

**Prepared on behalf of**

**Huddersfield Sporting Pride Ltd.**

# FLOOD RISK ASSESSMENT

**Proposed Training Ground  
Woodfield Park, Armitage Bridge, Huddersfield**

**Flood Risk Assessment**

## Acknowledgements:

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<b>Author:</b>	Thomas Walker		
<b>Checked &amp; Approved:</b>	Darren Hawkyard	<b>Date:</b>	22 December 2016

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*9715-002 – Existing and Proposed Permeable Areas*

*Received Layout Plans*

*Topographical Survey*

### **Appendix B – Environment Agency Consultation**

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## **1 Introduction**

- 1.1 Sanderson Associates Consulting Engineers Ltd have been appointed to undertake a Site Specific Flood Risk Assessment for a proposed training ground development, located at Woodfield Park, Armitage Bridge, Huddersfield. The aim of this assessment is to discuss the potential flood risk to the proposed development and recommend mitigation measures to protect the development and end users from a potential flooding event.
- 1.2 This Flood Risk Assessment has been undertaken in accordance with the National Planning Policy Framework (NPPF), March 2012 and the associated Planning Practice Guidance, 2014 (PPG, 2014).
- 1.3 Direct consultation with the Environment Agency (EA) has taken place for this development, as the site is shown to be located within Flood Zone 1, 2 and 3, the EA standing advice has also been taken into account during production of this report. British Geological Survey records and local authority documents have also been reviewed and referred to within this report.
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## 2 Existing Situation

### 2.1 *Existing Site Description*

- 2.1.1 The site is located in the Armitage Bridge areas of Huddersfield in West Yorkshire and is currently occupied by Woodfield Park sports and recreation grounds, which includes open play areas, a cricket club, a bowling club, tennis courts and an associated clubhouse/pavilion and parking facilities.
- 2.1.2 The River Holme flows down the eastern boundary of the Woodfield Park recreation ground and generally flows from south to north. The river is not tidal and sources from uplands to the south of the site.
- 2.1.3 Although there are building and impermeable areas currently on the site from a formal survey there is limited evidence of a formal drainage system, it is likely that impermeable areas on the site currently shed surface water to adjacent permeable land which makes up the majority of the sites area.
- 2.1.4 In accordance with PPG, 2014 the sites current use is classed as a 'water-compatible Development' in terms of flood risk as it is occupied by sports and recreational facilities.
- 2.1.5 Site levels range from 75.51m AOD at the northeastern boundary of the site and 86.42m AOD to the southwestern boundary.
- 2.1.6 The estimated run off rate from existing impermeable areas has been assessed using the WinDES software. With an existing impermeable area of 1,721m<sup>2</sup>, the estimated outfall rate has been calculated at 20.9l/s for a 1 in 1 year return period. The WinDES results are contained in Appendix B and an area take off plan is included in Appendix A.
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### 3 Consultations

- 3.1.1 As part of this assessment, Environment Agency (EA) mapping has been reviewed in relation to potential flooding from a number of sources.
- 3.1.2 EA mapping confirms that the site falls within Flood Zone 1, 2 and 3. Flood Zone 1 is defined as land having a less than a 1 in 1000 (0.1%) annual probability of flooding in any given year. Flood Zone 2 is defined as land having between a 1 in 100 and 1 in 1000 annual probability of flooding in any given year and Flood Zone 3 is defined as land having a greater than a 1 in 100 (1%) annual probability of flooding in any given year. Environment Agency consultation has been provided including flood levels for a number of storm events, these will be referred to in section 6.
- 3.1.3 Groundwater mapping confirms that the sites underlying bedrock and superficial strata are classed as a Secondary A aquifers, these are layers that have a level of void capacity and can support river base flow on a local rather than strategic level. Secondary A are strata that have previously been designated as a minor aquifers due to their limited water bearing capacity.
- 3.1.4 The EA have also confirmed that the site is not located within receptor sensitive Groundwater Protection Zone.
- 3.1.5 Surface water mapping has also been reviewed and will be referred to in Section 6 of this report.
-

## 4 Proposed Development

- 4.1 It is proposed that the site is redeveloped for use by Huddersfield Giants Rugby Club as a training facility. The existing clubhouse/pavilion will be demolished and a new training facility constructed on the site, including two training pitches and building to including training and club facilities. A formal parking area will be introduced and the exiting tennis courts retained.
- 4.2 Received layout and site plans have been provided by Hockey Architectural, which are contained in Appendix A of this report.
- 4.3 Access to the site will remain from Meltham Road to the west via the existing access Road.
- 4.4 The Proposed drainage design for the development should take into account the requirements of Part H3 of the Building Regulation and the current non-statutory guidance for sustainable drainage. Firstly, the proposed surface water outfall should give priority to onsite treatment such as infiltration. If infiltration is unsuitable, a watercourse outfall should be investigated and then a connection to local sewer. The rate of outfall will require restricting to the existing calculated rate for storm events up to a 1 in 100 year + a 30% allowance for climate change/uncertainty.
- 4.5 The proposed estimated surface water run off rate from the site has been assessed using WinDES System 1 based on areas on plan 9715-002 contained in Appendix A. Proposed unrestricted run off has been calculated at 71.7l/s for a 1 in 1 year return period.
- 4.6 The proposed drainage design for the project should be restricted to 14.63l/s which is a 30% reduction over the existing rate of 20.9l/s for up to a 1 in 100 year flood event + a 30% allowance for climate change.
-

## 5 Sequential and Exception Tests

### 5.1 *Sequential Approach*

- 5.1.1 EA mapping confirms that the site falls within Flood Zone 1, 2 and 3. Flood Zone 1 is defined as land having a less than a 1 in 1000 (0.1%) annual probability of flooding in any given year. Flood Zone 2 is defined as land having between a 1 in 100 and 1 in 1000 annual probability of flooding in any given year and Flood Zone 3 is defined as land having a greater than a 1 in 100 (1%) annual probability of flooding in any given year.
- 5.1.2 The sites current and proposed use are for sports and recreation. The site layout has been set out with flooding in mind with the proposed onsite building directed towards the lowest risk areas of the site.
- 5.1.3 In accordance with PPG, 2014 a sports and recreational development is classed as a 'water compatible' development in terms of flood risk. It should be noted that the proposed development does not alter the vulnerability classification from the current use as the site will remain for sports use.
- 5.1.4 In summary, it is considered that the development is appropriate in terms of flood risk as it is located within a compatible flood zones and the layout has been designed to set facilities to appropriate areas of the site.
-

## 6 Assessment of Flood Risk

### 6.1 *Flooding from Land*

6.1.1 The main risk of flooding from overland flow comes from the impermeable areas within the site and adjacent highway where accumulation of storm water could potentially encroach within the building. Modelled surface water data has been reviewed to ascertain whether the local area is at an elevated risk from surface water flooding.

6.1.2 Environment Agency modelled surface water flood mapping shows the site itself is within an area that is shown to have a generally very low risk of surface water flooding (less than 1 in 1000 annual probability in any given year) this is the lowest risk classification in accordance with EA delineation. An isolated area at the north-eastern boundary of the site is shown to be at an elevated risk, this area is the lowest lying area of the site and appears to be where surface water is directed to during low probability storm event. On review of development plans this area will remain undeveloped.

6.1.3 Based on the assessed information there is a residual risk from surface water during low probability storm events to the low lying area of the site, although from Environment Agency data, the developed area of the site is shown to be at a very low risk.

6.1.4 Mitigation measures as discussed in Section 7 will ensure the development is resilient to any potential flooding due to overland flow should an localised low probability event occur.

### 6.2 *Flooding from Rivers / Watercourses*

6.2.1 As discussed in Section 3, EA mapping confirms that the site falls within Flood Zone 1, 2 and 3. Flood Zone 1 is defined as land having a less than a 1 in 1000 (0.1%) annual probability of flooding in any given year. Flood Zone 2 is defined as land having between a 1 in 100 and 1 in 1000 annual probability of flooding in any

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given year and Flood Zone 3 is defined as land having a greater than a 1 in 100 (1%) annual probability of flooding in any given year, as per flood zone delineation set out in Planning Practice Guidance, 2014.

- 6.2.2 The main risk to the site is from the River Holme, which is located on the eastern boundary of the site. The flood mechanism appears to be exceedance flow within the rivers channel during low probability storm events flooding out of channel onto adjacent land. The Lead Local Flood Authority have also indicated that a culvert on the site has had previous issues with flooding due to blockages. Mitigation to address all sources of flooding have been included in Section 7.
- 6.2.3 The EA mapping suggests that there are defences located on the western bank of the River Holme, adjacent to the site in the form of a mixture of walled channel sides and natural embankments, no data has been provided regarding the standard of protection of these defence or the upstream or downstream crest levels.
- 6.2.4 The EA consultation and Kirklees Strategic Flood Risk Assessment confirm that an element of the Woodfield Park sports ground is within Flood Zone 3b. The area is located to the north eastern limits sports field at the boundary with the River Holme and does not extend to the area where proposed buildings are to be sited. The developed should ensure there is no land raising within this area to preserve an identified area of flood plain.
- 6.2.5 The Environment Agency have provided modelled flood data for a number of return periods including a 1 in 100 and 1 in 1000 year return period level. As no data has been provided for a 1 in 100 year event + an allowance for future climate change/uncertainty the 1 in 1000 year level will be used to ensure a robust assessment. For the purpose of this report data at node 2600 will be used as it is located upstream of the site.
- 6.2.6 At node 2600 a 1 in 1000 year flood level is given at 81.42m AOD.
-

6.2.7 When comparing site specific level data at the location of the proposed building it can be seen that existing levels are in the range of 82.50m AOD and 82.90m AOD. These are a minimum of 1.08m above the received 1 in 1000 year flood level. Therefore if the finished floor level of the proposed onsite building should be set relative to existing ground levels, which would mean the proposed building will be wholly within Flood Zone 1.

### **6.3 *Flooding from Sewers***

6.3.1 At the time of writing the report there was no evidence available to suggest the site has been directly affected from flooding from overloaded sewers/drainage apparatus in the past.

6.3.2 The mitigation measures proposed for the development as discussed in section 7 will also protect against any flooding from this source should the risk increase over the lifetime of the development.

### **6.4 *Flooding from Groundwater***

6.4.1 The potential for groundwater flooding has been assessed with the aid of groundwater mapping from the Environment Agency and British Geological Survey records.

6.4.2 Groundwater mapping confirms that the sites underlying bedrock and superficial strata are classed as a Secondary A aquifers, these are layers that have a level of void capacity and can support river base flow on a local rather than strategic level. Secondary A are strata that have previously been designated as a minor aquifers due to their limited water bearing capacity.

6.4.3 The British Geological Survey of the UK shows that the superficial strata is Alluvium made up of clay, sand and gravel. The Bedrock Geology is of the Millstone Grit Formation.

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6.4.4 The British Geological Survey Borehole records has been reviewed in the vicinity of the site. Borehole records are available, which were excavated as part of a development approximately 200m south of the site and in the same geological groups for both superficial and bedrock formations. The borehole records show a superficial strata of made ground to a depth of 2.5m to 3m below ground level underlain by a gravel, sand and areas of clay strata to approximately 7.0m below ground level. Groundwater was encountered in one reviewed boreholes in the form of seepage at a depth of 3m below ground level others remained dry during excavation.

From evidence reviewed there is a residual risk from groundwater in the area due to the sites location within a superficial strata that is classed as a minor aquifer. Although local borehole records, held by the British Geological Survey suggests that there is limited held water within the upper superficial strata of the superficial formation. It should be noted that no below ground structures are proposed as part of this development.

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## 7 Mitigation Measures

### 7.1 *Recommended Mitigation Measures*

- 7.1.1 The finished floor level of the proposed on site building should be set no lower than 600mm above the 1 in 1000 year level of 81.42mAOD with a 150mm upstand in relation to adjacent ground levels to prevent the ingress of surface water at the buildings interface.
- 7.1.2 The proposed sport pitches should be set to a level that ensures that there is no positive land raising to ensure that there is no loss of flood storage area in the areas of the site that are shown to be in Flood Zones 2 and 3. The pitches are water compatible therefore no specific measures have been proposed to protect them outside of ensuring a balance in cut and fill.
- 7.1.3 Infiltration testing should be carried out on the site to BRE 365 to confirm the suitability of soakaways at this location. Surface water management will need to be provided and it is highly unlikely that there is sewer apparatus within the area due to the site locality.
- 7.1.4 As previously stated the site layout has been set out to ensure that the most vulnerable parts of the development i.e. the proposed building, have been located in the lowest vulnerable areas of the site.
- 7.1.5 Footway areas should be constructed to naturally fall towards and into garden/green areas to encourage the informal percolation of surface water runoff.
- 7.1.6 Where any external surfaces within the proposed development do not fall away from access points to the proposed buildings, a suitable linear drain should be installed across any access points to reduce the risk of any surface water entering the building.
-

- 7.1.7 Drainage apparatus associated with the development should be maintained to ensure that they remain fit for purpose and to reduce the risk from blockages.
- 7.1.8 Based on surface water run off calculations the proposed runoff from the site should be restricted to 14.63l/s which is a 30% reduction over the existing rate up to a 1 in 100 year + 30% allowance for climate change. A suitable planning condition should be introduced in order to ensure a suitable drainage strategy and design is implemented to meet the requirements of the local planning authority.
- 7.1.9 It has been calculated that to enable a discharge rate of 14.63l/s for up to a 1 in 100 year storm event + a 30% allowance for climate change, approximately 246m<sup>3</sup> of storage would be required. As above the proposed discharge rate could be conditioned as part of a planning approval, this would allow a number of options to control surface water within the site. (WinDES output contained in Appendix C)
-

## 8 Conclusions

- 8.1 This report serves to review and assess the sources of potential flooding to the site, the impact of the proposed development on the flood mechanisms of the site and the impact on the surrounding area in accordance with NPPF.
- 8.2 Sequential and Exception Tests have been assessed in accordance with NPPF and it is concluded that the development is suitable for this location.
- 8.3 The flood risk to the site from a number of sources of flooding are not considered significant other than fluvial flooding. Mitigation measures have been proposed to manage this and the site layout designed to ensure the proposed building is located in an area of the site wholly within Flood Zone 1.
- 8.4 This report concludes that the site can be developed without increasing flood risk to the site itself and other sites in the vicinity with the implementation of suitable mitigation measures.
-

***APPENDIX A – Drawings***

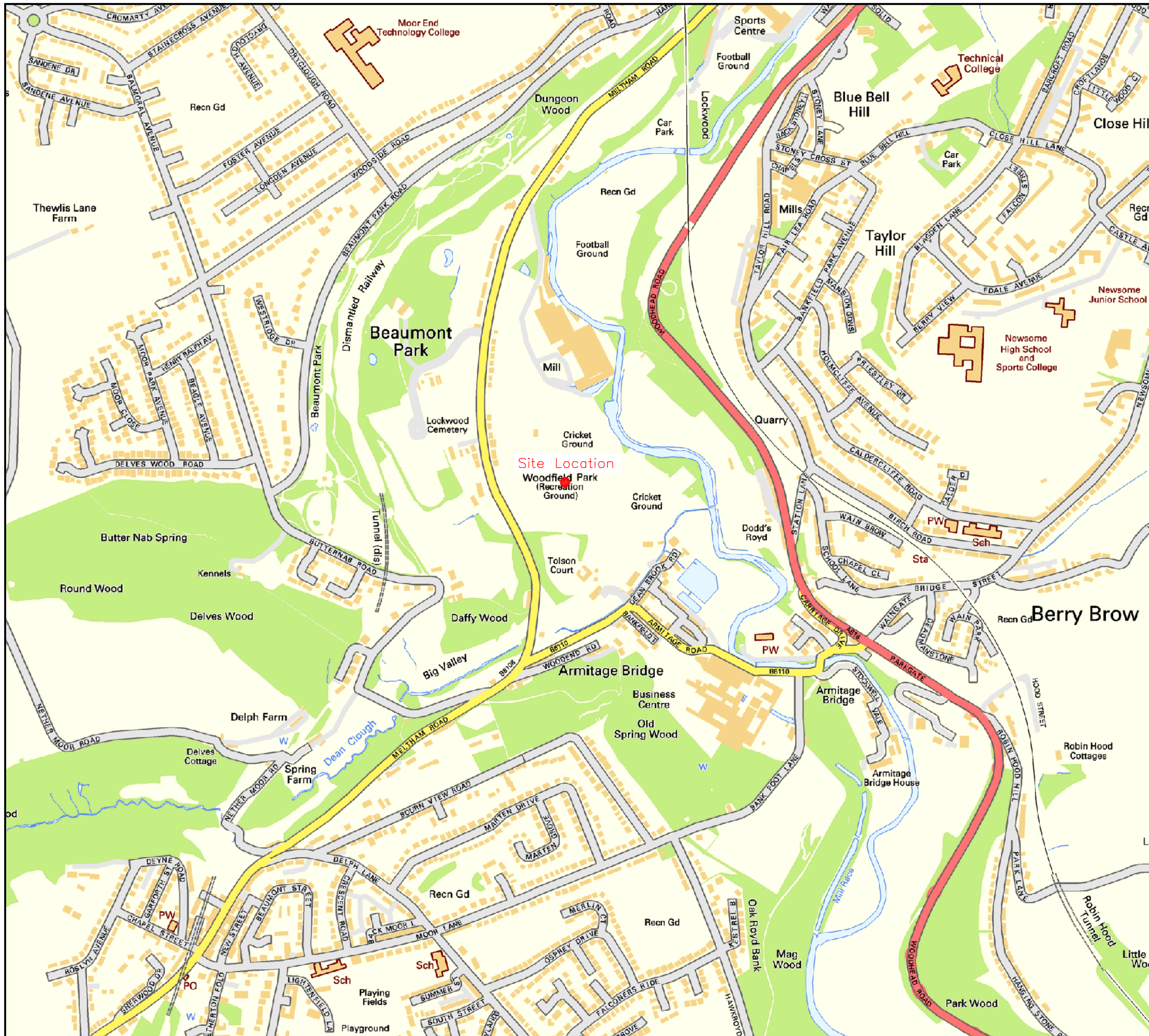
***9715-001 – Site Location Plan***

***9715-002 – Existing and Proposed Permeable Areas***

***Received Layout Plans***

***Topographical Survey***

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Site O.S. Grid Reference: 413040,414059

Rev	Amendment	Drawn	Date	Checked



Highways | Traffic | Transportation | Water

T 01924 844080 mail@sandersonassociates.co.uk  
F 01924 844081 www.sandersonassociates.co.uk

Project Name  
**Proposed Training Ground  
 Woodfield Park  
 Armitage Bridge, Huddersfield**

Drawing Title  
**Site Location**

Scale N.T.S	Drawn By TW
Drawing Size A3	Checked By DH
Date Nov 16	Approved By DH

	Drawing Number	Rev
	9715-001	



**Existing Key:**

- Site Boundary
- Area (Building)
- Area (Hardstanding)
- Permeable Area

Total Impermeable Area = 1,721m<sup>2</sup>

Permeable Area = 4,640m<sup>2</sup>

Total Area = 6,361m<sup>2</sup>

**Proposed Key:**

- Site Boundary
- Area (Building)
- Area (Hardstanding)
- Permeable Area

Total Impermeable Area = 5,896m<sup>2</sup>

Permeable Area = 465m<sup>2</sup>

Total Area = 6,361m<sup>2</sup>

Rev	Amendment	Drawn	Date	Checked

**sanderson**  
associates  
(consulting engineers) Ltd

Highways | Traffic | Transportation | Water

T 01924 844080 mail@sandersonassociates.co.uk  
F 01924 844081 www.sandersonassociates.co.uk

Project Name

**Woodfield Park  
Huddersfield**

Drawing Title

**Existing and Proposed Impermeability**

Scale 1:1000	Drawn By TW
Drawing Size A3	Checked By DH
Date 03/17	Approved By DH

	Drawing Number	Rev
	9715-002	

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Date	Revision	Rev No.

Project  
Replacement and upgrading of recreational facilities, inclusive of the demolition of existing pavilion and formation of new training facility building with ancillary sports areas for The Huddersfield Giants

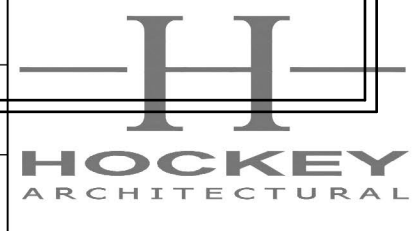
Drawing Description  
Level Survey

Drawing No.  
068-04

Scale  
1:500 @ A1

Client  
Huddersfield Sporting Pride Ltd

Date  
July 2016



KEY

SPOT LEVEL	○
CONTOUR LINE 0.5m INTERVALS	—
FENCE LINE	—
SURVEY STATION	○
RIDGE LEVEL	○
EAVES LEVEL	○
FLOODLIGHT	○

ALL POINTS AND LEVELS ARE RELATIVE TO ORDNANCE GRID AND DATUM.

Project <b>WOODFIELD PARK, MELTHAM ROAD, HUDDERSFIELD.</b>
Client <b>HUDDERSFIELD SPORTING PRIDE LTD.</b>
Drawing title <b>TOPOGRAPHICAL SURVEY, JULY 2016.</b>
Derek Brook Surveying Services Ltd 14111 Street Huddersfield West Yorkshire HP1 1AP
Scale 1:500
Drawn/Trace DB
Checked DB
Drawn number WOODFIELD001
revision date JULY 2016

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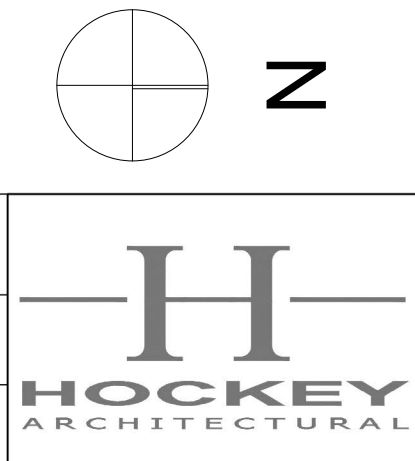
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Date	Revision	Rev No.

Project  
Replacement and upgrading of recreational facilities, inclusive of the demolition of existing pavilion and formation of new training facility building with ancillary sports areas for The Huddersfield Giants

Drawing Description  
**Site Plan**  
Drawing No.  
**068-03-R2**  
Scale  
**1:500 @ A1**

Client  
**Huddersfield Sporting Pride Ltd**  
Date  
**Oct 2016**



***Appendix B – Environment Agency Consultation***

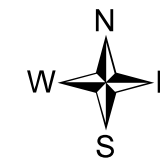
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# RFI: 30701 Flood Map for Planning for Armitage Bridge Date Created: 08/12/16

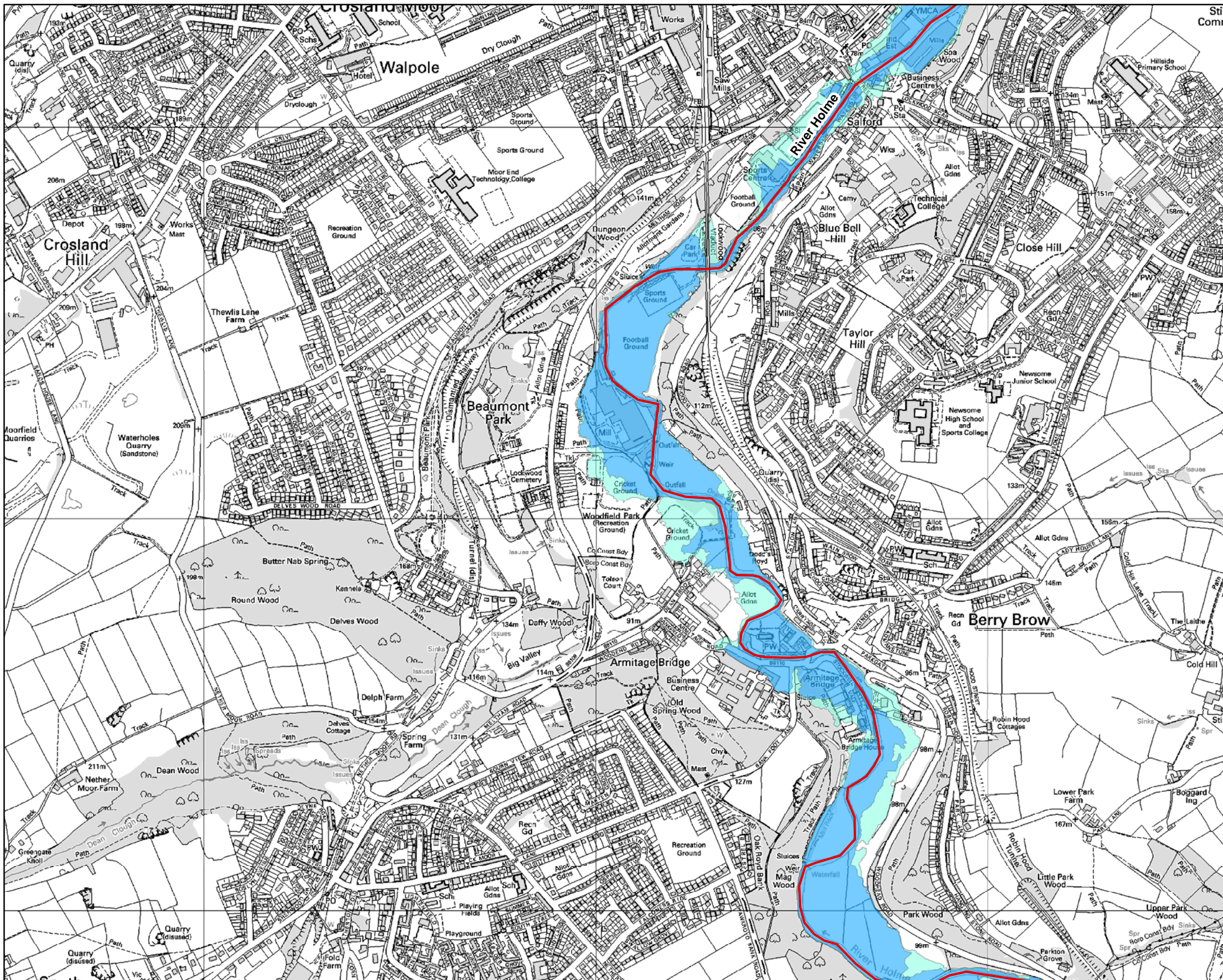


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Scale: 1:10,000



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## LEGEND

- Main River
- Flood Map Flood Defences
- Areas Benefitting From Flood Defences
- Flood Storage Areas
- Flood Zone 3 (FZ3)
- Flood Zone 2 (FZ2)

# RFI: 30701 Node Location Map - Armitage Bridge Date Created: 12/12/16



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Scale: 1:3,500

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### LEGEND

- Main River
- Node Locations

RFI: 30701

Node Point Information – Colne & Holme 2010 Model

Label	Maximum modelled stages (Maod) and flows (m3/s) - Defended Scenario											
	10 Year		25 Year		50 Year		75 year		100 Year		1000 Year	
	Max Stage	Max Flow	Max Stage	Max Flow	Max Stage	Max Flow	Max Stage	Max Flow	Max Stage	Max Flow	Max Stage	Max Flow
HOLM01_2193	79.11	78.65	79.40	97.20	79.70	115.45	79.87	126.07	79.94	130.55	80.80	206.80
HOLM01_2293	79.37	78.67	79.66	97.27	79.91	115.55	80.04	126.20	80.10	130.65	80.87	206.80
HOLM01_2416	79.68	78.74	79.90	97.44	80.09	115.76	80.20	126.47	80.25	131.08	80.94	206.80
HOLM01_2507	79.83	78.75	80.22	97.47	80.38	115.84	80.46	126.55	80.49	131.36	81.05	206.80
HOLM01_2600	80.46	78.75	80.70	97.55	80.87	115.87	80.95	126.59	80.99	131.43	81.42	206.80
HOLM01_2703u	80.79	77.50	80.89	96.31	80.96	114.64	81.00	125.37	81.05	130.24	81.67	206.80
HOLM01_2804u	81.21	77.50	81.45	96.31	81.67	114.65	81.88	125.37	82.05	130.25	83.23	204.10
HOLM01_2867	81.36	77.51	81.74	96.30	82.08	114.67	82.26	125.38	82.36	130.32	83.31	204.10
HOLM01_2982	81.92	77.51	82.22	96.31	82.42	114.69	82.53	125.40	82.59	130.48	83.30	204.10
HOLM01_3096	82.30	77.51	82.57	96.32	82.76	114.69	82.87	125.40	82.92	130.54	83.50	204.10
HOLM01_3220	83.19	77.51	83.52	96.33	83.73	114.69	83.84	125.42	83.89	130.62	84.50	204.10

Label	Maximum modelled stages (Maod) and flows (m3/s) for the Undefended Scenario - 2010 model										
	10 Year		25 Year		50 Year		75 year		100 Year		
	Max Stage	Max Flow	Max Stage	Max Flow	Max Stage	Max Flow	Max Stage	Max Flow	Max Stage	Max Flow	
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HOLM01_2293	79.36	78.51	79.66	96.88	79.90	115.24	80.04	125.87	80.09	130.27	
HOLM01_2416	79.68	78.57	79.90	97.00	80.09	115.46	80.20	126.15	80.25	130.80	
HOLM01_2507	79.83	78.60	80.21	97.07	80.38	115.52	80.46	126.25	80.49	131.09	
HOLM01_2600	80.46	78.60	80.70	97.14	80.87	115.57	80.95	126.27	80.99	131.18	
HOLM01_2703u	80.79	77.34	80.89	95.91	80.96	114.36	80.99	125.05	81.04	129.96	
HOLM01_2804u	81.21	77.33	81.45	95.90	81.67	114.36	81.88	125.06	82.04	130.00	
HOLM01_2867	81.36	77.33	81.74	95.91	82.08	114.37	82.26	125.08	82.35	130.09	
HOLM01_2982	81.92	77.33	82.22	95.92	82.42	114.37	82.53	125.10	82.59	130.33	
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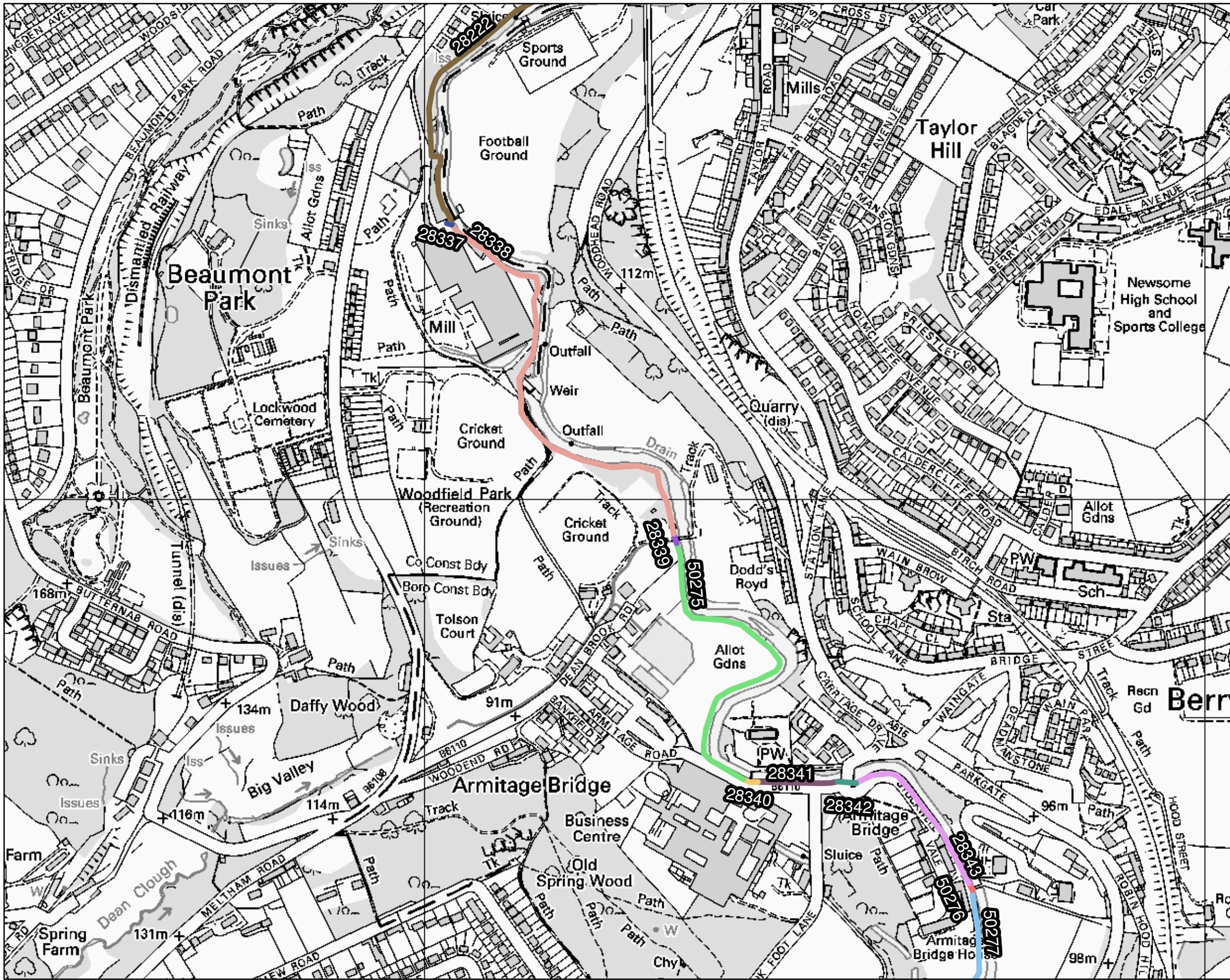
# RFI: 30701 Asset Location Map - Armitage Bridge Date Created: 12/12/16



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Scale: 1:5,000

when reproduced @ A3



**LEGEND**

Asset ID	Color	Asset ID	Color
28341	Dark Purple	28342	Teal
28222	Brown	28343	Pink
28337	Blue	50275	Light Green
28338	Orange	50276	Red
28339	Purple	50277	Light Blue
28340	Yellow		

RFI: 30701

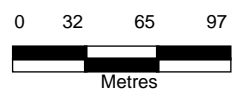
Asset Information

Asset ID	Asset Type	Asset Subtype	Maintainer	Description	Design Standard of Protection (yrs)	Actual Downstream Crest Level (mAOD)	Actual Upstream Crest Level (mAOD)	Actual Condition Rating
50277	defence	high_ground	private	NATURAL CHANNEL SIDES	Na	Na	Na	3
50276	defence	high_ground	private	OLD ACCESS BRIDGE ABUTMENT	Na	Na	Na	2
28343	defence	high_ground	private	OPEN CHANNEL	Na	Na	Na	3
28341	defence	high_ground	private	WALLED CHANNEL SIDE	Na	Na	Na	3
28342	defence	high_ground	local_authority	ROAD BRIDGE ABUTMENT 8M	Na	Na	Na	2
28340	defence	high_ground	private	FOOTBRIDGE ABUTMENT 2M	Na	Na	Na	3
50275	defence	high_ground	private	NATURAL CHANNEL SIDE	Na	Na	Na	3
28339	defence	high_ground	private	STEEL/WOODEN BRIDGE ABUTMENT 4M	Na	Na	Na	3
28338	defence	high_ground	private	WALLED CHANNEL SIDE	Na	Na	Na	2
28337	defence	high_ground	private	FOOTBRIDGE ABUTMENT	Na	Na	Na	3
28222	defence	high_ground	private	OPEN CHANNEL WITH SMALL STONE WALL	Na	Na	Na	3

# Risk of Flooding from Surface Water

## Legend

- High ( $\geq 3.3\%$ )
- Medium (3.3% - 1%)
- Low (1% - 0.1%)



## ***APPENDIX C – WinDES Calculations***

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Sanderson House  
 Jubilee Way  
 Huddersfield, WF4 4TD



**Existing 1 in 1 year run off**

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	1	PIMP (%)	100
M5-60 (mm)	19.000	Add Flow / Climate Change (%)	0
Ratio R	0.304	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	10.000	0.100	100.0	0.172	5.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	44.86	5.13	0.000	0.172	0.0	0.0	0.0	1.31	52.0	20.9

Sanderson House  
 Jubilee Way  
 Huddersfield, WF4 4TD



**Proposed 1 in 1 year run off**

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	1	PIMP (%)	100
M5-60 (mm)	19.000	Add Flow / Climate Change (%)	0
Ratio R	0.304	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	10.000	0.100	100.0	0.589	5.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	44.94	5.11	0.000	0.589	0.0	0.0	0.0	1.57	111.1	71.7

Sanderson House  
 Jubilee Way  
 Huddersfield, WF4 4TD



**Storage Estimate**

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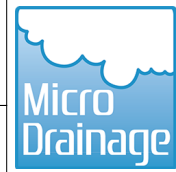
Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m <sup>3</sup> )	Status
15 min Summer	98.431	0.431	14.9	107.7	O K
30 min Summer	98.582	0.582	14.9	145.5	O K
60 min Summer	98.726	0.726	14.9	181.5	O K
120 min Summer	98.824	0.824	14.9	205.9	O K
180 min Summer	98.841	0.841	14.9	210.3	O K
240 min Summer	98.834	0.834	14.9	208.4	O K
360 min Summer	98.802	0.802	14.9	200.6	O K
480 min Summer	98.758	0.758	14.9	189.6	O K
600 min Summer	98.710	0.710	14.9	177.6	O K
720 min Summer	98.662	0.662	14.9	165.4	O K
960 min Summer	98.568	0.568	14.9	142.1	O K
1440 min Summer	98.414	0.414	14.9	103.5	O K
2160 min Summer	98.269	0.269	14.3	67.3	O K
2880 min Summer	98.195	0.195	13.4	48.8	O K
4320 min Summer	98.149	0.149	10.6	37.2	O K
5760 min Summer	98.127	0.127	8.7	31.8	O K
7200 min Summer	98.114	0.114	7.4	28.5	O K
8640 min Summer	98.105	0.105	6.4	26.1	O K
10080 min Summer	98.098	0.098	5.7	24.4	O K
15 min Winter	98.487	0.487	14.9	121.8	O K
30 min Winter	98.660	0.660	14.9	165.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m <sup>3</sup> )	Discharge Volume (m <sup>3</sup> )	Time-Peak (mins)
15 min Summer	109.649	0.0	120.1	24
30 min Summer	75.673	0.0	166.1	37
60 min Summer	49.937	0.0	220.1	64
120 min Summer	31.760	0.0	280.1	118
180 min Summer	23.941	0.0	316.7	150
240 min Summer	19.434	0.0	342.9	182
360 min Summer	14.501	0.0	383.8	250
480 min Summer	11.758	0.0	414.9	316
600 min Summer	9.982	0.0	440.4	384
720 min Summer	8.726	0.0	462.0	450
960 min Summer	7.050	0.0	497.6	578
1440 min Summer	5.206	0.0	551.0	816
2160 min Summer	3.834	0.0	609.3	1156
2880 min Summer	3.080	0.0	652.7	1500
4320 min Summer	2.259	0.0	717.6	2208
5760 min Summer	1.816	0.0	769.8	2936
7200 min Summer	1.533	0.0	812.2	3672
8640 min Summer	1.335	0.0	848.8	4400
10080 min Summer	1.188	0.0	881.0	5136
15 min Winter	109.649	0.0	134.6	24
30 min Winter	75.673	0.0	186.1	37

Sanderson House  
 Jubilee Way  
 Huddersfield, WF4 4TD

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Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m <sup>3</sup> )	Status
60 min Winter	98.830	0.830	14.9	207.4	O K
120 min Winter	98.961	0.961	14.9	240.3	O K
180 min Winter	98.986	0.986	14.9	246.5	O K
240 min Winter	98.967	0.967	14.9	241.8	O K
360 min Winter	98.913	0.913	14.9	228.2	O K
480 min Winter	98.837	0.837	14.9	209.3	O K
600 min Winter	98.756	0.756	14.9	189.1	O K
720 min Winter	98.677	0.677	14.9	169.2	O K
960 min Winter	98.530	0.530	14.9	132.5	O K
1440 min Winter	98.318	0.318	14.6	79.5	O K
2160 min Winter	98.180	0.180	13.0	45.1	O K
2880 min Winter	98.148	0.148	10.6	37.1	O K
4320 min Winter	98.119	0.119	7.8	29.7	O K
5760 min Winter	98.104	0.104	6.3	25.9	O K
7200 min Winter	98.094	0.094	5.3	23.4	O K
8640 min Winter	98.086	0.086	4.6	21.5	O K
10080 min Winter	98.081	0.081	4.1	20.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m <sup>3</sup> )	Discharge Volume (m <sup>3</sup> )	Time-Peak (mins)
60 min Winter	49.937	0.0	246.6	64
120 min Winter	31.760	0.0	313.7	120
180 min Winter	23.941	0.0	354.8	174
240 min Winter	19.434	0.0	384.1	204
360 min Winter	14.501	0.0	429.9	274
480 min Winter	11.758	0.0	464.8	348
600 min Winter	9.982	0.0	493.3	418
720 min Winter	8.726	0.0	517.5	484
960 min Winter	7.050	0.0	557.4	610
1440 min Winter	5.206	0.0	617.3	838
2160 min Winter	3.834	0.0	682.5	1132
2880 min Winter	3.080	0.0	731.1	1480
4320 min Winter	2.259	0.0	803.9	2208
5760 min Winter	1.816	0.0	862.2	2944
7200 min Winter	1.533	0.0	909.8	3664
8640 min Winter	1.335	0.0	950.7	4400
10080 min Winter	1.188	0.0	986.9	5040

Sanderson House Jubilee Way Huddersfield, WF4 4TD		
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Model Details

Storage is Online Cover Level (m) 100.000

Tank or Pond Structure

Invert Level (m) 98.000

Depth (m)	Area (m <sup>2</sup> )	Depth (m)	Area (m <sup>2</sup> )	Depth (m)	Area (m <sup>2</sup> )	Depth (m)	Area (m <sup>2</sup> )
0.000	250.0	0.700	250.0	1.400	0.0	2.100	0.0
0.100	250.0	0.800	250.0	1.500	0.0	2.200	0.0
0.200	250.0	0.900	250.0	1.600	0.0	2.300	0.0
0.300	250.0	1.000	250.0	1.700	0.0	2.400	0.0
0.400	250.0	1.100	0.0	1.800	0.0	2.500	0.0
0.500	250.0	1.200	0.0	1.900	0.0		
0.600	250.0	1.300	0.0	2.000	0.0		

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0167-1490-1500-1490
Design Head (m)	1.500
Design Flow (l/s)	14.9
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	167
Invert Level (m)	98.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	14.9
Flush-Flo™	0.445	14.9
Kick-Flo®	0.960	12.1
Mean Flow over Head Range	-	12.9

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	6.0	1.200	13.4	3.000	20.7	7.000	31.1
0.200	13.4	1.400	14.4	3.500	22.3	7.500	32.2
0.300	14.5	1.600	15.4	4.000	23.8	8.000	33.2
0.400	14.9	1.800	16.2	4.500	25.2	8.500	34.2
0.500	14.9	2.000	17.1	5.000	26.5	9.000	35.2
0.600	14.7	2.200	17.9	5.500	27.7	9.500	36.1
0.800	13.9	2.400	18.6	6.000	28.9		
1.000	12.3	2.600	19.4	6.500	30.0		