.055
55:30:00	0.000	0.000	0.000	0.000	5.962	5.962

Appendix

Catchment descriptors

Name	Value	User-defined value used?
Area (km²)	60.34	No
ALTBAR	388	No
ASPBAR	185	No
ASPVAR	0.12	No
BFIHOST	0.34	No
DPLBAR (km)	9.14	No
DPSBAR (mkm-¹)	153.3	No
FARL	1	No
LDP	17.65	No
PROPWET (mm)	0.62	No
RMED1H	11.9	No
RMED1D	54	No
RMED2D	71.2	No
SAAR (mm)	1686	No
SAAR4170 (mm)	1675	No
SPRHOST	49.68	No
Urbext2000	0.01	No
Urbext1990	0	No
URBCONC	0.73	No
URBLOC	0.2	No
Urban Area (km²)	0.66	No
DDF parameter C	-0.02	No
DDF parameter D1	0.46	No
DDF parameter D2	0.4	No
DDF parameter D3	0.37	No
DDF parameter E	0.29	No
DDF parameter F	2.56	No
DDF parameter C (1km grid value)	-0.02	No
DDF parameter D1 (1km grid value)	0.43	No
DDF parameter D2 (1km grid value)	0.35	No
DDF parameter D3 (1km grid value)	0.37	No
DDF parameter E (1km grid value)	0.29	No
DDF parameter F (1km grid value)	2.46	No

UK Design Flood Estimation

Generated on 16 January 2018 11:00:30 by User
Printed from the ReFH Flood Modelling software package, version 2.2.6029.28099

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

Site details Checksum: 674E-CEE5

Site name: FEH_Catchment_Descriptors_368950_472750

Easting: 368950

Northing: 472750

Country: England, Wales or Northern Ireland

Catchment Area (km²): 60.34

Using plot scale calculations: No

Site description: None

Model run: 100 year

Summary of results

Rainfall - FEH 2013 (mm):	82.36	Total runoff (ML):	2795.51
Total Rainfall (mm):	67.57	Total flow (ML):	5531.92
Peak Rainfall (mm):	13.18	Peak flow (m³/s):	160.83

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.
** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH 2013 model)

Name	Value	User-defined?
Duration (hh:mm:ss)	06:30:00	No
Timestep (hh:mm:ss)	00:30:00	No
SCF (Seasonal correction factor)	0.89	No
ARF (Areal reduction factor)	0.92	No
Seasonality	Winter	n/a

Loss model parameters

Name	Value	User-defined?
Cini (mm)	128.19	No
Cmax (mm)	236.27	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	2.38	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	5.92	No
BL (hr)	32.44	No
BR	0.99	No

Urbanisation parameters

Name	Value	User-defined?
Urban area (km^2)	0.66	No
Urbext 2000	0.01	No
Impervious runoff factor	0.7	No
Imperviousness factor	0.3	No
Tp scaling factor	0.5	No
Sewered area (km^2)	0.00	Yes
Sewer capacity (m^3/s)	0.00	Yes

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	1.203	0.000	0.656	0.000	5.921	5.921
00:30:00	1.862	0.000	1.028	0.328	5.833	6.161
01:00:00	2.874	0.000	1.615	1.498	5.757	7.255
01:30:00	4.414	0.000	2.549	3.981	5.708	9.689
02:00:00	6.731	0.000	4.045	8.495	5.712	14.206
02:30:00	10.116	0.000	6.439	16.192	5.805	21.996
03:00:00	13.175	0.000	9.033	28.273	6.042	34.316
03:30:00	10.116	0.000	7.433	46.468	6.499	52.967
04:00:00	6.731	0.000	5.185	70.349	7.260	77.609
04:30:00	4.414	0.000	3.504	96.558	8.382	104.939
05:00:00	2.874	0.000	2.325	121.009	9.867	130.876
05:30:00	1.862	0.000	1.525	139.332	11.654	150.987
06:00:00	1.203	0.000	0.993	147.213	13.617	160.830
06:30:00	0.000	0.000	0.000	144.951	15.597	160.547
07:00:00	0.000	0.000	0.000	135.245	17.461	152.707
07:30:00	0.000	0.000	0.000	120.893	19.121	140.014
08:00:00	0.000	0.000	0.000	104.638	20.528	125.166
08:30:00	0.000	0.000	0.000	88.499	21.671	110.171
09:00:00	0.000	0.000	0.000	73.102	22.561	95.663
09:30:00	0.000	0.000	0.000	59.159	23.216	82.374
10:00:00	0.000	0.000	0.000	46.665	23.661	70.326
10:30:00	0.000	0.000	0.000	35.424	23.920	59.344
11:00:00	0.000	0.000	0.000	25.465	24.015	49.480
11:30:00	0.000	0.000	0.000	17.052	23.969	41.021
12:00:00	0.000	0.000	0.000	10.544	23.811	34.355
12:30:00	0.000	0.000	0.000	6.109	23.573	29.682
13:00:00	0.000	0.000	0.000	3.285	23.284	26.569
13:30:00	0.000	0.000	0.000	1.575	22.964	24.539
14:00:00	0.000	0.000	0.000	0.612	22.630	23.242
14:30:00	0.000	0.000	0.000	0.145	22.289	22.434
15:00:00	0.000	0.000	0.000	0.001	21.949	21.950
15:30:00	0.000	0.000	0.000	0.000	21.614	21.614
16:00:00	0.000	0.000	0.000	0.000	21.283	21.283
16:30:00	0.000	0.000	0.000	0.000	20.958	20.958
17:00:00	0.000	0.000	0.000	0.000	20.637	20.637

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
17:30:00	0.000	0.000	0.000	0.000	20.321	20.321
18:00:00	0.000	0.000	0.000	0.000	20.011	20.011
18:30:00	0.000	0.000	0.000	0.000	19.704	19.704
19:00:00	0.000	0.000	0.000	0.000	19.403	19.403
19:30:00	0.000	0.000	0.000	0.000	19.106	19.106
20:00:00	0.000	0.000	0.000	0.000	18.814	18.814
20:30:00	0.000	0.000	0.000	0.000	18.526	18.526
21:00:00	0.000	0.000	0.000	0.000	18.243	18.243
21:30:00	0.000	0.000	0.000	0.000	17.964	17.964
22:00:00	0.000	0.000	0.000	0.000	17.689	17.689
22:30:00	0.000	0.000	0.000	0.000	17.419	17.419
23:00:00	0.000	0.000	0.000	0.000	17.152	17.152
23:30:00	0.000	0.000	0.000	0.000	16.890	16.890
24:00:00	0.000	0.000	0.000	0.000	16.632	16.632
24:30:00	0.000	0.000	0.000	0.000	16.377	16.377
25:00:00	0.000	0.000	0.000	0.000	16.127	16.127
25:30:00	0.000	0.000	0.000	0.000	15.880	15.880
26:00:00	0.000	0.000	0.000	0.000	15.637	15.637
26:30:00	0.000	0.000	0.000	0.000	15.398	15.398
27:00:00	0.000	0.000	0.000	0.000	15.162	15.162
27:30:00	0.000	0.000	0.000	0.000	14.931	14.931
28:00:00	0.000	0.000	0.000	0.000	14.702	14.702
28:30:00	0.000	0.000	0.000	0.000	14.477	14.477
29:00:00	0.000	0.000	0.000	0.000	14.256	14.256
29:30:00	0.000	0.000	0.000	0.000	14.038	14.038
30:00:00	0.000	0.000	0.000	0.000	13.823	13.823
30:30:00	0.000	0.000	0.000	0.000	13.612	13.612
31:00:00	0.000	0.000	0.000	0.000	13.404	13.404
31:30:00	0.000	0.000	0.000	0.000	13.199	13.199
32:00:00	0.000	0.000	0.000	0.000	12.997	12.997
32:30:00	0.000	0.000	0.000	0.000	12.798	12.798
33:00:00	0.000	0.000	0.000	0.000	12.602	12.602
33:30:00	0.000	0.000	0.000	0.000	12.409	12.409
34:00:00	0.000	0.000	0.000	0.000	12.220	12.220
34:30:00	0.000	0.000	0.000	0.000	12.033	12.033
35:00:00	0.000	0.000	0.000	0.000	11.849	11.849

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
35:30:00	0.000	0.000	0.000	0.000	11.667	11.667
36:00:00	0.000	0.000	0.000	0.000	11.489	11.489
36:30:00	0.000	0.000	0.000	0.000	11.313	11.313
37:00:00	0.000	0.000	0.000	0.000	11.140	11.140
37:30:00	0.000	0.000	0.000	0.000	10.970	10.970
38:00:00	0.000	0.000	0.000	0.000	10.802	10.802
38:30:00	0.000	0.000	0.000	0.000	10.637	10.637
39:00:00	0.000	0.000	0.000	0.000	10.474	10.474
39:30:00	0.000	0.000	0.000	0.000	10.314	10.314
40:00:00	0.000	0.000	0.000	0.000	10.156	10.156
40:30:00	0.000	0.000	0.000	0.000	10.001	10.001
41:00:00	0.000	0.000	0.000	0.000	9.848	9.848
41:30:00	0.000	0.000	0.000	0.000	9.697	9.697
42:00:00	0.000	0.000	0.000	0.000	9.549	9.549
42:30:00	0.000	0.000	0.000	0.000	9.403	9.403
43:00:00	0.000	0.000	0.000	0.000	9.259	9.259
43:30:00	0.000	0.000	0.000	0.000	9.117	9.117
44:00:00	0.000	0.000	0.000	0.000	8.978	8.978
44:30:00	0.000	0.000	0.000	0.000	8.841	8.841
45:00:00	0.000	0.000	0.000	0.000	8.705	8.705
45:30:00	0.000	0.000	0.000	0.000	8.572	8.572
46:00:00	0.000	0.000	0.000	0.000	8.441	8.441
46:30:00	0.000	0.000	0.000	0.000	8.312	8.312
47:00:00	0.000	0.000	0.000	0.000	8.185	8.185
47:30:00	0.000	0.000	0.000	0.000	8.060	8.060
48:00:00	0.000	0.000	0.000	0.000	7.937	7.937
48:30:00	0.000	0.000	0.000	0.000	7.815	7.815
49:00:00	0.000	0.000	0.000	0.000	7.696	7.696
49:30:00	0.000	0.000	0.000	0.000	7.578	7.578
50:00:00	0.000	0.000	0.000	0.000	7.462	7.462
50:30:00	0.000	0.000	0.000	0.000	7.348	7.348
51:00:00	0.000	0.000	0.000	0.000	7.235	7.235
51:30:00	0.000	0.000	0.000	0.000	7.125	7.125
52:00:00	0.000	0.000	0.000	0.000	7.016	7.016
52:30:00	0.000	0.000	0.000	0.000	6.909	6.909
53:00:00	0.000	0.000	0.000	0.000	6.803	6.803

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
53:30:00	0.000	0.000	0.000	0.000	6.699	6.699
54:00:00	0.000	0.000	0.000	0.000	6.596	6.596
54:30:00	0.000	0.000	0.000	0.000	6.495	6.495
55:00:00	0.000	0.000	0.000	0.000	6.396	6.396
55:30:00	0.000	0.000	0.000	0.000	6.298	6.298
56:00:00	0.000	0.000	0.000	0.000	6.202	6.202
56:30:00	0.000	0.000	0.000	0.000	6.107	6.107
57:00:00	0.000	0.000	0.000	0.000	6.014	6.014

Appendix

Catchment descriptors

Name	Value	User-defined value used?
Area (km²)	60.34	No
ALTBAR	388	No
ASPBAR	185	No
ASPVAR	0.12	No
BFIHOST	0.34	No
DPLBAR (km)	9.14	No
DPSBAR (mkm-¹)	153.3	No
FARL	1	No
LDP	17.65	No
PROPWET (mm)	0.62	No
RMED1H	11.9	No
RMED1D	54	No
RMED2D	71.2	No
SAAR (mm)	1686	No
SAAR4170 (mm)	1675	No
SPRHOST	49.68	No
Urbext2000	0.01	No
Urbext1990	0	No
URBCONC	0.73	No
URBLOC	0.2	No
Urban Area (km²)	0.66	No
DDF parameter C	-0.02	No
DDF parameter D1	0.46	No
DDF parameter D2	0.4	No
DDF parameter D3	0.37	No
DDF parameter E	0.29	No
DDF parameter F	2.56	No
DDF parameter C (1km grid value)	-0.02	No
DDF parameter D1 (1km grid value)	0.43	No
DDF parameter D2 (1km grid value)	0.35	No
DDF parameter D3 (1km grid value)	0.37	No
DDF parameter E (1km grid value)	0.29	No
DDF parameter F (1km grid value)	2.46	No

UK Design Flood Estimation

Generated on 16 January 2018 11:00:41 by User
Printed from the ReFH Flood Modelling software package, version 2.2.6029.28099

Summary of estimate using the Flood Estimation Handbook revitalised flood hydrograph method (ReFH)

Site details Checksum: 674E-CEE5

Site name: FEH_Catchment_Descriptors_368950_472750

Easting: 368950

Northing: 472750

Country: England, Wales or Northern Ireland

Catchment Area (km²): 60.34

Using plot scale calculations: No

Site description: None

Model run: 1000 year

Summary of results

Rainfall - FEH 2013 (mm):	131.89	Total runoff (ML):	5035.98
Total Rainfall (mm):	108.21	Total flow (ML):	9965.07
Peak Rainfall (mm):	21.10	Peak flow (m³/s):	286.84

Parameters

Where the user has overriden a system-generated value, this original value is shown in square brackets after the value used.
** Indicates that the user locked the duration/timestep*

Rainfall parameters (Rainfall - FEH 2013 model)

Name	Value	User-defined?
Duration (hh:mm:ss)	06:30:00	No
Timestep (hh:mm:ss)	00:30:00	No
SCF (Seasonal correction factor)	0.89	No
ARF (Areal reduction factor)	0.92	No
Seasonality	Winter	n/a

Loss model parameters

Name	Value	User-defined?
Cini (mm)	128.19	No
Cmax (mm)	236.27	No
Use alpha correction factor	No	No
Alpha correction factor	n/a	No

Routing model parameters

Name	Value	User-defined?
Tp (hr)	2.38	No
Up	0.65	No
Uk	0.8	No

Baseflow model parameters

Name	Value	User-defined?
BF0 (m^3/s)	5.92	No
BL (hr)	32.44	No
BR	0.99	No

Urbanisation parameters

Name	Value	User-defined?
Urban area (km^2)	0.66	No
Urbext 2000	0.01	No
Impervious runoff factor	0.7	No
Imperviousness factor	0.3	No
Tp scaling factor	0.5	No
Sewered area (km^2)	0.00	Yes
Sewer capacity (m^3/s)	0.00	Yes

Time series data

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
00:00:00	1.926	0.000	1.054	0.000	5.921	5.921
00:30:00	2.982	0.000	1.662	0.527	5.834	6.361
01:00:00	4.601	0.000	2.639	2.412	5.766	8.178
01:30:00	7.068	0.000	4.227	6.432	5.742	12.173
02:00:00	10.779	0.000	6.853	13.802	5.801	19.604
02:30:00	16.199	0.000	11.220	26.526	6.008	32.534
03:00:00	21.097	0.000	16.273	46.899	6.454	53.354
03:30:00	16.199	0.000	13.769	78.374	7.277	85.650
04:00:00	10.779	0.000	9.775	120.679	8.632	129.311
04:30:00	7.068	0.000	6.676	168.122	10.633	178.755
05:00:00	4.601	0.000	4.460	213.426	13.300	226.726
05:30:00	2.982	0.000	2.938	248.538	16.536	265.074
06:00:00	1.926	0.000	1.917	265.124	20.122	285.246
06:30:00	0.000	0.000	0.000	263.071	23.771	286.842
07:00:00	0.000	0.000	0.000	246.911	27.236	274.147
07:30:00	0.000	0.000	0.000	221.658	30.344	252.002
08:00:00	0.000	0.000	0.000	192.417	33.000	225.416
08:30:00	0.000	0.000	0.000	163.064	35.178	198.242
09:00:00	0.000	0.000	0.000	134.925	36.891	171.816
09:30:00	0.000	0.000	0.000	109.444	38.174	147.618
10:00:00	0.000	0.000	0.000	86.634	39.073	125.707
10:30:00	0.000	0.000	0.000	66.088	39.631	105.719
11:00:00	0.000	0.000	0.000	47.816	39.887	87.703
11:30:00	0.000	0.000	0.000	32.264	39.882	72.147
12:00:00	0.000	0.000	0.000	20.097	39.669	59.766
12:30:00	0.000	0.000	0.000	11.705	39.302	51.007
13:00:00	0.000	0.000	0.000	6.316	38.838	45.154
13:30:00	0.000	0.000	0.000	3.034	38.314	41.349
14:00:00	0.000	0.000	0.000	1.182	37.760	38.942
14:30:00	0.000	0.000	0.000	0.280	37.194	37.473
15:00:00	0.000	0.000	0.000	0.002	36.627	36.629
15:30:00	0.000	0.000	0.000	0.000	36.067	36.067
16:00:00	0.000	0.000	0.000	0.000	35.515	35.515
16:30:00	0.000	0.000	0.000	0.000	34.972	34.972
17:00:00	0.000	0.000	0.000	0.000	34.437	34.437

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
17:30:00	0.000	0.000	0.000	0.000	33.910	33.910
18:00:00	0.000	0.000	0.000	0.000	33.392	33.392
18:30:00	0.000	0.000	0.000	0.000	32.881	32.881
19:00:00	0.000	0.000	0.000	0.000	32.378	32.378
19:30:00	0.000	0.000	0.000	0.000	31.883	31.883
20:00:00	0.000	0.000	0.000	0.000	31.395	31.395
20:30:00	0.000	0.000	0.000	0.000	30.915	30.915
21:00:00	0.000	0.000	0.000	0.000	30.442	30.442
21:30:00	0.000	0.000	0.000	0.000	29.976	29.976
22:00:00	0.000	0.000	0.000	0.000	29.518	29.518
22:30:00	0.000	0.000	0.000	0.000	29.067	29.067
23:00:00	0.000	0.000	0.000	0.000	28.622	28.622
23:30:00	0.000	0.000	0.000	0.000	28.184	28.184
24:00:00	0.000	0.000	0.000	0.000	27.753	27.753
24:30:00	0.000	0.000	0.000	0.000	27.329	27.329
25:00:00	0.000	0.000	0.000	0.000	26.911	26.911
25:30:00	0.000	0.000	0.000	0.000	26.499	26.499
26:00:00	0.000	0.000	0.000	0.000	26.094	26.094
26:30:00	0.000	0.000	0.000	0.000	25.695	25.695
27:00:00	0.000	0.000	0.000	0.000	25.302	25.302
27:30:00	0.000	0.000	0.000	0.000	24.915	24.915
28:00:00	0.000	0.000	0.000	0.000	24.534	24.534
28:30:00	0.000	0.000	0.000	0.000	24.158	24.158
29:00:00	0.000	0.000	0.000	0.000	23.789	23.789
29:30:00	0.000	0.000	0.000	0.000	23.425	23.425
30:00:00	0.000	0.000	0.000	0.000	23.067	23.067
30:30:00	0.000	0.000	0.000	0.000	22.714	22.714
31:00:00	0.000	0.000	0.000	0.000	22.366	22.366
31:30:00	0.000	0.000	0.000	0.000	22.024	22.024
32:00:00	0.000	0.000	0.000	0.000	21.688	21.688
32:30:00	0.000	0.000	0.000	0.000	21.356	21.356
33:00:00	0.000	0.000	0.000	0.000	21.029	21.029
33:30:00	0.000	0.000	0.000	0.000	20.708	20.708
34:00:00	0.000	0.000	0.000	0.000	20.391	20.391
34:30:00	0.000	0.000	0.000	0.000	20.079	20.079
35:00:00	0.000	0.000	0.000	0.000	19.772	19.772

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
35:30:00	0.000	0.000	0.000	0.000	19.469	19.469
36:00:00	0.000	0.000	0.000	0.000	19.172	19.172
36:30:00	0.000	0.000	0.000	0.000	18.878	18.878
37:00:00	0.000	0.000	0.000	0.000	18.590	18.590
37:30:00	0.000	0.000	0.000	0.000	18.305	18.305
38:00:00	0.000	0.000	0.000	0.000	18.025	18.025
38:30:00	0.000	0.000	0.000	0.000	17.750	17.750
39:00:00	0.000	0.000	0.000	0.000	17.478	17.478
39:30:00	0.000	0.000	0.000	0.000	17.211	17.211
40:00:00	0.000	0.000	0.000	0.000	16.948	16.948
40:30:00	0.000	0.000	0.000	0.000	16.688	16.688
41:00:00	0.000	0.000	0.000	0.000	16.433	16.433
41:30:00	0.000	0.000	0.000	0.000	16.182	16.182
42:00:00	0.000	0.000	0.000	0.000	15.934	15.934
42:30:00	0.000	0.000	0.000	0.000	15.691	15.691
43:00:00	0.000	0.000	0.000	0.000	15.451	15.451
43:30:00	0.000	0.000	0.000	0.000	15.214	15.214
44:00:00	0.000	0.000	0.000	0.000	14.982	14.982
44:30:00	0.000	0.000	0.000	0.000	14.752	14.752
45:00:00	0.000	0.000	0.000	0.000	14.527	14.527
45:30:00	0.000	0.000	0.000	0.000	14.305	14.305
46:00:00	0.000	0.000	0.000	0.000	14.086	14.086
46:30:00	0.000	0.000	0.000	0.000	13.870	13.870
47:00:00	0.000	0.000	0.000	0.000	13.658	13.658
47:30:00	0.000	0.000	0.000	0.000	13.449	13.449
48:00:00	0.000	0.000	0.000	0.000	13.244	13.244
48:30:00	0.000	0.000	0.000	0.000	13.041	13.041
49:00:00	0.000	0.000	0.000	0.000	12.842	12.842
49:30:00	0.000	0.000	0.000	0.000	12.645	12.645
50:00:00	0.000	0.000	0.000	0.000	12.452	12.452
50:30:00	0.000	0.000	0.000	0.000	12.261	12.261
51:00:00	0.000	0.000	0.000	0.000	12.074	12.074
51:30:00	0.000	0.000	0.000	0.000	11.889	11.889
52:00:00	0.000	0.000	0.000	0.000	11.707	11.707
52:30:00	0.000	0.000	0.000	0.000	11.528	11.528
53:00:00	0.000	0.000	0.000	0.000	11.352	11.352

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
53:30:00	0.000	0.000	0.000	0.000	11.178	11.178
54:00:00	0.000	0.000	0.000	0.000	11.007	11.007
54:30:00	0.000	0.000	0.000	0.000	10.839	10.839
55:00:00	0.000	0.000	0.000	0.000	10.673	10.673
55:30:00	0.000	0.000	0.000	0.000	10.510	10.510
56:00:00	0.000	0.000	0.000	0.000	10.349	10.349
56:30:00	0.000	0.000	0.000	0.000	10.191	10.191
57:00:00	0.000	0.000	0.000	0.000	10.035	10.035
57:30:00	0.000	0.000	0.000	0.000	9.882	9.882
58:00:00	0.000	0.000	0.000	0.000	9.730	9.730
58:30:00	0.000	0.000	0.000	0.000	9.582	9.582
59:00:00	0.000	0.000	0.000	0.000	9.435	9.435
59:30:00	0.000	0.000	0.000	0.000	9.291	9.291
60:00:00	0.000	0.000	0.000	0.000	9.149	9.149
60:30:00	0.000	0.000	0.000	0.000	9.009	9.009
61:00:00	0.000	0.000	0.000	0.000	8.871	8.871
61:30:00	0.000	0.000	0.000	0.000	8.735	8.735
62:00:00	0.000	0.000	0.000	0.000	8.602	8.602
62:30:00	0.000	0.000	0.000	0.000	8.470	8.470
63:00:00	0.000	0.000	0.000	0.000	8.341	8.341
63:30:00	0.000	0.000	0.000	0.000	8.213	8.213
64:00:00	0.000	0.000	0.000	0.000	8.087	8.087
64:30:00	0.000	0.000	0.000	0.000	7.964	7.964
65:00:00	0.000	0.000	0.000	0.000	7.842	7.842
65:30:00	0.000	0.000	0.000	0.000	7.722	7.722
66:00:00	0.000	0.000	0.000	0.000	7.604	7.604
66:30:00	0.000	0.000	0.000	0.000	7.487	7.487
67:00:00	0.000	0.000	0.000	0.000	7.373	7.373
67:30:00	0.000	0.000	0.000	0.000	7.260	7.260
68:00:00	0.000	0.000	0.000	0.000	7.149	7.149
68:30:00	0.000	0.000	0.000	0.000	7.040	7.040
69:00:00	0.000	0.000	0.000	0.000	6.932	6.932
69:30:00	0.000	0.000	0.000	0.000	6.826	6.826
70:00:00	0.000	0.000	0.000	0.000	6.722	6.722
70:30:00	0.000	0.000	0.000	0.000	6.619	6.619
71:00:00	0.000	0.000	0.000	0.000	6.518	6.518

Time (hh:mm:ss)	Rain (mm)	Sewer Loss (mm)	Net Rain (mm)	Runoff (m^3/s)	Baseflow (m^3/s)	Total Flow (m^3/s)
71:30:00	0.000	0.000	0.000	0.000	6.418	6.418
72:00:00	0.000	0.000	0.000	0.000	6.320	6.320
72:30:00	0.000	0.000	0.000	0.000	6.223	6.223
73:00:00	0.000	0.000	0.000	0.000	6.128	6.128
73:30:00	0.000	0.000	0.000	0.000	6.034	6.034

Appendix

Catchment descriptors

Name	Value	User-defined value used?
Area (km²)	60.34	No
ALTBAR	388	No
ASPBAR	185	No
ASPVAR	0.12	No
BFIHOST	0.34	No
DPLBAR (km)	9.14	No
DPSBAR (mkm-¹)	153.3	No
FARL	1	No
LDP	17.65	No
PROPWET (mm)	0.62	No
RMED1H	11.9	No
RMED1D	54	No
RMED2D	71.2	No
SAAR (mm)	1686	No
SAAR4170 (mm)	1675	No
SPRHOST	49.68	No
Urbext2000	0.01	No
Urbext1990	0	No
URBCONC	0.73	No
URBLOC	0.2	No
Urban Area (km²)	0.66	No
DDF parameter C	-0.02	No
DDF parameter D1	0.46	No
DDF parameter D2	0.4	No
DDF parameter D3	0.37	No
DDF parameter E	0.29	No
DDF parameter F	2.56	No
DDF parameter C (1km grid value)	-0.02	No
DDF parameter D1 (1km grid value)	0.43	No
DDF parameter D2 (1km grid value)	0.35	No
DDF parameter D3 (1km grid value)	0.37	No
DDF parameter E (1km grid value)	0.29	No
DDF parameter F (1km grid value)	2.46	No

HEC-RAS Plan: Plan 01 River: River Greta Reach: 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
1	4	100	160.92	99.00	101.50	101.08	101.95	0.006073	3.02	54.98	31.68	0.69
1	4	100+20%	193.10	99.00	101.73	101.30	102.24	0.006045	3.20	62.56	33.28	0.70
1	4	100+30%	209.20	99.00	101.84	101.41	102.37	0.006024	3.27	66.27	34.04	0.70
1	4	100+50%	241.38	99.00	102.05	101.59	102.62	0.006004	3.42	73.41	35.44	0.70
1	4	1000	287.53	99.00	102.31	101.85	102.95	0.006049	3.62	82.93	37.23	0.72
1	3		Bridge									
1	2	100	160.92	97.70	100.28	100.05	100.93	0.009792	3.59	44.85	24.80	0.85
1	2	100+20%	193.10	97.70	100.46	100.30	101.24	0.010805	3.91	49.40	25.83	0.90
1	2	100+30%	209.20	97.70	100.54	100.42	101.38	0.011244	4.05	51.60	26.32	0.92
1	2	100+50%	241.38	97.70	100.70	100.63	101.65	0.012088	4.33	55.78	27.21	0.97
1	2	1000	287.53	97.70	100.90	100.90	102.02	0.013224	4.69	61.28	29.13	1.02
1	1	100	160.92	97.00	99.14	99.14	99.87	0.014382	3.77	42.68	29.81	1.01
1	1	100+20%	193.10	97.00	99.36	99.36	100.14	0.013777	3.93	49.24	32.18	1.00
1	1	100+30%	209.20	97.00	99.46	99.46	100.27	0.013418	4.00	52.50	33.48	0.99
1	1	100+50%	241.38	97.00	99.65	99.65	100.51	0.012740	4.11	59.14	35.97	0.98
1	1	1000	287.53	97.00	99.90	99.90	100.82	0.011958	4.26	68.70	39.29	0.97

APPENDIX 8 – HEC-RAS Model Results: Manning's n increase by 20%

HEC-RAS Plan: Plan 01 River: River Greta Reach: 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
1	4	100	160.92	99.00	101.56	101.08	101.98	0.007863	2.91	57.05	32.13	0.65
1	4	100+20%	193.10	99.00	101.81	101.30	102.28	0.007761	3.07	65.14	33.81	0.66
1	4	100+30%	209.20	99.00	101.92	101.41	102.41	0.007726	3.15	69.03	34.59	0.66
1	4	100+50%	241.38	99.00	102.13	101.59	102.66	0.007744	3.30	76.34	36.00	0.67
1	4	1000	287.53	99.00	102.38	101.85	102.98	0.007972	3.51	85.59	37.72	0.69
1	3		Bridge									
1	2	100	160.92	97.70	100.59	100.05	101.06	0.008912	3.04	52.98	26.62	0.69
1	2	100+20%	193.10	97.70	100.82	100.30	101.36	0.009523	3.27	59.06	27.90	0.72
1	2	100+30%	209.20	97.70	100.91	100.42	101.50	0.009835	3.39	61.80	30.10	0.73
1	2	100+50%	241.38	97.70	101.08	100.63	101.75	0.010410	3.62	67.97	54.85	0.76
1	2	1000	287.53	97.70	101.30	100.90	102.03	0.010508	3.82	81.24	59.36	0.77
1	1	100	160.92	97.00	99.14	99.14	99.87	0.020711	3.77	42.68	29.81	1.01
1	1	100+20%	193.10	97.00	99.36	99.36	100.14	0.019838	3.93	49.24	32.18	1.00
1	1	100+30%	209.20	97.00	99.46	99.46	100.27	0.019321	4.00	52.50	33.48	0.99
1	1	100+50%	241.38	97.00	99.65	99.65	100.51	0.018346	4.11	59.14	35.97	0.98
1	1	1000	287.53	97.00	99.90	99.90	100.82	0.017219	4.26	68.70	39.29	0.97

APPENDIX 9 – HEC-RAS Model Results: Manning's n decrease by 20%

HEC-RAS Plan: Plan 01 River: River Greta Reach: 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
1	4	100	160.92	99.00	101.43	101.08	101.92	0.004351	3.13	52.86	31.22	0.72
1	4	100+20%	193.10	99.00	101.66	101.30	102.21	0.004303	3.31	60.27	32.81	0.73
1	4	100+30%	209.20	99.00	101.77	101.41	102.34	0.004276	3.39	63.90	33.56	0.73
1	4	100+50%	241.38	99.00	101.98	101.59	102.59	0.004244	3.54	70.88	34.95	0.74
1	4	1000	287.53	99.00	102.25	101.85	102.92	0.004195	3.73	80.59	36.80	0.74
1	3		Bridge									
1	2	100	160.92	97.70	100.05	100.05	100.90	0.008938	4.08	39.45	23.52	1.01
1	2	100+20%	193.10	97.70	100.30	100.30	101.22	0.008706	4.25	45.44	24.94	1.01
1	2	100+30%	209.20	97.70	100.42	100.42	101.37	0.008558	4.32	48.46	25.62	1.00
1	2	100+50%	241.38	97.70	100.63	100.63	101.65	0.008456	4.47	54.00	26.84	1.01
1	2	1000	287.53	97.70	100.90	100.90	102.02	0.008464	4.69	61.28	29.13	1.02
1	1	100	160.92	97.00	99.14	99.14	99.87	0.009204	3.77	42.69	29.81	1.01
1	1	100+20%	193.10	97.00	99.36	99.36	100.14	0.008817	3.93	49.24	32.18	1.00
1	1	100+30%	209.20	97.00	99.46	99.46	100.27	0.008587	4.00	52.50	33.48	0.99
1	1	100+50%	241.38	97.00	99.65	99.65	100.51	0.008154	4.11	59.14	35.97	0.98
1	1	1000	287.53	97.00	99.90	99.90	100.82	0.007653	4.26	68.70	39.29	0.97

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Job No.	
Sheet no.	1
Date	18/01/18
Project	Land to the south of Bentham Road, Ingleton
Title	IoH 124 Method Calculations

By	Checked	Reviewed

Hydrological Data:-

FSR Hydrology:-

Location = INGLETON (N.YORKS) Grid reference = SD6972
M5-60 (mm) = 18.9 r = 0.25
Soil runoff = 0.50 SAAR (mm/yr) = 1190
WRAP = 5 Area = England & Wales
Hydrological area = 10 Hydrological zone = 7

Soil classification for WRAP type 5
Soils of wet uplands -
i) with peaty or humose surface horizons and impermeable layers at shallow depth;
ii) deep raw peat associated with gentle upland slopes or basin sites;
iii) bare rock cliffs and screes;
iv) shallow, permeable rocky soils on steep slopes.

Design data:-

Area = 0.024 Km² - 2.4 Ha - 24000 m² % Urbanisation = 0.00%

Calculation method:-

Runoff is calculated from:-

$$Q_{BAR(urban);} = Q_{BAR(rural)} (1 + URBAN)^{2NC}[1 + URBAN\{(21/CIND) - 0.3\}]$$

where:-

NC varies with the value of SAAR:-
for 500<SAAR<1100 mm then NC = 0.92 - 0.00024SAAR
for 1100<SAAR<3000 mm then NC = 0.74 - 0.000082SAAR

CIND = 102.4SOIL + 0.28(CWI - 125) CWI = Catchment Wetness Index

so

CIND =50.041 CWI =120.860 NC =0.642

For areas less than 50Ha, a modified calculation which multiplies the 50Ha runoff value by the ratio of the site area to 50Ha is used
Reducing factor used for these calculations is 0.048

$Q_{BAR(rural)}$ = 24.655 (l/s)

$Q_{BAR(urban)}$ = 24.655 (l/s)

$Q_{BAR(urban)}$ is then multiplied by a growth factor - GC(T) - for different storm return periods derived from EA publication W5-074/A.

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Job No.	
Sheet no.	2
Date	18/01/18
Project	Land to the south of Bentham Road, Ingleton
Title	IoH 124 Method Calculations

By	Checked	Reviewed

Mean Annual Peak Flow $Q_{BAR(urban)}$ = 24.65 l/s

Values for $Q_{BAR(urban)}$

Ret. per.	m³/hr	l/s	l/s/ha	Ret. per.	m³/hr	l/s	l/s/ha
1yr	0.021	20.957	8.732	100yr	0.052	51.775	21.573
2yr	0.023	22.929	9.554	100yr+20%	0.062	62.130	25.888
5yr	0.030	29.832	12.430	100yr+30%	0.067	67.308	28.045
10yr	0.034	34.024	14.177	200yr	0.059	59.172	24.655
30yr	0.041	41.420	17.258	200yr + 30%	0.077	76.923	32.051
50yr	0.046	45.612	19.005	500yr	0.067	67.308	28.045
				1000yr	0.075	74.951	31.230

Growth factors -

1yr	2yr	5yr	10yr	30yr	50yr	100yr	200yr	500yr	1000yr
0.85	0.93	1.21	1.38	1.68	1.85	2.10	2.40	2.73	3.04

The above is based on the Institute of Hydrology Report 124 to which you are referred for further details (see Sect 7). Note that the 200 year growth curve was taken from W5-074/A.

For WRAP type 1 soils, CIND can become negative for lower values of SAAR. In this case the CIND value is multiplied by -1 to return a positive value (CIND is very small at this point).

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SW 16.05

Job No.			
Sheet no.	1		
Date	18/01/18		
Project	Land to the south of Bentham Road, Ingleton	By	Checked / Reviewed
Title	1 in 100 Year (+40%) Soakaway Calculations		

Concrete ring design:-

Ring diameter = 1200 mm
Percentage voids = 63.0
Climate change = 40%

Return period = 100 yrs
Imperm. area = 55m²
Infiltration factor = 0.02 m/hr

Depth below invert = 1.5m
Pit side length = 2.4m

Calculations :-

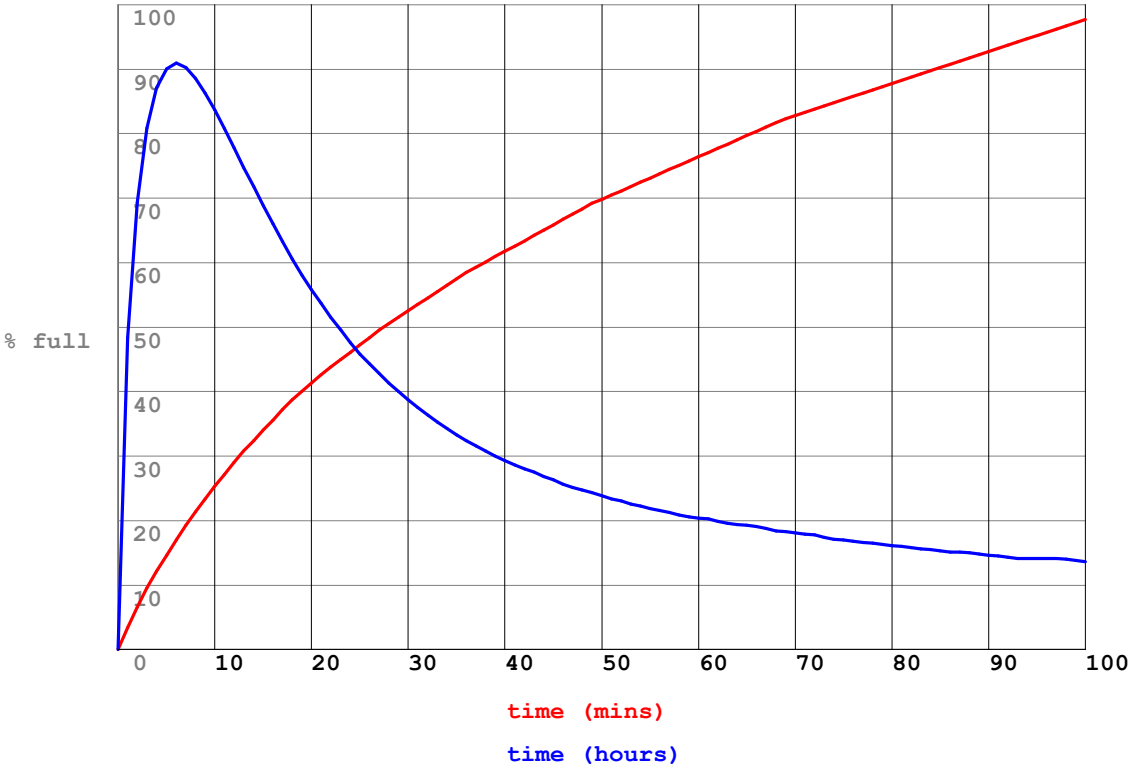
Surface area of soakaway to 50% depth - a_{s50} = Length of side x 4 x Depth/2 = 7.2 m² (base not included).

Outflow factor - OFact = a_{s50} x f =0.144 m³/s where Infilt. factor (f)= 0.02 m/s

Soakaway ring storage volume - S_{actual} = Pi x (Ring diam/2000)² x depth = 1.7 m³

Gross soakaway pit storage volume - S_{pit} = Length of side² x depth = 8.6 m³

Nett soakaway pit storage volume - S_{nett} = Gross pit volume - infill (half depth) = 6.1 m³ (storage + void)



Required volume (S_{reqd}) = 5.9 m³

Available storage volume = 6.1 m³

Spare capacity = 0.14 m³

Emptying time to 50% volume = 23 hours

Soakaway emptying time OK.

Soakaway dimensions OK.

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Job No.	
Sheet no.	2
Date	18/01/18

MasterDrain
SW 16.05

Project	Land to the south of Bentham Road, Ingleton	By	Checked / Reviewed
Title	Soakaway data - 100 mins		

Duration	Rain mm/hr	Inflow m³	Outflow m³	Storage m³	Depth m	% full
1	231.05	0.21	0.000	0.21	0.04	3
2	208.36	0.19	0.001	0.40	0.10	7
3	191.02	0.18	0.001	0.58	0.15	10
4	177.24	0.16	0.002	0.74	0.18	12
5	165.96	0.15	0.002	0.89	0.22	15
6	156.52	0.14	0.002	1.03	0.26	17
7	148.49	0.14	0.003	1.17	0.28	19
8	141.54	0.13	0.003	1.30	0.32	21
9	135.46	0.12	0.003	1.42	0.34	23
10	130.09	0.12	0.003	1.54	0.38	25
11	125.30	0.11	0.004	1.65	0.40	27
12	120.99	0.11	0.004	1.76	0.44	29
13	117.10	0.11	0.004	1.87	0.46	31
14	113.55	0.10	0.004	1.97	0.48	32
15	110.14	0.10	0.005	2.07	0.51	34
16	106.93	0.10	0.005	2.16	0.54	36
17	103.96	0.10	0.005	2.26	0.56	37
18	101.19	0.09	0.005	2.35	0.58	39
19	98.62	0.09	0.006	2.43	0.60	40
20	96.21	0.09	0.006	2.51	0.62	41
21	93.94	0.09	0.006	2.59	0.64	43
22	91.82	0.08	0.006	2.66	0.66	44
23	89.81	0.08	0.006	2.73	0.68	45
24	87.92	0.08	0.006	2.80	0.69	46
25	86.12	0.08	0.007	2.87	0.70	47
26	84.42	0.08	0.007	2.94	0.72	48
27	82.80	0.08	0.007	3.01	0.75	50
28	81.27	0.07	0.007	3.07	0.76	51
29	79.80	0.07	0.007	3.13	0.78	52
30	78.40	0.07	0.007	3.19	0.80	53
31	77.06	0.07	0.007	3.25	0.81	54
32	75.78	0.07	0.008	3.31	0.82	55
33	74.56	0.07	0.008	3.37	0.84	56
34	73.38	0.07	0.008	3.43	0.84	56
35	72.25	0.07	0.008	3.49	0.86	57
36	71.17	0.07	0.008	3.55	0.87	58
37	70.12	0.06	0.008	3.60	0.88	59
38	69.12	0.06	0.008	3.65	0.90	60
39	68.15	0.06	0.008	3.70	0.92	61
40	67.21	0.06	0.009	3.75	0.93	62
41	66.31	0.06	0.009	3.80	0.94	63
42	65.43	0.06	0.009	3.85	0.94	63
43	64.59	0.06	0.009	3.90	0.96	64
44	63.77	0.06	0.009	3.95	0.98	65
45	62.98	0.06	0.009	4.00	0.99	66
46	62.21	0.06	0.009	4.05	1.00	67
47	61.47	0.06	0.009	4.10	1.02	68
48	60.75	0.06	0.009	4.15	1.02	68
49	60.05	0.06	0.010	4.20	1.04	69
50	59.37	0.05	0.010	4.24	1.05	70
51	58.70	0.05	0.010	4.28	1.05	3
52	58.06	0.05	0.010	4.32	1.06	7
53	57.43	0.05	0.010	4.36	1.08	10
54	56.83	0.05	0.010	4.40	1.08	12
55	56.23	0.05	0.010	4.44	1.10	15
56	55.65	0.05	0.010	4.48	1.11	17
57	55.09	0.05	0.010	4.52	1.11	19
58	54.54	0.05	0.010	4.56	1.12	21
59	54.01	0.05	0.010	4.60	1.14	23
60	53.48	0.05	0.011	4.64	1.14	25
61	52.97	0.05	0.011	4.68	1.16	27
62	52.47	0.05	0.011	4.72	1.17	29
63	51.99	0.05	0.011	4.76	1.17	31
64	51.51	0.05	0.011	4.80	1.18	32
65	51.05	0.05	0.011	4.84	1.20	34
66	50.59	0.05	0.011	4.88	1.20	36
67	50.15	0.05	0.011	4.92	1.22	37
68	49.71	0.05	0.011	4.96	1.23	39
69	49.28	0.05	0.011	5.00	1.23	40
70	48.87	0.04	0.011	5.03	1.24	41
71	48.46	0.04	0.012	5.06	1.24	43
72	48.06	0.04	0.012	5.09	1.26	44
73	47.66	0.04	0.012	5.12	1.26	45
74	47.28	0.04	0.012	5.15	1.28	46
75	46.90	0.04	0.012	5.18	1.28	47
76	46.53	0.04	0.012	5.21	1.29	48
77	46.17	0.04	0.012	5.24	1.29	50
78	45.81	0.04	0.012	5.27	1.30	51
79	45.46	0.04	0.012	5.30	1.30	52
80	45.12	0.04	0.012	5.33	1.32	53
81	44.78	0.04	0.012	5.36	1.32	54
82	44.45	0.04	0.012	5.39	1.34	55
83	44.12	0.04	0.012	5.42	1.34	56
84	43.80	0.04	0.012	5.45	1.35	56
85	43.49	0.04	0.012	5.48	1.35	57
86	43.18	0.04	0.013	5.51	1.36	58
87	42.88	0.04	0.013	5.54	1.36	59
88	42.58	0.04	0.013	5.57	1.38	60
89	42.29	0.04	0.013	5.60	1.38	61
90	42.00	0.04	0.013	5.63	1.40	62
91	41.71	0.04	0.013	5.66	1.40	63
92	41.43	0.04	0.013	5.69	1.41	63
93	41.16	0.04	0.013	5.72	1.41	64
94	40.89	0.04	0.013	5.75	1.42	65
95	40.62	0.04	0.013	5.78	1.42	66
96	40.36	0.04	0.013	5.81	1.44	67
97	40.10	0.04	0.013	5.84	1.44	68
98	39.85	0.04	0.013	5.87	1.46	68
99	39.60	0.04	0.013	5.90	1.46	69
100	39.35	0.04	0.013	5.93	1.47	70

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MasterDrain
SW 16.05

Job No.	
Sheet no.	3
Date	18/01/18
Project	Land to the south of Bentham Road, Ingleton
Title	Soakaway data - 100 hours
By	
Checked	
Reviewed	

Duration	Rain mm/hr	Inflow m³	Outflow m³	Storage m³	Depth m	%full	Duration	Rain mm/hr	Inflow m³	Outflow m³	Storage m³	Depth m	% full
1	53.5	2.94	0.000	2.94	0.72	48	51	3.6	0.20	0.225	1.42	0.72	23
2	35.1	1.93	0.664	4.21	1.04	69	52	3.6	0.20	0.221	1.40	1.04	23
3	26.8	1.47	0.774	4.91	1.22	81	53	3.5	0.19	0.217	1.37	1.22	23
4	22.0	1.21	0.833	5.29	1.30	87	54	3.5	0.19	0.213	1.35	1.30	22
5	18.9	1.04	0.862	5.47	1.35	90	55	3.4	0.19	0.209	1.33	1.35	22
6	16.7	0.92	0.870	5.52	1.36	91	56	3.4	0.19	0.207	1.31	1.36	22
7	15.0	0.82	0.864	5.48	1.35	90	57	3.3	0.18	0.204	1.29	1.35	21
8	13.7	0.75	0.849	5.38	1.34	89	58	3.3	0.18	0.200	1.27	1.34	21
9	12.6	0.69	0.828	5.24	1.29	86	59	3.3	0.18	0.198	1.25	1.29	21
10	11.7	0.64	0.801	5.08	1.26	84	60	3.2	0.18	0.194	1.24	1.26	20
11	10.9	0.60	0.774	4.91	1.22	81	61	3.2	0.18	0.194	1.23	1.22	20
12	10.3	0.57	0.747	4.73	1.17	78	62	3.1	0.17	0.190	1.21	1.17	20
13	9.7	0.53	0.716	4.54	1.12	75	63	3.1	0.17	0.188	1.19	1.12	20
14	9.2	0.51	0.687	4.36	1.08	72	64	3.1	0.17	0.184	1.18	1.08	19
15	8.8	0.48	0.659	4.18	1.04	69	65	3.0	0.17	0.184	1.17	1.04	19
16	8.4	0.46	0.632	4.01	0.99	66	66	3.0	0.17	0.182	1.16	0.99	19
17	8.0	0.44	0.607	3.84	0.94	63	67	3.0	0.16	0.180	1.14	0.94	19
18	7.7	0.42	0.580	3.68	0.92	61	68	2.9	0.16	0.177	1.12	0.92	18
19	7.4	0.41	0.557	3.53	0.87	58	69	2.9	0.16	0.175	1.11	0.87	18
20	7.1	0.39	0.534	3.39	0.84	56	70	2.9	0.16	0.173	1.10	0.84	18
21	6.9	0.38	0.513	3.26	0.81	54	71	2.9	0.16	0.171	1.09	0.81	18
22	6.7	0.37	0.495	3.13	0.78	52	72	2.8	0.16	0.171	1.08	0.78	18
23	6.5	0.36	0.476	3.01	0.75	50	73	2.8	0.15	0.167	1.06	0.75	17
24	6.3	0.34	0.457	2.89	0.72	48	74	2.8	0.15	0.165	1.04	0.72	17
25	6.1	0.33	0.438	2.78	0.69	46	75	2.7	0.15	0.161	1.03	0.69	17
26	5.9	0.33	0.424	2.69	0.66	44	76	2.7	0.15	0.161	1.02	0.66	17
27	5.8	0.32	0.411	2.60	0.64	43	77	2.7	0.15	0.159	1.01	0.64	17
28	5.6	0.31	0.396	2.51	0.62	41	78	2.7	0.15	0.157	1.00	0.62	16
29	5.5	0.30	0.382	2.43	0.60	40	79	2.6	0.15	0.157	0.99	0.60	16
30	5.3	0.29	0.371	2.35	0.58	39	80	2.6	0.14	0.154	0.98	0.58	16
31	5.2	0.29	0.359	2.28	0.57	38	81	2.6	0.14	0.152	0.97	0.57	16
32	5.1	0.28	0.349	2.21	0.54	36	82	2.6	0.14	0.152	0.96	0.54	16
33	5.0	0.27	0.338	2.14	0.52	35	83	2.6	0.14	0.150	0.95	0.52	16
34	4.9	0.27	0.328	2.08	0.51	34	84	2.5	0.14	0.148	0.94	0.51	15
35	4.8	0.26	0.319	2.02	0.50	33	85	2.5	0.14	0.148	0.93	0.50	15
36	4.7	0.26	0.311	1.97	0.48	32	86	2.5	0.14	0.146	0.92	0.48	15
37	4.6	0.25	0.301	1.92	0.48	32	87	2.5	0.14	0.144	0.92	0.48	15
38	4.5	0.25	0.296	1.87	0.46	31	88	2.4	0.13	0.142	0.91	0.46	15
39	4.4	0.24	0.288	1.82	0.45	30	89	2.4	0.13	0.142	0.90	0.45	15
40	4.3	0.24	0.280	1.78	0.44	29	90	2.4	0.13	0.140	0.89	0.44	15
41	4.2	0.23	0.275	1.74	0.44	29	91	2.4	0.13	0.138	0.88	0.44	14
42	4.2	0.23	0.269	1.70	0.42	28	92	2.4	0.13	0.138	0.87	0.42	14
43	4.1	0.23	0.263	1.67	0.42	28	93	2.4	0.13	0.136	0.86	0.42	14
44	4.0	0.22	0.257	1.63	0.40	27	94	2.3	0.13	0.134	0.86	0.40	14
45	4.0	0.22	0.252	1.60	0.39	26	95	2.3	0.13	0.134	0.86	0.39	14
46	3.9	0.21	0.246	1.56	0.39	26	96	2.3	0.13	0.134	0.86	0.39	14
47	3.8	0.21	0.242	1.53	0.38	25	97	2.3	0.13	0.134	0.86	0.38	14
48	3.8	0.21	0.236	1.50	0.38	25	98	2.3	0.12	0.134	0.85	0.38	14
49	3.7	0.21	0.232	1.48	0.36	24	99	2.2	0.12	0.132	0.84	0.36	14
50	3.7	0.20	0.228	1.45	0.36	24	100	2.2	0.12	0.131	0.83	0.36	14

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MasterDrain
SW 16.05

Job No.			
Sheet no.	4		
Date	18/01/18		
Project	Land to the south of Bentham Road, Ingleton	By	Checked / Reviewed
Title	Hydrology data		

Location hydrological data (FSR):-

Location	= INGLETON (N.YORKS)	Grid reference	= SD6972
M5-60 (mm)	= 18.9	r	= 0.25
Soil index	= 0.50	SAAR (mm/yr)	= 1190
WRAP	= 5	Area = England and Wales	

Soil classification for WRAP type 5
Soils of wet uplands -
i) with peaty or humose surface horizons and impermeable layers at shallow depth;
ii) deep raw peat associated with gentle upland slopes or basin sites;
iii) bare rock cliffs and screes;
iv) shallow, permeable rocky soils on steep slopes.

N.B. The rainfall rates are calculated using the location specific values above in accordance with the Wallingford procedure.

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Job No.	
Sheet no.	1
Date	18/01/18
Project	Land to the south of Bentham Road, Ingleton
Title	1 in 30 Year (+40%) Soakaway Calculations

By	Checked	Reviewed

Concrete ring design:-

Ring diameter = 1200 mm
Percentage voids = 63.0
Climate change = 40%

Return period = 30 yrs
Imperm. area = 55m²
Infiltration factor = 0.02 m/hr

Depth below invert = 1.5m
Pit side length = 2.4m

Calculations :-

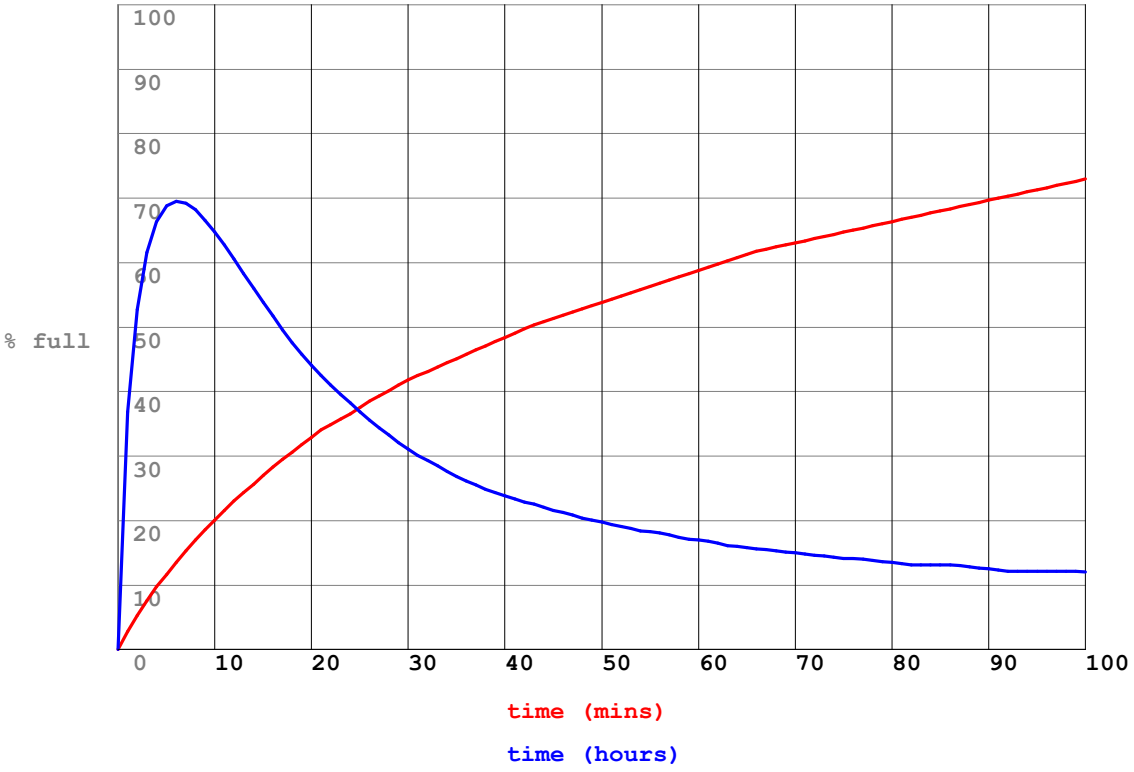
Surface area of soakaway to 50% depth - a_{s50} = Length of side x 4 x Depth/2 = 7.2 m² (base not included).

Outflow factor - OFact = a_{s50} x f =0.144 m³/s where Infilt. factor (f)= 0.02 m/s

Soakaway ring storage volume - S_{actual} = Pi x (Ring diam/2000)² x depth = 1.7 m³

Gross soakaway pit storage volume - S_{pit} = Length of side² x depth = 8.6 m³

Nett soakaway pit storage volume - S_{nett} = Gross pit volume - infill (half depth) = 6.1 m³ (storage + void)



Required volume (S_{reqd}) = 4.4 m³

Available storage volume = 6.1 m³

Spare capacity = 1.64 m³

Emptying time to 50% volume = 17 hours

Soakaway emptying time OK.

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MasterDrain
SW 16.05

Job No.	
Sheet no.	2
Date	18/01/18
Project	Land to the south of Bentham Road, Ingleton
Title	Soakaway data - 100 mins
By	
Checked	
Reviewed	

Duration	Rain mm/hr	Inflow m³	Outflow m³	Storage m³	Depth m	% full	Duration	Rain mm/hr	Inflow m³	Outflow m³	Storage m³	Depth m	% full
1	187.23	0.17	0.000	0.17	0.04	3	51	44.74	0.04	0.008	3.30	0.81	3
2	168.00	0.15	0.001	0.32	0.08	5	52	44.25	0.04	0.008	3.33	0.82	5
3	153.35	0.14	0.001	0.46	0.12	8	53	43.76	0.04	0.008	3.36	0.82	8
4	141.72	0.13	0.001	0.59	0.15	10	54	43.29	0.04	0.008	3.39	0.84	10
5	132.23	0.12	0.002	0.71	0.18	12	55	42.83	0.04	0.008	3.42	0.84	12
6	124.29	0.11	0.002	0.82	0.21	14	56	42.39	0.04	0.008	3.45	0.86	14
7	117.54	0.11	0.002	0.93	0.22	15	57	41.95	0.04	0.008	3.48	0.86	15
8	111.72	0.10	0.002	1.03	0.26	17	58	41.53	0.04	0.008	3.51	0.87	17
9	106.63	0.10	0.003	1.13	0.28	19	59	41.11	0.04	0.008	3.54	0.87	19
10	102.13	0.09	0.003	1.22	0.30	20	60	40.71	0.04	0.008	3.57	0.88	20
11	98.12	0.09	0.003	1.31	0.33	22	61	40.32	0.04	0.008	3.60	0.88	22
12	94.52	0.09	0.003	1.40	0.34	23	62	39.93	0.04	0.008	3.63	0.90	23
13	91.27	0.08	0.003	1.48	0.36	24	63	39.56	0.04	0.008	3.66	0.90	24
14	88.31	0.08	0.004	1.56	0.39	26	64	39.19	0.04	0.008	3.69	0.92	26
15	85.53	0.08	0.004	1.64	0.40	27	65	38.84	0.04	0.008	3.72	0.92	27
16	82.94	0.08	0.004	1.72	0.42	28	66	38.49	0.04	0.009	3.75	0.93	28
17	80.54	0.07	0.004	1.79	0.44	29	67	38.15	0.03	0.009	3.77	0.93	29
18	78.32	0.07	0.004	1.86	0.46	31	68	37.81	0.03	0.009	3.79	0.93	31
19	76.25	0.07	0.004	1.93	0.48	32	69	37.48	0.03	0.009	3.81	0.94	32
20	74.32	0.07	0.005	2.00	0.50	33	70	37.16	0.03	0.009	3.83	0.94	33
21	72.51	0.07	0.005	2.07	0.51	34	71	36.85	0.03	0.009	3.85	0.94	34
22	70.81	0.06	0.005	2.12	0.52	35	72	36.54	0.03	0.009	3.87	0.96	35
23	69.21	0.06	0.005	2.17	0.54	36	73	36.24	0.03	0.009	3.89	0.96	36
24	67.70	0.06	0.005	2.22	0.56	37	74	35.95	0.03	0.009	3.91	0.96	37
25	66.27	0.06	0.005	2.28	0.57	38	75	35.66	0.03	0.009	3.93	0.98	38
26	64.92	0.06	0.005	2.34	0.58	39	76	35.38	0.03	0.009	3.95	0.98	39
27	63.64	0.06	0.005	2.39	0.58	39	77	35.10	0.03	0.009	3.97	0.98	39
28	62.42	0.06	0.006	2.44	0.60	40	78	34.83	0.03	0.009	3.99	0.99	40
29	61.26	0.06	0.006	2.49	0.62	41	79	34.56	0.03	0.009	4.01	0.99	41
30	60.16	0.06	0.006	2.54	0.63	42	80	34.30	0.03	0.009	4.03	0.99	42
31	59.10	0.05	0.006	2.58	0.63	42	81	34.04	0.03	0.009	4.05	1.00	42
32	58.09	0.05	0.006	2.62	0.64	43	82	33.79	0.03	0.009	4.07	1.00	43
33	57.13	0.05	0.006	2.66	0.66	44	83	33.54	0.03	0.009	4.09	1.00	44
34	56.20	0.05	0.006	2.70	0.66	44	84	33.30	0.03	0.009	4.11	1.02	44
35	55.32	0.05	0.006	2.74	0.68	45	85	33.06	0.03	0.009	4.13	1.02	45
36	54.46	0.05	0.006	2.78	0.69	46	86	32.83	0.03	0.009	4.15	1.02	46
37	53.64	0.05	0.006	2.82	0.69	46	87	32.60	0.03	0.010	4.17	1.04	46
38	52.86	0.05	0.007	2.86	0.70	47	88	32.37	0.03	0.010	4.19	1.04	47
39	52.10	0.05	0.007	2.90	0.72	48	89	32.15	0.03	0.010	4.21	1.04	48
40	51.37	0.05	0.007	2.94	0.72	48	90	31.93	0.03	0.010	4.23	1.05	48
41	50.66	0.05	0.007	2.98	0.74	49	91	31.71	0.03	0.010	4.25	1.05	49
42	49.98	0.05	0.007	3.02	0.75	50	92	31.50	0.03	0.010	4.27	1.05	50
43	49.32	0.05	0.007	3.06	0.75	50	93	31.29	0.03	0.010	4.29	1.06	50
44	48.68	0.04	0.007	3.09	0.76	51	94	31.09	0.03	0.010	4.31	1.06	51
45	48.07	0.04	0.007	3.12	0.76	51	95	30.89	0.03	0.010	4.33	1.06	51
46	47.47	0.04	0.007	3.15	0.78	52	96	30.69	0.03	0.010	4.35	1.08	52
47	46.89	0.04	0.007	3.18	0.78	52	97	30.49	0.03	0.010	4.37	1.08	52
48	46.33	0.04	0.007	3.21	0.80	53	98	30.30	0.03	0.010	4.39	1.08	53
49	45.79	0.04	0.007	3.24	0.80	53	99	30.11	0.03	0.010	4.41	1.10	53
50	45.26	0.04	0.007	3.27	0.81	54	100	29.92	0.03	0.010	4.43	1.10	54

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Job No.
Sheet no. 3
Date 18/01/18

Project: Land to the south of Bentham Road, Ingleton

Title: Soakaway data - 100 hours

By	Checked	Reviewed

Duration	Rain mm/hr	Inflow m³	Outflow m³	Storage m³	Depth m	%full	Duration	Rain mm/hr	Inflow m³	Outflow m³	Storage m³	Depth m	% full
1	40.7	2.24	0.000	2.24	0.56	37	51	3.0	0.17	0.186	1.18	0.56	19
2	26.7	1.47	0.505	3.20	0.80	53	52	3.0	0.16	0.182	1.16	0.80	19
3	20.5	1.13	0.589	3.74	0.93	62	53	2.9	0.16	0.180	1.14	0.93	19
4	17.0	0.93	0.636	4.03	0.99	66	54	2.9	0.16	0.177	1.12	0.99	18
5	14.7	0.81	0.659	4.18	1.04	69	55	2.9	0.16	0.175	1.11	1.04	18
6	13.0	0.71	0.666	4.22	1.05	70	56	2.8	0.16	0.173	1.10	1.05	18
7	11.7	0.64	0.662	4.20	1.04	69	57	2.8	0.15	0.171	1.08	1.04	18
8	10.7	0.59	0.653	4.14	1.02	68	58	2.8	0.15	0.167	1.06	1.02	17
9	9.9	0.54	0.637	4.04	1.00	67	59	2.7	0.15	0.165	1.04	1.00	17
10	9.2	0.51	0.620	3.93	0.98	65	60	2.7	0.15	0.161	1.03	0.98	17
11	8.6	0.48	0.601	3.81	0.94	63	61	2.7	0.15	0.161	1.02	0.94	17
12	8.1	0.45	0.580	3.68	0.92	61	62	2.6	0.14	0.157	1.00	0.92	16
13	7.7	0.42	0.559	3.54	0.87	58	63	2.6	0.14	0.156	0.98	0.87	16
14	7.3	0.40	0.538	3.40	0.84	56	64	2.6	0.14	0.152	0.97	0.84	16
15	7.0	0.38	0.515	3.27	0.81	54	65	2.5	0.14	0.152	0.96	0.81	16
16	6.7	0.37	0.495	3.14	0.78	52	66	2.5	0.14	0.150	0.95	0.78	16
17	6.4	0.35	0.476	3.01	0.75	50	67	2.5	0.14	0.148	0.94	0.75	15
18	6.2	0.34	0.457	2.89	0.72	48	68	2.5	0.14	0.148	0.93	0.72	15
19	6.0	0.33	0.438	2.78	0.69	46	69	2.4	0.13	0.144	0.92	0.69	15
20	5.7	0.32	0.422	2.68	0.66	44	70	2.4	0.13	0.142	0.91	0.66	15
21	5.6	0.31	0.407	2.58	0.63	42	71	2.4	0.13	0.142	0.90	0.63	15
22	5.4	0.30	0.392	2.49	0.62	41	72	2.4	0.13	0.140	0.89	0.62	15
23	5.2	0.29	0.378	2.40	0.60	40	73	2.4	0.13	0.138	0.88	0.60	14
24	5.1	0.28	0.365	2.32	0.57	38	74	2.3	0.13	0.138	0.87	0.57	14
25	4.9	0.27	0.353	2.24	0.56	37	75	2.3	0.13	0.136	0.86	0.56	14
26	4.8	0.26	0.340	2.16	0.54	36	76	2.3	0.13	0.134	0.86	0.54	14
27	4.7	0.26	0.330	2.09	0.51	34	77	2.3	0.12	0.134	0.85	0.51	14
28	4.6	0.25	0.319	2.02	0.50	33	78	2.2	0.12	0.132	0.84	0.50	14
29	4.5	0.24	0.307	1.95	0.48	32	79	2.2	0.12	0.131	0.83	0.48	14
30	4.3	0.24	0.298	1.89	0.46	31	80	2.2	0.12	0.129	0.82	0.46	14
31	4.3	0.23	0.288	1.83	0.45	30	81	2.2	0.12	0.129	0.81	0.45	13
32	4.2	0.23	0.280	1.78	0.44	29	82	2.2	0.12	0.127	0.80	0.44	13
33	4.1	0.22	0.273	1.73	0.42	28	83	2.2	0.12	0.125	0.80	0.42	13
34	4.0	0.22	0.265	1.68	0.42	28	84	2.1	0.12	0.125	0.80	0.42	13
35	3.9	0.21	0.257	1.63	0.40	27	85	2.1	0.12	0.125	0.80	0.40	13
36	3.8	0.21	0.252	1.59	0.39	26	86	2.1	0.12	0.125	0.80	0.39	13
37	3.8	0.21	0.246	1.55	0.39	26	87	2.1	0.11	0.125	0.79	0.39	13
38	3.7	0.20	0.238	1.51	0.38	25	88	2.1	0.11	0.123	0.78	0.38	13
39	3.6	0.20	0.232	1.48	0.36	24	89	2.1	0.11	0.121	0.77	0.36	13
40	3.6	0.20	0.228	1.45	0.36	24	90	2.0	0.11	0.119	0.76	0.36	13
41	3.5	0.19	0.223	1.42	0.34	23	91	2.0	0.11	0.119	0.75	0.34	12
42	3.4	0.19	0.219	1.39	0.34	23	92	2.0	0.11	0.117	0.74	0.34	12
43	3.4	0.19	0.215	1.37	0.34	23	93	2.0	0.11	0.115	0.74	0.34	12
44	3.3	0.18	0.211	1.34	0.33	22	94	2.0	0.11	0.115	0.74	0.33	12
45	3.3	0.18	0.207	1.31	0.33	22	95	2.0	0.11	0.115	0.74	0.33	12
46	3.2	0.18	0.204	1.29	0.32	21	96	2.0	0.11	0.115	0.74	0.32	12
47	3.2	0.18	0.200	1.27	0.32	21	97	1.9	0.11	0.115	0.74	0.32	12
48	3.1	0.17	0.196	1.24	0.30	20	98	1.9	0.11	0.115	0.74	0.30	12
49	3.1	0.17	0.192	1.22	0.30	20	99	1.9	0.11	0.115	0.74	0.30	12
50	3.1	0.17	0.190	1.20	0.30	20	100	1.9	0.10	0.115	0.73	0.30	12

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Job No.			
Sheet no.	4		
Date	18/01/18		
Project	Land to the south of Bentham Road, Ingleton	By	Checked / Reviewed
Title	Hydrology data		

Location hydrological data (FSR):-

Location	= INGLETON (N.YORKS)	Grid reference	= SD6972
M5-60 (mm)	= 18.9	r	= 0.25
Soil index	= 0.50	SAAR (mm/yr)	= 1190
WRAP	= 5	Area = England and Wales	

Soil classification for WRAP type 5
Soils of wet uplands -
i) with peaty or humose surface horizons and impermeable layers at shallow depth;
ii) deep raw peat associated with gentle upland slopes or basin sites;
iii) bare rock cliffs and screes;
iv) shallow, permeable rocky soils on steep slopes.

N.B. The rainfall rates are calculated using the location specific values above in accordance with the Wallingford procedure.

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Job No.	
Sheet no.	1
Date	18/01/18
Project	Land to the south of Bentham Road, Ingleton
Title	1 in 10 Year (+40%) Soakaway Calculations
By / Checked / Reviewed	

Concrete ring design:-

Ring diameter = 1200 mm
Percentage voids = 63.0
Climate change = 40%

Return period = 10 yrs
Imperm. area = 55m²
Infiltration factor = 0.02 m/hr

Depth below invert = 1.5m
Pit side length = 2.4m

Calculations :-

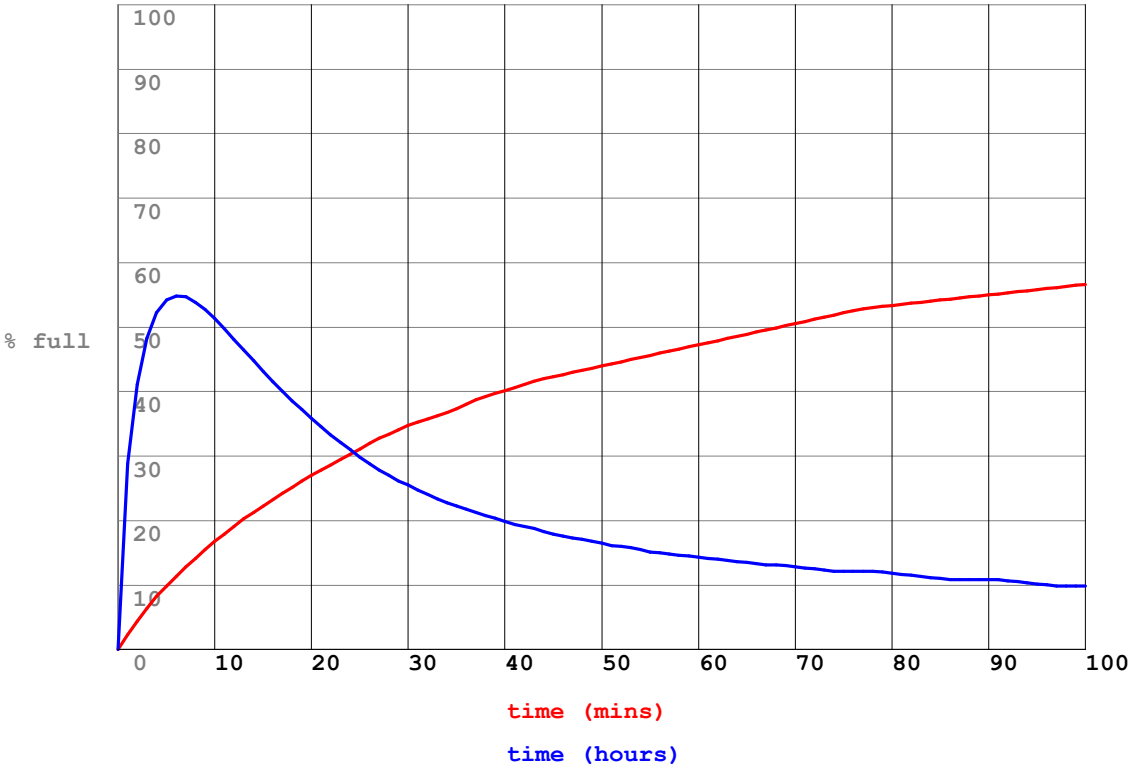
Surface area of soakaway to 50% depth - a_{s50} = Length of side x 4 x Depth/2 = 7.2 m² (base not included).

Outflow factor - OFact = a_{s50} x f =0.144 m³/s where Infilt. factor (f)= 0.02 m/s

Soakaway ring storage volume - S_{actual} = Pi x (Ring diam/2000)² x depth = 1.7 m³

Gross soakaway pit storage volume - S_{pit} = Length of side² x depth = 8.6 m³

Nett soakaway pit storage volume - S_{nett} = Gross pit volume - infill (half depth) = 6.1 m³ (storage + void)



Required volume (S_{reqd}) = 3.4 m³

Available storage volume = 6.1 m³

Spare capacity = 2.63 m³

Emptying time to 50% volume = 11 hours

Soakaway emptying time OK.

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Job No.
Sheet no. 2
Date 18/01/18

MasterDrain
SW 16.05

Project: Land to the south of Bentham Road, Ingleton

Title: Soakaway data - 100 mins

By	Checked	Reviewed

Duration	Rain mm/hr	Inflow m³	Outflow m³	Storage m³	Depth m	% full
1	154.54	0.14	0.000	0.14	0.03	2
2	138.04	0.13	0.001	0.27	0.06	4
3	125.49	0.12	0.001	0.39	0.09	6
4	115.56	0.11	0.001	0.50	0.12	8
5	107.46	0.10	0.001	0.60	0.15	10
6	100.71	0.09	0.002	0.69	0.16	11
7	94.97	0.09	0.002	0.78	0.20	13
8	90.02	0.08	0.002	0.86	0.21	14
9	85.70	0.08	0.002	0.94	0.22	15
10	81.89	0.08	0.002	1.02	0.26	17
11	78.50	0.07	0.002	1.09	0.27	18
12	75.46	0.07	0.003	1.16	0.28	19
13	72.71	0.07	0.003	1.23	0.30	20
14	70.21	0.06	0.003	1.29	0.32	21
15	67.90	0.06	0.003	1.35	0.33	22
16	65.77	0.06	0.003	1.41	0.34	23
17	63.81	0.06	0.003	1.47	0.36	24
18	61.99	0.06	0.003	1.53	0.38	25
19	60.30	0.06	0.004	1.59	0.39	26
20	58.72	0.05	0.004	1.64	0.40	27
21	57.24	0.05	0.004	1.69	0.42	28
22	55.86	0.05	0.004	1.74	0.44	29
23	54.56	0.05	0.004	1.79	0.44	29
24	53.34	0.05	0.004	1.84	0.45	30
25	52.18	0.05	0.004	1.89	0.46	31
26	51.09	0.05	0.004	1.94	0.48	32
27	50.05	0.05	0.005	1.99	0.50	33
28	49.07	0.04	0.005	2.03	0.50	33
29	48.13	0.04	0.005	2.07	0.51	34
30	47.24	0.04	0.005	2.11	0.52	35
31	46.39	0.04	0.005	2.14	0.52	35
32	45.58	0.04	0.005	2.17	0.54	36
33	44.81	0.04	0.005	2.20	0.54	36
34	44.06	0.04	0.005	2.23	0.56	37
35	43.35	0.04	0.005	2.27	0.56	37
36	42.67	0.04	0.005	2.31	0.57	38
37	42.01	0.04	0.005	2.35	0.58	39
38	41.38	0.04	0.005	2.38	0.58	39
39	40.77	0.04	0.006	2.41	0.60	40
40	40.19	0.04	0.006	2.44	0.60	40
41	39.63	0.04	0.006	2.47	0.62	41
42	39.08	0.04	0.006	2.50	0.62	41
43	38.56	0.04	0.006	2.53	0.63	42
44	38.05	0.03	0.006	2.55	0.63	42
45	37.56	0.03	0.006	2.57	0.63	42
46	37.09	0.03	0.006	2.59	0.64	43
47	36.63	0.03	0.006	2.61	0.64	43
48	36.18	0.03	0.006	2.63	0.64	43
49	35.75	0.03	0.006	2.65	0.66	44
50	35.33	0.03	0.006	2.67	0.66	44
51	34.93	0.03	0.006	2.69	0.66	2
52	34.53	0.03	0.006	2.71	0.68	4
53	34.15	0.03	0.006	2.73	0.68	6
54	33.77	0.03	0.006	2.75	0.68	8
55	33.41	0.03	0.006	2.77	0.69	10
56	33.06	0.03	0.006	2.79	0.69	11
57	32.72	0.03	0.006	2.81	0.69	13
58	32.38	0.03	0.006	2.83	0.70	14
59	32.06	0.03	0.006	2.85	0.70	15
60	31.74	0.03	0.007	2.87	0.70	17
61	31.43	0.03	0.007	2.89	0.72	18
62	31.13	0.03	0.007	2.91	0.72	19
63	30.83	0.03	0.007	2.93	0.72	20
64	30.54	0.03	0.007	2.95	0.74	21
65	30.26	0.03	0.007	2.97	0.74	22
66	29.99	0.03	0.007	2.99	0.74	23
67	29.72	0.03	0.007	3.01	0.75	24
68	29.46	0.03	0.007	3.03	0.75	25
69	29.20	0.03	0.007	3.05	0.75	26
70	28.95	0.03	0.007	3.07	0.76	27
71	28.70	0.03	0.007	3.09	0.76	28
72	28.46	0.03	0.007	3.11	0.76	29
73	28.23	0.03	0.007	3.13	0.78	29
74	28.00	0.03	0.007	3.15	0.78	30
75	27.77	0.03	0.007	3.17	0.78	31
76	27.55	0.03	0.007	3.19	0.80	32
77	27.34	0.03	0.007	3.21	0.80	33
78	27.12	0.02	0.007	3.22	0.80	33
79	26.91	0.02	0.007	3.23	0.80	34
80	26.71	0.02	0.007	3.24	0.80	35
81	26.51	0.02	0.007	3.25	0.81	35
82	26.31	0.02	0.007	3.26	0.81	36
83	26.12	0.02	0.007	3.27	0.81	36
84	25.93	0.02	0.007	3.28	0.81	37
85	25.75	0.02	0.007	3.29	0.81	37
86	25.56	0.02	0.008	3.30	0.81	38
87	25.38	0.02	0.008	3.31	0.82	39
88	25.21	0.02	0.008	3.32	0.82	39
89	25.03	0.02	0.008	3.33	0.82	40
90	24.86	0.02	0.008	3.34	0.82	40
91	24.70	0.02	0.008	3.35	0.82	41
92	24.53	0.02	0.008	3.36	0.82	41
93	24.37	0.02	0.008	3.37	0.84	42
94	24.21	0.02	0.008	3.38	0.84	42
95	24.05	0.02	0.008	3.39	0.84	42
96	23.90	0.02	0.008	3.40	0.84	43
97	23.75	0.02	0.008	3.41	0.84	43
98	23.60	0.02	0.008	3.42	0.84	43
99	23.45	0.02	0.008	3.43	0.84	44
100	23.31	0.02	0.008	3.44	0.86	44

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Job No.	
Sheet no.	3
Date	18/01/18
Project	Land to the south of Bentham Road, Ingleton
Title	Soakaway data - 100 hours
By	
Checked	
Reviewed	

Duration	Rain mm/hr	Inflow m³	Outflow m³	Storage m³	Depth m	%full	Duration	Rain mm/hr	Inflow m³	Outflow m³	Storage m³	Depth m	% full
1	31.7	1.75	0.000	1.75	0.44	29	51	2.5	0.14	0.156	0.98	0.44	16
2	20.8	1.15	0.396	2.50	0.62	41	52	2.5	0.14	0.152	0.97	0.62	16
3	16.1	0.89	0.463	2.93	0.72	48	53	2.5	0.14	0.152	0.96	0.72	16
4	13.4	0.74	0.499	3.17	0.78	52	54	2.5	0.13	0.148	0.94	0.78	15
5	11.6	0.64	0.518	3.29	0.81	54	55	2.4	0.13	0.146	0.92	0.81	15
6	10.3	0.57	0.526	3.33	0.82	55	56	2.4	0.13	0.142	0.91	0.82	15
7	9.3	0.51	0.522	3.32	0.82	55	57	2.4	0.13	0.142	0.90	0.82	15
8	8.6	0.47	0.516	3.27	0.81	54	58	2.3	0.13	0.140	0.89	0.81	15
9	7.9	0.44	0.505	3.20	0.80	53	59	2.3	0.13	0.138	0.88	0.80	14
10	7.4	0.41	0.492	3.12	0.76	51	60	2.3	0.13	0.138	0.87	0.76	14
11	7.0	0.38	0.476	3.02	0.75	50	61	2.3	0.12	0.134	0.86	0.75	14
12	6.6	0.36	0.461	2.92	0.72	48	62	2.2	0.12	0.134	0.85	0.72	14
13	6.3	0.34	0.444	2.82	0.69	46	63	2.2	0.12	0.132	0.84	0.69	14
14	6.0	0.33	0.428	2.72	0.68	45	64	2.2	0.12	0.131	0.83	0.68	14
15	5.7	0.31	0.413	2.62	0.64	43	65	2.2	0.12	0.129	0.82	0.64	14
16	5.5	0.30	0.397	2.52	0.63	42	66	2.1	0.12	0.129	0.81	0.63	13
17	5.2	0.29	0.382	2.43	0.60	40	67	2.1	0.12	0.127	0.80	0.60	13
18	5.1	0.28	0.369	2.34	0.58	39	68	2.1	0.12	0.125	0.80	0.58	13
19	4.9	0.27	0.355	2.26	0.56	37	69	2.1	0.11	0.125	0.79	0.56	13
20	4.7	0.26	0.344	2.18	0.54	36	70	2.1	0.11	0.123	0.78	0.54	13
21	4.6	0.25	0.330	2.10	0.52	35	71	2.0	0.11	0.121	0.77	0.52	13
22	4.4	0.24	0.319	2.02	0.50	33	72	2.0	0.11	0.119	0.76	0.50	13
23	4.3	0.24	0.307	1.95	0.48	32	73	2.0	0.11	0.119	0.75	0.48	12
24	4.2	0.23	0.298	1.88	0.46	31	74	2.0	0.11	0.117	0.74	0.46	12
25	4.1	0.22	0.286	1.81	0.45	30	75	2.0	0.11	0.115	0.74	0.45	12
26	4.0	0.22	0.276	1.75	0.44	29	76	2.0	0.11	0.115	0.74	0.44	12
27	3.9	0.21	0.267	1.69	0.42	28	77	1.9	0.11	0.115	0.74	0.42	12
28	3.8	0.21	0.259	1.64	0.40	27	78	1.9	0.11	0.115	0.74	0.40	12
29	3.7	0.20	0.252	1.59	0.39	26	79	1.9	0.10	0.115	0.73	0.39	12
30	3.6	0.20	0.244	1.55	0.39	26	80	1.9	0.10	0.113	0.72	0.39	12
31	3.5	0.19	0.236	1.50	0.38	25	81	1.9	0.10	0.111	0.71	0.38	12
32	3.5	0.19	0.230	1.46	0.36	24	82	1.9	0.10	0.109	0.70	0.36	12
33	3.4	0.19	0.225	1.42	0.34	23	83	1.8	0.10	0.109	0.69	0.34	11
34	3.3	0.18	0.219	1.38	0.34	23	84	1.8	0.10	0.108	0.68	0.34	11
35	3.3	0.18	0.213	1.35	0.33	22	85	1.8	0.10	0.106	0.67	0.33	11
36	3.2	0.18	0.209	1.32	0.33	22	86	1.8	0.10	0.106	0.66	0.33	11
37	3.1	0.17	0.204	1.29	0.32	21	87	1.8	0.10	0.104	0.66	0.32	11
38	3.1	0.17	0.200	1.26	0.32	21	88	1.8	0.10	0.104	0.66	0.32	11
39	3.0	0.17	0.194	1.24	0.30	20	89	1.8	0.10	0.104	0.66	0.30	11
40	3.0	0.16	0.190	1.21	0.30	20	90	1.8	0.10	0.104	0.66	0.30	11
41	2.9	0.16	0.186	1.18	0.28	19	91	1.7	0.10	0.104	0.66	0.28	11
42	2.9	0.16	0.182	1.16	0.28	19	92	1.7	0.09	0.102	0.65	0.28	11
43	2.8	0.16	0.180	1.14	0.28	19	93	1.7	0.09	0.100	0.64	0.28	11
44	2.8	0.15	0.177	1.11	0.27	18	94	1.7	0.09	0.100	0.63	0.27	10
45	2.8	0.15	0.171	1.09	0.27	18	95	1.7	0.09	0.098	0.62	0.27	10
46	2.7	0.15	0.169	1.07	0.27	18	96	1.7	0.09	0.096	0.61	0.27	10
47	2.7	0.15	0.167	1.05	0.26	17	97	1.7	0.09	0.096	0.60	0.26	10
48	2.6	0.15	0.163	1.04	0.26	17	98	1.7	0.09	0.094	0.60	0.26	10
49	2.6	0.14	0.161	1.02	0.26	17	99	1.6	0.09	0.094	0.60	0.26	10
50	2.6	0.14	0.157	1.00	0.24	16	100	1.6	0.09	0.094	0.60	0.24	10

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MasterDrain
SW 16.05

Job No.			
Sheet no.	4		
Date	18/01/18		
Project	Land to the south of Bentham Road, Ingleton	By	Checked / Reviewed
Title	Hydrology data		

Location hydrological data (FSR):-

Location	= INGLETON (N.YORKS)	Grid reference	= SD6972
M5-60 (mm)	= 18.9	r	= 0.25
Soil index	= 0.50	SAAR (mm/yr)	= 1190
WRAP	= 5	Area = England and Wales	

Soil classification for WRAP type 5
Soils of wet uplands -
i) with peaty or humose surface horizons and impermeable layers at shallow depth;
ii) deep raw peat associated with gentle upland slopes or basin sites;
iii) bare rock cliffs and screes;
iv) shallow, permeable rocky soils on steep slopes.

N.B. The rainfall rates are calculated using the location specific values above in accordance with the Wallingford procedure.

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		Sheet no. 1		
		Date 18/01/18		
Project Land to the south of Bentham Road, Ingleton		By	Checked	Reviewed
Title Permeable Paving Calculations				

Data:-

FSR Hydrology:-

Location = INGLETON (N.YORKS)
M5-60 (mm) = 18.9
Soil index = 0.50
Return period = 100

Grid reference = SD6972
r = 0.25
SAAR (mm/yr) = 1190
WRAP = 5

Soils of wet uplands -
i) with peaty or humose surface horizons and impermeable layers at shallow depth;
ii) deep raw peat associated with gentle upland slopes or basin sites;
iii) bare rock cliffs and screes;
iv) shallow, permeable rocky soils on steep slopes.

Design data:-

Total drained area = 30 m²
Storm duration = 6.00 hrs
Inf. coefficient = 0.0200 m/hr

Perm. pavior area = 30 m²
Climate change factor = 1.40
% Voids = 30.0%

Calculated data:-

Mean rain intensity = 16.7 mm/hr @ 100yrs/6hrs with 1.4 climate change factor

Total rainfall volume = 3.002 m³.

Total runoff volume = 2.852 m³.

Mean discharge rate = 0.167 l/s.

Infiltration volume = 3.600 m³.

Infiltration volume exceeds the total runoff volume.
Minimal storage is required, therefore a minimum construction thickness of 375mm should be used.

Storm profile used = Winter

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		Sheet no.	1
		Date	18/01/18
Project: Land to the south of Bentham Road, Ingleton		By	Checked / Reviewed
Title: 1 in 100 Year (+40%) Attenuation Storage Calculations			

Data:-

Location = INGLETON (N.YORKS)
M5-60 (mm) = 18.9
Soil index = 0.50
Return period = 100
UCWI = 0.0

Grid reference = SD6972
r = 0.25
SAAR (mm/yr) = 1190
WRAP = 5
Climate change = 40%

Soils of wet uplands -
i) with peaty or humose surface horizons and impermeable layers at shallow depth;
ii) deep raw peat associated with gentle upland slopes or basin sites;
iii) bare rock cliffs and screes;
iv) shallow, permeable rocky soils on steep slopes.

Pipeline storage = 0.0 m³
Offline storage = 0.0 m³

Available MH storage = 0.0 m³

Percentage runoff = 100.0% (manual setting)

Imperv. area = 2400 m²
Total area = 2400 m²
Total runoff = 226.9 m³

Pervious area = 0 m²
Equiv area = 2400 m² (Tot. area x % runoff).
Discharge rate = 6.500 l/s

Storage (m³) = 135.1 m³ (Sum of all balance quantities)

Total rainfall depth = 94.5 mm

Calculations :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
0.050	20.0	3.8	0.454	1.170	0.000	0.000
0.100	20.0	3.8	0.454	1.170	0.000	0.000
0.150	21.0	4.0	0.476	1.170	0.000	0.000
0.200	21.0	4.0	0.476	1.170	0.000	0.000
0.250	22.0	4.2	0.499	1.170	0.000	0.000
0.300	23.0	4.3	0.522	1.170	0.000	0.000
0.350	24.0	4.5	0.544	1.170	0.000	0.000
0.400	26.0	4.9	0.590	1.170	0.000	0.000
0.450	27.0	5.1	0.613	1.170	0.000	0.000
0.500	29.0	5.5	0.658	1.170	0.000	0.000
0.550	31.0	5.9	0.703	1.170	0.000	0.000
0.600	32.0	6.0	0.726	1.170	0.000	0.000
0.650	33.0	6.2	0.749	1.170	0.000	0.000
0.700	34.0	6.4	0.771	1.170	0.000	0.000
0.750	36.0	6.8	0.817	1.170	0.000	0.000
0.800	38.0	7.2	0.862	1.170	0.000	0.000
0.850	39.0	7.4	0.885	1.170	0.000	0.000
0.900	40.0	7.6	0.907	1.170	0.000	0.000
0.950	42.0	7.9	0.953	1.170	0.000	0.000
1.000	45.0	8.5	1.021	1.170	0.000	0.000
1.050	49.0	9.3	1.112	1.170	0.000	0.000
1.100	53.0	10.0	1.202	1.170	0.032	0.032
1.150	57.0	10.8	1.293	1.170	0.123	0.156
1.200	62.0	11.7	1.407	1.170	0.237	0.392
1.250	66.0	12.5	1.497	1.170	0.327	0.720
1.300	71.0	13.4	1.611	1.170	0.441	1.160
1.350	77.0	14.6	1.747	1.170	0.577	1.737
1.400	84.0	15.9	1.906	1.170	0.736	2.473
1.450	91.0	17.2	2.065	1.170	0.895	3.368
1.500	98.0	18.5	2.223	1.170	1.053	4.421
1.550	105.0	19.9	2.382	1.170	1.212	5.633
1.600	114.0	21.6	2.586	1.170	1.416	7.050
1.650	125.0	23.6	2.836	1.170	1.666	8.715
1.700	135.0	25.5	3.063	1.170	1.893	10.608
1.750	143.0	27.0	3.244	1.170	2.074	12.683
1.800	154.0	29.1	3.494	1.170	2.324	15.006
1.850	164.0	31.0	3.721	1.170	2.551	17.557
1.900	173.0	32.7	3.925	1.170	2.755	20.312
1.950	183.0	34.6	4.152	1.170	2.982	23.294

Calculations (cont.) :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
2.050	204.0	38.6	4.628	1.170	3.458	29.983
2.100	212.0	40.1	4.810	1.170	3.640	33.623
2.150	219.0	41.4	4.969	1.170	3.799	37.422
2.200	226.0	42.7	5.127	1.170	3.957	41.379
2.250	233.0	44.1	5.286	1.170	4.116	45.495
2.300	239.0	45.2	5.422	1.170	4.252	49.748
2.350	244.0	46.1	5.536	1.170	4.366	54.113
2.400	248.0	46.9	5.626	1.170	4.456	58.570
2.450	249.0	47.1	5.649	1.170	4.479	63.049
2.500	250.0	47.3	5.672	1.170	4.502	67.551
2.550	250.0	47.3	5.672	1.170	4.502	72.053
2.600	249.0	47.1	5.649	1.170	4.479	76.532
2.650	248.0	46.9	5.626	1.170	4.456	80.988
2.700	244.0	46.1	5.536	1.170	4.366	85.354
2.750	239.0	45.2	5.422	1.170	4.252	89.606
2.800	233.0	44.1	5.286	1.170	4.116	93.723
2.850	226.0	42.7	5.127	1.170	3.957	97.680
2.900	219.0	41.4	4.969	1.170	3.799	101.478
2.950	212.0	40.1	4.810	1.170	3.640	105.118
3.000	204.0	38.6	4.628	1.170	3.458	108.576
3.050	194.0	36.7	4.401	1.170	3.231	111.808
3.100	183.0	34.6	4.152	1.170	2.982	114.790
3.150	173.0	32.7	3.925	1.170	2.755	117.544
3.200	164.0	31.0	3.721	1.170	2.551	120.095
3.250	154.0	29.1	3.494	1.170	2.324	122.419
3.300	143.0	27.0	3.244	1.170	2.074	124.493
3.350	135.0	25.5	3.063	1.170	1.893	126.386
3.400	125.0	23.6	2.836	1.170	1.666	128.052
3.450	114.0	21.6	2.586	1.170	1.416	129.468
3.500	105.0	19.9	2.382	1.170	1.212	130.681
3.550	98.0	18.5	2.223	1.170	1.053	131.734
3.600	91.0	17.2	2.065	1.170	0.895	132.629
3.650	84.0	15.9	1.906	1.170	0.736	133.364
3.700	77.0	14.6	1.747	1.170	0.577	133.941
3.750	71.0	13.4	1.611	1.170	0.441	134.382
3.800	66.0	12.5	1.497	1.170	0.327	134.709
3.850	62.0	11.7	1.407	1.170	0.237	134.946
3.900	57.0	10.8	1.293	1.170	0.123	135.069
3.950	53.0	10.0	1.202	1.170	0.032	135.102
4.000	49.0	9.3	1.112	1.170	0.000	135.043
4.050	45.0	8.5	1.021	1.170	0.000	134.894
4.100	42.0	7.9	0.953	1.170	0.000	134.677
4.150	40.0	7.6	0.907	1.170	0.000	134.415
4.200	39.0	7.4	0.885	1.170	0.000	134.129
4.250	38.0	7.2	0.862	1.170	0.000	133.822
4.300	36.0	6.8	0.817	1.170	0.000	133.468
4.350	34.0	6.4	0.771	1.170	0.000	133.070
4.400	33.0	6.2	0.749	1.170	0.000	132.648
4.450	32.0	6.0	0.726	1.170	0.000	132.204
4.500	31.0	5.9	0.703	1.170	0.000	131.738
4.550	29.0	5.5	0.658	1.170	0.000	131.226
4.600	27.0	5.1	0.613	1.170	0.000	130.668
4.650	26.0	4.9	0.590	1.170	0.000	130.088
4.700	24.0	4.5	0.544	1.170	0.000	129.463
4.750	23.0	4.3	0.522	1.170	0.000	128.814
4.800	22.0	4.2	0.499	1.170	0.000	128.143
4.850	21.0	4.0	0.476	1.170	0.000	127.450
4.900	21.0	4.0	0.476	1.170	0.000	126.756
4.950	20.0	3.8	0.454	1.170	0.000	126.040
5.000	20.0	3.8	0.454	1.170	0.000	125.324

Storage volume (m^3) = 135.1 m^3 (Sum of all balance quantities)

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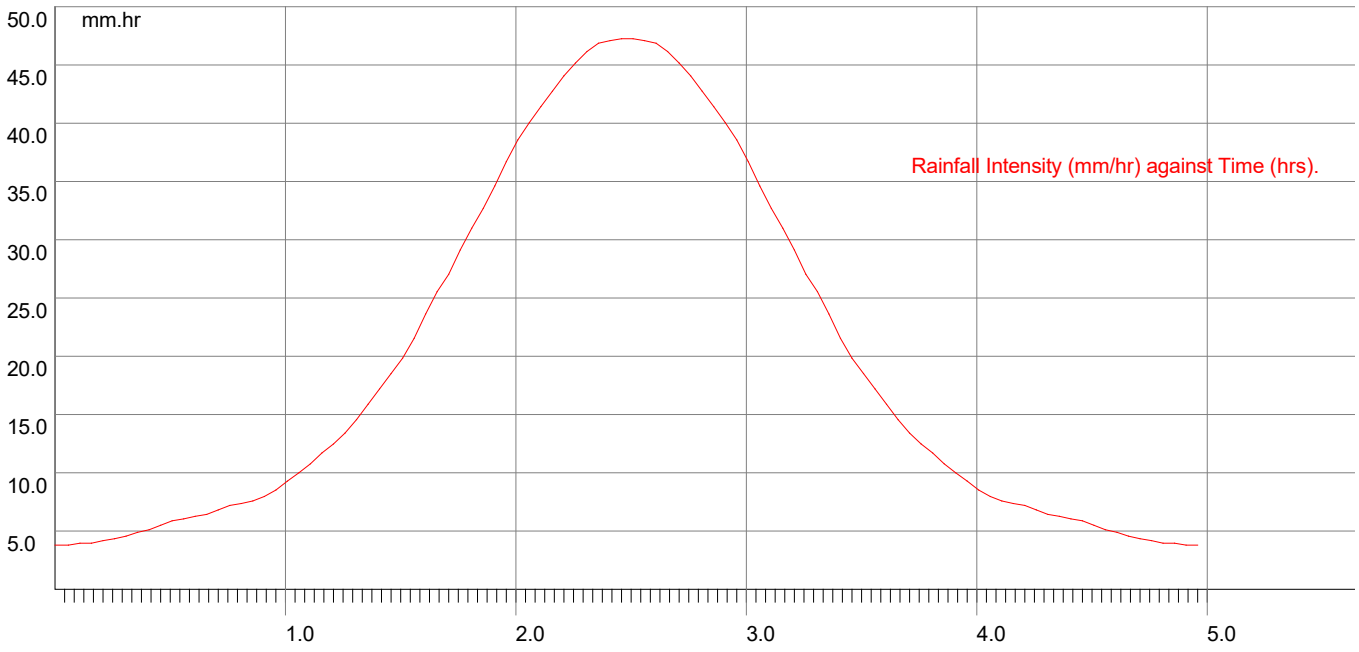
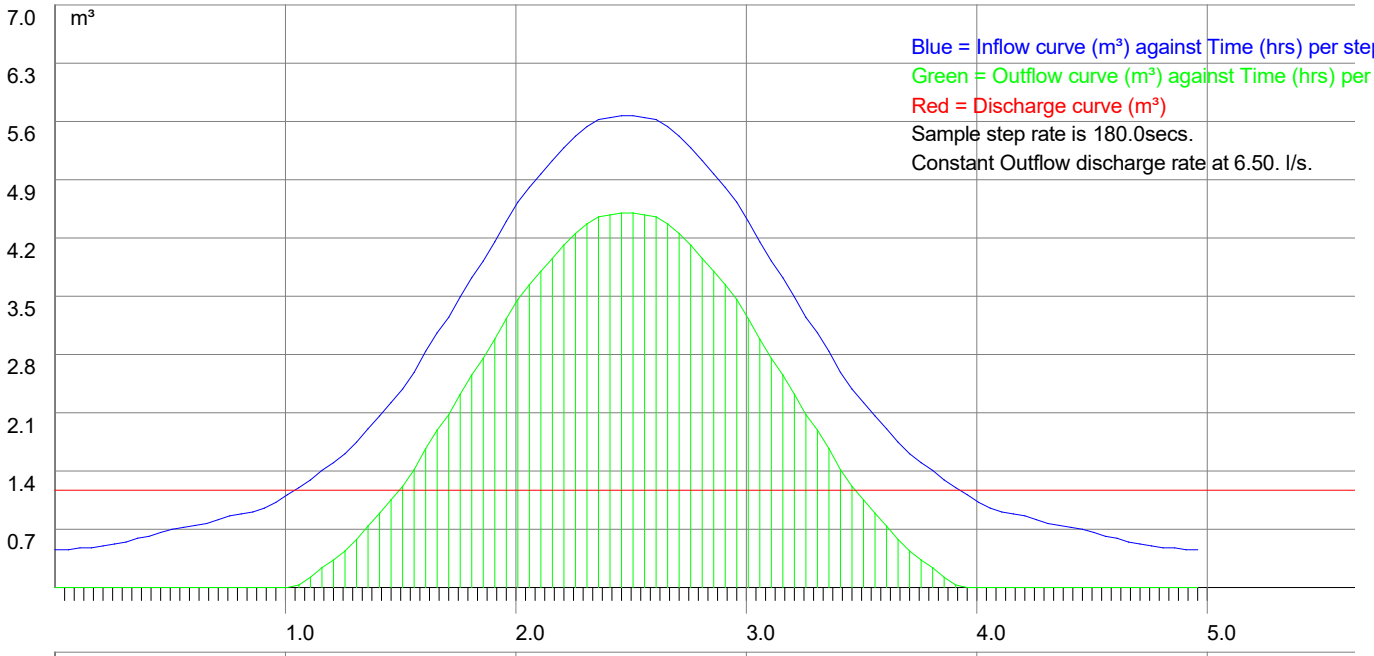
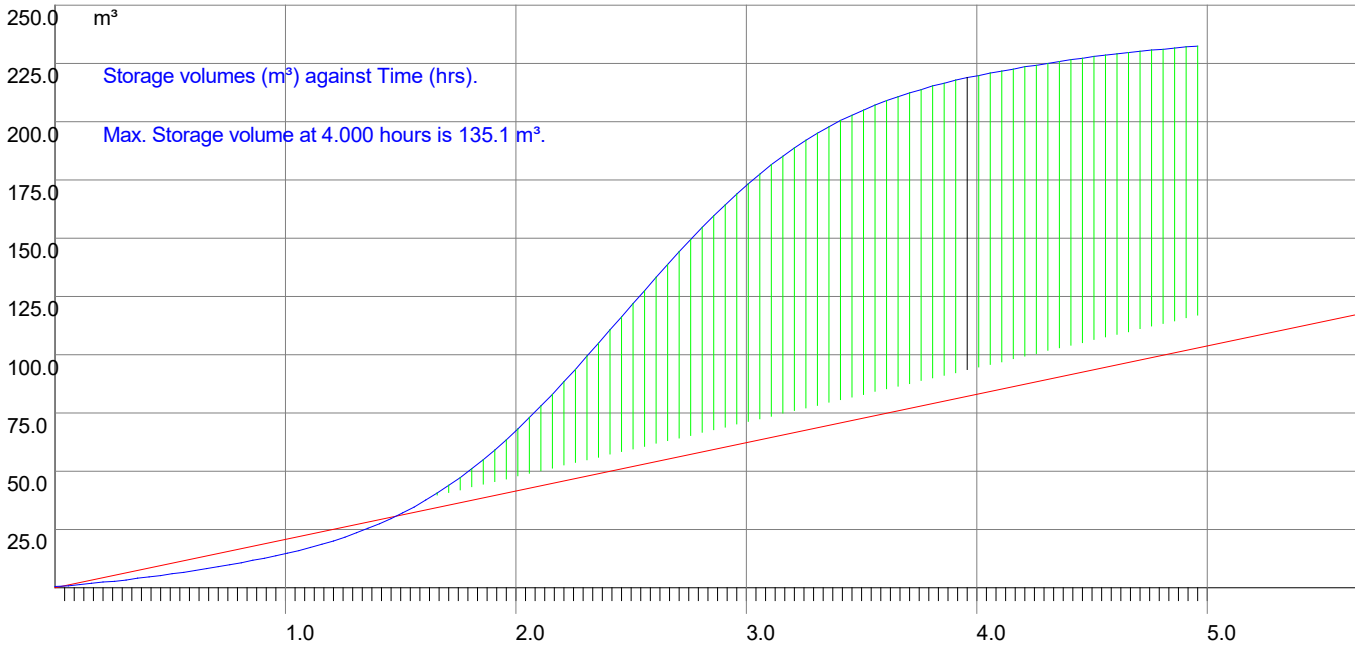
Job No.	
Sheet no.	3
Date	18/01/18
By / Checked / Reviewed	

Project: **Land to the south of Bentham Road, Ingleton**

Title: **1 in 100 Year (+40%) Attenuation Storage Calculations**







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		Sheet no. 4		
		Date 18/01/18		
Project Land to the south of Bentham Road, Ingleton		By	Checked	Reviewed
Title 1 in 100 Year (+40%) Attenuation Storage Calculations				

Maximum storage volumes for varying duration storms.

Storm length (hrs)	Max. Vol (m^3)	Max. Vol time	Mean intens (mm/hr)	Step time. (mins)	Peak found
0.25	61.89	0.25	110.14	0.2	
0.5	84.73	0.50	78.40	0.3	
1	108.17	1.00	53.48	0.6	
2	127.28	2.00	35.07	1.2	
3	133.17	3.00	26.79	1.8	
4	135.02	4.00	22.02	2.4	
5	135.10	5.00	18.91	3.0	Peak found
6	133.76	---	16.68	3.6	
7	131.48	---	14.99	4.2	
8	128.61	---	13.66	4.8	
9	125.32	---	12.58	5.4	
10	121.67	---	11.69	6.0	
12	113.73	---	10.28	7.2	
15	101.02	---	8.78	9.0	
18	87.85	---	7.71	10.8	
20	79.04	---	7.15	12.0	
24	62.09	---	6.27	14.4	
30	38.89	---	5.33	18.0	
36	19.37	---	4.67	21.6	
42	5.17	---	4.17	25.2	
48	0.00	---	3.79	28.8	
54	0.00	---	3.48	32.4	
60	0.00	---	3.22	36.0	
66	0.00	---	3.01	39.6	
72	0.00	---	2.83	43.2	
84	0.00	---	2.53	50.4	
96	0.00	---	2.30	57.6	
120	0.00	---	1.96	72.0	
150	0.00	---	1.68	90.0	
175	0.00	---	1.51	105.0	
200	0.00	---	1.38	120.0	
250	0.00	---	1.18	150.0	
300	0.00	---	1.05	180.0	
375	0.00	---	0.90	225.0	
500	0.00	---	0.75	300.0	
750	0.00	---	0.57	450.0	
1000	0.00	---	0.47	600.0	
1250	0.00	---	0.40	750.0	
1500	0.00	---	0.36	900.0	
1570	0.00	---	0.35	942.0	
2000	0.00	---	0.29	1200.0	
2500	0.00	---	0.25	1500.0	
3000	0.00	---	0.22	1800.0	
3500	0.00	---	0.20	2100.0	
4000	0.00	---	0.18	2400.0	

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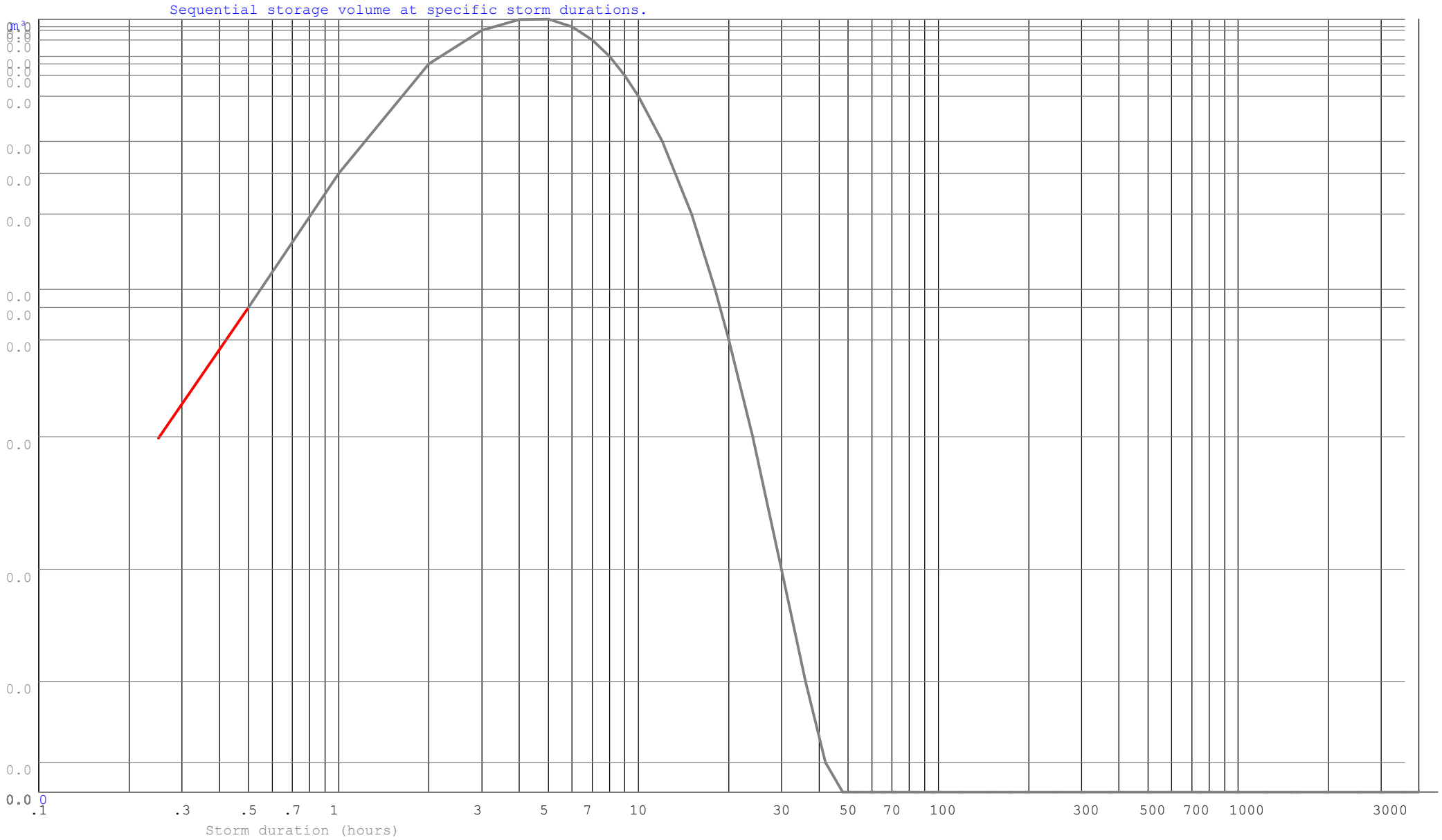
			Sheet no.	5	
			Date	18/01/18	
Project: Land to the south of Bentham Road, Ingleton			By	Checked	Reviewed
Title: 1 in 100 Year (+40%) Attenuation Storage Calculations					



Explanatory notes for Peak Flow Storage

1) This system uses the rainfall intensity/ duration curve calculated using either the Wallingford or FEH method as selected.
2) The balance is calculated from the inflow minus the outflow.
3) The storage volume is the maximum value of the balance curve.
4) This method was described by Davis (1963) - see Butler & Davies, 2nd edition, p294
5) References to 'storm duration' relate only to the hydrograph method (qv).
6) There are always 600 steps in the calculation process, thus a 'run' time of 10 hours will be sampled every minute,

Explanatory notes for Hydrograph Storage

1) The user has the choice of Summer or Winter curves
2) The mean intensity varies with the duration of the storm curve
3) There are always 120 steps in the calculation process, irrespective of storm duration.
4) The balance is calculated from the inflow minus the outflow.
5) The storage volume is the sum of the balance values for each step.
6) Varying durations should be tried to find the maximum storage value - this can be narrowed down very closely.

*Modelling using the flow characteristics of the restrictor is available using Vortex Control modelling function. Please be aware that this function needs the full design data file to function.

Why do the two methods give different results?

The rainfall characteristics for each method are very different.

The Peak flow (using the Intensity/Duration/Frequency curve) does not model the actual rainfall. This curve is joined points which represent the mean intensity of a storm at a given duration i.e. a value of 19.5 mm/hr for a 60 minute storm indicates that over the sixty minute period, the mean intensity was 19.5 mm/hr. The calculation method samples the IDF curve for a given location and frequency (Return Period) and calculates the storage for that rate and duration less the outflow volume. The maximum value is displayed as the 'worst case' storage.

The hydrograph method uses a standard curve for either Winter or Summer storms. Traditionally these are symmetrical about the central peak. UK rainfall does not fit into this convenient curve, so the calculations are dealing with a stylised set of data. The mean intensity for the storm is calculated from the IDF curve and applied to the curve data, calculating the storage for that step less the outflow volume. The final storage volume is the sum of the storage for all the steps.

It can be seen that these two methods are very different, and the user may have the choice of which result to use. This is not an exact science, though is often treated as such by those that do not understand the principles of the calculations.

MasterDrain SW

KRS Environmental Limited. www.krsenvironmental.com	3 Princes Square, Princes Street, Montgomery Powys, SY15 6PZ [redacted]	Job No.	
		Sheet no.	1
		Date	18/01/18
Project: Land to the south of Bentham Road, Ingleton		By	Checked / Reviewed
Title: 1 in 30 Year (+40%) Attenuation Storage Calculations			

Data:-

Location = INGLETON (N.YORKS)
M5-60 (mm) = 18.9
Soil index = 0.50
Return period = 30
UCWI = 0.0

Grid reference = SD6972
r = 0.25
SAAR (mm/yr) = 1190
WRAP = 5
Climate change = 40%

Soils of wet uplands -
i) with peaty or humose surface horizons and impermeable layers at shallow depth;
ii) deep raw peat associated with gentle upland slopes or basin sites;
iii) bare rock cliffs and screes;
iv) shallow, permeable rocky soils on steep slopes.

Pipeline storage = 0.0 m³
Offline storage = 0.0 m³

Available MH storage = 0.0 m³

Percentage runoff = 100.0% (manual setting)

Imperv. area = 2400 m²
Total area = 2400 m²
Total runoff = 163.1 m³

Pervious area = 0 m²
Equiv area = 2400 m² (Tot. area x % runoff).
Discharge rate = 6.500 l/s

Storage (m³) = 91.8 m³ (Sum of all balance quantities)

Total rainfall depth = 67.9 mm

Calculations :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
0.040	20.0	3.4	0.326	0.936	0.000	0.000
0.080	20.0	3.4	0.326	0.936	0.000	0.000
0.120	21.0	3.6	0.342	0.936	0.000	0.000
0.160	21.0	3.6	0.342	0.936	0.000	0.000
0.200	22.0	3.7	0.359	0.936	0.000	0.000
0.240	23.0	3.9	0.375	0.936	0.000	0.000
0.280	24.0	4.1	0.391	0.936	0.000	0.000
0.320	26.0	4.4	0.424	0.936	0.000	0.000
0.360	27.0	4.6	0.440	0.936	0.000	0.000
0.400	29.0	4.9	0.473	0.936	0.000	0.000
0.440	31.0	5.3	0.506	0.936	0.000	0.000
0.480	32.0	5.4	0.522	0.936	0.000	0.000
0.520	33.0	5.6	0.538	0.936	0.000	0.000
0.560	34.0	5.8	0.554	0.936	0.000	0.000
0.600	36.0	6.1	0.587	0.936	0.000	0.000
0.640	38.0	6.5	0.620	0.936	0.000	0.000
0.680	39.0	6.6	0.636	0.936	0.000	0.000
0.720	40.0	6.8	0.652	0.936	0.000	0.000
0.760	42.0	7.1	0.685	0.936	0.000	0.000
0.800	45.0	7.6	0.734	0.936	0.000	0.000
0.840	49.0	8.3	0.799	0.936	0.000	0.000
0.880	53.0	9.0	0.864	0.936	0.000	0.000
0.920	57.0	9.7	0.930	0.936	0.000	0.000
0.960	62.0	10.5	1.011	0.936	0.075	0.075
1.000	66.0	11.2	1.076	0.936	0.140	0.215
1.040	71.0	12.1	1.158	0.936	0.222	0.437
1.080	77.0	13.1	1.256	0.936	0.320	0.757
1.120	84.0	14.3	1.370	0.936	0.434	1.191
1.160	91.0	15.5	1.484	0.936	0.548	1.738
1.200	98.0	16.6	1.598	0.936	0.662	2.401
1.240	105.0	17.8	1.712	0.936	0.776	3.177
1.280	114.0	19.4	1.859	0.936	0.923	4.100
1.320	125.0	21.2	2.038	0.936	1.102	5.202
1.360	135.0	22.9	2.201	0.936	1.265	6.468
1.400	143.0	24.3	2.332	0.936	1.396	7.864
1.440	154.0	26.2	2.511	0.936	1.575	9.439
1.480	164.0	27.9	2.674	0.936	1.738	11.177
1.520	173.0	29.4	2.821	0.936	1.885	13.062
1.560	183.0	31.1	2.984	0.936	2.048	15.110

Calculations (cont.) :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
1.640	204.0	34.7	3.327	0.936	2.391	19.729
1.680	212.0	36.0	3.457	0.936	2.521	22.250
1.720	219.0	37.2	3.571	0.936	2.635	24.885
1.760	226.0	38.4	3.685	0.936	2.749	27.634
1.800	233.0	39.6	3.800	0.936	2.864	30.498
1.840	239.0	40.6	3.897	0.936	2.961	33.459
1.880	244.0	41.4	3.979	0.936	3.043	36.502
1.920	248.0	42.1	4.044	0.936	3.108	39.610
1.960	249.0	42.3	4.060	0.936	3.124	42.735
2.000	250.0	42.5	4.077	0.936	3.141	45.876
2.040	250.0	42.5	4.077	0.936	3.141	49.016
2.080	249.0	42.3	4.060	0.936	3.124	52.141
2.120	248.0	42.1	4.044	0.936	3.108	55.249
2.160	244.0	41.4	3.979	0.936	3.043	58.292
2.200	239.0	40.6	3.897	0.936	2.961	61.253
2.240	233.0	39.6	3.800	0.936	2.864	64.117
2.280	226.0	38.4	3.685	0.936	2.749	66.866
2.320	219.0	37.2	3.571	0.936	2.635	69.501
2.360	212.0	36.0	3.457	0.936	2.521	72.022
2.400	204.0	34.7	3.327	0.936	2.391	74.413
2.440	194.0	33.0	3.164	0.936	2.228	76.641
2.480	183.0	31.1	2.984	0.936	2.048	78.689
2.520	173.0	29.4	2.821	0.936	1.885	80.574
2.560	164.0	27.9	2.674	0.936	1.738	82.312
2.600	154.0	26.2	2.511	0.936	1.575	83.888
2.640	143.0	24.3	2.332	0.936	1.396	85.284
2.680	135.0	22.9	2.201	0.936	1.265	86.549
2.720	125.0	21.2	2.038	0.936	1.102	87.651
2.760	114.0	19.4	1.859	0.936	0.923	88.574
2.800	105.0	17.8	1.712	0.936	0.776	89.351
2.840	98.0	16.6	1.598	0.936	0.662	90.013
2.880	91.0	15.5	1.484	0.936	0.548	90.561
2.920	84.0	14.3	1.370	0.936	0.434	90.994
2.960	77.0	13.1	1.256	0.936	0.320	91.314
3.000	71.0	12.1	1.158	0.936	0.222	91.536
3.040	66.0	11.2	1.076	0.936	0.140	91.676
3.080	62.0	10.5	1.011	0.936	0.075	91.751
3.120	57.0	9.7	0.930	0.936	0.000	91.745
3.160	53.0	9.0	0.864	0.936	0.000	91.673
3.200	49.0	8.3	0.799	0.936	0.000	91.536
3.240	45.0	7.6	0.734	0.936	0.000	91.334
3.280	42.0	7.1	0.685	0.936	0.000	91.083
3.320	40.0	6.8	0.652	0.936	0.000	90.799
3.360	39.0	6.6	0.636	0.936	0.000	90.499
3.400	38.0	6.5	0.620	0.936	0.000	90.183
3.440	36.0	6.1	0.587	0.936	0.000	89.834
3.480	34.0	5.8	0.554	0.936	0.000	89.452
3.520	33.0	5.6	0.538	0.936	0.000	89.054
3.560	32.0	5.4	0.522	0.936	0.000	88.640
3.600	31.0	5.3	0.506	0.936	0.000	88.210
3.640	29.0	4.9	0.473	0.936	0.000	87.746
3.680	27.0	4.6	0.440	0.936	0.000	87.251
3.720	26.0	4.4	0.424	0.936	0.000	86.739
3.760	24.0	4.1	0.391	0.936	0.000	86.194
3.800	23.0	3.9	0.375	0.936	0.000	85.633
3.840	22.0	3.7	0.359	0.936	0.000	85.056
3.880	21.0	3.6	0.342	0.936	0.000	84.462
3.920	21.0	3.6	0.342	0.936	0.000	83.869
3.960	20.0	3.4	0.326	0.936	0.000	83.259
4.000	20.0	3.4	0.326	0.936	0.000	82.649

Storage volume (m^3) = 91.8 m^3 (Sum of all balance quantities)

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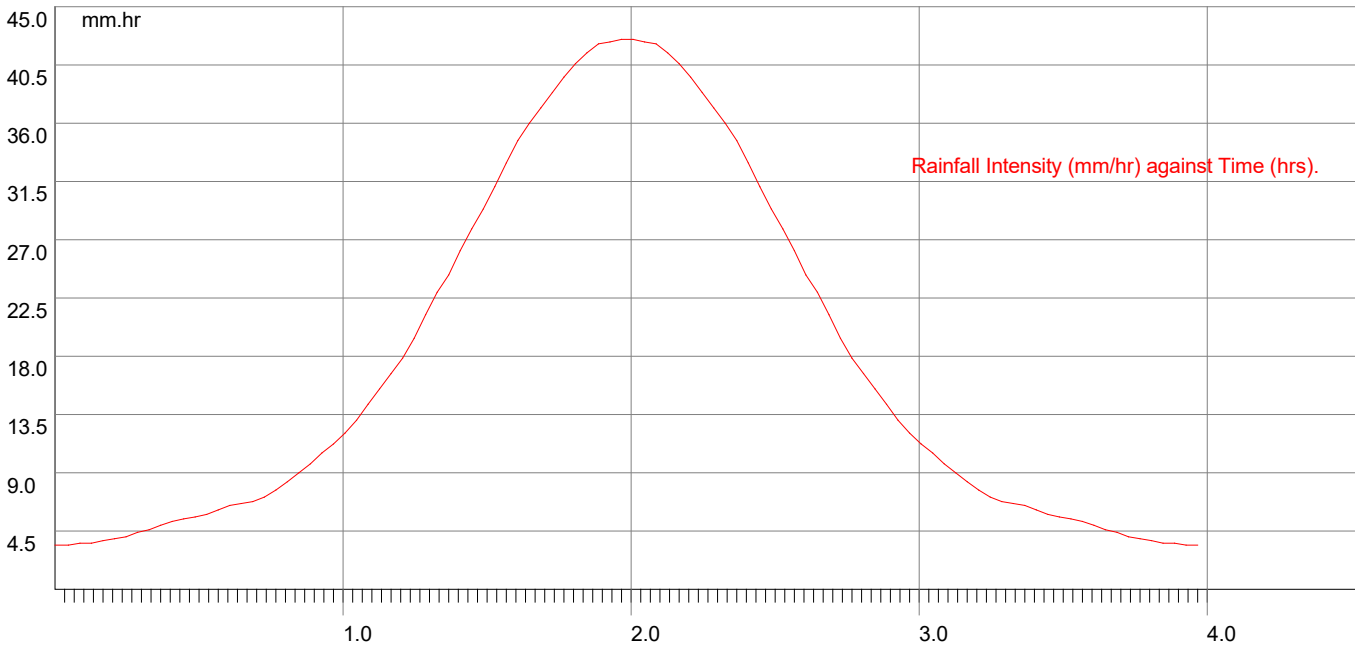
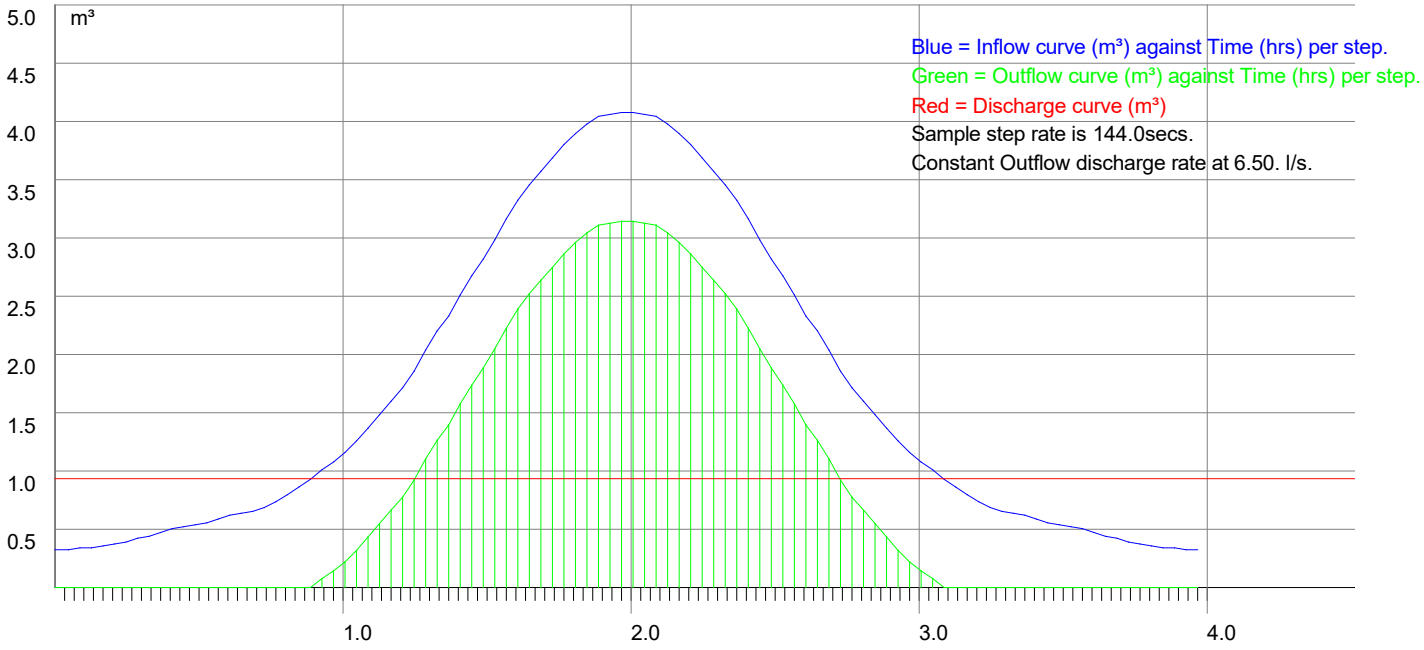
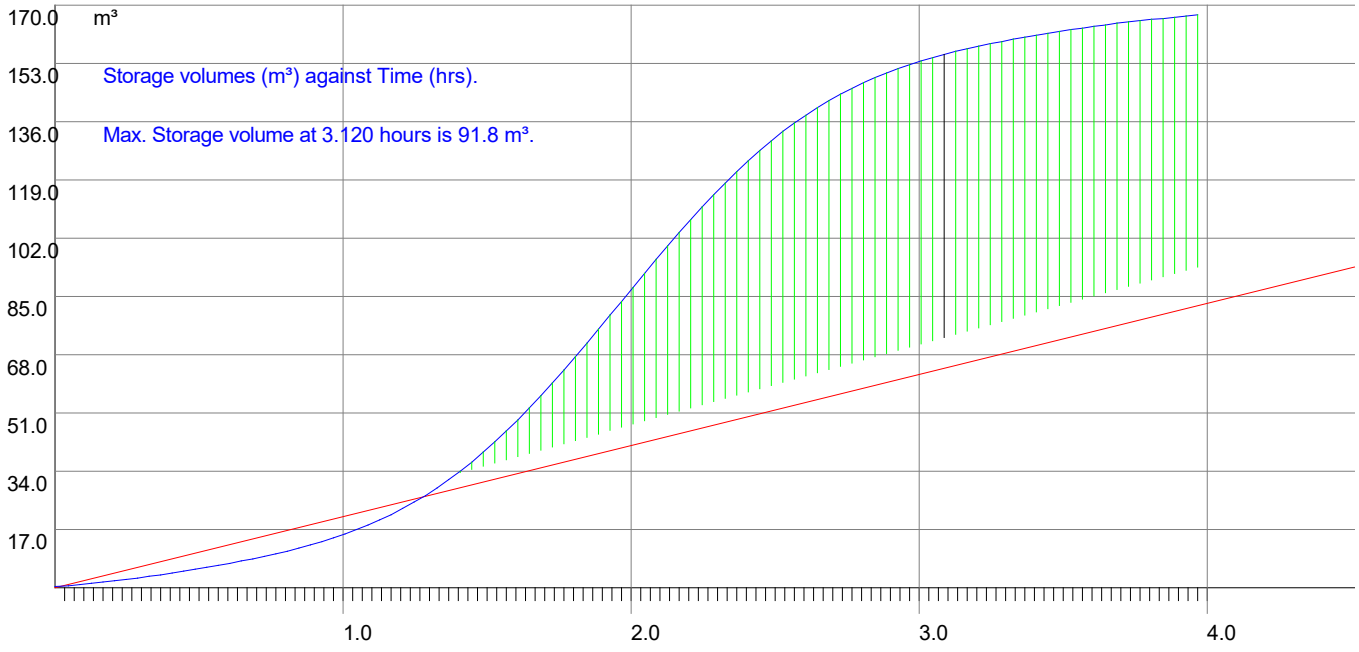
Job No.	
Sheet no.	3
Date	18/01/18
By	
Checked	
Reviewed	

Project: **Land to the south of Bentham Road, Ingleton**

Title: **1 in 30 Year (+40%) Attenuation Storage Calculations**







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		Sheet no. 4		
		Date 18/01/18		
Project Land to the south of Bentham Road, Ingleton		By	Checked	Reviewed
Title 1 in 30 Year (+40%) Attenuation Storage Calculations				

Maximum storage volumes for varying duration storms.

Storm length (hrs)	Max. Vol (m^3)	Max. Vol time	Mean intens (mm/hr)	Step time. (mins)	Peak found
0.25	46.75	0.25	85.53	0.2	
0.5	62.29	0.50	60.16	0.3	
1	77.08	1.00	40.71	0.6	
2	88.37	2.00	26.70	1.2	
3	91.61	3.00	20.54	1.8	
4	91.75	4.00	16.99	2.4	Peak found
5	90.46	---	14.66	3.0	
6	88.29	---	12.98	3.6	
7	85.48	---	11.71	4.2	
8	82.25	---	10.71	4.8	
9	78.77	---	9.89	5.4	
10	75.13	---	9.21	6.0	
12	67.58	---	8.15	7.2	
15	55.74	---	7.00	9.0	
18	44.27	---	6.18	10.8	
20	36.95	---	5.75	12.0	
24	23.59	---	5.07	14.4	
30	7.48	---	4.35	18.0	
36	0.00	---	3.83	21.6	
42	0.00	---	3.44	25.2	
48	0.00	---	3.14	28.8	
54	0.00	---	2.90	32.4	
60	0.00	---	2.69	36.0	
66	0.00	---	2.52	39.6	
72	0.00	---	2.38	43.2	
84	0.00	---	2.14	50.4	
96	0.00	---	1.95	57.6	
120	0.00	---	1.67	72.0	
150	0.00	---	1.44	90.0	
175	0.00	---	1.30	105.0	
200	0.00	---	1.19	120.0	
250	0.00	---	1.03	150.0	
300	0.00	---	0.91	180.0	
375	0.00	---	0.79	225.0	
500	0.00	---	0.65	300.0	
750	0.00	---	0.50	450.0	
1000	0.00	---	0.41	600.0	
1250	0.00	---	0.36	750.0	
1500	0.00	---	0.32	900.0	
1570	0.00	---	0.31	942.0	
2000	0.00	---	0.26	1200.0	
2500	0.00	---	0.22	1500.0	
3000	0.00	---	0.20	1800.0	
3500	0.00	---	0.18	2100.0	
4000	0.00	---	0.16	2400.0	

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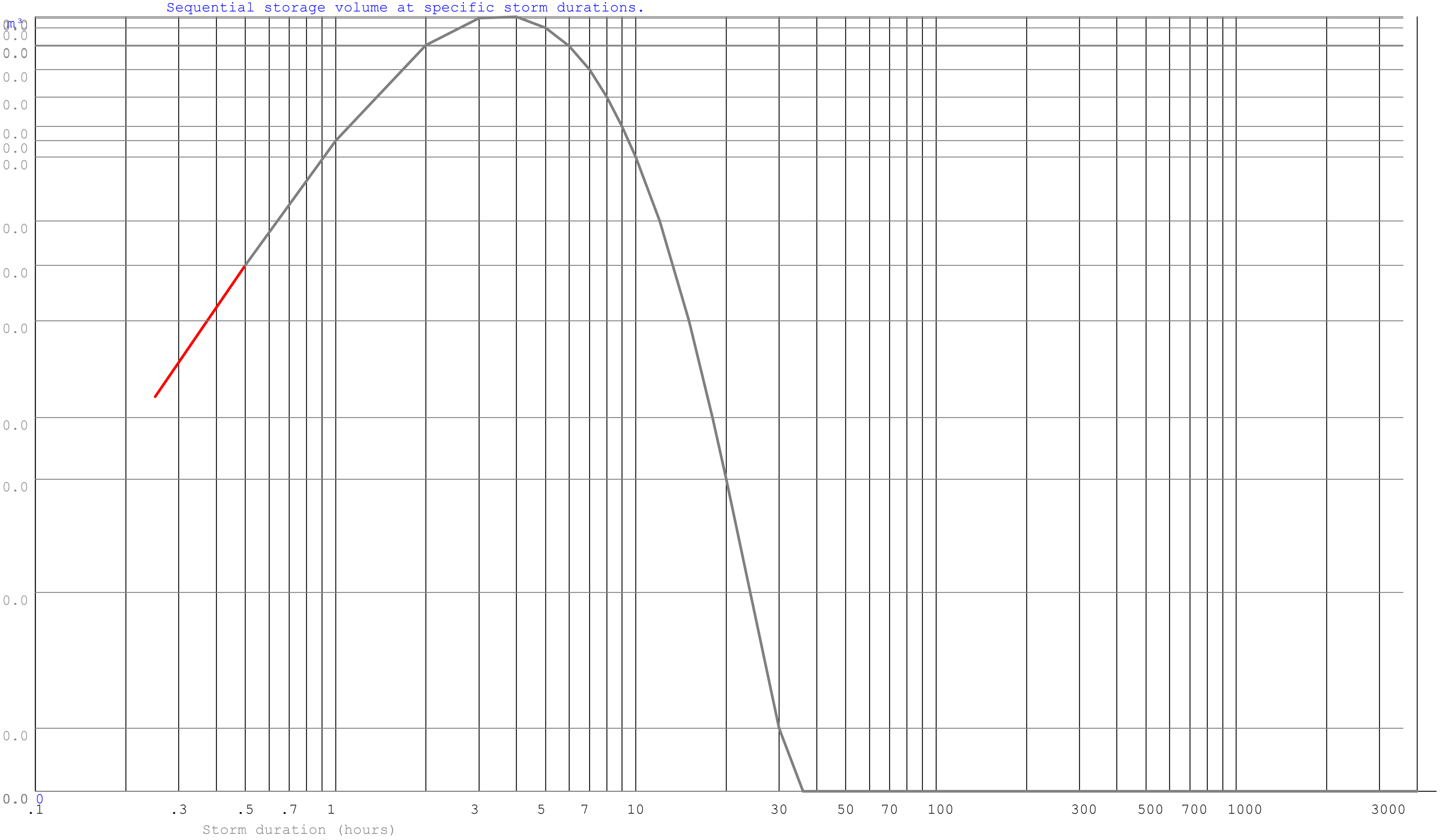
Job No.	
Sheet no.	5
Date	18/01/18

Project Land to the south of Bentham Road, Ingleton

Title 1 in 30 Year (+40%) Attenuation Storage Calculations

By	Checked	Reviewed

Sequential storage volume at specific storm durations.



Explanatory notes for Peak Flow Storage

1) This system uses the rainfall intensity/ duration curve calculated using either the Wallingford or FEH method as selected.
2) The balance is calculated from the inflow minus the outflow.
3) The storage volume is the maximum value of the balance curve.
4) This method was described by Davis (1963) - see Butler & Davies, 2nd edition, p294
5) References to 'storm duration' relate only to the hydrograph method (qv).
6) There are always 600 steps in the calculation process, thus a 'run' time of 10 hours will be sampled every minute,

Explanatory notes for Hydrograph Storage

1) The user has the choice of Summer or Winter curves
2) The mean intensity varies with the duration of the storm curve
3) There are always 120 steps in the calculation process, irrespective of storm duration.
4) The balance is calculated from the inflow minus the outflow.
5) The storage volume is the sum of the balance values for each step.
6) Varying durations should be tried to find the maximum storage value - this can be narrowed down very closely.

*Modelling using the flow characteristics of the restrictor is available using Vortex Control modelling function. Please be aware that this function needs the full design data file to function.

Why do the two methods give different results?

The rainfall characteristics for each method are very different.

The Peak flow (using the Intensity/Duration/Frequency curve) does not model the actual rainfall. This curve is joined points which represent the mean intensity of a storm at a given duration i.e. a value of 19.5 mm/hr for a 60 minute storm indicates that over the sixty minute period, the mean intensity was 19.5 mm/hr. The calculation method samples the IDF curve for a given location and frequency (Return Period) and calculates the storage for that rate and duration less the outflow volume. The maximum value is displayed as the 'worst case' storage.

The hydrograph method uses a standard curve for either Winter or Summer storms. Traditionally these are symmetrical about the central peak. UK rainfall does not fit into this convenient curve, so the calculations are dealing with a stylised set of data. The mean intensity for the storm is calculated from the IDF curve and applied to the curve data, calculating the storage for that step less the outflow volume. The final storage volume is the sum of the storage for all the steps.

It can be seen that these two methods are very different, and the user may have the choice of which result to use. This is not an exact science, though is often treated as such by those that do not understand the principles of the calculations.

MasterDrain SW

KRS Environmental Limited. www.krsenvironmental.com	3 Princes Square, Princes Street, Montgomery Powys, SY15 6PZ [redacted]	Job No.	
		Sheet no.	1
		Date	18/01/18
Project: Land to the south of Bentham Road, Ingleton		By	Checked / Reviewed
Title: 1 in 1 Year (+40%) Attenuation Storage Calculations			

Data:-

Location = INGLETON (N.YORKS)
M5-60 (mm) = 18.9
Soil index = 0.50
Return period = 1
UCWI = 0.0

Grid reference = SD6972
r = 0.25
SAAR (mm/yr) = 1190
WRAP = 5
Climate change = 40%

Soils of wet uplands -
i) with peaty or humose surface horizons and impermeable layers at shallow depth;
ii) deep raw peat associated with gentle upland slopes or basin sites;
iii) bare rock cliffs and screes;
iv) shallow, permeable rocky soils on steep slopes.

Pipeline storage = 0.0 m³
Offline storage = 0.0 m³

Available MH storage = 0.0 m³

Percentage runoff = 100.0% (manual setting)

Imperv. area = 2400 m²
Total area = 2400 m²
Total runoff = 59.3 m³

Pervious area = 0 m²
Equiv area = 2400 m² (Tot. area x % runoff).
Discharge rate = 6.500 l/s

Storage (m³) = 27.0 m³ (Sum of all balance quantities)

Total rainfall depth = 24.7 mm

Calculations :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
0.020	20.0	2.5	0.119	0.468	0.000	0.000
0.040	20.0	2.5	0.119	0.468	0.000	0.000
0.060	21.0	2.6	0.125	0.468	0.000	0.000
0.080	21.0	2.6	0.125	0.468	0.000	0.000
0.100	22.0	2.7	0.131	0.468	0.000	0.000
0.120	23.0	2.8	0.136	0.468	0.000	0.000
0.140	24.0	3.0	0.142	0.468	0.000	0.000
0.160	26.0	3.2	0.154	0.468	0.000	0.000
0.180	27.0	3.3	0.160	0.468	0.000	0.000
0.200	29.0	3.6	0.172	0.468	0.000	0.000
0.220	31.0	3.8	0.184	0.468	0.000	0.000
0.240	32.0	4.0	0.190	0.468	0.000	0.000
0.260	33.0	4.1	0.196	0.468	0.000	0.000
0.280	34.0	4.2	0.202	0.468	0.000	0.000
0.300	36.0	4.4	0.214	0.468	0.000	0.000
0.320	38.0	4.7	0.225	0.468	0.000	0.000
0.340	39.0	4.8	0.231	0.468	0.000	0.000
0.360	40.0	4.9	0.237	0.468	0.000	0.000
0.380	42.0	5.2	0.249	0.468	0.000	0.000
0.400	45.0	5.6	0.267	0.468	0.000	0.000
0.420	49.0	6.1	0.291	0.468	0.000	0.000
0.440	53.0	6.6	0.314	0.468	0.000	0.000
0.460	57.0	7.0	0.338	0.468	0.000	0.000
0.480	62.0	7.7	0.368	0.468	0.000	0.000
0.500	66.0	8.2	0.392	0.468	0.000	0.000
0.520	71.0	8.8	0.421	0.468	0.000	0.000
0.540	77.0	9.5	0.457	0.468	0.000	0.000
0.560	84.0	10.4	0.498	0.468	0.030	0.030
0.580	91.0	11.2	0.540	0.468	0.072	0.102
0.600	98.0	12.1	0.581	0.468	0.113	0.216
0.620	105.0	13.0	0.623	0.468	0.155	0.371
0.640	114.0	14.1	0.676	0.468	0.208	0.579
0.660	125.0	15.5	0.742	0.468	0.274	0.853
0.680	135.0	16.7	0.801	0.468	0.333	1.186
0.700	143.0	17.7	0.848	0.468	0.380	1.566
0.720	154.0	19.0	0.914	0.468	0.446	2.012
0.740	164.0	20.3	0.973	0.468	0.505	2.517
0.760	173.0	21.4	1.026	0.468	0.558	3.076
0.780	183.0	22.6	1.086	0.468	0.618	3.693

Calculations (cont.) :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
0.820	204.0	25.2	1.210	0.468	0.742	5.119
0.840	212.0	26.2	1.258	0.468	0.790	5.909
0.860	219.0	27.1	1.299	0.468	0.831	6.740
0.880	226.0	27.9	1.341	0.468	0.873	7.613
0.900	233.0	28.8	1.382	0.468	0.914	8.527
0.920	239.0	29.5	1.418	0.468	0.950	9.478
0.940	244.0	30.2	1.448	0.468	0.980	10.457
0.960	248.0	30.7	1.471	0.468	1.003	11.461
0.980	249.0	30.8	1.477	0.468	1.009	12.470
1.000	250.0	30.9	1.483	0.468	1.015	13.485
1.020	250.0	30.9	1.483	0.468	1.015	14.501
1.040	249.0	30.8	1.477	0.468	1.009	15.510
1.060	248.0	30.7	1.471	0.468	1.003	16.514
1.080	244.0	30.2	1.448	0.468	0.980	17.493
1.100	239.0	29.5	1.418	0.468	0.950	18.443
1.120	233.0	28.8	1.382	0.468	0.914	19.358
1.140	226.0	27.9	1.341	0.468	0.873	20.231
1.160	219.0	27.1	1.299	0.468	0.831	21.062
1.180	212.0	26.2	1.258	0.468	0.790	21.852
1.200	204.0	25.2	1.210	0.468	0.742	22.594
1.220	194.0	24.0	1.151	0.468	0.683	23.278
1.240	183.0	22.6	1.086	0.468	0.618	23.895
1.260	173.0	21.4	1.026	0.468	0.558	24.454
1.280	164.0	20.3	0.973	0.468	0.505	24.959
1.300	154.0	19.0	0.914	0.468	0.446	25.405
1.320	143.0	17.7	0.848	0.468	0.380	25.785
1.340	135.0	16.7	0.801	0.468	0.333	26.118
1.360	125.0	15.5	0.742	0.468	0.274	26.392
1.380	114.0	14.1	0.676	0.468	0.208	26.600
1.400	105.0	13.0	0.623	0.468	0.155	26.755
1.420	98.0	12.1	0.581	0.468	0.113	26.869
1.440	91.0	11.2	0.540	0.468	0.072	26.941
1.460	84.0	10.4	0.498	0.468	0.030	26.971
1.480	77.0	9.5	0.457	0.468	0.000	26.960
1.500	71.0	8.8	0.421	0.468	0.000	26.913
1.520	66.0	8.2	0.392	0.468	0.000	26.837
1.540	62.0	7.7	0.368	0.468	0.000	26.736
1.560	57.0	7.0	0.338	0.468	0.000	26.607
1.580	53.0	6.6	0.314	0.468	0.000	26.453
1.600	49.0	6.1	0.291	0.468	0.000	26.276
1.620	45.0	5.6	0.267	0.468	0.000	26.075
1.640	42.0	5.2	0.249	0.468	0.000	25.856
1.660	40.0	4.9	0.237	0.468	0.000	25.625
1.680	39.0	4.8	0.231	0.468	0.000	25.389
1.700	38.0	4.7	0.225	0.468	0.000	25.146
1.720	36.0	4.4	0.214	0.468	0.000	24.892
1.740	34.0	4.2	0.202	0.468	0.000	24.626
1.760	33.0	4.1	0.196	0.468	0.000	24.353
1.780	32.0	4.0	0.190	0.468	0.000	24.075
1.800	31.0	3.8	0.184	0.468	0.000	23.791
1.820	29.0	3.6	0.172	0.468	0.000	23.495
1.840	27.0	3.3	0.160	0.468	0.000	23.187
1.860	26.0	3.2	0.154	0.468	0.000	22.874
1.880	24.0	3.0	0.142	0.468	0.000	22.548
1.900	23.0	2.8	0.136	0.468	0.000	22.217
1.920	22.0	2.7	0.131	0.468	0.000	21.879
1.940	21.0	2.6	0.125	0.468	0.000	21.536
1.960	21.0	2.6	0.125	0.468	0.000	21.192
1.980	20.0	2.5	0.119	0.468	0.000	20.843
2.000	20.0	2.5	0.119	0.468	0.000	20.494

Storage volume (m^3) = 27.0 m^3 (Sum of all balance quantities)

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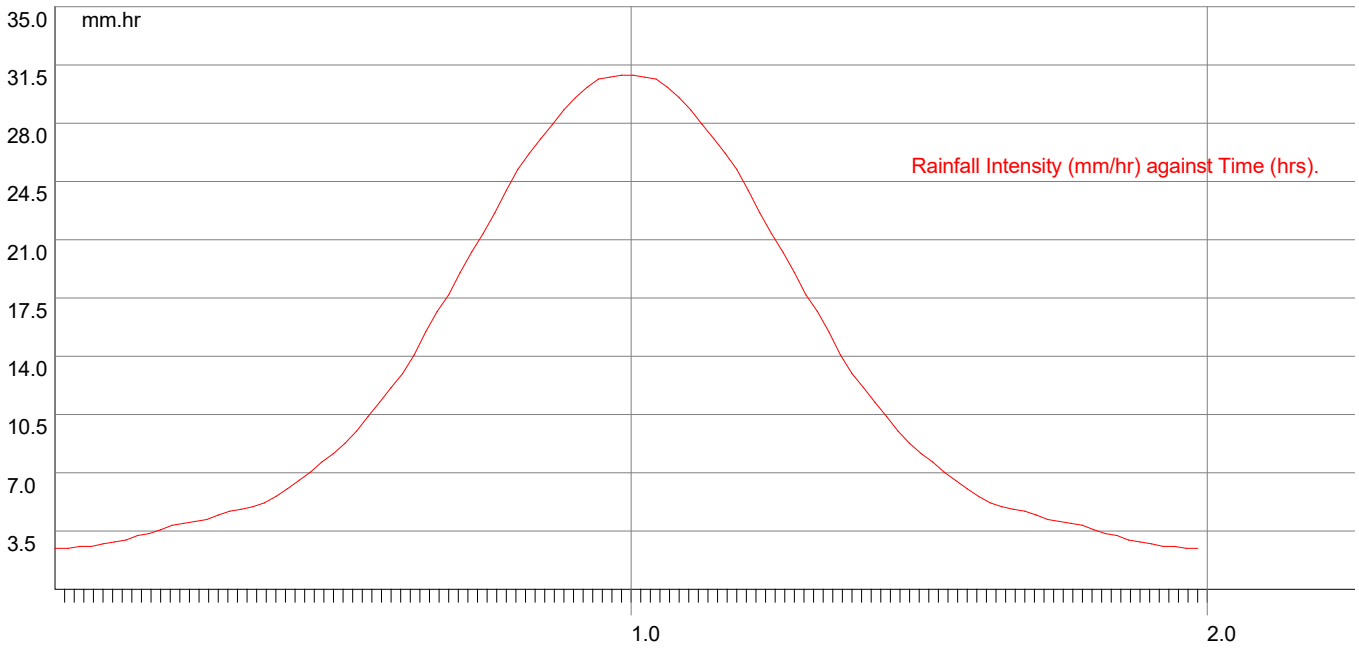
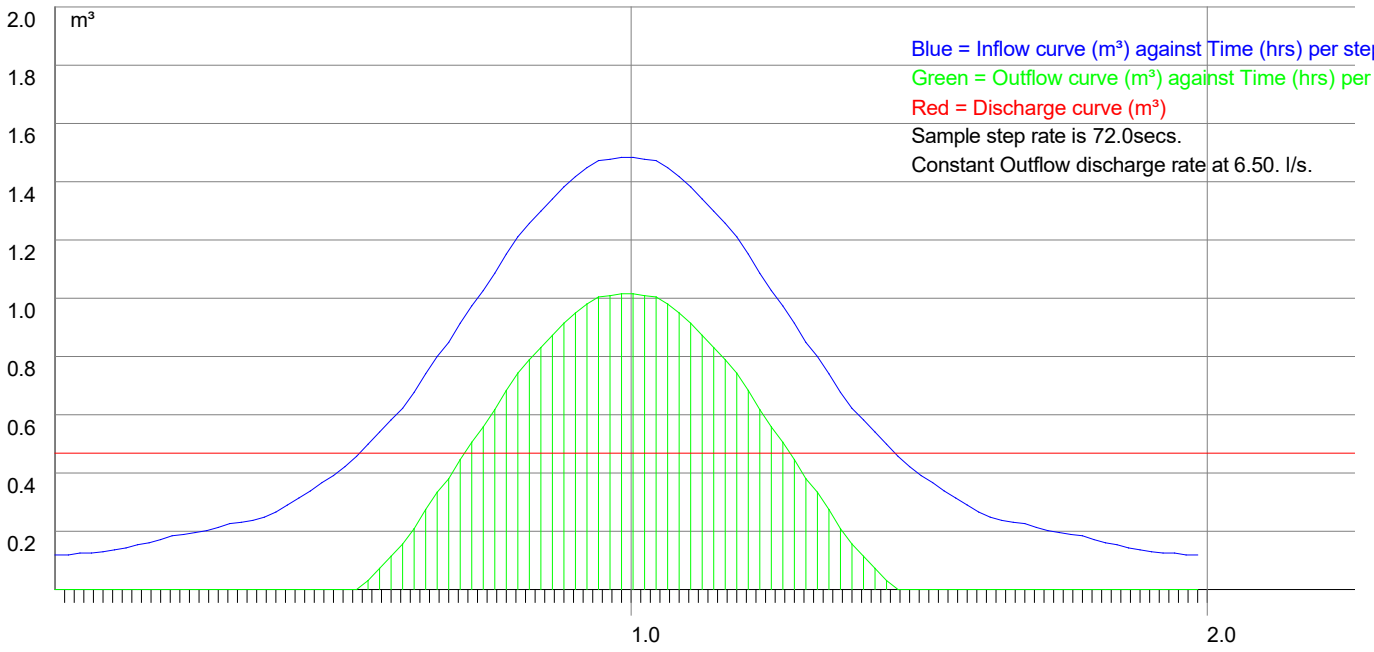
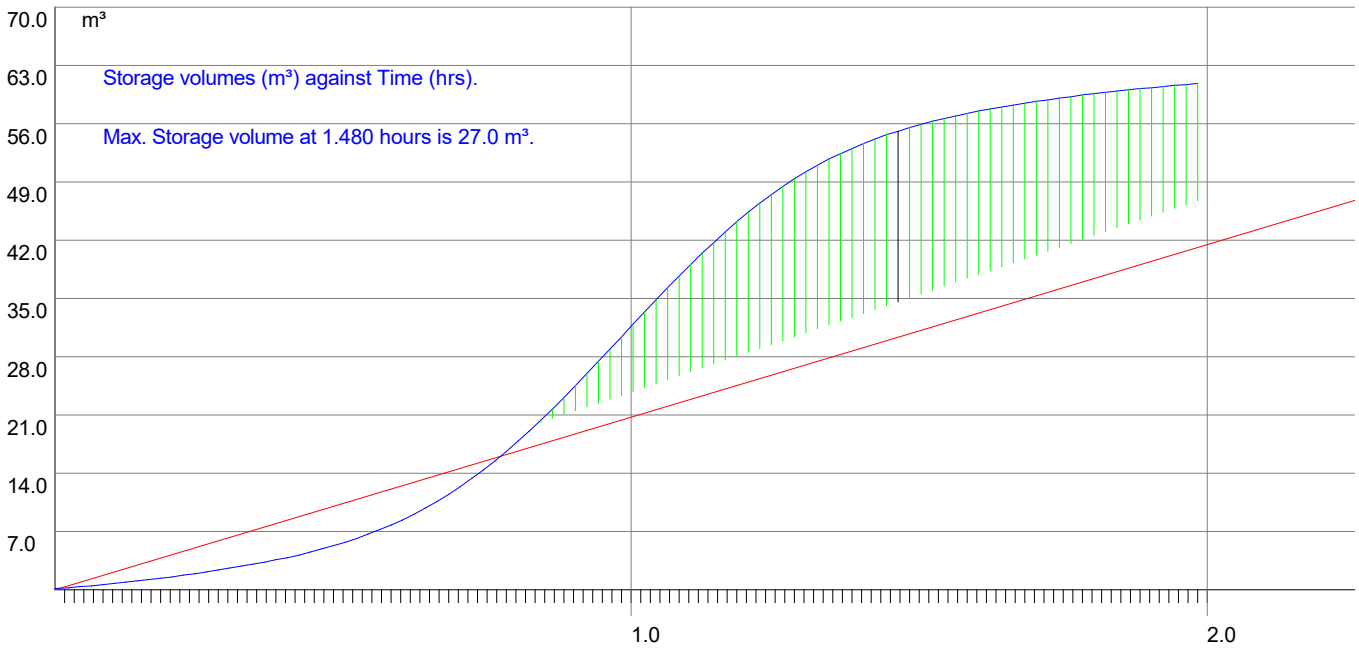
Reviewed	

Project Land to the south of Bentham Road, Ingleton

Title 1 in 1 Year (+40%) Attenuation Storage Calculations







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		Sheet no. 4		
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Project: Land to the south of Bentham Road, Ingleton		By	Checked	Reviewed
Title: 1 in 1 Year (+40%) Attenuation Storage Calculations				

Maximum storage volumes for varying duration storms.

Storm length (hrs)	Max. Vol (m^3)	Max. Vol time	Mean intens (mm/hr)	Step time. (mins)	Peak found
0.25	19.96	0.25	41.87	0.2	
0.5	24.11	0.50	28.47	0.3	
1	26.87	1.00	18.83	0.6	
2	26.97	2.00	12.36	1.2	Peak found
3	25.17	---	9.70	1.8	
4	22.65	---	8.16	2.4	
5	19.69	---	7.14	3.0	
6	16.69	---	6.40	3.6	
7	13.71	---	5.83	4.2	
8	10.88	---	5.38	4.8	
9	8.21	---	5.01	5.4	
10	5.77	---	4.71	6.0	
12	1.86	---	4.22	7.2	
15	0.00	---	3.69	9.0	
18	0.00	---	3.31	10.8	
20	0.00	---	3.11	12.0	
24	0.00	---	2.79	14.4	
30	0.00	---	2.44	18.0	
36	0.00	---	2.20	21.6	
42	0.00	---	2.00	25.2	
48	0.00	---	1.85	28.8	
54	0.00	---	1.73	32.4	
60	0.00	---	1.62	36.0	
66	0.00	---	1.53	39.6	
72	0.00	---	1.45	43.2	
84	0.00	---	1.33	50.4	
96	0.00	---	1.22	57.6	
120	0.00	---	1.07	72.0	
150	0.00	---	0.94	90.0	
175	0.00	---	0.85	105.0	
200	0.00	---	0.78	120.0	
250	0.00	---	0.68	150.0	
300	0.00	---	0.61	180.0	
375	0.00	---	0.53	225.0	
500	0.00	---	0.44	300.0	
750	0.00	---	0.34	450.0	
1000	0.00	---	0.29	600.0	
1250	0.00	---	0.25	750.0	
1500	0.00	---	0.22	900.0	
1570	0.00	---	0.22	942.0	
2000	0.00	---	0.19	1200.0	
2500	0.00	---	0.16	1500.0	
3000	0.00	---	0.15	1800.0	
3500	0.00	---	0.13	2100.0	
4000	0.00	---	0.12	2400.0	

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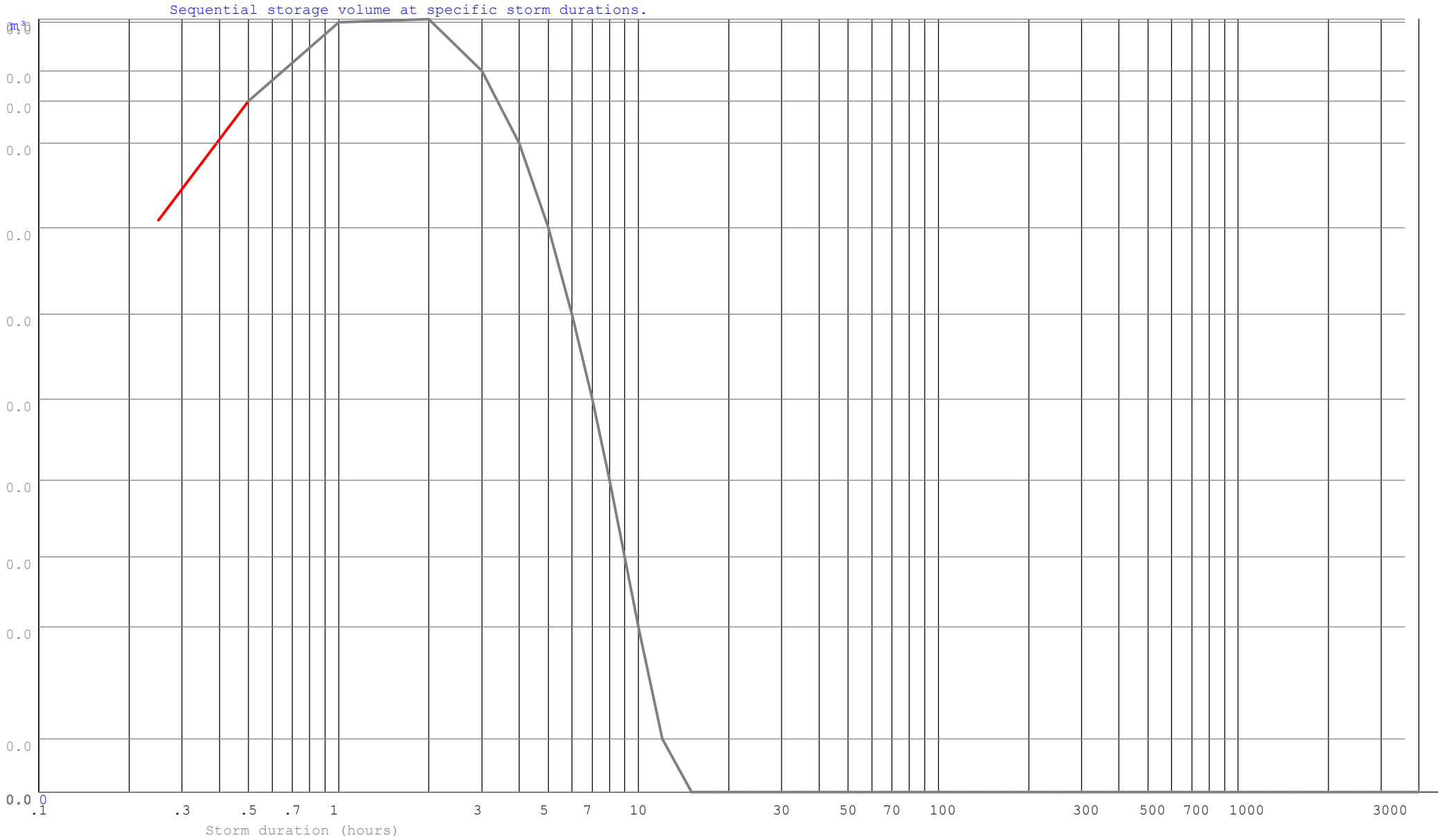
Job No.	
Sheet no.	5
Date	18/01/18

Project	By	Checked	Reviewed
Land to the south of Bentham Road, Ingleton			

Title: **1 in 1 Year (+40%) Attenuation Storage Calculations**



Explanatory notes for Peak Flow Storage

1) This system uses the rainfall intensity/ duration curve calculated using either the Wallingford or FEH method as selected.
2) The balance is calculated from the inflow minus the outflow.
3) The storage volume is the maximum value of the balance curve.
4) This method was described by Davis (1963) - see Butler & Davies, 2nd edition, p294
5) References to 'storm duration' relate only to the hydrograph method (qv).
6) There are always 600 steps in the calculation process, thus a 'run' time of 10 hours will be sampled every minute,

Explanatory notes for Hydrograph Storage

1) The user has the choice of Summer or Winter curves
2) The mean intensity varies with the duration of the storm curve
3) There are always 120 steps in the calculation process, irrespective of storm duration.
4) The balance is calculated from the inflow minus the outflow.
5) The storage volume is the sum of the balance values for each step.
6) Varying durations should be tried to find the maximum storage value - this can be narrowed down very closely.

*Modelling using the flow characteristics of the restrictor is available using Vortex Control modelling function. Please be aware that this function needs the full design data file to function.

Why do the two methods give different results?

The rainfall characteristics for each method are very different.

The Peak flow (using the Intensity/Duration/Frequency curve) does not model the actual rainfall. This curve is joined points which represent the mean intensity of a storm at a given duration i.e. a value of 19.5 mm/hr for a 60 minute storm indicates that over the sixty minute period, the mean intensity was 19.5 mm/hr. The calculation method samples the IDF curve for a given location and frequency (Return Period) and calculates the storage for that rate and duration less the outflow volume. The maximum value is displayed as the 'worst case' storage.

The hydrograph method uses a standard curve for either Winter or Summer storms. Traditionally these are symmetrical about the central peak. UK rainfall does not fit into this convenient curve, so the calculations are dealing with a stylised set of data. The mean intensity for the storm is calculated from the IDF curve and applied to the curve data, calculating the storage for that step less the outflow volume. The final storage volume is the sum of the storage for all the steps.

It can be seen that these two methods are very different, and the user may have the choice of which result to use. This is not an exact science, though is often treated as such by those that do not understand the principles of the calculations.

KRS Environmental Ltd

Mob: [redacted]

Tel: [redacted]

Email: [redacted]

Web: www.krsenvironmental.com