

Proposed Residential Development Netherley Drive, Marsden

Flood Risk Assessment

July 2018

Alfa Homes

Report

This report consists of a Flood Risk Assessment and Drainage Strategy, produced to support the proposed residential development of the site located at Netherley Drive, Marsden. It has been produced by FORTEM Civil Engineering Consultants Ltd for Alfa Homes.

Revision History

Rev Ref	Date	Amendments	By	Chk'd
1	11.07.2018	First Issue	PB	AC
2	13.07.2018	Appendix B Updated	PB	AC

Contract

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Executive Summary

Site Description	The proposed development is located off Netherley Drive, Marsden near Huddersfield, is 0.52ha in size and currently consists of agricultural grassland. The site is steeply sloping with gradients of 1:10 from west to east and 1:16 from south to north. There is a culverted watercourse located within the southern boundary of the proposed development and a foul water sewer located in Netherley Drive.
Proposed Development	It is proposed for Alfa Homes to construct 5No residential dwellings on the site, with associated infrastructure.
Flood Risk	The site is located in Flood Zone 1 with other sources of flood risk low. The flood risk from groundwater is however medium and is to be mitigated by the construction of the development drainage system and a western boundary land drain. Finished floor levels to be set minimum 150mm above external levels to mitigate any risk from blockage and exceedance events. Within the detailed drainage design blockage/exceedance events should be considered ensuring the proposed development and surrounding areas are not put at risk from overland flows.
Drainage	It is proposed for the development to discharge surface water runoff to the existing 225mm culverted watercourse within Netherley Drive. Due to site topography, it is necessary to pump the flows from the development at a restricted rate of 6l/s, with a requirement of 60m³ of attenuation. In order to mitigate additional flood risk from the pumping station, emergency surface storage is to be provided to the north-east of the development. The foul water flows from the development will discharge to the existing 225mm diameter Foul sewer located in Netherley Drive. Due to topography it is necessary to pump the development foul water flows to the sewer connection.

Contents

1.	Introduction	5
1.1	Report Background	5
1.2	Site Description	5
1.3	Proposed Development	6
1.4	Consultation	6
2.	Sources of Flood Risk	7
2.1	Summary	7
2.2	Groundwater	7
2.3	Mitigation	7
3.	Development Drainage	8
3.1	Existing Site Drainage	8
3.2	Development Surface Water Drainage	8
3.3	Development Foul Water Drainage	9
4.	Conclusion	10
4.1	Flood Risk	10
4.2	Drainage	10

Appendix A	Existing Site
	Location Plan
	Drawing S13705-T - Topographical Survey
	Yorkshire Water Sewer Records
	Drawing 1003-001 – Existing Drainage
	FORTEM Site Visit Photo Record 27.06.2017
	IH124 Calculations
Appendix B	Proposed Development
	Drawing P18515302 - Proposed Site Layout
	Drawing 1003-003 – Proposed Drainage Strategy
	Drawing 1003-004A – Exceedance Flow Routing
	Attenuation Calculations
Appendix C	Flood Risk Mapping
	EA Map Risk from Rivers or Sea
	EA Map Risk from Surface Water
	EA Map Risk from Reservoir
Appendix D	FORTEM
	FORTEM Consultants Ltd T&Cs

1. Introduction

1.1. Report Background

- 1.1.1. This report has been produced to support the detailed application by Alfa Homes for the proposed residential development off Netherley Drive, Marsden.
- 1.1.2. This report has been produced in accordance with the National Planning Policy Framework (NPPF) and guidance documents produced by Kirklees Council.
- 1.1.3. The study consists of data collection, consultation and review with regulatory bodies and third parties in relation to flood risk and drainage. FORTEM cannot guarantee the reliability of third party information and/or changes in consultee conclusions/responses.

1.2. Site Description

- 1.2.1. The site is located off Netherley Drive, Marsden, OS grid reference SE 04451 10723, see Appendix A for Location Plan. Details of the site are tabled below:

Site Area		0.52ha (development), 0.86ha (total land ownership)
Topography		The site is steeply sloping falling from a high point located on the south-west corner 244.67m AOD (high point) to the north-east corner 231.41m AOD (low point). The western part of site falls eastern 1:10 typ, with the Southern to Northern 1:16 typ, see Appendix A for topographical survey.
Land Use		The proposed development site is currently agricultural grassland.
Boundaries	North:	Open farmland.
	South:	Netherley Drive.
	East:	An electrical substation is located on the southern part, allotments located centrally and dwellings on the northern part.
	West:	A small number of existing dwellings on the southern part of the boundary with open farmland in the northern part.
Watercourses		There is a culverted watercourse located adjacent to the southern boundary which runs into Netherley Drive. Possibly becoming an open unnamed watercourse to the east of the site and discharging to the aqueduct, located 210m to the east of the proposed development.
Public Sewers		Yorkshire Water records confirm foul and surface water sewers within the frontage and rear of the dwellings to the east of proposed development. Located within Netherley Drive is a 150mm diameter foul sewer, upsizing to 225mm and connecting to the combined sewer located in Mount Road. See Appendix A for Yorkshire Water Records.
Other Drainage		There are no confirmed existing connections to the culverted watercourse within the development boundary, however anecdotal information suggests the southern part of the site has field drainage connections.
Ground		BGS records confirm the natural strata of the area consists of CLAYS overlaying MUDSTONE and SHALE.

- 1.2.2. FORTEM undertook a site walkover on 27.06.2017, see Appendix A for a photographic record of the visit.

1.3. Proposed Development

- 1.3.1. The detailed application is for the construction of 5No residential dwellings complete with associated infrastructure. The site layout has been provided by JRP Associates, P18515302, see Appendix B.

1.4. Consultation

- 1.4.1. Consultation with the relevant consultees has been undertaken, see summary below:

Consultee	Response Summary
Kirklees Council	A meeting was held with Kirklees Council Flood Risk Management Team in April 2018. In the meeting it was confirmed: • The site is in Flood Zone 1; • The site is considered wet/boggy and there is evidence of emergence through existing retaining walls to the east; • There is a 225mm diameter watercourse located to south of development in Netherley Drive, to which the development could discharge; • KCC preference is for developments not to pump surface water on the grounds of flood risk.
Yorkshire Water	A meeting was held with Yorkshire Water Planning team in November 2017. They confirmed that their records did not indicate any incidents of historic sewer flooding that would affect the proposed development. They confirmed their acceptance of foul water discharge from the proposed development to the foul water sewer in Netherley Drive and that there is no capacity within their surface water or combined networks to accept surface water discharge from the development. The possibility of requisitioning foul and/or surface water sewers to the existing combined sewer network to the east was reviewed. Yorkshire Water confirmed that this would not be feasible on the grounds of sewer capacity, topography/existing retaining, sewer easements and impact on existing residents.

2. Sources of Flood Risk

2.1. Summary

- 2.1.1. Below is a summary of the sources of flood risk and the potential risk associated to the proposed development:

Source	Risk Level	Notes
Fluvial	low	Site is within Flood Zone 1, see Appendix C for EA flood mapping.
Tidal	low	Site is within Flood Zone 1, see Appendix C for EA flood mapping.
Surface Water/Pluvial	low	No risk of flooding indicated on EA flood mapping.
Groundwater	Medium (low by mitigation)	Both Kirklees Council and local residents have highlighted the wet/boggy nature of the site, including evidence of emergence through low lying retaining walls. See mitigation below in Section 2.2.
Sewers	low	Based upon the searches undertaken and meeting with Yorkshire Water, no historic incidents have been recorded either within the proposed development or within the vicinity.
Other Man-Made Sources	low	The site is not in an area at risk from a major failure of a reservoir and there are known artificial sources of flood risk.

Copies of the Environment Agency flood maps are included in Appendix C.

2.2. Groundwater

- 2.2.1. The local topography of steeply sloping ground, combined with the natural strata of Clays overlaying Mudstone (low permeability), is likely to be a key contributor to the existing water migration highlighted by Kirklees Council. However to ensure this is not being contributed to by natural springs, supplementary investigation will be undertaken as part of the Phase 2 detailed site investigation, post planning. This will include additional excavation work in the south-west corner (high point), where there is plant evidence of standing water.
- 2.2.2. Within the development footprint the existing water migration will be addressed by the development of the site and a positive drainage system. This will be supplemented by the inclusion of a western boundary land drain. The inclusion of these works will significantly improve the existing arrangement and mitigate any groundwater flood risk of the proposed development.

2.3. Mitigation

- 2.3.1. In addition to the specific flood risk mitigation measures above, it is recommended the following standard development measures are incorporated into the scheme:
- 2.3.2. Finished floor levels to be set minimum 150mm above external levels to mitigate any risk from blockage and exceedance events.
- 2.3.3. Within the detailed drainage design blockage/exceedance events should be considered ensuring the proposed development and surrounding areas are not put at risk from overland flows.
- 2.3.4. Development surface water drainage scheme to be designed such that there is no external flooding for the 1 in 30 year event and all flows retained on site for up to the 1 in 100 year plus climate change event.

3. Development Drainage

3.1. Existing Site Drainage

- 3.1.1. As covered in section 1.2 Yorkshire Water records confirm foul and surface water networks to the east and south of the proposed development. Based upon the historic use and records, we are not aware of any connection from the site. A 150mm diameter culverted watercourse is recorded within the site and connects to a 225mm diameter culvert in Netherley Road, see Appendix A, Existing Drainage. Whilst to date not intrusive drainage investigation has been undertaken, it is considered that the 150mm culvert extension into the development site, is part of the wider field drainage network.
- 3.1.2. The existing greenfield run-off for the site has been assessed using IH124, with a QBAR for 50ha of 621.20/s, reducing to 6l/s for the 0.52ha development site, see Appendix A for calculations.

3.2. Development Surface Water Drainage

- 3.2.1. The potential surface water outfall/discharge options have been considered and summarised below:

Outfall/Discharge Option (Ranked in order of Preference)	✓/✗	Notes
1. Infiltration	✗	Infiltration drainage is not considered appropriate for use as part of the development due to: - Natural strata (Clays, Mudstone, Shale (low permeability)); - Steep site topography (migration/propagation).
2. Discharge to Watercourse	✓	Discharge to existing 150/225 culverted watercourse in Netherley Drive.
3. Discharge to Public Surface Water Sewer.	✗	Yorkshire Water has confirmed there is insufficient capacity of the local surface water sewer network. These networks then connect to the combined system, see below.
4. Discharge to Public Combined Sewer.	✗	Yorkshire Water has confirmed there is insufficient capacity of the local combined sewer networks. Enquires have been made regarding the requisition of a sewer to the existing combined network to the east of the development, however it was confirmed this is not viable on the following ground: - sewer capacity; - topography/existing retaining; - sewer easements; - impact on existing residents.

- 3.2.2. Based upon the findings of the review above, it is proposed to discharge the surface water from the proposed development to the existing culverted watercourse within Netherley Drive adjacent to the southern boundary. In accordance with the greenfield runoff calculation, it is proposed to restrict the discharge from the development to 6l/s (greenfield runoff).
- 3.2.3. The proposed development surface water drainage is to be designed such that there is no external flooding for the 1 in 30 year event and all flows retained on site for up to the 1 in 100 year plus climate change event.

- 3.2.4. Based upon a discharge rate of 6l/s, the attenuation required for the development is 60m³ (1 in 100 + 30% c/c event), with the water attenuated in underground cellular storage and discharge by pumping to the existing culverted watercourse, see Appendix B for attenuation calculations and drawing 1003-001.
- 3.2.5. It is necessary to pump the surface water flows due the existing natural topography, however by doing so there is a potential flood risk in the event of pump failure. This has been considered as part of the exceedance and blockage assessment, see Appendix B, Exceedance Flow Routing. In order to mitigate catastrophic failure of the system, it is proposed to construct a lagoon to the north of the proposed development. This will provide sufficient storage for two sequential storms (680m³ min) and will include draw down pipework (Stage 1), to allow tanker extraction and/or discharge back into the drainage system (see item 3.2.6 for maintenance). In the event of total failure (Stage 2), any runoff from this area will overland flow to the west and between two buildings, preventing the flooding of existing dwellings.
- 3.2.6. It is proposed to maintain the foul and surface water drainage networks as private and incorporate the systems in to a structured monitoring and management agreement. The agreement will be with a pump operation and maintenance specialist. The scope of drainage management will include annual maintenance, telemetry on both pumping stations and 24hr call out (including tankering).

3.3. Development Foul Water Drainage

- 3.3.1. It is proposed to discharge the foul water flows from the development by pumping to the existing 150mm diameter foul sewer located in Netherley Drive.
- 3.3.2. The foul water system will be managed under the same arrangement as the surface water system, see 3.2.6.

4. Conclusion

4.1. Flood Risk

- 4.1.1. The proposed development is located in Flood Zone 1 with other sources of flood risk being low. Groundwater flood risk is however considered Medium.
- 4.1.2. Groundwater flood risk is to be mitigated by the construction of a new foul and surface water drainage system to national standards to serve the development. In addition a new western boundary land drain will be constructed.
- 4.1.3. The following mitigation measures are recommended:
 - Finished floor levels to be set minimum 150mm above external levels to mitigate any risk from blockage and exceedance events.
 - Within the detailed drainage design blockage/exceedance events should be considered ensuring the proposed development and surrounding areas are not put at risk from overland flows.

4.2. Drainage

- 4.2.1. It is proposed for the development to discharge surface water runoff to the existing 225mm culverted watercourse within Netherley Drive. Due to site topography, it is necessary to pump the flows from the development at a restricted rate of 6l/s.
- 4.2.2. Surface water drainage is to be designed such that there is no external flooding for the 1 in 30 year event and all flows retained on site for up to the 1 in 100 year plus climate change event.
- 4.2.3. In order to mitigate additional flood risk from the pumping station, emergency surface storage is to be provided to the north-east of the development.
- 4.2.4. The foul water flows from the development will discharge via a pumping station to the existing 150mm diameter foul water sewer in Netherley Drive.

Appendix A Existing Site

Location Plan

Drawing S13705-T Sheet 1 - Topographical Survey

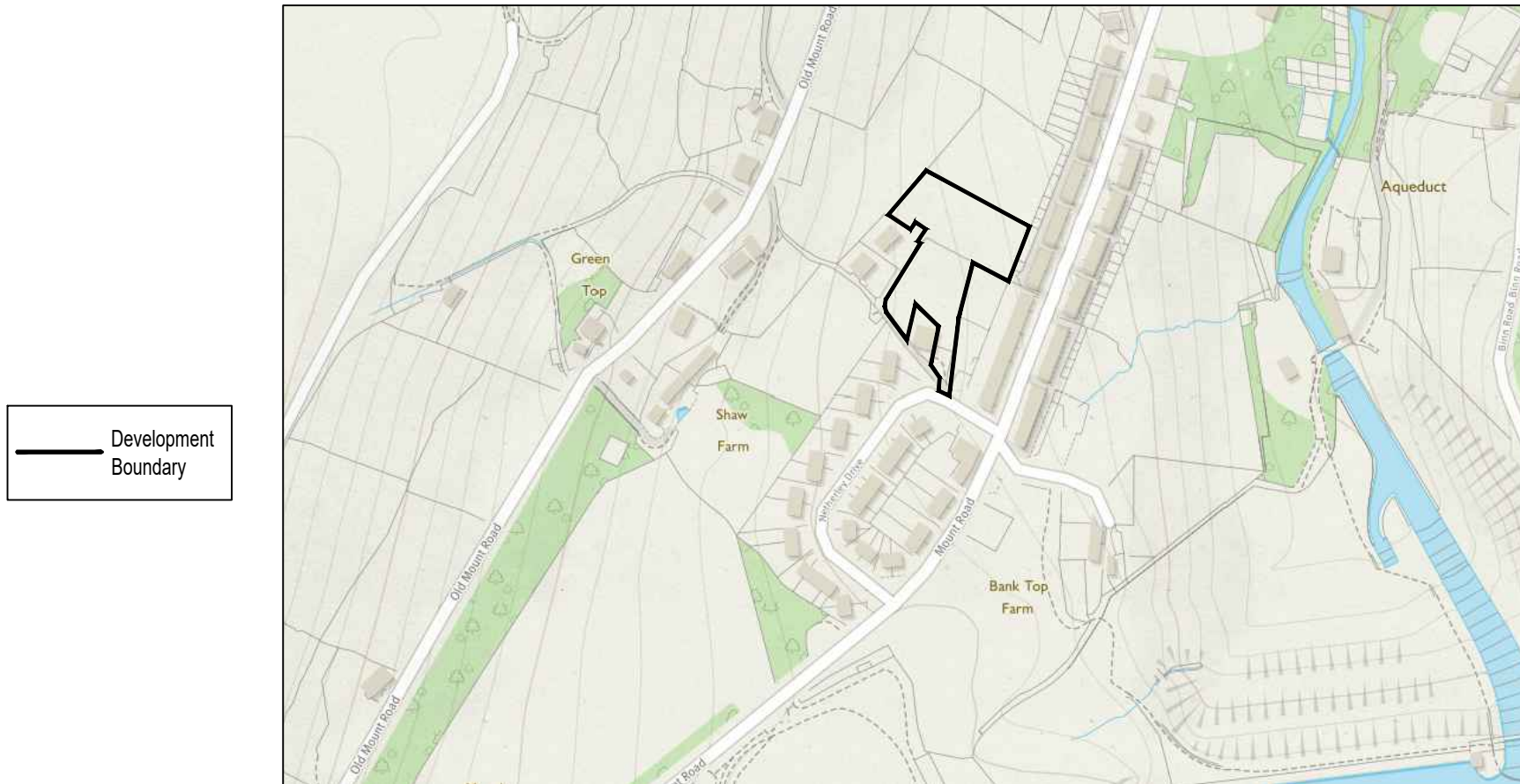
Drawing S13705-T Sheet 2 - Topographical Survey

Yorkshire Water Sewer Records

Drawing 1003-001 – Existing Drainage

FORTEM Site Visit Photo Record 27.06.2017

IH124 Calculations



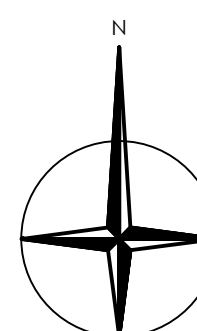
NETHERLEY DRIVE, MARSDEN DEVELOPMENT LOCATION PLAN

EXTRACT TAKEN 03.07.2018 : NTS

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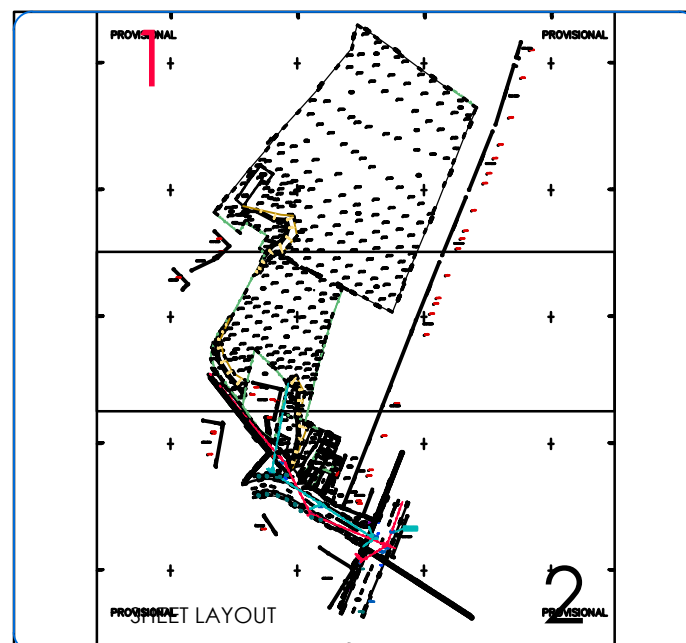


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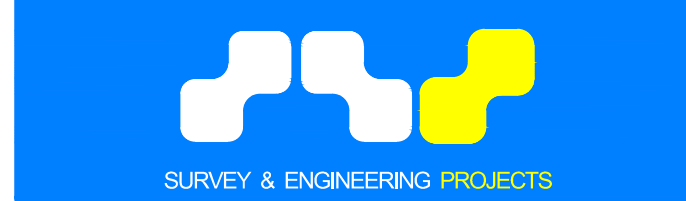
NOTES:
All levels are to O.D. (British Datum). Distances are to nearest 1mm.
Survey plotted on a plane local grid, orientated to National Grid.

REV	DATE	DESCRIPTION	BY	CHECKED
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2	17/01/20	Issue for tender	JB	JB
3	17/01/20	Issue for tender	JB	JB
4	17/01/20	Issue for tender	JB	JB
5	17/01/20	Issue for tender	JB	JB



SCALE BAR
0 2m 4m 8m 12m 16m

REV	DATE	DESCRIPTION
1	17/01/20	Issue for tender
2	17/01/20	Issue for tender
3	17/01/20	Issue for tender
4	17/01/20	Issue for tender
5	17/01/20	Issue for tender



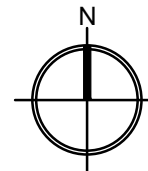
Client:
4 Front Limited

Project title:
Topographical Survey of Land at:
Netherley Drive
Morden
Huddersfield
West Yorkshire
HD7 6HL

Surveyed 1 Bryning	Drawn R Webb	Checked 1 Bryning
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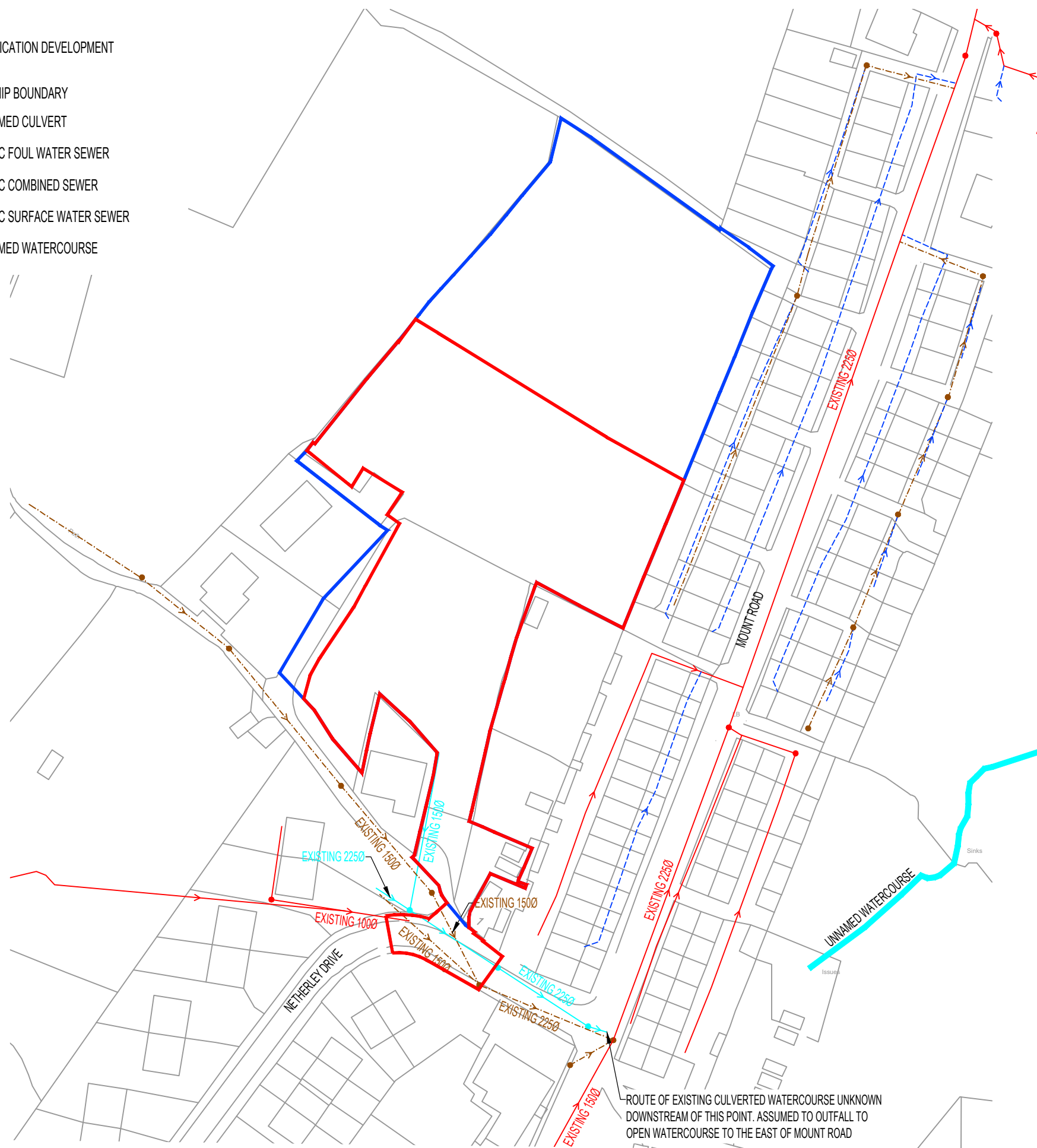


afemove Apart of YorkshireWater	404125 : 410601		Map Name : SE0410NW		Title		Partial Key		This plan is furnished as a general guide only and no warranty as to its correctness is given or implied. This plan must not be relied upon in the event of excavations or other works made in the vicinity of public sewers. No house or property connections are shown.	
	 YorkshireWater		Yorkshire Water, PO Box 500, Halifax Road, Bradford BD6 2LZ Contact Name : S Edon Contact Tel :		Notes (Ody) COPYRIGHT STATEMENTS: Reproduced by permission of Ordnance Survey on behalf of HMSO © Crown copyright and database 2014. All rights reserved Ordnance Survey Licence number 100022432		Foul Sewer = F Combined Sewer = C Surface Water Sewer = SW Trade Sewer = TD Partially Separate = PS			
							Date Req : 15/02/2017, 12:18:21		Date Gen : 15/02/2017, 12:18:28	
							Source : Sewer Network Enquiry			



KEY:

-  PLANNING APPLICATION DEVELOPMENT BOUNDARY
-  LAND OWNERSHIP BOUNDARY
-  EXISTING UNNAMED CULVERT
-  EXISTING PUBLIC FOUL WATER SEWER
-  EXISTING PUBLIC COMBINED SEWER
-  EXISTING PUBLIC SURFACE WATER SEWER
-  EXISTING UNNAMED WATERCOURSE



NOTES:

1. THIS DRAWING IS BASED ON SURVEY AND ENGINEERING PROJECTS TOPOGRAPHICAL SURVEY DRAWING S13705-T DATED JANUARY 2017, YORKSHIRE WATER RECORDS AND ORDINANCE SURVEY DATA.
2. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE FORTEM FLOOD RISK ASSESSMENT REF: 1003-R001-V1.

Rev	Date	Amendments	By
Drawing Status.			
PLANNING			
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Client			
ALFA HOMES			
Project			
NETHERLEY DRIVE, MARSDEN			
Drawing Title.			
EXISTING DRAINAGE			
Drawn: PB Checked: ADC		Scale: 1:1000 @ A3 Date: JULY 2018	
Drawing No.			Rev.
1003 - 001			-

SITE VISIT RECORD SHEET

FORTEM

E: info@fortemconsultants.co.uk

W: www.fortemconsultants.co.uk

Location: Netherley Drive, Marsden

Purpose: Site Visit

Job No: 1003

Attendees: Andrew Calvert (FORTEM)

Visit Date: 27.06.2017



View of development entrance, off Netherley Drive



View from access east down Netherley Drive



Natural topography fall west – east.



Development site, view north.



View on western boundary



View on eastern boundary

FORTEM Civil Engineering Consultants Ltd		Page 1
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Date 10/08/2017 09:49 File	Designed by ricky Checked by	
XP Solutions Source Control 2017.1.2		

IH 124 Mean Annual Flood

Input

Return Period (years)	1	Soil	0.500
Area (ha)	50.000	Urban	0.000
SAAR (mm)	1400	Region Number	Region 3

Results l/s

QBAR Rural	621.2
QBAR Urban	621.2
Q1 year	534.2
Q1 year	534.2
Q2 years	586.2
Q5 years	776.5
Q10 years	900.8
Q20 years	1020.2
Q25 years	1059.8
Q30 years	1091.9
Q50 years	1176.6
Q100 years	1292.1
Q200 years	1466.1
Q250 years	1522.0
Q1000 years	1888.5

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Appendix B Proposed Development

Drawing P1851302 – Proposed Site Layout

Drawing 1031-003 – Proposed Drainage Strategy

Drawing 1031-004A – Exceedance Flow Routing

Attenuation Calculations



PLANNING LAYOUT LAYERS KEY:

- APPLICATION BOUNDARY
- RETAINING WALL TBC
- 1800mm TIMBER FENCE
- 450mm KNEE HIGH RAIL
- REAR ACCESS GATES (LOCKABLE)
- FOCAL POINT
- BLOCK PAVING
- PROPOSED TREES
- LAND GRADIENT
- BIN STORE
- BIN COLLECTION POINT
- VISITOR PARKING

SCHEDULE OF ACCOMMODATION:

OPEN MARKET UNITS	HOUSETYPE	AMOUNT
	T-502 (2013R) 2 STOREY 5 BED DETACHED	2 No.
	T-510(2119P) 3 STOREY (SPLIT LEVEL) 5 BED DETACHED	3 No.

- NOTES:**
- FOR SITE LEVELS AND RETAINING WALLS REFER TO SEPARATE ENGINEERS DESIGNS AND SPECIFICATIONS.
 - LANDSCAPE INDICATIVE REFER TO SEPARATE LANDSCAPE DRAWINGS FOR PLANTING SCHEME
 - LAND OWNERSHIP AND ACCESS TO SUB STATION TBC.
 - TURNING HEAD TO BE ABLE TO ACCOMMODATE BOTH REFUSE AND FIRE VEHICLES. PRIVATE DRIVE CONSTRUCTION SUBJECT TO CIVIL ENGINEERS DESIGN AND SPECIFICATION.

ARCHITECTURE | PLANNING | LANDSCAPE

CLIENT:
BERKLEY DEVEER

PROJECT:
LAND OFF NETHERLEY DRIVE
MARSDEN

DRAWING:
PROPOSED SITE LAYOUT

DRAWING NUMBER:
P18 5153 02

SCALE @ A2:
1:500

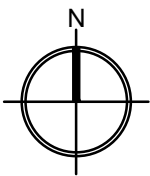
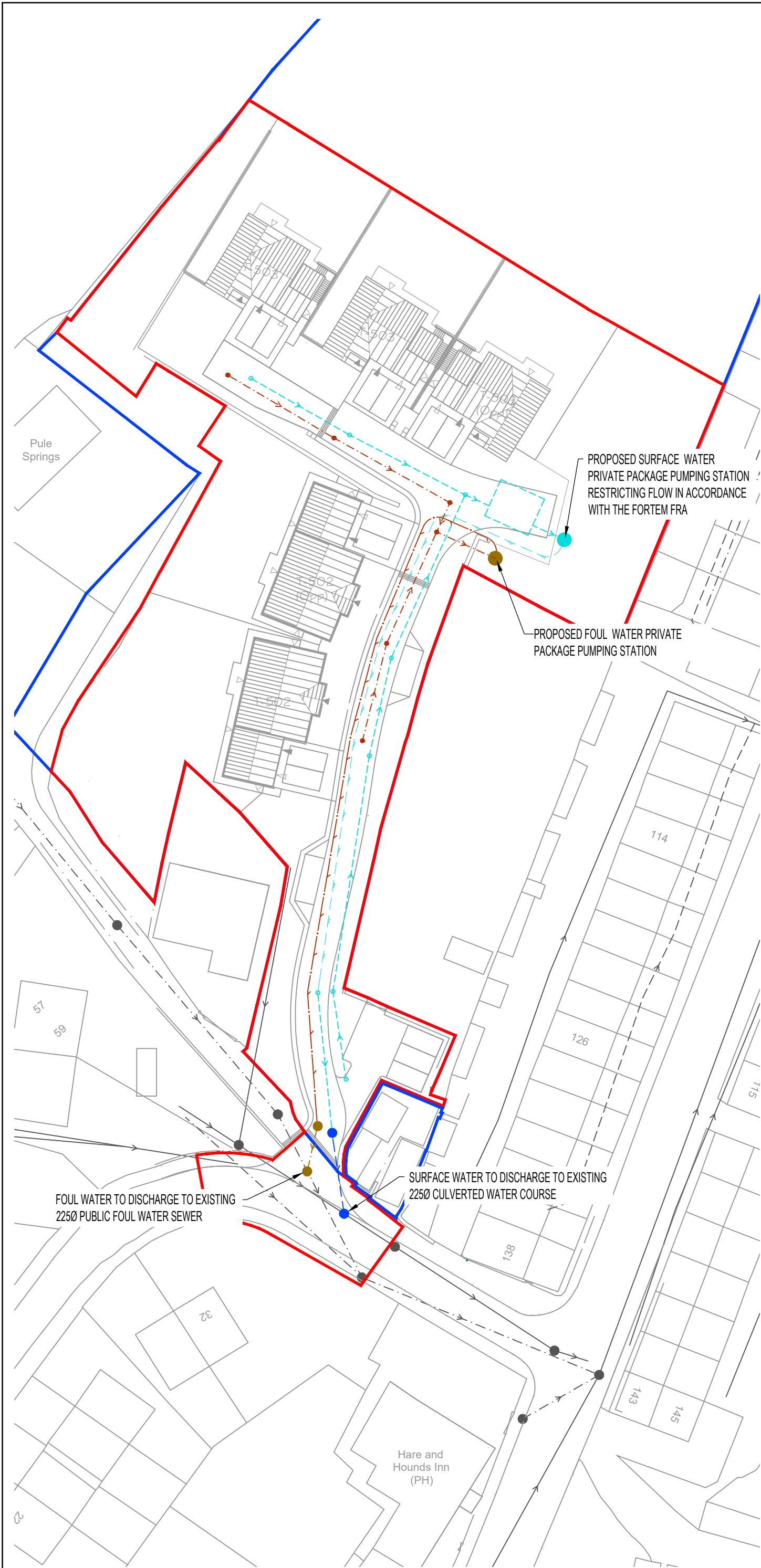
DRAWN:
THS

CHECKED:
VS

DATE:
JAN 18

DATE:
JAN 18

14 MARINER COURT / CALDER PARK / WAKEFIELD / WF4 3FL
01924 383322 / www.jpassoc.co.uk / info@jpassoc.co.uk
Jrpassodates is a trading style of John R Paley Associates Limited



NOTES:

- THIS DRAWING IS BASED ON JRP PROPOSED SITE LAYOUT DRAWING P18515302 DATED JANUARY 2018, SURVEY AND ENGINEERING PROJECTS TOPOGRAPHICAL SURVEY DRAWING S13705-T DATED JANUARY 2017 AND ORDINANCE SURVEY DATA.
- THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE FORTEM FLOOD RISK ASSESSMENT REF: 1003-R001-V1.

KEY:

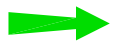
- PLANNING APPLICATION DEVELOPMENT BOUNDARY
- LAND OWNERSHIP BOUNDARY
- PROPOSED SURFACE WATER NETWORK
- PROPOSED SURFACE WATER DRAINAGE (PRIVATE)
- PROPOSED SURFACE WATER RISING MAIN (PRIVATE)
- PROPOSED FOUL WATER NETWORK
- PROPOSED FOUL WATER DRAINAGE (PRIVATE)
- PROPOSED FOUL WATER RISING MAIN (PRIVATE)
- EXISTING UNNAMED CULVERT
- EXISTING PUBLIC FOUL WATER SEWER
- EXISTING PUBLIC COMBINED SEWER
- EXISTING PUBLIC SURFACE WATER SEWER

Rev	Date	Amendments	By
Drawing Status.			
PLANNING			
FORTEM			
FORTEM Civil Engineering Consultants Ltd T. 07377 556170 / 07748982468 E. info@fortemconsultants.co.uk W. www.fortemconsultants.co.uk			
Client			
ALFA HOMES			
Project			
NETHERLEY DRIVE, MARSDEN			
Drawing Title.			
PROPOSED DRAINAGE STRATEGY			
Drawn: PB		Scale: 1:500 @ A3	
Checked: ADC		Date: JULY 2018	
Drawing No.			Rev.
1003 - 003			-



1. THIS DRAWING IS BASED ON JRP PROPOSED SITE LAYOUT DRAWING P18515302 DATED JANUARY 2018, SURVEY AND ENGINEERING PROJECTS TOPOGRAPHICAL SURVEY DRAWING S13705-T DATED JANUARY 2017 AND ORDINANCE SURVEY DATA.
2. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH FORTEMI DRAWINGS 1003-002 - PROPOSED LEVELS STRATEGY, 1003-003 - PROPOSED DRAINAGE STRATEGY AND THE FLOOD RISK ASSESSMENT REF: 1003-R001-V1.

KEY:

- | | |
|---|---|
|  | PLANNING APPLICATION DEVELOPMENT
BOUNDARY |
|  | LAND OWNERSHIP BOUNDARY |
|  | FLOOD ROUTE MAPPING (STAGE 1) |
|  | EXCEEDANCE VOLUME PUMPED ROUTE (STAGE 1) |
|  | TOTAL FAILURE FLOW ROUTE (STAGE 2) |
|  | PROPOSED SURFACE WATER NETWORK |
|  | PROPOSED SURFACE WATER DRAINAGE
(PRIVATE) |
|  | PROPOSED SURFACE WATER RISING
MAIN (PRIVATE) |
|  | PROPOSED FOUL WATER NETWORK |
|  | PROPOSED FOUL WATER DRAINAGE
(PRIVATE) |
|  | PROPOSED FOUL WATER RISING MAIN
(PRIVATE) |
|  | EXISTING UNNAMED CULVERT |
|  | EXISTING PUBLIC FOUL WATER SEWER |
|  | EXISTING PUBLIC COMBINED SEWER |
|  | EXISTING PUBLIC SURFACE WATER SEWER |
|  | PROPOSED RETAINING WALL |

EXCEEDANCE STORAGE AREA FOR
2NO. SEQUENTIAL STORMS (680m³ MIN.)

IN THE EVENT OF AN EXCEEDANCE EVENT OR BLOCKAGE THE FLOW ROUTING WOULD REPLICATE THE EXISTING SITE TOPOGRAPHY WITH OVERLAND FLOWS ONTO THE EXISTING AGRICULTURAL FIELDS (UNDER DEVELOPER OWNERSHIP).

-STORAGE EXCEEDANCE VOLUMES PUMPED
TO DRAINAGE SYSTEM POST EVENT

A	13.07.18	FFLs AMENDED	PB
Rev	Date	Amendments	By
Drawing Status.			
PLANNING			
FORTEM			
FORTEM Civil Engineering Consultants Ltd T. 07377 556170 / 07748982468 E. info@fortemconsultants.co.uk W. www.fortemconsultants.co.uk			
Client			
ALFA HOMES			
Project			
NETHERLEY DRIVE, MARSDEN			
Drawing Title.			
EXCEEDANCE FLOW ROUTING			
Drawn: PB Checked: ADC		Scale: 1:500 @ A2 Date: JULY 2018	
Drawing No.			Rev.
1003 - 004			A

FORTEM Civil Engineering Consultants Ltd					Page 1	
11 The Covert York YO24 1JN		Netherley Drive Marsden				
Date 02/07/2018 File 180518 Netherley Drive,...		Designed by Peter Booth Checked by Ricky Dale				
XP Solutions		Source Control 2017.1.2				
<u>Summary of Results for 100 year Return Period (+30%)</u>						
	Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
	15 min Summer	235.564	0.914	5.2	27.2	O K
	30 min Summer	235.913	1.263	5.2	37.7	O K
	60 min Summer	236.209	1.559	5.3	46.6	O K
	120 min Summer	236.353	1.703	5.6	50.9	O K
	180 min Summer	236.355	1.705	5.6	50.9	O K
	240 min Summer	236.334	1.684	5.5	50.3	O K
	360 min Summer	236.259	1.609	5.4	48.1	O K
	480 min Summer	236.164	1.514	5.3	45.2	O K
	600 min Summer	236.063	1.413	5.2	42.2	O K
	720 min Summer	235.961	1.311	5.2	39.1	O K
	960 min Summer	235.754	1.104	5.2	32.9	O K
	1440 min Summer	235.262	0.612	5.2	18.2	O K
	2160 min Summer	234.937	0.287	5.1	8.4	O K
	2880 min Summer	234.821	0.171	4.5	4.9	O K
	4320 min Summer	234.756	0.106	3.5	3.0	O K
	5760 min Summer	234.738	0.088	2.9	2.4	O K
	7200 min Summer	234.728	0.078	2.5	2.1	O K
	8640 min Summer	234.722	0.072	2.2	1.9	O K
	10080 min Summer	234.717	0.067	2.0	1.8	O K
	15 min Winter	235.690	1.040	5.2	31.0	O K
	30 min Winter	236.087	1.437	5.2	42.9	O K
	Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
	15 min Summer	110.022	0.0	32.4	23	
	30 min Summer	78.257	0.0	46.1	36	
	60 min Summer	53.203	0.0	62.6	62	
	120 min Summer	34.605	0.0	81.5	100	
	180 min Summer	26.307	0.0	92.9	134	
	240 min Summer	21.639	0.0	101.9	168	
	360 min Summer	16.371	0.0	115.7	238	
	480 min Summer	13.398	0.0	126.2	308	
	600 min Summer	11.453	0.0	134.9	376	
	720 min Summer	10.067	0.0	142.2	442	
	960 min Summer	8.199	0.0	154.5	578	
	1440 min Summer	6.120	0.0	173.0	802	
	2160 min Summer	4.556	0.0	193.1	1132	
	2880 min Summer	3.701	0.0	209.2	1476	
	4320 min Summer	2.764	0.0	234.3	2200	
	5760 min Summer	2.251	0.0	254.4	2872	
	7200 min Summer	1.923	0.0	271.7	3640	
	8640 min Summer	1.694	0.0	287.3	4328	
	10080 min Summer	1.524	0.0	301.6	5112	
	15 min Winter	110.022	0.0	36.3	24	
	30 min Winter	78.257	0.0	51.6	36	
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FORTEM Civil Engineering Consultants Ltd					Page 2
11 The Covert York YO24 1JN		Netherley Drive Marsden			
Date 02/07/2018 File 180518 Netherley Drive,...		Designed by Peter Booth Checked by Ricky Dale			
XP Solutions		Source Control 2017.1.2			
<u>Summary of Results for 100 year Return Period (+30%)</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	236.443	1.793	5.7	53.6	O K
120 min Winter	236.621	1.971	6.0	58.9	O K
180 min Winter	236.614	1.964	5.9	58.7	O K
240 min Winter	236.570	1.920	5.9	57.4	O K
360 min Winter	236.432	1.782	5.7	53.2	O K
480 min Winter	236.271	1.621	5.4	48.4	O K
600 min Winter	236.107	1.457	5.2	43.5	O K
720 min Winter	235.942	1.292	5.2	38.6	O K
960 min Winter	235.573	0.923	5.2	27.5	O K
1440 min Winter	234.972	0.322	5.1	9.4	O K
2160 min Winter	234.781	0.131	4.2	3.7	O K
2880 min Winter	234.753	0.103	3.4	2.9	O K
4320 min Winter	234.730	0.080	2.6	2.2	O K
5760 min Winter	234.720	0.070	2.1	1.9	O K
7200 min Winter	234.713	0.063	1.8	1.7	O K
8640 min Winter	234.708	0.058	1.6	1.5	O K
10080 min Winter	234.705	0.055	1.4	1.4	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)	
60 min Winter	53.203	0.0	70.2	62	
120 min Winter	34.605	0.0	91.3	104	
180 min Winter	26.307	0.0	104.1	142	
240 min Winter	21.639	0.0	114.2	180	
360 min Winter	16.371	0.0	129.5	256	
480 min Winter	13.398	0.0	141.4	330	
600 min Winter	11.453	0.0	151.0	402	
720 min Winter	10.067	0.0	159.3	476	
960 min Winter	8.199	0.0	173.0	624	
1440 min Winter	6.120	0.0	193.7	798	
2160 min Winter	4.556	0.0	216.3	1112	
2880 min Winter	3.701	0.0	234.3	1468	
4320 min Winter	2.764	0.0	262.4	2204	
5760 min Winter	2.251	0.0	284.9	2920	
7200 min Winter	1.923	0.0	304.3	3576	
8640 min Winter	1.694	0.0	321.7	4352	
10080 min Winter	1.524	0.0	337.8	5048	
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11 The Covert York YO24 1JN

Netherley Drive
Marsden

Date 02/07/2018
File 180518 Netherley Drive,...

Designed by Peter Booth
Checked by Ricky Dale



XP Solutions

Source Control 2017.1.2

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.200	Shortest Storm (mins)	15
Ratio R	0.250	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 0.157

Time (mins)	Area	Time (mins)	Area	Time (mins)	Area
From: To:	(ha)	From: To:	(ha)	From: To:	(ha)
0	4 0.052	4	8 0.052	8	12 0.052

FORTEM Civil Engineering Consultants Ltd		Page 4
11 The Covert York YO24 1JN	Netherley Drive Marsden	
Date 02/07/2018 File 180518 Netherley Drive,...	Designed by Peter Booth Checked by Ricky Dale	
XP Solutions	Source Control 2017.1.2	

Model Details

Storage is Online Cover Level (m) 238.100

Box Culvert Structure

Height (m) 2.000 Slope (1:X) 500.000 Downstream Invert (m) 234.650
Width (m) 4.000 Length (m) 7.250

Hydro-Brake® Optimum Outflow Control

Unit Reference MD-SHE-0101-6000-2000-6000
Design Head (m) 2.000
Design Flow (l/s) 6.0
Flush-Flo™ Calculated
Objective Minimise upstream storage
Application Surface
Sump Available Yes
Diameter (mm) 101
Invert Level (m) 234.650
Minimum Outlet Pipe Diameter (mm) 150
Suggested Manhole Diameter (mm) 1200

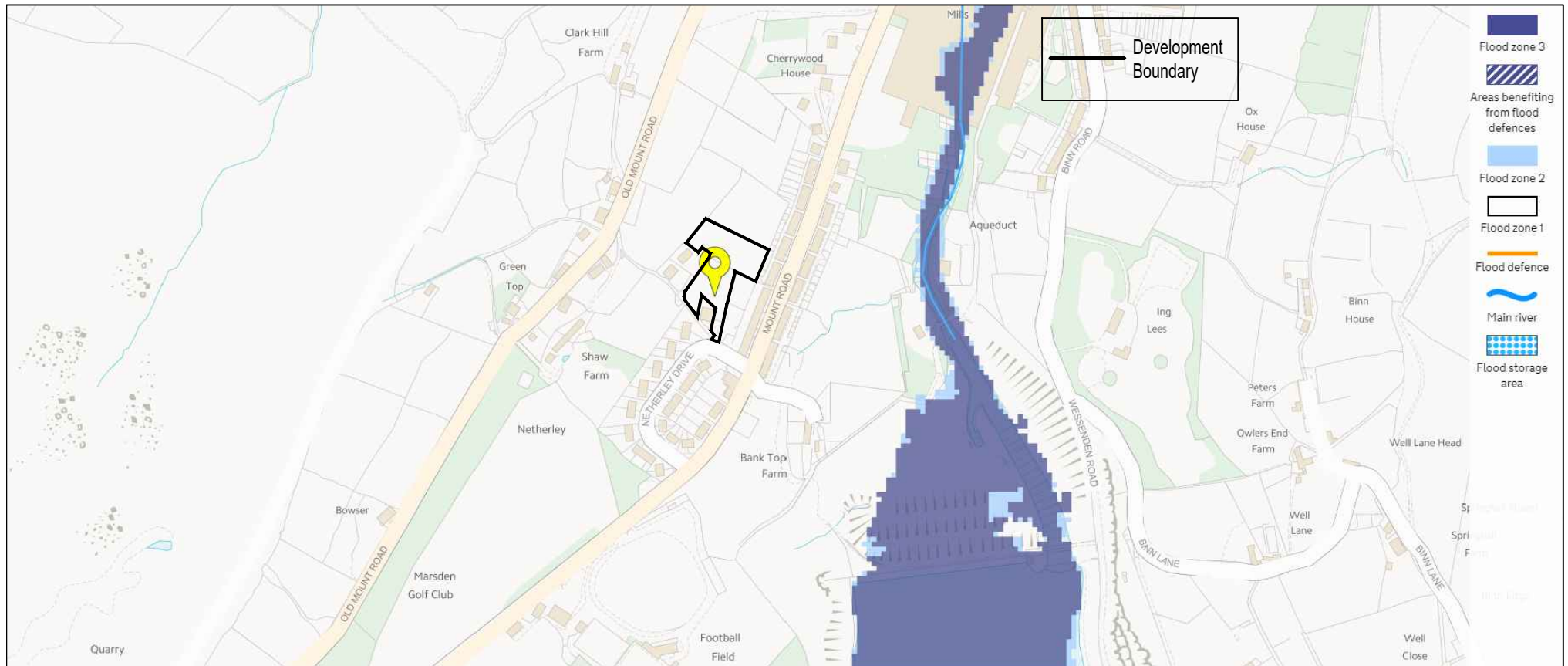
Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.000	6.0
Flush-Flo™	0.438	5.2
Kick-Flo®	0.900	4.1
Mean Flow over Head Range	-	4.8

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

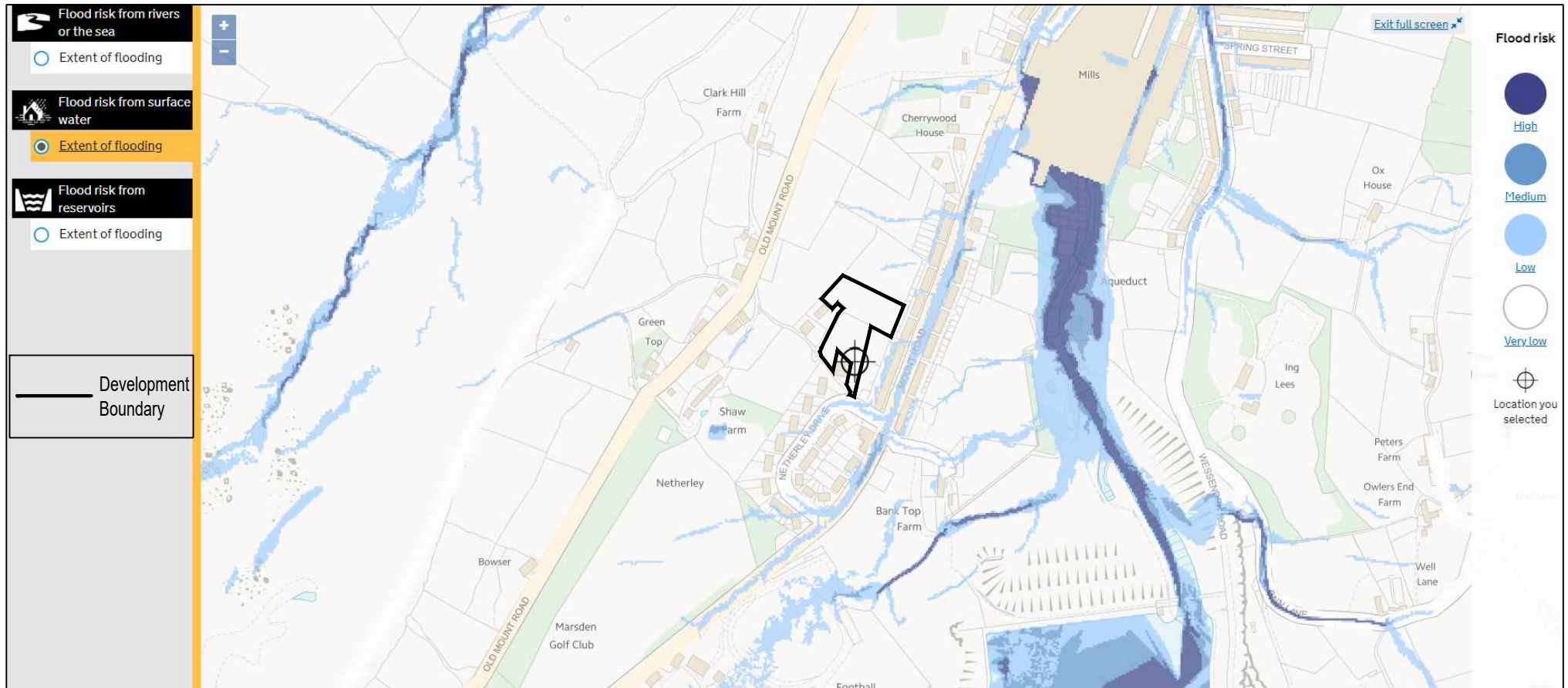
Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.3	1.200	4.7	3.000	7.3	7.000	10.8
0.200	4.7	1.400	5.1	3.500	7.8	7.500	11.2
0.300	5.1	1.600	5.4	4.000	8.3	8.000	11.5
0.400	5.2	1.800	5.7	4.500	8.8	8.500	11.9
0.500	5.2	2.000	6.0	5.000	9.2	9.000	12.2
0.600	5.1	2.200	6.3	5.500	9.7	9.500	12.5
0.800	4.7	2.400	6.5	6.000	10.1		
1.000	4.3	2.600	6.8	6.500	10.5		

Appendix C Flood Risk Mapping

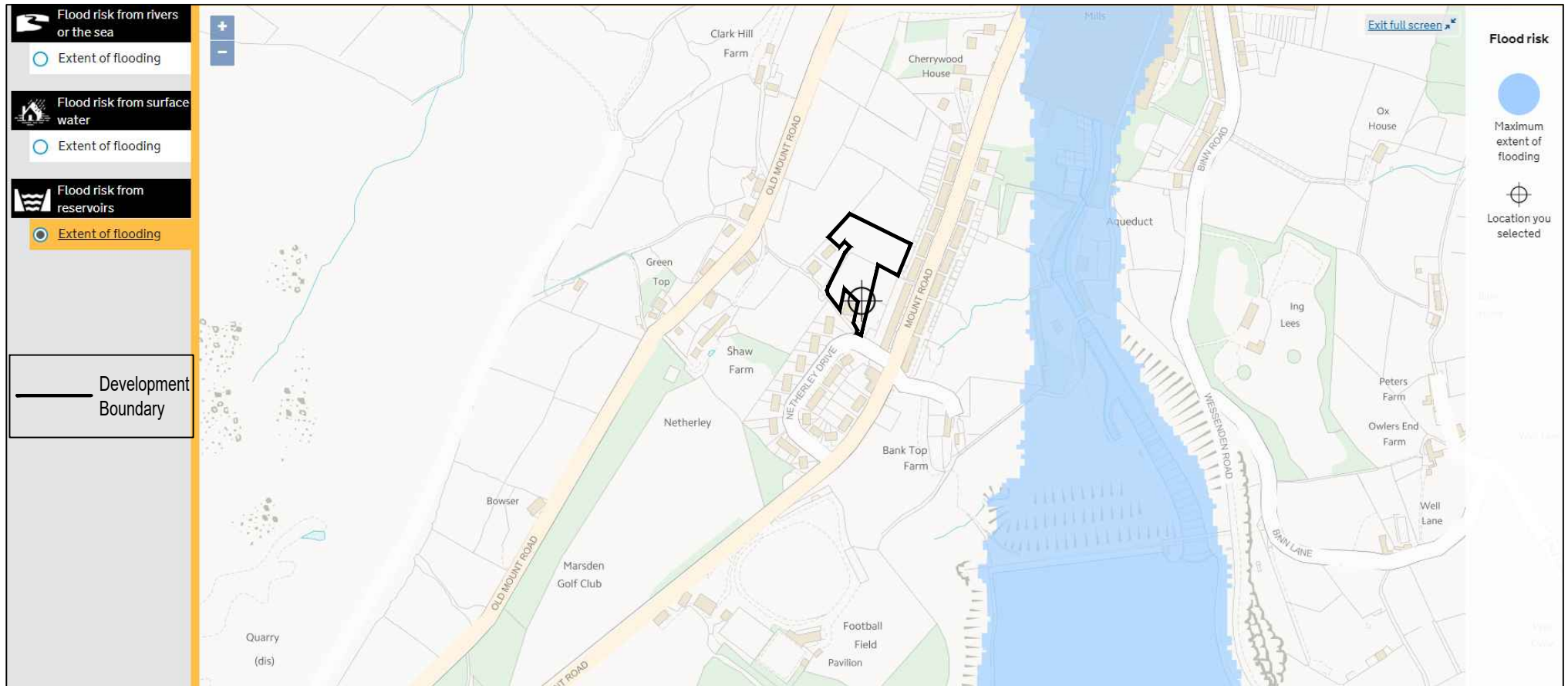
EA Map Risk from Rivers or Sea
EA Map Risk from Surface Water
EA Map Risk from Reservoir



NETHERLEY DRIVE, MARSDEN
 EXTRACT FROM ENVIRONMENT AGENCY MAPPING (GOV.UK)
 RISK FROM FLOODING FROM RIVERS OR SEA
 EXTRACT TAKEN 03.07.2018 : NTS



NETHERLEY DRIVE, MARSDEN
 EXTRACT FROM ENVIRONMENT AGENCY MAPPING (GOV.UK)
 RISK FROM FLOODING FROM SURFACE WATER
 EXTRACT TAKEN 03.07.2018 : NTS



NETHERLEY DRIVE, MARSDEN
EXTRACT FROM ENVIRONMENT AGENCY MAPPING (GOV.UK)
RISK FROM FLOODING FROM RESERVOIR
EXTRACT TAKEN 03.07.2018 : NTS

Appendix D FORTEM
FORTEM Consultants Ltd T&Cs

TERMS AND CONDITIONS

1. DEFINITIONS

“the Client” the company, individual or organisation identified within the Fee Proposal and commissioner of FORTEM Civil Engineering Consultants Ltd to undertake services on behalf of.

“the Scope of Services” list of services stated in the Fee Proposal.

“the Contract” these Terms and Conditions and the Fee Proposal unless and until they are replaced by a written, agreed and signed alternative contract.

“Fee Proposal” associated letter or document which covers the Scope of Services and the fees FORTEM Civil Engineering Consultants Ltd will charge the Client for the delivery of the Scope of Services, with any additional express terms of contact agreed between FORTEM Civil Engineering Consultants Ltd and the Client.

“Expenses and Disbursements” expenses incurred and disbursements made by FORTEM Civil Engineering Consultants Ltd in carrying out the Scope of Services for the Client, which include but are not limited to third party costs, document reproduction, travel, accommodation and sub-consultants costs.

“Due Date for Payment” date of FORTEM Civil Engineering Consultants Ltd invoice.

“Overdue Date for Payment” the date 28 days after the Due Date for payment.

“the Fees” fees, expenses and disbursements set out in the Fee Proposal.

“Additional Services” services undertaken not specifically covered by the list of services stated in the Fee Proposal.

- 1.1. If any of the Terms and Conditions of the Contract are for any reason held to be illegal, invalid, ineffective, inoperable or otherwise unenforceable, it shall sever and be deemed to be deleted from this agreement and the validity and enforceability of the remainder of this agreement shall not be affected or impaired thereby.

2. SCOPE OF SERVICES

- 2.1. Any services required in addition of the Scope of Services shall be Additional Services and shall be charged in addition to the agreed Fees.
- 2.2. FORTEM Civil Engineering Consultants Ltd shall exercise reasonable skill and care in the delivery of the Scope of Services.
- 2.3. Any budgetary cost consultancy or programming offered by FORTEM Civil Engineering Consultants Ltd is to be regarded by the Client as guidance only.
- 2.4. The Client shall without charge and in the time required, so as not to disrupt the performance of the Scope of Services, do all things required to enable the Scope of Services to be performed and will indemnify FORTEM Civil Engineering Consultants Ltd against all losses and costs as a result of any failure to do so.

3. PAYMENT AND INVOICING

- 3.1. FORTEM Civil Engineering Consultants Ltd shall be entitled to be paid the Fees, Expenses and Disbursements stated within the Fee Proposal unless specifically agreed otherwise.
- 3.2. Invoices will be issued monthly unless agreed otherwise by FORTEM Civil Engineering Consultants Ltd.
- 3.3. If FORTEM Civil Engineering Consultants Ltd takes legal action to recover any outstanding Fees, all sums outstanding including un-invoiced Fees due for services wholly or partially complete will be due and payable immediately. The Client shall be liable for all legal costs incurred by FORTEM Civil Engineering Consultants Ltd in the recovery of the fees.
- 3.4. If payment is not received by the Overdue Date for Payment, FORTEM Civil Engineering Consultants Ltd shall be entitled to charge interest in accordance with the Late Payment of Commercial Debts (Interest) Act 1998 at the relevant reference rate plus the statutory rate of interest on the outstanding balance until payment is received by FORTEM Civil Engineering Consultants Ltd.
- 3.5. FORTEM Civil Engineering Consultants Ltd is entitled to issue invoices to the Client at any time to recharge the cost of management of third party services, if such third party services have been used by FORTEM Civil Engineering Consultants Ltd to complete the Scope of Services for the Client, FORTEM Civil Engineering Consultants Ltd is entitled to charge an additional fee of 10% of the third party costs.

4. INTELLECTUAL PROPERTY

- 4.1. All intellectual property rights associated with the Scope of Services shall remain vested in FORTEM Civil Engineering Consultants Ltd. A specific licence for use may be granted by FORTEM Civil Engineering Consultants Ltd. If the Client defaults on payment to FORTEM Civil Engineering Consultants Ltd any such licence is hereby automatically revoked.
- 4.2. FORTEM Civil Engineering Consultants Ltd shall not be liable for any use of copyright material for any purpose other than the original intent.
- 4.3. FORTEM Civil Engineering Consultants Ltd shall not be liable for any copyright infringement by the Client using copyright materials.
- 4.4. FORTEM Civil Engineering Consultants Ltd shall not be liable for any use of information produced for the Client in whole or part that have not had prior consent by any third party who have an obligation to approve the output.
- 4.5. The information contained in the Fee Proposal is provided in confidence and regarded as commercially sensitive and confidential as defined under the Freedom of Information Act.

5. INSURANCE, LIABILITIES & INDEMNITIES

- 5.1. The total liability of FORTEM Civil Engineering Consultants Ltd to the Client from the date of the Fee Proposal for each claim or series of claims arising from the same originating clause shall not exceed the sum of £2 million (two million pounds), save where specifically excluded.
- 5.2. FORTEM Civil Engineering Consultants Ltd shall have no liability for any losses arising from war and terrorism, toxic mould, nuclear risk, pollution and contamination and/or asbestos unless specifically agreed in writing with the Client.
- 5.3. FORTEM Civil Engineering Consultants Ltd shall have no responsibility for the removal, treatment, storage, transport or disposal of hazardous or toxic substances or other waste materials unless specifically agreed in writing with the Client.
- 5.4. FORTEM Civil Engineering Consultants Ltd liability for any claim or claims shall be further limited to such sum as it would be just and equitable for FORTEM Civil Engineering Consultants Ltd to pay having regard to the extent of its responsibility for the loss or damage suffered as a result of each claim or series of claims ("the loss and damage") and on the assumption that:
 - 5.4.1. all other legal entities working for the Client in relation to the project to which the Scope of Services relates ("the Other Parties") shall have provided contractual undertakings on terms no less onerous than those applying to FORTEM Civil Engineering Consultants Ltd, in respect of the carrying out of their obligations;
 - 5.4.2. there are no exclusions of or limitations of liability nor joint insurance or co-insurance provisions between the Client and the Other Parties and any other party who is responsible to any extent for the loss and damage is liable to the Client for the loss and damage, and:
 - 5.4.3. the Other Parties have paid, or agreed to pay, to the Client such proportion of the loss and damage which it would be just and equitable for them to pay having regard to the extent of their responsibility for the loss and damage.
- 5.5. The amount of Professional Indemnity Insurance provided by FORTEM Civil Engineering Consultants Ltd for each claim or series of claims arising from the same original clause shall be £2 million (two million pounds) in the aggregate provided such insurance is available at commercially reasonable rates and terms.
- 5.6. The amount of Public Liability Insurance carried by FORTEM Civil Engineering Consultants Ltd is £2 million (two million pounds).
- 5.7. FORTEM Civil Engineering Consultants Ltd accepts no responsibility for economic, consequential and indirect losses however caused and whether claimed in contract or tort which include, but are not limited to, loss of profits, loss of opportunity, loss of production, loss of business, opportunity or diminution in value of any asset.

6. ENTIRE AGREEMENT CLAUSE

- 6.1. The Contract forms the entire agreement between FORTEM Civil Engineering Consultants Ltd and the Client and replaces any previous agreements, understandings, discussions or arrangements relating to the Scope of Services. FORTEM Civil Engineering Consultants Ltd and the Client acknowledge that no statement or representation made by either party have been relied upon by the other in agreeing to enter into the Contract.

7. DISPUTES AND TERMINATION

- 7.1. In the event of a dispute that cannot be resolved by negotiation, FORTEM Civil Engineering Consultants Ltd and the Client agree to the initial process of Mediation. All costs, other than legal costs associated with the process, shall be shared equally by FORTEM Civil Engineering Consultants Ltd and the Client.
- 7.2. Either party has the right to refer a dispute in relation to the Scope of Services that relate to the United Kingdom based upon construction operations (as defined in the Act) to adjudication pursuant of the Housing Grant, Construction and Regeneration Act 1996 ("the Act") and any amendments thereto. The rules governing the adjudication will be Part 1 of the Scheme of the Construction Contracts (England and Wales) Regulations 1998 or equivalent in Scotland or Northern Ireland (as amended).
- 7.3. If the client terminates the Contract, the Client shall pay FORTEM Civil Engineering Consultants Ltd in full for all the work performed in relation to any of the Scope of Services and any Additional Services at the date of termination.

8. COLLATERAL WARRANTY, NOVATION AND ASSIGNMENT

- 8.1. FORTEM Civil Engineering Consultants Ltd is under no obligation to provide a collateral warranty to any party or consent a novation of the Contract to any third party unless such obligation is specifically included in the Fee Proposal.
- 8.2. The Contract shall not be transferrable or assignable by the Client to any other party.
- 8.3. The provisions of the Contracts (Rights of Third Parties) Act 1999 are specifically excluded from the Contract.

9. GOVERNING LAW

- 9.1. The Contract shall be governed by and constructed in accordance with English Law.
- 9.2. The Client and the Company hereby submit to the jurisdiction of the English Courts.