Weetwood

Development • Planning • Environment

KIRK MILL, CHIPPING

FLOOD RISK ASSESSMENT

Final Report v2.0

July 2015

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Report Title:	**Kirk Mill, Chipping** Flood Risk Assessment Final Report v2.0
Client:	SCPi Bowland Ltd
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1 INTRODUCTION

1.1 PURPOSE OF REPORT

Weetwood Services Ltd ("Weetwood") has been instructed by SCPi Bowland Ltd to undertake a Flood Risk Assessment (FRA) for the proposed redevelopment of the Kirk Mills site in Chipping.

The FRA has been undertaken in accordance with the requirements of the National Planning Policy Framework (NPPF) and supporting Planning Practice Guidance.

1.2 STRUCTURE OF THE REPORT

The report is structured as follows:

Section 1 Introduction and report structure
Section 2 Presents national and local flood risk and drainage planning policy
Section 3 Provides background information relating to the development site, the development proposals, ground conditions and existing site access arrangements
Section 4 Assesses the potential sources of flooding to the development site
Section 5 Presents flood risk mitigation measures based on the findings of the assessment
Section 6 Addresses the effect of the proposed development on surface water runoff and presents an illustrative surface water drainage scheme to ensure that surface water runoff is sustainably managed and flood risk is not increased elsewhere.
Section 7 Presents a summary of key findings
Section 8 Presents the recommendations

2 PLANNING POLICY AND GUIDANCE

2.1 NATIONAL PLANNING POLICY

The aim of the NPPF is to ensure that flood risk is taken into account at all stages in the planning process and is appropriately addressed.

2.1.1 Sequential Test

Paragraph 100 of the NPPF states that *'inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk but where development is necessary, making it safe without increasing flood risk elsewhere*'.

This policy is implemented through the application of the flood risk Sequential Test which aims to steer new development to areas with the lowest probability of flooding.

2.1.2 Exception Test

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

As detailed in paragraph 102 of the NPPF, for the Exception Test to be passed:

- It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a Strategic Flood Risk Assessment (SFRA) where one has been prepared; and
- A site-specific FRA must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

2.2 REQUIREMENTS FOR SURFACE WATER DRAINAGE SYSTEMS

Planning applications for major developments[1] are required[2] to provide Sustainable Drainage Systems (SuDS) for the management of surface water runoff, unless demonstrated to be inappropriate[3] or disproportionately expensive.

SuDS aim to mimic natural drainage and can achieve multiple objectives such as removing pollutants from urban runoff at source, controlling surface water runoff from developments, and ensuring that flood risk is not increased downstream. Combining water management with green space can provide amenity and biodiversity enhancement.

[1] Developments of 10 dwellings or more; or equivalent non-residential or mixed development (as set out in Article 2(1) of the Town and Country Planning (Development Management Procedure) (England) Order 2010)
[2] Written Statement (HCWS161) made by the Secretary of State for Communities and Local Government (Mr Eric Pickles) on 18 December 2014
[3] Paragraph 082 (Reference ID: 7-082-20150323) of the Planning Practice Guidance outlines how a sustainable drainage system might be judged to be inappropriate

In considering a development that includes a sustainable drainage system, the local planning authority will want to be satisfied that the proposed minimum standards of operation are appropriate and that there are clear arrangements in place for ongoing maintenance. Technical standards have been published by Defra in relation to the design, construction and operation of sustainable drainage systems.

2.3 LOCAL PLANNING POLICY

The Ribble Valley Borough Council SFRA states that "surface water run-off from any future site allocation, whether greenfield or brownfield, must be attenuated to existing rates at minimum."

2.4 FLOOD DEFENCE CONSENT

Flood defence consent is required before the commencement of any works in, over, or under a main river to ensure that any works do not increase flood risk, damage flood defences, or harm the environment, fisheries, or wildlife (Water Resources Act 1991). Ordinary watercourse consent is required where the watercourse is not a main river (Land Drainage Act 1991).

For main rivers, responsibility for consenting rests with the Environment Agency (EA) in England. For ordinary watercourses, responsibility usually rests with the Lead Local Flood Authority or Internal Drainage Board (Flood and Water Management Act 2010).

Undertaking activities controlled by local Byelaws (made under the Water Resources Act 1991) also requires the relevant consent. Byelaws typically include erecting an obstruction with 8 metres of a main river or erecting structures within the floodplain.

3 SITE DETAILS AND PROPOSED DEVELOPMENT

3.1 SITE LOCATION

The approximately 7.6 hectare (ha) site comprises five parcels of land to the north-west of the village of Chipping (the "northern parcels") and one parcel to the south-east. The Kirk Mill site is located at Ordnance Survey National Grid Reference SD 620 434, as shown in **Figure 1** (Note: Red line is the site application boundary and blue line indicates additional land in ownership of the applicant).

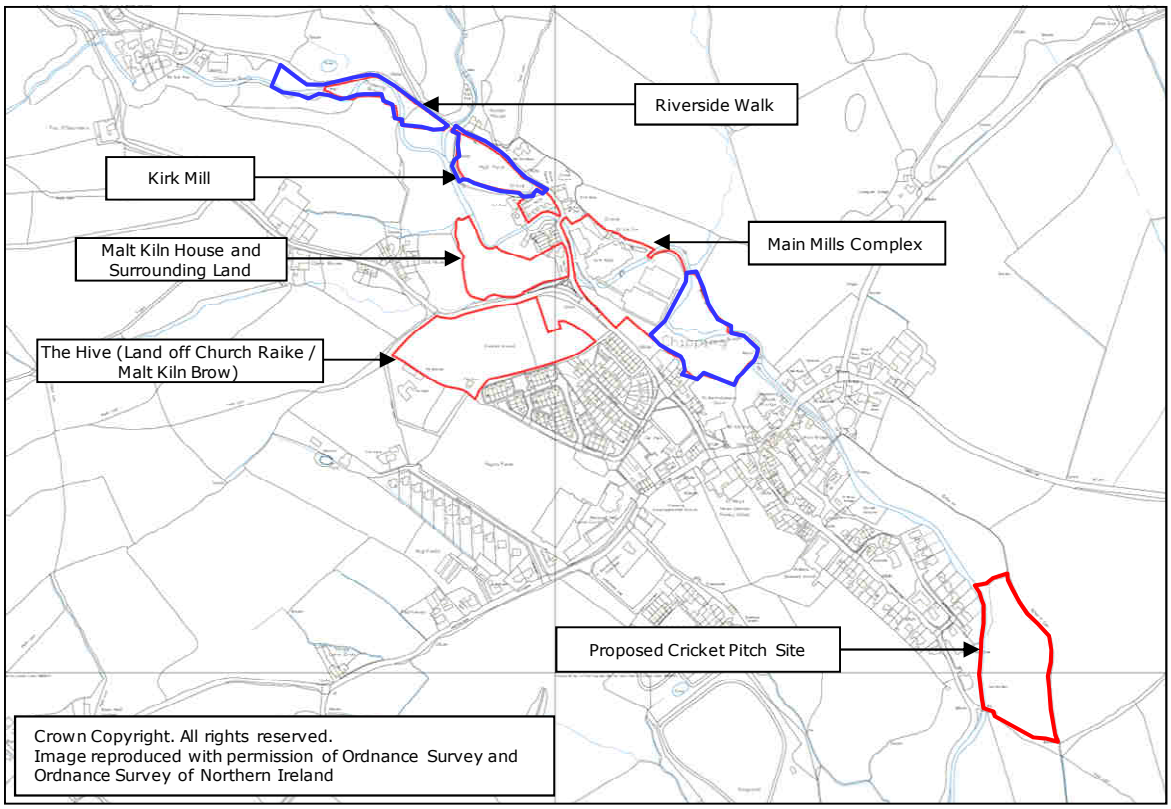

Figure 1: Site Location

3.2 EXISTING AND PROPOSED DEVELOPMENT

The Main Mills complex consists of various derelict buildings and warehouses. The Kirk Mill parcel and associated mill pond is located to the north-west of the Main Mills complex. Malt Kiln House and associated undeveloped land is located to the west of the Main Mills complex and there is agricultural land (The Hive parcel) to the south. The proposed Cricket Pitch parcel is located to the south-east of the Main Mills Complex respectively.

The proposals include the construction of the following:

1. Hotels, holiday chalets and residential units. All are classified as *'more vulnerable development'* in Table 2 of the NPPF Technical Guidance.
2. Commercial and leisure facilities (*'less vulnerable development')*
3. Access roads, car parking and public space (*'less vulnerable development'*).

The indicative masterplan is presented in **Appendix A**.

3.3 SITE LEVELS

A topographic survey of the site was undertaken by Met Geo Environmental Ltd in July 2011 and is provided in **Appendix B**. A digital terrain model (DTM) of the site is presented in **Figure 2**.

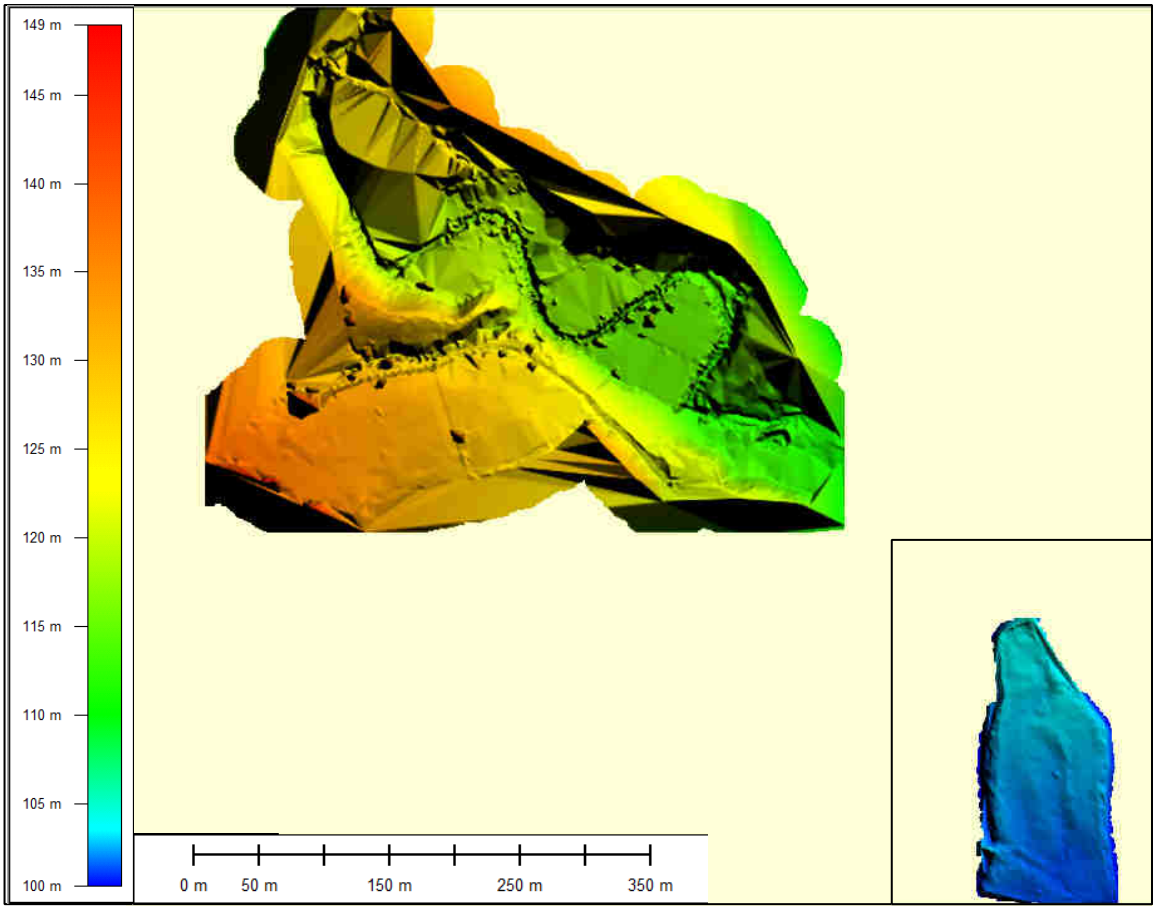

Figure 2: Digital Terrain Model

4 REVIEW OF FLOOD RISK

4.1 FLOOD ZONE DESIGNATION

Flood Zones refer to the probability of river and sea flooding, ignoring the presence of defences. The NPPF Planning Practice Guidance defines Flood Zones as follows:

- **Flood Zone 1: Low Probability**. Land having a less than 1 in 1,000 annual probability of river or sea flooding.
- **Flood Zone 2: Medium Probability**. Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or Land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding.
- **Flood Zone 3a: High Probability**. Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding.
- **Flood Zone 3b: The Functional Floodplain**. This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency.

The Flood Zones are shown on the EA Flood Map for Planning (Rivers and Sea). The Planning Practice Guidance states that the Zones shown on the EA Flood Map do not take account of the possible impacts of climate change and consequent changes in the future probability of flooding.

According to the EA Flood Map for Planning (Rivers and Sea) (**Figure 3**) the site development parcels are located in the following flood zones:

- Kirk Mill - Flood Zone 1
- The Hive - Flood Zone 1
- Malt Kiln House and Surrounding Land - Primarily within Flood Zone 1, with a small proportion at the eastern end of the development parcel located in Flood Zone 3
- Main Mills Complex - Approximately 50% located within Flood Zone 1 and 50% in Flood Zone 3
- Proposed Cricket Pitch Site - Flood Zones 2 and 3

A Level 1 SFRA was published by Ribble Valley Borough Council (RVBC) in May 2010. Paragraph 4.14 of the SFRA states "Following discussion with the EA, it is proposed that all rural/undeveloped sites within Flood Zone 3 should, at this stage, be identified as "potential" Flood Zone 3b". Malt Kiln House and the central portion of the Kirk Mills complex area are developed sites and are therefore deemed to be located in Flood Zone 3a.

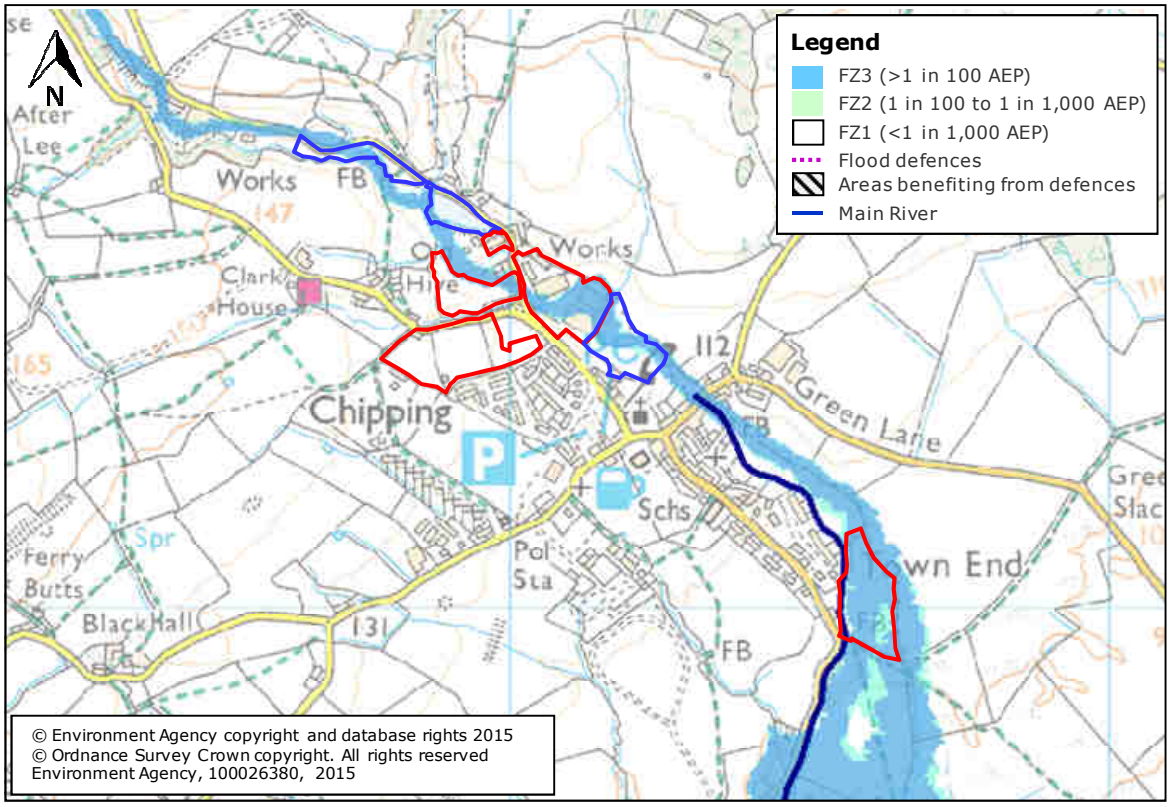

Figure 3: Environment Agency Flood Map

4.2 FLUVIAL FLOOD RISK

4.2.1 Introduction

Chipping Brook (**Figure 4**) in a principally south-easterly direction through the site. The brook is designated a Main River from the centre of Chipping. Upstream of this point, the brook is an Ordinary Watercourse.

Figure 4: Photographs of Chipping Brook

4.2.2 Historical Flooding

The EA has confirmed[4] that it does not hold any records of historic flooding at the site. No historic flood records for Chipping are recorded in the SFRA (paragraph 4.4 and Table 1 of the SFRA).

The British Hydrological Society (BHS) Chronology[5] has one record of flooding in Chipping, as follows:

"In the summer of 1851 Chipping was hit by a destructive and unique flood. The flood was quick, localised and all but put John Evans [the owner of Kirk Mill] out of business. Alfred Weld, a local landowner, later recalled that 'when the flood came down, it presented a perpendicular beast of two yards in height'. The flood was responsible for the gash in the flank of Parlick [Fell] and wreaked havoc throughout the village. Pots and pans were carried down the valley; Kirk Mill was four feet six inches deep in water. A mark was left on the side of the Talbot [inn] at the flood's highest point. Wooden bridges over Chipping Brook were washed away and the stone bridges were severely damaged."

This event was over 150 years ago and no details of the contributing factors which caused this flood event are available. The catchments and watercourses may have undergone significant changes since this event took place.

4.2.3 Flood Modelling

The EA has advised that the Flood Map flood outlines (shown in **Figure 3**) have been derived from application of the National Generalised Modelling (NGM) approach. This approach is used by the EA to generate flood outlines when more detailed flood modelling and mapping is not available. NGM has a number of limitations which can result in inaccuracy in modelled flood outlines in certain situations.

To better understand flooding mechanisms in the vicinity of the site, Weetwood has developed a detailed, site specific hydraulic model of Chipping Brook.

The model consists of a 1d component to model in-channel flows (ISIS) and a 2d component to model out of bank flood flows (TUFLOW). The extent of the 2d domain is presented in **Figure 5**; the domain does not include the Riverside Walk and Cricket Pitch parcels.

The hydraulic model has been used to:

1. Accurately map flood outlines in the vicinity of the development parcels to the north of Chipping.
2. Assess options for modifying the channel, floodplain and associated structures in order to optimise the development potential of the site.

A detailed modelling report[6] (**Appendix C**) has been reviewed by the EA, and the modelling approach and outputs approved by the EA[7] (**Appendix D**).

[4] E-mail from A Cottam (Environment Agency) to C Cornmell (Weetwood) on 8 April 2011

[5] British Hydrological Society Chronology http://www.dundee.ac.uk/geography/cbhe/

[6] Weetwood, Kirk Mill, Chipping: Chipping Brook Modelling Study Final Report v1.1, dated May 2012

[7] Letter from P Carter (EA) to J Cavill, Ref: NO/2012/103767/01-L01, 08 June 2012

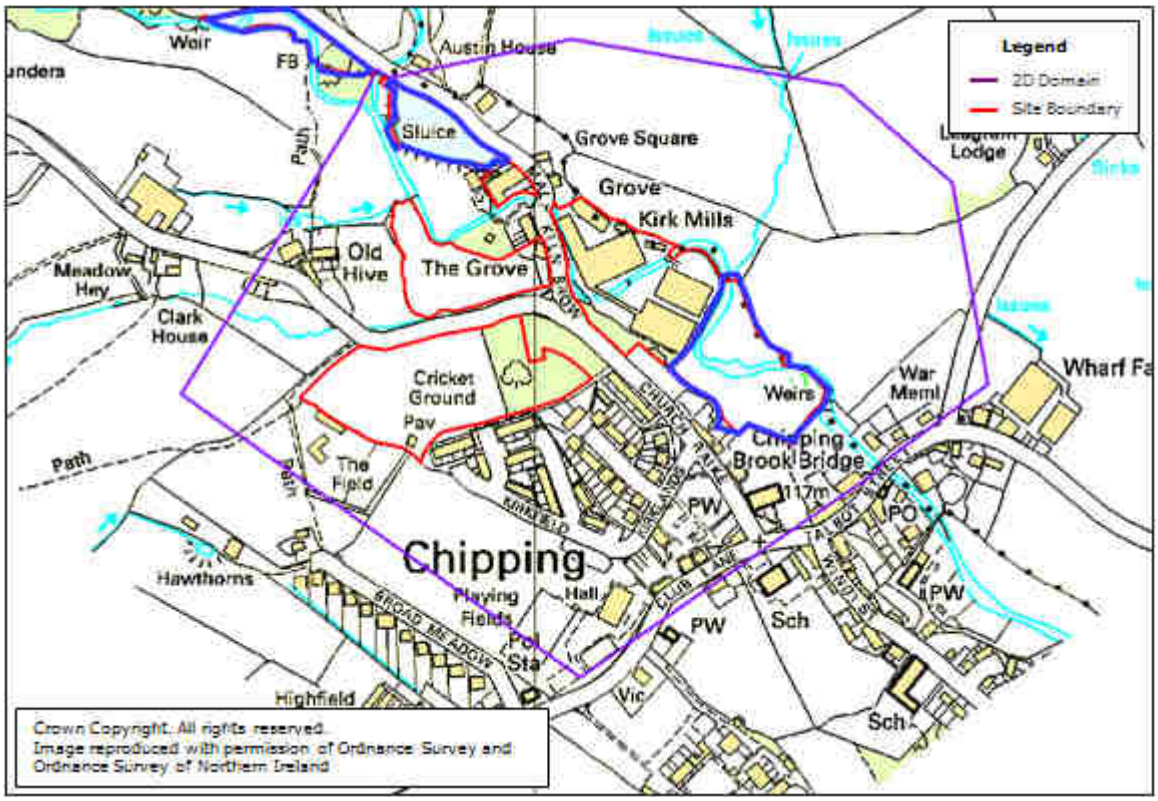

Figure 5: 2D Model Extent

4.2.4 Baseline Modelling

The flood outlines from the 1d/2d model for the 1 in 100 year, 1 in 100 year plus climate change and 1 in 1000 year events are presented in **Figure 6**. The maximum flood levels, depths and velocities at each of the modelled parcels are presented in **Table 1**.

Table 1: Maximum Flood Levels, Depths & Velocities - Baseline

Parcel	1 in 100 year			1 in 100 year + cc			1 in 1000 year		
	Level (m AOD)	Depth (m)	Velocity (m/s)	Level (m AOD)	Depth (m)	Velocity (m/s)	Level (m AOD)	Depth (m)	Velocity (m/s)
Kirk Mill	119.38	0.57	0.64	121.00	0.24	0.64	118.16	1.30	5.52
Main Mills Complex	119.61	0.81	0.89	121.15	0.44	2.21	118.50	1.38	5.76
Malt Kiln House	120.14	1.32	1.54	121.62	0.77	4.42	119.38	1.57	9.84
The Hive	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry

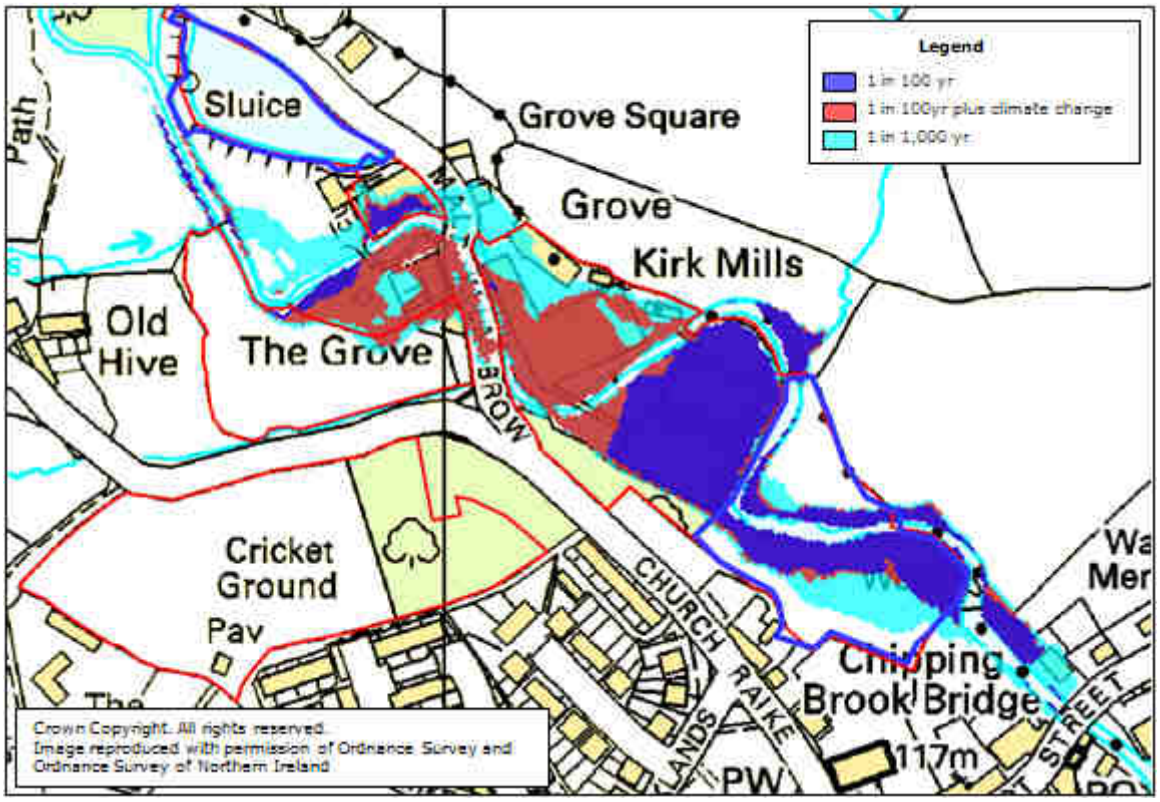

Figure 6: Modelled Flood Outlines – Baseline Scenario
(Floodplain only, hence the channel is not shown to be flooded)

The baseline modelling findings indicate the following:

1. Kirk Mill - Partially flooded during the 1 in 100 year flood event.
2. The Hive - Dry during all modelled flood events .
3. Malt Kiln House and Surrounding Land - Primarily dry during all modelled flood events, with a small proportion along the northern boundary of the development parcel being flooded during all modelled events.
4. Main Mills Complex - Approximately 40% is flooded during the 1 in 100 year event and 70% flooded during the 1 in 1000 year event.

The flood risk to the site will be mitigated though the implementation of the measures proposed in **Section 5** of this report.

4.3 FLOOD RISK FROM RESERVOIRS, CANALS AND OTHER ARTIFICIAL SOURCES

There are no canals in the vicinity of the development site. and the EA Risk of Flooding from Reservoirs Map indicates that the site is not at risk of reservoir flooding.

A mill pond is located to the north-west of Kirk Mill (see **Figure 7**).

Inflows to the mill pond are believed to have been historically taken from both Chipping Brook and Dobson's Brook. It is believed that latter inflow no longer exists and that the pond is fed by inflows from Chipping Brook. When the pond is full, excess water spills to Dobson's Brook via an overflow at the north-western end of the pond.(OS grid reference SD 6186 4370) upstream of the confluence of Dobson's Brook and Chipping Brook.

The mill pond is embanked along its southern and eastern edges. A condition survey of the embankment has been undertaken by BSCP[8] in June 2012. The report indicates, amongst others, that tree growth has damaged the clay embankment. As part of the proposed development, the Mill Pond will be drained, the embankment repaired and further survey work undertaken.

Residual flood risk associated with the mill pond will be mitigated though the implementation of the measures proposed in **Section 5** of this report.

Figure 7: Photographs of Mill Pond

4.4 GROUNDWATER FLOOD RISK

According to the British Geological Survey (BGS) Groundwater Flooding Hazard map (**Figure 8**) the susceptibility to groundwater flooding varies across the site. The four central parcels of land where the majority of development is to take place have mostly low susceptibility to groundwater flooding whilst the Riverside Walk and Cricket Pitch parcels are indicated to have moderate to significant susceptibility to groundwater flooding. The low permeability of the underlying soil will lower the risk of flooding from this source.

The residual risk of flooding from this source will be mitigated through the implementation of the measures proposed in **Section 5** of this report.

[8] BSCP, Inspection and Report; Kirk Mill Pond and Water Wheel, Project Ref: LS1271, 12 June 2012

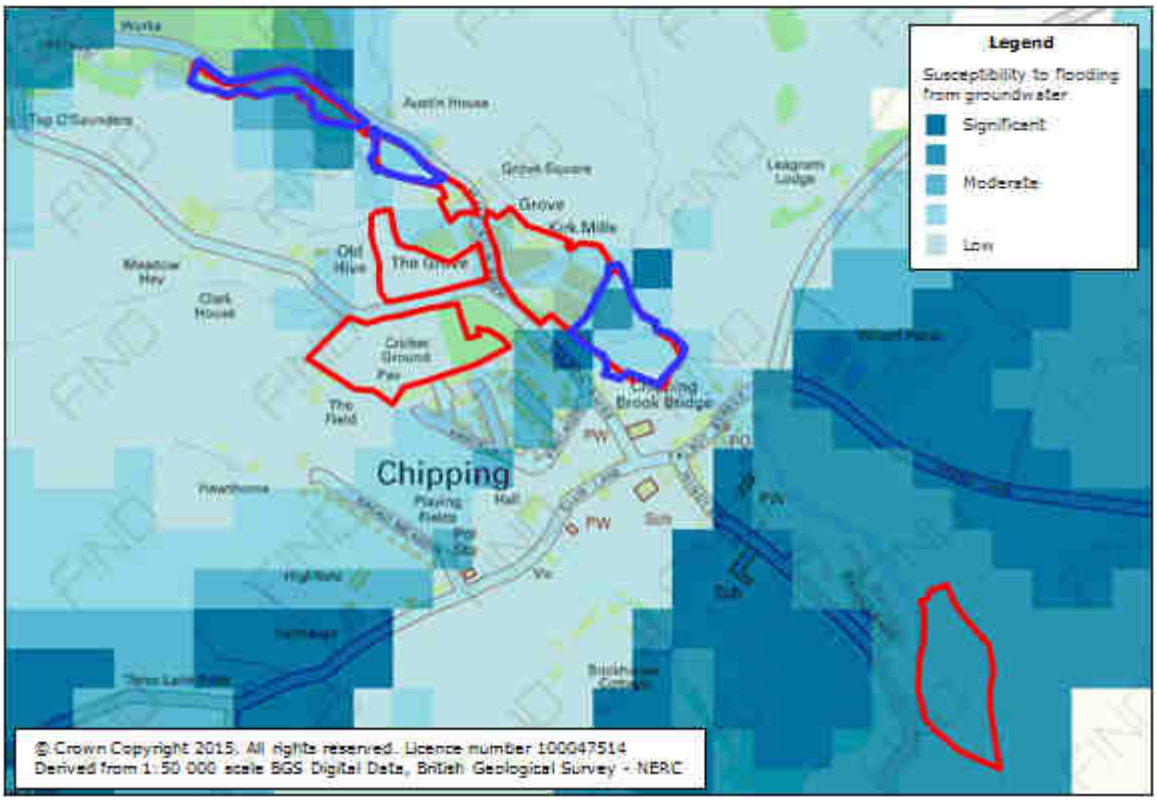

Figure 8: BGS Groundwater Flooding Hazard Map

(Source: British Geological Survey)

4.5 SURFACE WATER FLOOD RISK

The EA Risk of Flooding from Surface Water map (**Figure 9**) indicates that The Hive and Malt Kiln House parcels are at very low risk of flooding from surface water, with a medium to high risk of flooding expected within the other parcels. The EA Surface Water Depth Low Chance of Occurring map indicates that depths of flooding are expected to vary between 'less than 300 mm', '300 to 900 mm' and 'over 900 mm' across the site. The area indicated to expect depths of 'over 900 mm' is within the Mains Mill Complex.

United Utilities has no record of public sewer flooding of properties in this vicinity as a result of overloaded sewers and Lancashire County Council has stated that there are no major flooding problems with the highway surface water drainage at this location.

The risk of surface water flooding will be addressed through the mitigation measures as detailed in **Section 5** and the surface water drainage strategy in **Section 6**.

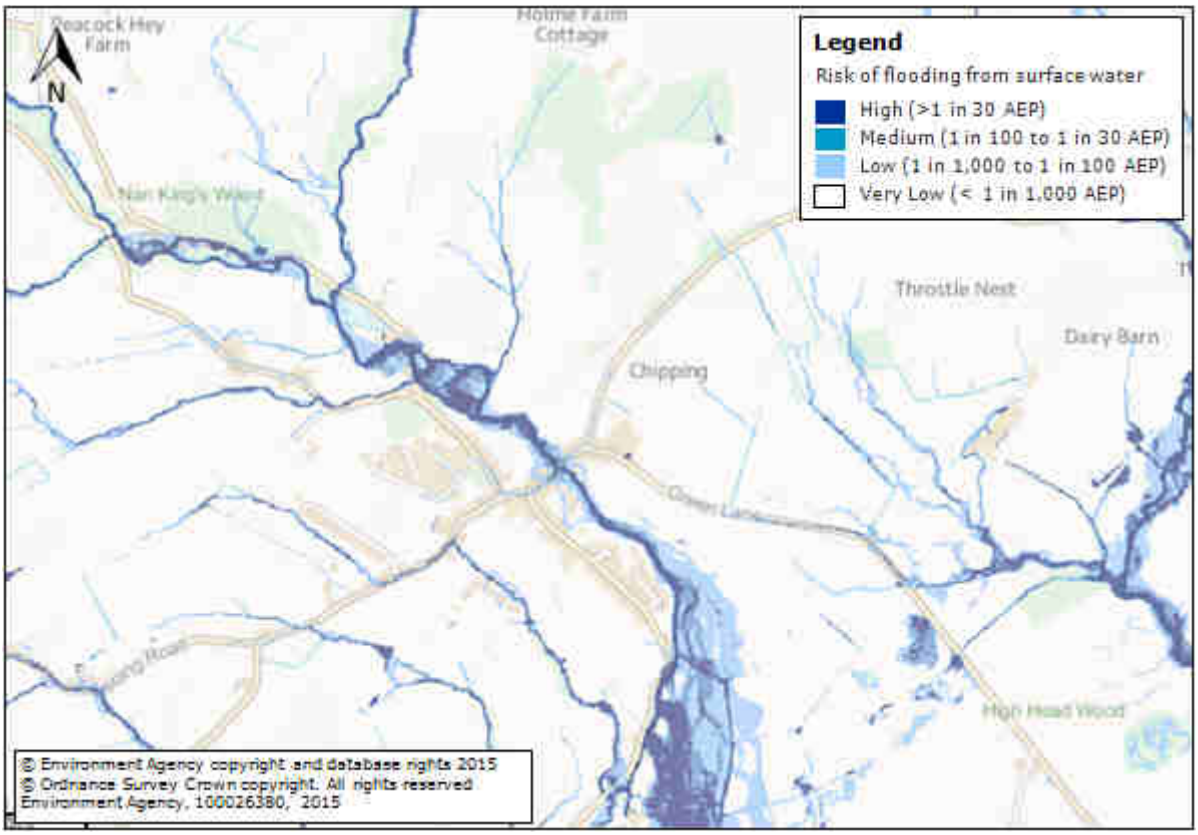

Figure 9: Environment Agency Risk of Flooding from Surface Water
(Source: EA website)

5 MITIGATION MEASURES

5.1 FLOOD MITIGATION

The flood risk to the site from all sources will be mitigated though the implementation of the measures proposed within the following section of this report.

5.1.1 Channel Alterations and Ground Raising

A scheme of measures, validated by the site specific hydraulic modelling study (see **Section 4.2.4**) has been proposed to ensure that the development remains safe throughout its lifetime and that flood risk is not increased elsewhere.

These measures are detailed as follows (refer to **Figure 10** for photographs of bridges and to Figure 11 for locations):

1. Removal of all channel bank walls within the 'Northern Area' and 'Central Area'.
2. Removal of concrete sills along 'Main Access Bridge' deck allowing water to spill over unimpeded.
3. Removal of 'Site Access Bridge 01'.
4. Removal of 'Site Access Bridge 02'.
5. Removal of 'Site Access Bridge 03'.
6. Increase crest levels along an 8 m section of wall along the southern boundary of Kirk Mill to tie into upstream and downstream crest levels (see **Figure 12**). The upstream and downstream ends of the wall will be raised to 120.33 m AOD and 119.56 m AOD respectively.
7. Raise ground levels in the 'Northern Area' to 118.78 m AOD and 117.00 m AOD at the upstream and downstream extents of the area respectively to ensure that no flooding occurs in the 1 in 100 year plus climate change event (see **Figure 12**). Width of raised strip is approximately 10 m.
8. Raise ground levels in the 'Central Area' to 117.84 m AOD and 115.34 m AOD at the upstream and downstream extents of the area respectively to ensure that no flooding occurs in the 1 in 100 year plus climate change event (see **Figure 12**). The width of the raised strip is approximately 20 m.

The Flood Map presented in **Figure 13** presents the risk of flooding at the site following the implementation of the above measures. The flood map has been derived from the 1d/2d hydraulic model. The maximum flood levels, depths and velocities that occur at each of the development parcels within the model domain are presented in **Table 2.**

Table 2: Flood Levels, Depths and Velocities - Proposed

Parcel	1 in 100 year			1 in 100 year + cc			1 in 1000 year		
	Level (m AOD)	Depth (m)	Velocity (m/s)	Level (m AOD)	Depth (m)	Velocity (m/s)	Level (m AOD)	Depth (m)	Velocity (m/s)
Kirk Mill	Dry	Dry	Dry	Dry	Dry	Dry	1.33	120.21	2.02
Main Mills Complex	121.00	0.32	0.73	121.15	0.45	2.20	121.60	0.84	4.29
Malt Kiln House	115.07	1.30	5.46	119.21	1.39	5.76	119.76	1.66	10.00
The Hive	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry

Main Access Bridge – upstream face

Site Bridge (1) – downstream face

Site Bridge (2) – upstream face

Site Bridge (3) – upstream face

Figure 10: Photographs of Bridges

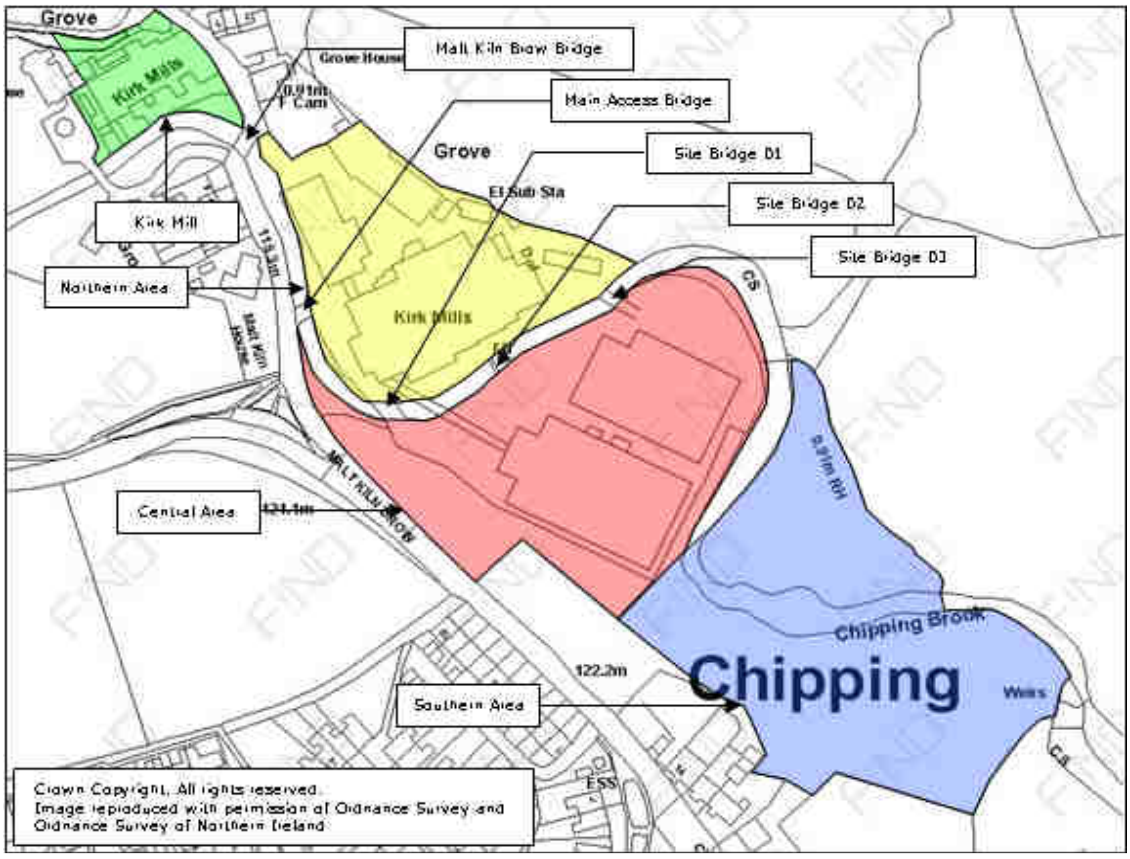

Figure 11: Proposed Scheme of Mitigation Measures

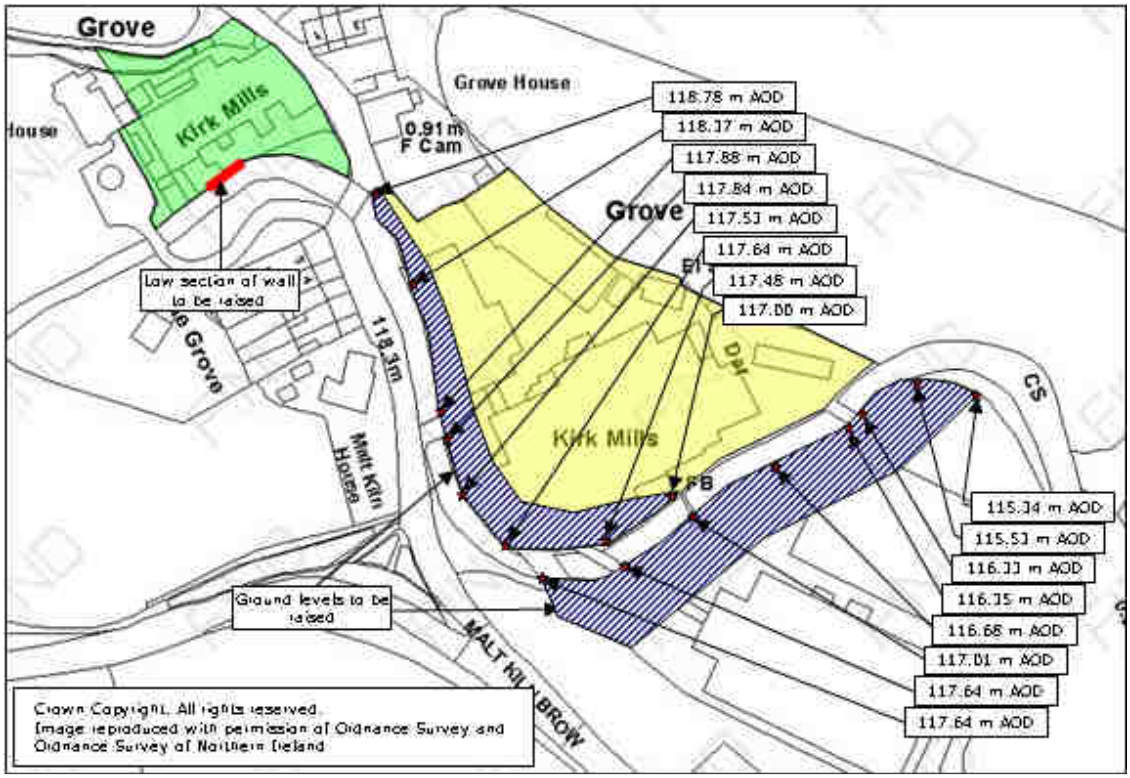

Figure 12: Proposed Increases in Levels

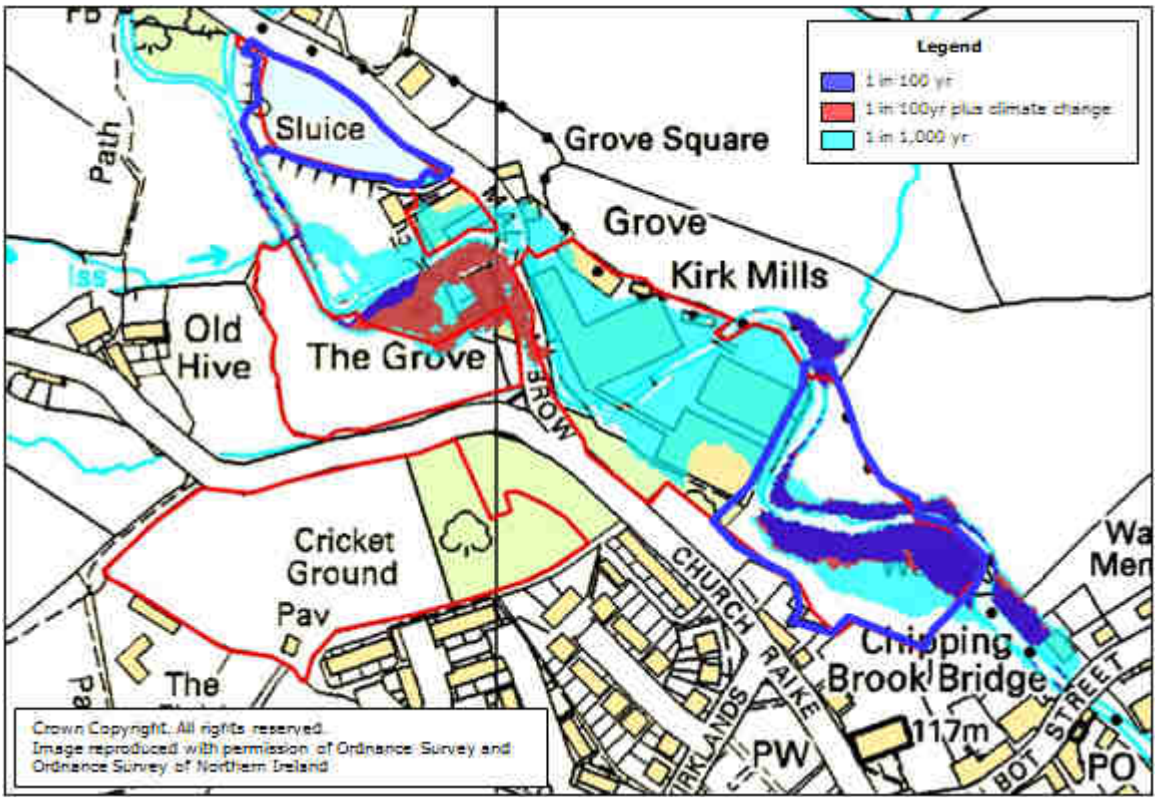

Figure 13: Modelled Flood Outlines – Proposed Scenario

5.1.2 Finished Floor Levels

Kirk Mill
The proposed development is for the refurbishment of the existing building, and as such; finished floor levels (FFL) should be set no lower than existing levels.

Malt Kiln House
The dwellings will be situated in Flood Zone 1. As such, FFL should be not less than 150 mm above adjacent ground levels.

Main Mills Complex
To ensure a minimum of 300 mm freeboard above the 1 in 100 year plus climate change flood level:

- Northernmost building (refer to **Figure 14**): FFL should be set at a minimum of 119.08 m AOD and not less than 150 mm above adjacent ground levels.
- South-western building and small north-eastern building: FFL should be set at a minimum of 118.18 m AOD and not less than 150 mm above adjacent ground levels.
- Easternmost building: FFL should be set at a minimum of 116.98 m AOD and not less than 150 mm above adjacent ground levels.
- Plant: FFL should be set at a minimum of 115.64 m AOD and not less than 150 mm above adjacent ground levels.

The Hive
The dwellings will be situated in Flood Zone 1. As such FFL should be not less than 150 mm above adjacent ground levels

Cricket Pitch
Cricket Pavilion: FFL should be set not less than 600 mm above adjacent ground levels.

5.1.3 Flood Risk Elsewhere

Any proposal to modify ground levels should demonstrate that there is no increase in flood risk to the development itself, or to any existing buildings which are known to, or are likely to flood.

Developers must ensure there will be no loss of flood flow or flood storage capacity for floods up to the 1 in 100 year event. Whilst not specified, it is generally recommend that this should be the case over the lifetime of development (i.e. should take into account climate change).

Model outputs for the 1 in 100 year plus climate change event for the existing (baseline) and post development (mitigated) scenarios are shown in **Figure 15**. The model outputs indicate that there will be in no increase to surrounding properties as a result of the proposed mitigation measures.

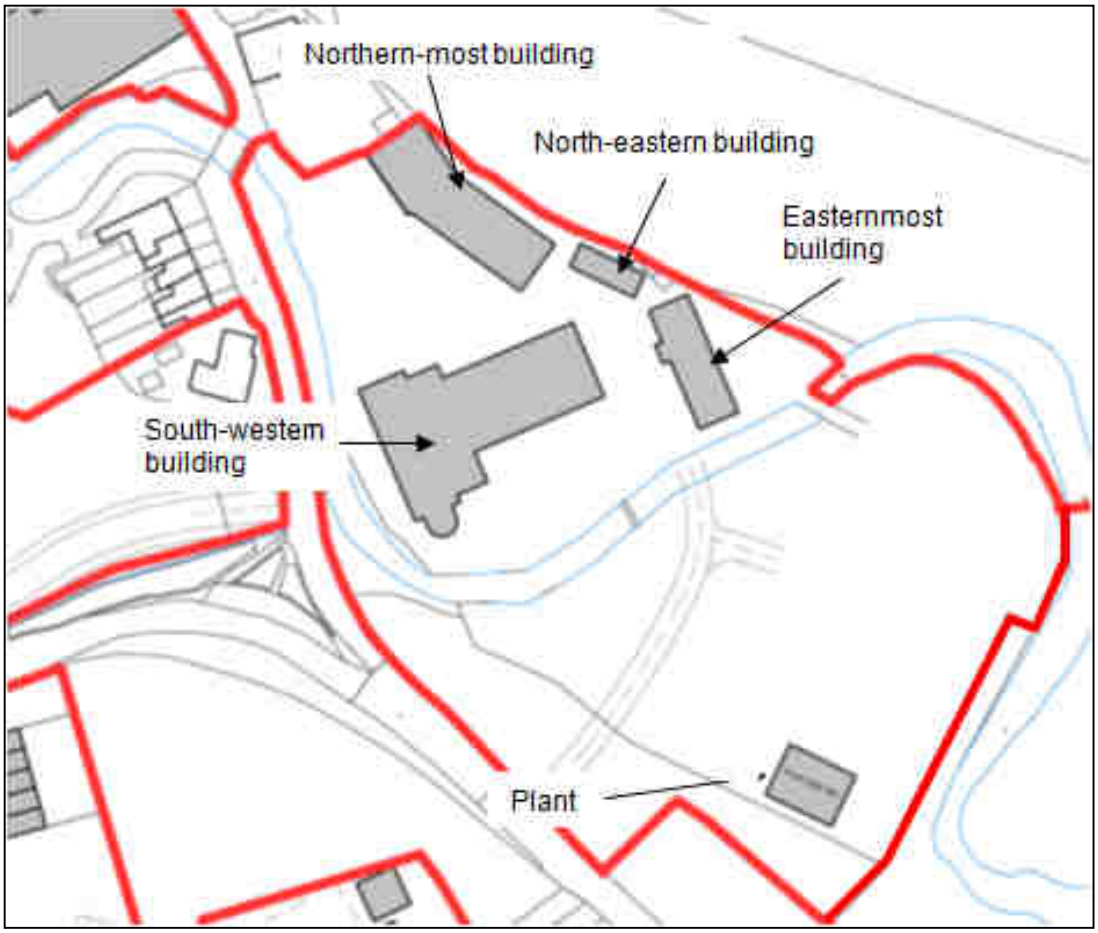

Figure 14: Naming Convention for Main Mills Complex

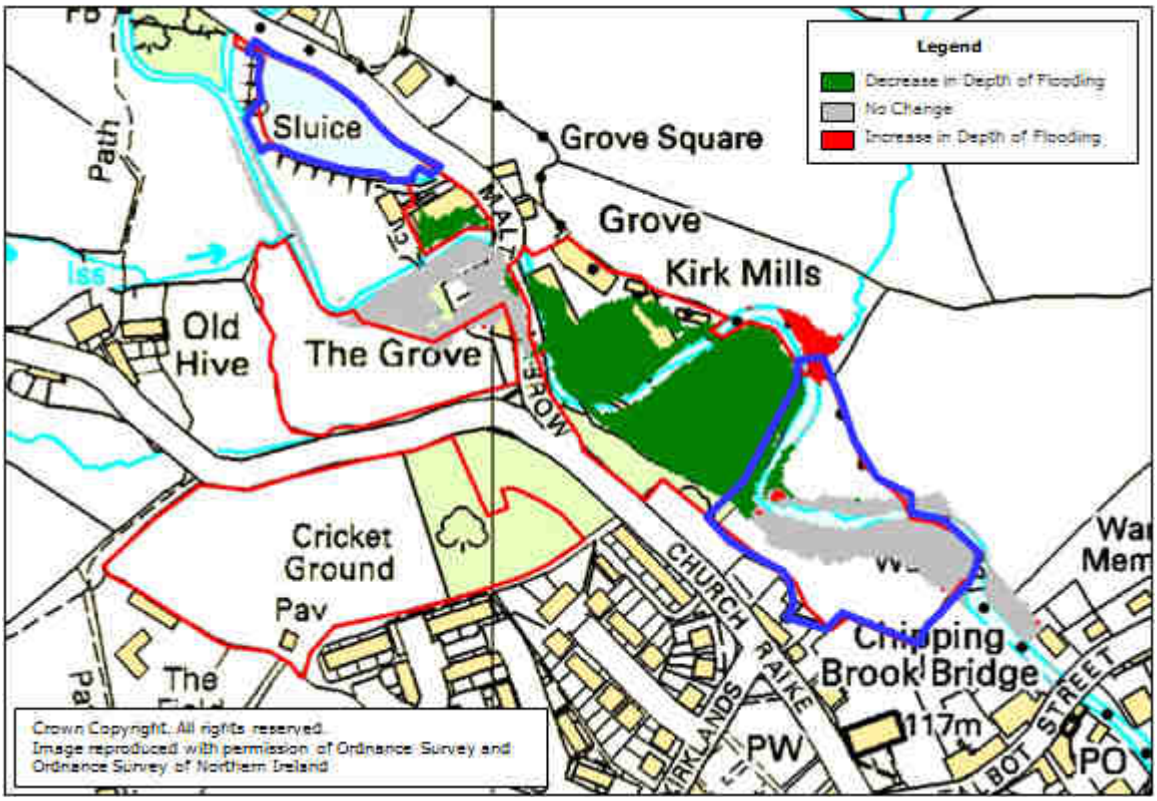

Figure 15: Comparison Plot – 1 in 100 year + cc flood event

As discussed in **Section 4.2.4**, the Cricket Pitch parcel has not been included within the model. As part of the development on this parcel of land, a club house is to be constructed. This will be located entirely within Flood Zone 3 and as such to ensure floodwater is not displaced as a result of the development, it is proposed to construct voids beneath the club house. This will ensure that there is no reduction in flood storage or change to flood flow pathways following development.

5.2 ACCESS AND EGRESS

Access and egress post development will be off Church Raike for all development parcels apart from Kirk Mill which will be accessed off Malt Kiln Brow.

Church Raike is located in Flood Zone 1 and remains dry in greater than the 1 in 1000 year flood event. Malt Kiln Brow is located outside the 1 in 1000 year outline apart from where it crosses Chipping Brook. Safe egress can be provided north along Malt Kiln Brow from Kirk Mill.

5.2.1 Proposed Access Bridge (Main Mills Complex)

A new road access bridge spanning Chipping Brook, within the Main Mills complex is proposed (see **Appendix A**).

The soffit level of the proposed road bridge should be set at a minimum of 117.27 m AOD. This is 600 mm above the modelled 1 in 100 year plus climate change flood level.

5.2.2 New Access Bridge (Cricket Pitch)

A farm track crossing exists between Longridge Road and the Cricket Pitch parcel. It is proposed to construct a new structure adjacent to and downstream of the existing bridge to provide vehicular access.

The soffit level of the new bridge should be set no lower than the existing bridge soffit to ensure the conveyance capacity of the channel is not reduced.

5.3 FLOOD WARNING

According to the EA Flood Warning Map (**Figure 16**) the Cricket Pitch parcel is located within the 'Upper River Ribble, Hodder' Flood Alert area.

It is recommended that a Flood Management Plan is prepared in consultation with Ribble Valley Borough Council's Emergency Planners prior to the site coming into use. The requirement to produce a Flood Management Plan may be conditioned as part of any planning permission granted.

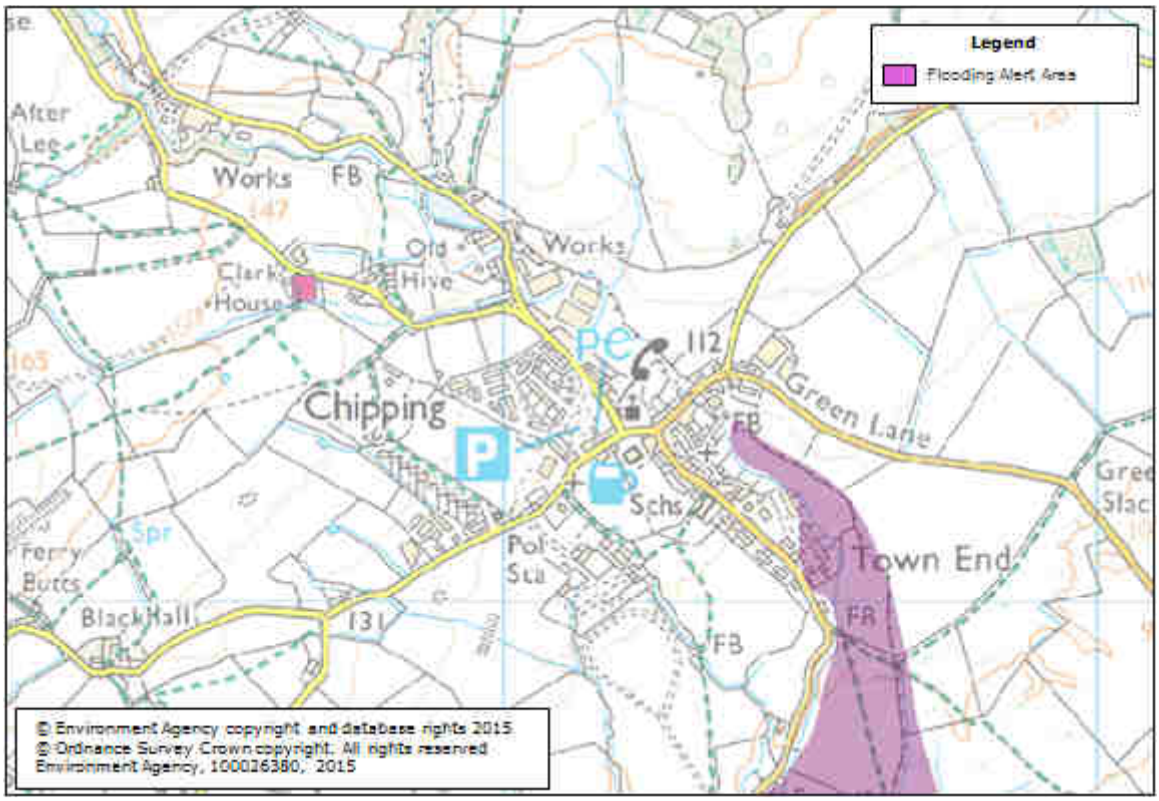

Figure 16: Environment Agency Flood Warning Map

(Source: Environment Agency website)

6 SURFACE WATER MANAGEMENT

6.1 SITE AREAS

The total development site comprises 6.426 ha.

The existing and proposed impermeable and permeable areas for the development parcels are summarised in **Table 3**.

The following areas have been omitted from the calculations because they will not impact on proposed drainage arrangements:

- Chipping Brook channel
- Impermeable surfaces relating to the Pavilion located at the Hive have been calculated as greenfield due to its small size and that it is understood that no formal drainage system exists.

Table 3 indicates that the total impermeable areas at the site will increase post development.

Table 3: Site Areas

Development Parcel	Impermeable Area (ha)		Permeable Area (ha)	
	Existing	Proposed	Existing	Proposed
Kirk Mill	0.124	0.124	0.042	0.042
Malt Kiln House and Surrounding Land	0.032	0.136	0.779	0.675
Main Mills Complex	1.170	0.712	1.064	1.522
The Hive	0.000	0.610	1.772	1.162
Cricket Pitch Site	0.000	0.000	1.443	1.443
Total Area	1.326	1.559	5.100	4.867

6.2 SURFACE WATER RUNOFF FROM THE EXISTING SITE

The existing runoff arrangements for each part of the site are summarised in **Table 4**.

Table 4: Existing Drainage Arrangements

Parcel	Existing Drainage Arrangements
Kirk Mill	It is believed that runoff drains via the existing private drainage network serving the site to Chipping Brook
Malt Kiln House and Surrounding Land	Runoff generated across the permeable areas infiltrates into the ground, drains to Chipping Brook or enters the small watercourse to the north of Church Raike road. It is not known where runoff from the impermeable areas drains to
Main Mills Complex	It is believed that runoff drains via the existing private drainage network serving the site to Chipping Brook

Parcel	Existing Drainage Arrangements
The Hive	Entirely permeable with runoff infiltrating into the ground, entering the small watercourse to the north of Church Raike road or flowing overland off the site via the south-eastern boundary
Cricket Pitch	Entirely permeable with runoff infiltrating into the ground, draining to Chipping Brook or flowing overland off the site via the southern boundary

The peak runoff rates for from each of the development parcels at the existing site are summarised in **Table 5**.

The Modified Rational Method[9] has been used to calculate existing peak runoff rates from the impermeable surfaces (**Appendix E)**. Greenfield peak runoff rates from permeable surfaces have been calculated using the ICP SuDS method within MicroDrainage. Details of the MicroDrainage input parameters and the output results are provided in **Appendix F**.

Table 5: Total Peak Runoff Rate - Existing Site

Return Period	Runoff Rate (l/s)		
	Impermeable areas	Permeable areas	Total
Kirk Mill			
1 in 1 year	18.2	0.3	18.5
1 in 2 year	23.2	0.4	23.6
1 in 30 year	41.9	0.7	42.6
1 in 100 year	52.6	0.8	53.4
Malt Kiln House and Surrounding Land			
1 in 1 year	4.7	6.4	11.1
1 in 2 year	6.0	7.4	13.4
1 in 30 year	10.8	12.5	23.3
1 in 100 year	13.5	15.3	28.8
Main Mills Complex			
1 in 1 year	170.9	8.7	179.6
1 in 2 year	217.9	10.1	228.2
1 in 30 year	393.4	17.1	411.0
1 in 100 year	493.6	21.0	515.2
The Hive			
1 in 1 year	0.0	14.5	14.5
1 in 2 year	0.0	16.8	16.8
1 in 30 year	0.0	28.5	28.5
1 in 100 year	0.0	34.9	34.9
Proposed Cricket Pitch Site			
1 in 1 year	0.0	11.8	11.8
1 in 2 year	0.0	13.7	13.7
1 in 30 year	0.0	23.2	23.2
1 in 100 year	0.0	28.4	28.4

[9] The Wallingford Procedure, Volume 4, 1981

6.3 SURFACE WATER RUNOFF FROM THE DEVELOPED SITE

The following sections describe how surface water runoff from the redeveloped site may be managed in accordance with the requirements of national and local planning policy.

Building Regulations Approved Document Part H sets out a hierarchy of preferred methods for the disposal of surface water runoff[10]. These are listed below in order of preference:

1. Disposal by infiltration - As detailed in **Section 4.4**, according to the Soilscapes maps soil conditions are described as *'loamy and clayey soils'*. It is therefore unlikely that infiltration will be a feasible method for disposal of surface water runoff from the redeveloped site.
2. Disposal to a watercourse - It is proposed to ultimately discharge all surface water to Chipping Brook. 'The Hive' and 'Malt Kiln House' will discharge to the drain flowing along the northern side of Church Raike prior to discharging to Chipping Brook.
3. Disposal to a public sewer - Following development of the site it should not be necessary to discharge surface water runoff into the public sewer system.

6.3.1 Surface Water Discharge Rates and Storage Calculations

Kirk Mill

Table 3 indicates that extent of permeable / impermeable surfaces will remain unchanged. As such, surface water will drain as per the existing arrangements.

Malt Kiln House and Surrounding Land

Impermeable areas are expected to increase by approximately 0.104 ha following development.

Runoff from the existing impermeable surfaces associated with the existing dwelling, will continue to drain as per existing arrangements.

Runoff from new impermeable areas will be restricted to a maximum rate of 5.0 l/s through the use of attenuation storage and outlet flow control device (5.0 l/s is the minimum achievable discharge rate from a 100 mm diameter flow control device).

The surface water storage facilities have been modelled using the Detailed Design module of MicroDrainage Source Control (**Appendix G**). The required storage volume has been sized to store the 1 in 100 annual probability rainfall event including a 30% increase in rainfall intensity in order to allow for climate change in accordance with EA guidance[11].

The modelling indicates that a storage volume of 45 m^3 would be required. The form of storage used will be confirmed by the detailed design, but may be achieved by permeable paving on the driveways and road, provision of a detention basin or over-sized pipes.

[10] Building Regulations Approved Document H Section 3 page 45

[11] Climate Change Allowances for Planners – Guidance to Support the National Planning Policy Framework, September 2013, EA ref: LIT 8496 NA/EAD/Sept 2013/V12

Permeable areas will drain at Greenfield runoff rates.

Main Mills Complex

Table 3 indicates that impermeable areas are expected to decrease by approximately 0.458 ha following redevelopment. The reduction in surface water runoff will provide significant betterment compared to the existing situation, with peak runoff rates decreasing by 38%.

It is therefore proposed to discharge surface water from the redeveloped parcel unrestricted to Chipping Brook.

The permeable areas will drain at Greenfield runoff rates.

The Hive

Table 3 indicates that impermeable areas are expected to increase by approximately 0.610 ha following development.

Runoff rates from the proposed impermeable areas will be limited to 5.0 l/s, the existing 1 in 1 year Greenfield runoff rate. This will ensure that runoff rates from the parcel do not increase following redevelopment, and that betterment is provided.

The surface water storage facilities have been modelled using the Detailed Design module of MicroDrainage Source Control (**Appendix G**). The required storage volume has been sized to store the 1 in 100 annual probability rainfall event including a 30% increase in rainfall intensity in order to allow for climate change in accordance with EA guidance[12]. The modelling indicates that a storage volume of 665 m^3 would be required.

The form of storage used will be confirmed by the detailed design, but may be achieved by permeable paving on the driveways and road, provision of a detention basin or over-sized pipes.

Permeable areas will continue to drain at greenfield runoff rates.

Cricket Pitch

Table 3 indicates that impermeable surfaces at the cricket pitch area will marginally increase post-development**.** The proposed access road and car parking will comprise unsurfaced self-binding gravel which will therefore not increase surface water runoff.

Given the size of the club house, the impact on surface water runoff is assessed to be negligible. As such it is therefore proposed to discharge surface water runoff unrestricted to Chipping Brook.

6.3.2 Volume Control

For Malt Kiln House Parcel and The Hive Parcel, the difference in the volume of runoff leaving the site resulting from the proposed development has been calculated using the long-term storage formula presented in the SuDS Manual[12]. Impermeable areas for the remaining parcels do not increase following redevelopment and as such the volume of runoff will not increase.

[12] The SuDS Manual, Box 4.11, page 135

Based upon this, an additional 33 m^3 and 193 m^3 of surface water runoff would be expected respectively from the developed parcels (**Appendix I**).

Defra/EA guidance[13] state that the additional volume of surface water runoff should be accounted for within the drainage strategy by providing a 'long term storage' facility which will be designed to discharge at a maximum rate of 2.0 l/s/ha. As the minimum discharge rate from a flow control device is 5 l/s and given the storage volumes already being provided for each parcel, additional 'long term storage' is not required.

6.3.3 Maintenance of SuDS

SuDS elements within the curtilage of residential dwellings would be the responsibility of the owner of the property.

The pipe network, designed to Sewers for Adoption (7^{th} edition) standard, may be adopted by the sewerage undertaker. SuDS in open spaces may be adopted by the water company or maintained by a management company.

6.3.4 Summary

The purpose of this FRA is to demonstrate that a surface water drainage strategy is feasible for the site given the development proposals and the land available. The proposals provide the opportunity for the inclusion of SuDS elements, ensuring that there will be no increase in surface water runoff from the proposed development. The storage calculations may be refined at the detailed design stage and a final decision made on the types of storage to be provided

[13] Rainfall runoff management for developments – Report SC030219, Defra/EA

7 SUMMARY

There are proposals for mixed use development on a number of parcels of land located north-west and south-east of Chipping.

According to the EA flood map; areas of the proposed development site are located within the 1 in 100 year and 1 in 1000 year flood outlines and are situated within Flood Zone 1, Flood Zone 2 and Flood Zone 3 as defined by the NPPF.

A sequential approach has been taken for the development masterplanning with residential units located in Flood Zone 1.

Chipping Brook flows in a south-easterly direction through the site. In order to identify and assess the level of flood risk to the site a 1D-2D hydraulic model of the brook has been developed. The model outputs indicate that Kirk Mill and the Main Mills Complex development parcels are at risk of fluvial flooding. The risk of flooding from all other sources is assessed to be low.

Flood risk from will be mitigated through the implementation of a package of measures including raising of finished floor levels, removal of obsolete bridges along Chipping Brook, and ground raising on the development parcels.

Safe access and egress to/from the development parcels will be provided via Church Raike, Malt Kiln Brow or Longridge Road.

Following development the overall impermeable areas at the site will increase in some areas and decrease in others. A surface water drainage scheme has been developed to demonstrate that surface water runoff can be sustainably managed in accordance with national and local policy without increasing flood risk elsewhere. The scheme will enable phased development conditions to be applied in line with this strategy.

8 RECOMMENDATIONS

This FRA has demonstrated that the proposed development may be completed without conflicting with the requirements of the NPPF subject to implementation of the following mitigation measures.

8.1 CHANNEL MODIFICATIONS AND GROUND RAISING

Channel Modifications (refer to Figure 11)

- Removal of all channel bank walls within the 'Northern Area' and 'Central Area'.
- Removal of concrete sills along 'Main Access Bridge' deck allowing water to spill over unimpeded.
- Removal of 'Site Access Bridge 01'.
- Removal of 'Site Access Bridge 02'.
- Removal of 'Site Access Bridge 03'.

Ground Raising (refer to **Figure 12**)

- Increase crest levels along an 8 m section of wall along the southern boundary of Kirk Mill to tie into upstream and downstream crest levels. The upstream and downstream ends of the wall will be raised to 120.33 m AOD and 119.56 m AOD respectively.
- Raise ground levels in the 'Northern Area' to 118.78 m AOD and 117.00 m AOD at the upstream and downstream extents of the area respectively
- Raise ground levels in the 'Central Area' to 117.84 m AOD and 115.34 m AOD at the upstream and downstream extents of the area respectively.

8.2 FINISHED FLOOR LEVELS

Kirk Mill Parcel

Finished floor levels (FFL) should be set no lower than existing levels.

Malt Kiln House Parcel

- FFL should be 150 mm above adjacent ground levels.

Main Mills Complex Parcel

To ensure a minimum of 300 mm freeboard above the 1 in 100 year plus climate change flood level:

- Northern-most building (refer to **Figure 14**): FFL should be set at a minimum of 119.08 m AOD and not less than 150 mm above adjacent ground levels.
- South-western building and small north-eastern building: FFL should be set at a minimum of 118.18 m AOD and not less than 150 mm above adjacent ground levels.
- Eastern-most building: FFL should be set at a minimum of 116.98 m AOD and not less than 150 mm above adjacent ground levels.

- Plant: FFL should be set at a minimum of 115.64 m AOD and not less than 150 mm above adjacent ground levels.

The Hive Parcel

- FFL not less than 150 mm above adjacent ground levels

Cricket Pitch Parcel

- Cricket Pavilion FFL should be set not less than 600 mm above adjacent ground levels.

8.3 NEW BRIDGE CROSSINGS

- Main Mills Complex: Soffit level to be set at a minimum of 117.27 m AOD
- Cricket Pitch parcel: Soffit level to be set not lower than the existing soffit level

8.4 FLOOD MANAGEMENT PLAN

A Flood Management Plan should be prepared for the Cricket Pitch parcel in consultation with Ribble Valley Borough Council's Emergency Planners

8.5 SURFACE WATER DRAINAGE SCHEME

The detailed drainage design for each development parcel, developed in accordance with the principles set down in this FRA, should be submitted to and approved by the local planning authority prior to the commencement of development of each land parcel.

APPENDIX A: Development Proposals

KEY PLAN

Application Site Boundary

Additional Land in Ownership of Applicant

REV.	DATE:	DETAILS:
C	07/05/15	Residential layout revised. Trailhead centre removed.
B	13/10/14	Footpath to Kirklands amended.
A	03/03/14	Proposed bridge removed, cricket pavilion relocated.

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PROJECT:
Chipping
Masterplan

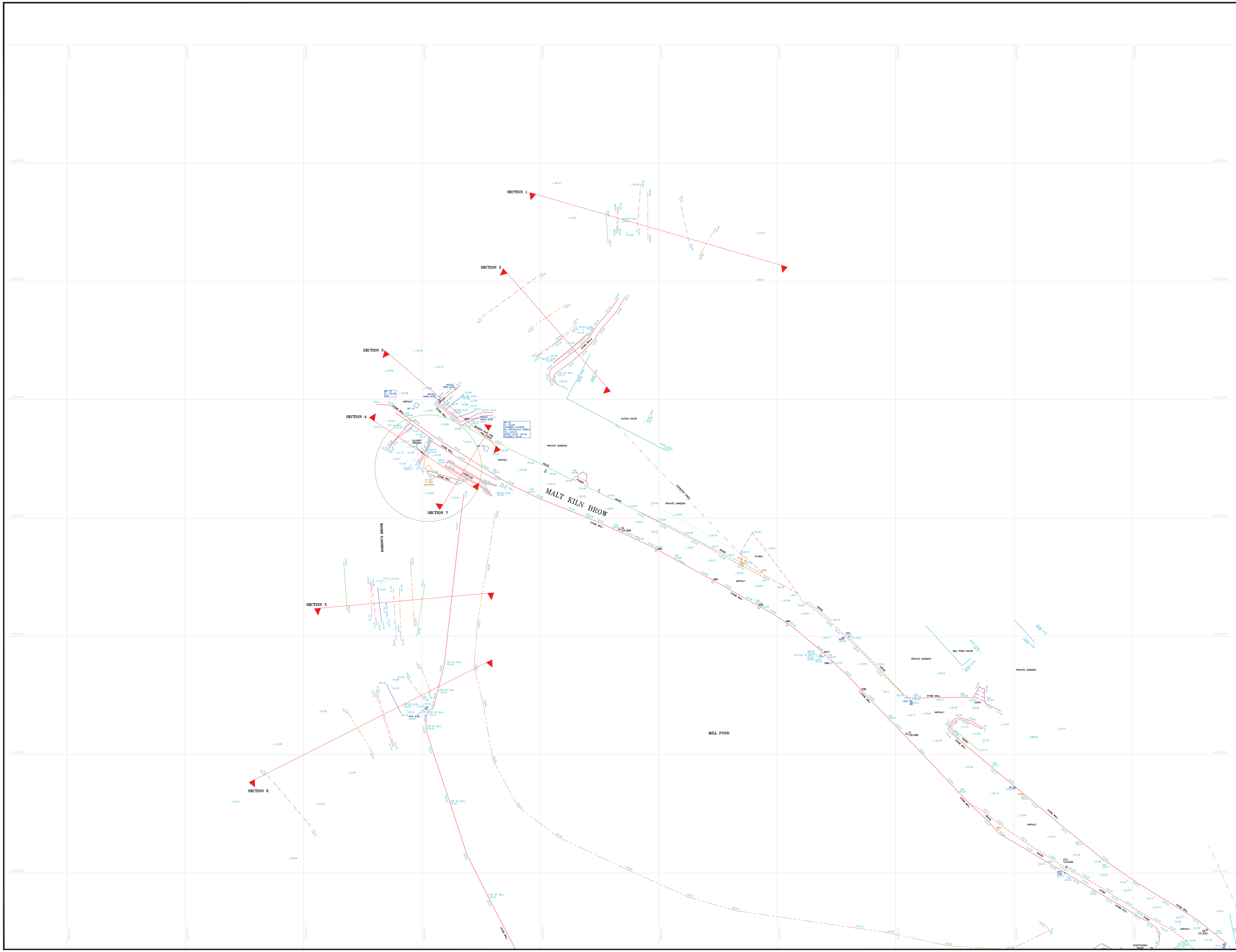
TITLE:
Indicative Masterplan

SCALE:	ORIGIN DATE:	DRAWN:	CHECKED:
1:2000 A1	20.08.13	JDH	JM

STATUS:
Planning

PROJECT	DRAWING NO:	REV:
05024	_MP_00_103	C

APPENDIX B: Topographic Survey



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N

Direction of North

Grid : OS National Grid.
Using the OS GPS Network and applying OSTN02 transformation and then removing the scale factor for true distances with a one-step transformation centred on S1

Datum : OS Level Datum.
Using the OS GPS Network and applying OSGM02 National Geoid Model to obtain local area corrections.

Station Listing

Station	Easting	Northing	Level	I11	361955.011	443486.245	126.610
B1	361990.872	443600.341	117.503	I12	361997.595	443503.024	125.139
B2	361971.395	443593.866	117.939	I13	362050.183	443470.283	123.654
B3	362019.442	443558.684	116.527	I14	362017.182	443519.012	119.681
B4	362023.903	443541.205	117.744	I15	362093.064	443436.198	122.433
B5	362037.408	443514.971	115.958	I16	362074.508	443445.676	122.822
B6	362047.575	443504.153	115.819	I17	362136.820	443389.847	120.906
B7	362066.296	443502.894	115.522	I18	362152.990	443410.950	120.763
B8	362082.743	443512.461	115.201	I19	362157.576	443411.991	120.379
B9	362108.919	443536.371	114.963	I20	362227.116	443379.120	118.349
B10	362128.538	443548.229	114.628	I21	362135.044	443416.389	121.121
B11	362159.299	443554.749	115.077	L1	361974.923	443577.202	119.780
B12	362174.652	443511.138	113.781	L2	361975.200	443557.658	120.186
B13	362167.332	443493.254	113.246	S1	362009.053	443588.846	119.606
B14	362146.002	443455.454	112.837	S2	362023.260	443531.814	118.709
B15	362159.319	443452.239	113.537	S3	362053.462	443503.953	117.391
B16	362180.784	443435.763	113.065	S4	362112.022	443540.124	117.060
B17	362218.398	443435.061	113.061	S5	362087.789	443563.880	117.647
B18	362262.137	443421.483	111.363	S6	362060.986	443561.615	117.883
C1	362076.815	443519.796	117.419	S7	362034.576	443581.755	118.532
C2	362158.823	443505.854	115.675	S8	362007.366	443613.048	119.712
C3	362133.182	443452.992	115.625	S9	361992.558	443630.424	121.552
C4	362076.977	443481.864	115.808	S10	361980.784	443624.431	121.685
C5	362033.936	443531.582	117.738	S11	361974.484	443626.974	121.942
C6	362048.697	443551.662	117.860	S12	361963.746	443620.887	122.359
C2A	362140.256	443465.723	115.546	S13	361969.131	443618.920	121.139
C3A	362090.370	443473.828	115.739	S14	361957.333	443612.004	119.187
C3B	362105.790	443466.622	115.702	S15	361966.550	443598.465	119.162
C3C	362118.963	443460.075	115.665	S16	361990.910	443607.427	119.524
G1	361941.848	443663.546	126.086	S11A	361960.249	443618.564	122.460
G2	361893.287	443698.095	125.968	S1A	361983.649	443589.375	119.565
G3	361918.678	443524.885	130.950	S1C	361992.757	443608.818	119.593
G4	361843.469	443472.682	131.087	S1D	361974.713	443601.906	119.206
G1A	361968.879	443641.061	124.606	S3A	362042.089	443516.163	117.465
I1	361967.119	443519.179	126.857	S6A	362072.044	443562.692	117.719
I2	361894.565	443571.979	121.391	S6B	362030.833	443583.301	118.559
I3	361990.694	443527.899	124.876	S8A	362012.166	443601.047	119.278
I4	362013.381	443569.325	118.301	S9A	362003.035	443619.892	120.288
I5	361808.220	443440.708	135.944	T1	362129.563	443596.927	127.021
I6	361860.540	443464.165	130.936	T2	362190.475	443560.007	120.318
I7	361840.426	443417.021	135.991	T3	362191.921	443473.255	116.092
I8	361906.552	443449.104	132.884	T4	362191.506	443530.074	116.605
I9	361904.399	443367.140	131.783	T1A	362069.731	443600.928	126.656
I10	361903.753	443480.011	129.464	T4A	362227.351	443490.015	119.940
				K1	362596.498	442917.776	101.821
				K2	362584.599	442949.978	102.247
				K3	362609.627	443008.992	102.730

Layout Key

(1) (2) (3) (4) (5) (6) (7) (8)

KEY

AIR VALVE	AV	KERB OUTLET	KO
BENCH MARK	BM	LAMP POST	LP
BIN	BIN	MANHOLE (CIRCULAR)	MH
BOLLARD	BOL	MANHOLE (RECTANGULAR)	MH
BORE HOLE	BH	MANHOLE (TRIANGULAR)	MH
BRITISH TELECOM COVER	BT	MARKER POST	MKR
BUS STOP	BUS	ROAD GULLY	RG
CABLE TV COVER	CATV	RODDING EYE	RE
CABLE TV SUPPLY	CA	SIGN POST	SIGN
COLUMN	COL	TELECOM COVER	TEL
EARTHING POINT	ER	TELEGRAPH POLE	TP
ELECTRICITY COVER	ELEC	THRESHOLD LEVEL	THL
ELECTRICITY POLE	EP	TRAFFIC LIGHT	TL
FIRE HYDRANT	FH	TRIAL PIT	PIT
GAS VALVE	GAS	WASH OUT	WO
GATE		WATER METER	WM
INSPECTION COVER (CIRCULAR)	IC	WATER STOP COCK	SC
INSPECTION COVER (RECTANGULAR)	IC	WATER STOP VALVE	SV
COVER LEVEL	CL	CHAMBER BASE LEVEL	Ch.L
INVERT LEVEL	IL	WATER SURFACE LEVEL	WL
UNABLE TO RAISE	UTR	UNABLE TO MEASURE	UTM
GIRTH OF TREE TRUNK	G	DIAMETER OF TREE TRUNK	D
HEIGHT TO TOP OF TREE CANOPY	H	MULTI BOLE TREE	MB

Rev	Date	Drawn	Description	Check
A	20/05/2013	KZ	Additional area surveyed.	DA

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Client
Till Assett Management LLP

Site
HJ BERRY & SONS, KIRK MILLS, CHIPPING, PRESTON

Title
TOPOGRAPHICAL SURVEY 2D

Surveyed	CC IG	Drawn	CC IG
Chk.	DA	Date	11/07/2011

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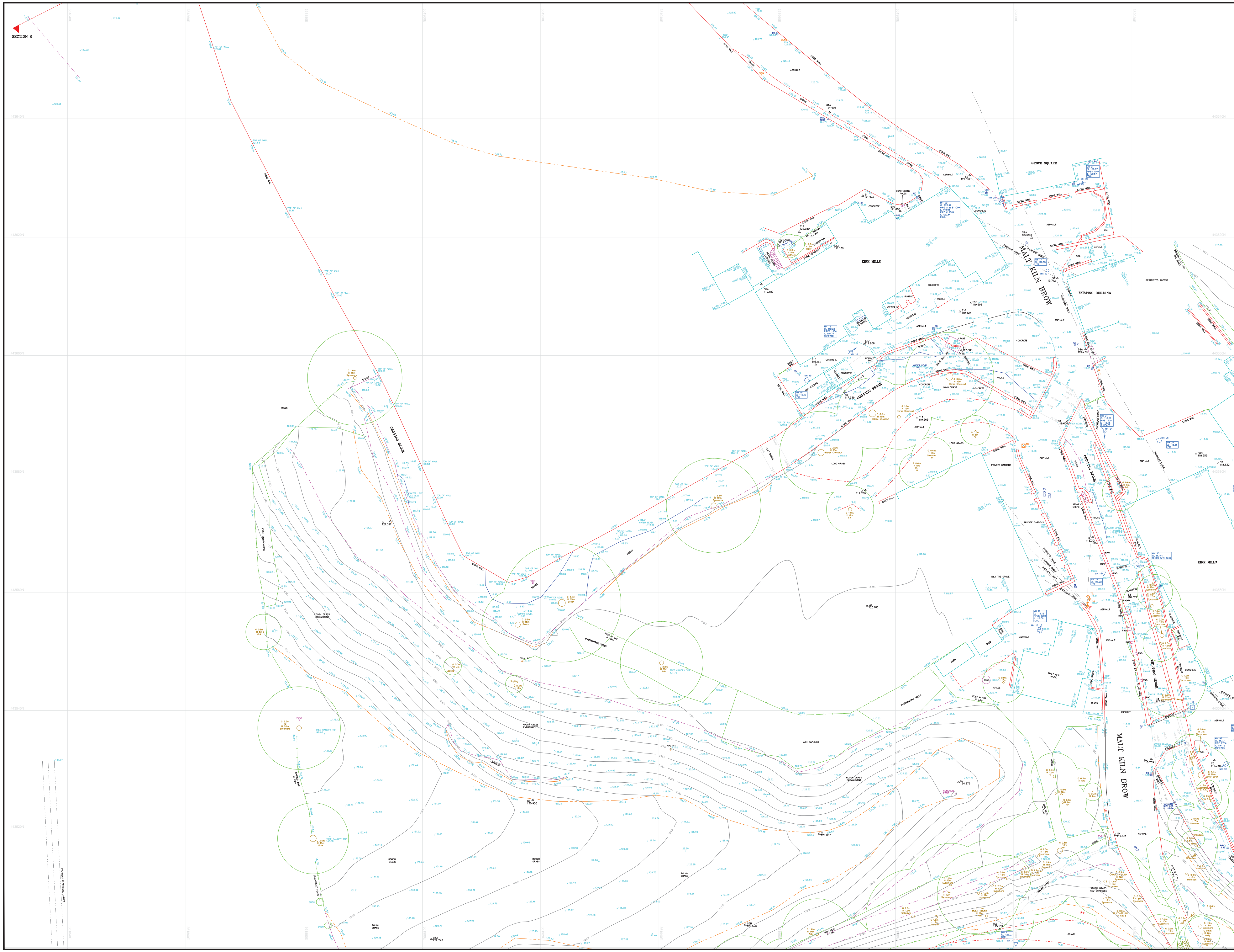

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B11	362159.299	443554.749	115.077
B12	362174.652	443511.138	113.781
B13	362167.332	443493.254	113.246
B14	362146.002	443455.454	112.837
B15	362159.319	443452.239	113.537
B16	362180.784	443435.763	113.065
B17	362218.398	443435.061	113.061
B18	362262.137	443421.483	111.363
C1	362076.815	443519.796	117.419
C2	362158.823	443505.854	115.675
C3	362133.182	443452.992	115.625
C4	362076.977	443481.864	115.808
C5	362033.936	443531.582	117.738
C6	362048.697	443551.662	117.860
C2A	362140.256	443465.723	115.546
C3A	362090.370	443473.828	115.739
C3B	362105.790	443466.622	115.702
C3C	362118.963	443460.075	115.665
G1	361941.848	443663.546	126.086
G2	361893.287	443698.095	125.968
G3	361918.678	443524.885	130.950
G4	361843.469	443472.682	131.087
G1A	361968.879	443641.061	124.606
I1	361967.119	443519.179	126.857
I2	361894.565	443571.979	121.391
I3	361990.694	443527.899	124.876
I4	362013.381	443569.325	118.301
I5	361808.220	443440.708	135.944
I6	361860.540	443464.165	130.936
I7	361840.426	443417.021	135.991
I8	361906.552	443449.104	132.884
I9	361904.399	443367.140	131.783
I10	361903.753	443480.011	129.464
I11	361955.011	443486.245	126.610
I12	361997.595	443503.024	125.139
I13	362050.183	443470.283	123.654
I14	362017.182	443519.012	119.681
I15	362093.064	443436.198	122.433
I16	362074.508	443445.676	122.822
I17	362136.820	443389.847	120.906
I18	362152.990	443410.950	120.763
I19	362157.576	443411.991	120.379
I20	362227.116	443379.120	118.349
I21	362135.044	443416.389	121.121
L1	361974.923	443577.202	119.780
L2	361975.200	443557.658	120.186
S1	362009.053	443588.846	119.606
S2	362023.260	443531.814	118.709
S3	362053.462	443503.953	117.391
S4	362112.022	443540.124	117.060
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S6	362060.986	443561.615	117.883
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S8	362007.366	443613.048	119.712
S9	361992.558	443630.424	121.552
S10	361980.784	443624.431	121.685
S11	361974.484	443626.974	121.942
S12	361963.746	443620.887	122.359
S13	361969.131	443618.920	121.139
S14	361957.333	443612.004	119.187
S15	361966.550	443598.465	119.162
S16	361990.910	443607.427	119.524
S11A	361960.249	443618.564	122.460
S1A	361983.649	443589.375	119.565
S1C	361992.757	443608.818	119.593
S1D	361974.713	443601.906	119.206
S3A	362042.089	443516.163	117.465
S6A	362072.044	443562.692	117.719
S6B	362030.833	443583.301	118.559
S8A	362012.166	443601.047	119.278
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T3	362191.921	443473.255	116.092
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T1A	362069.731	443600.928	126.656
T4A	362227.351	443490.015	119.940
K1	362596.498	442917.776	101.821
K2	362584.599	442949.978	102.247
K3	362609.627	443008.992	102.730

Layout Key

(1) (2) (3) (4) (5) (6) (7) (8)

KEY

AIR VALVE	AV	KERB OUTLET	KO
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BIN	BIN	MANHOLE (CIRCULAR)	MH
BOLLARD	BOL	MANHOLE (RECTANGULAR)	MH
BORE HOLE	BH	MANHOLE (TRIANGULAR)	MH
BRITISH TELECOM COVER	BT	MARKER POST	MKR
BUS STOP	BUS	ROAD GULLY	RG
CABLE TV COVER	CATV	RODDING EYE	RE
CABLE TV SUPPLY	CA	SIGN POST	SIGN
COLUMN	COL	TELECOM COVER	TEL
EARTHING POINT	ER	TELEGRAPH POLE	TP
ELECTRICITY COVER	ELEC	THRESHOLD LEVEL	THL
ELECTRICITY POLE	EP	TRAFFIC LIGHT	TL
FIRE HYDRANT	FH	TRIAL PIT	PIT
GAS VALVE	GAS	WASH OUT	WO
GATE		WATER METER	WM
INSPECTION COVER (CIRCULAR)	IC	WATER STOP COCK	SC
INSPECTION COVER (RECTANGULAR)	IC	WATER STOP VALVE	SV
COVER LEVEL	CL	CHAMBER BASE LEVEL	Ch.L
INVERT LEVEL	IL	WATER SURFACE LEVEL	WL
UNABLE TO RAISE	UTR	UNABLE TO MEASURE	UTM
GIRTH OF TREE TRUNK	G	DIAMETER OF TREE TRUNK	D
HEIGHT TO TOP OF TREE CANOPY	H	MULTI BOLE TREE	MB

Rev	Date	Drawn	Description	Check
A	20/05/2013	KZ	Additional area surveyed.	DA

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Client: Till Assett Management LLP

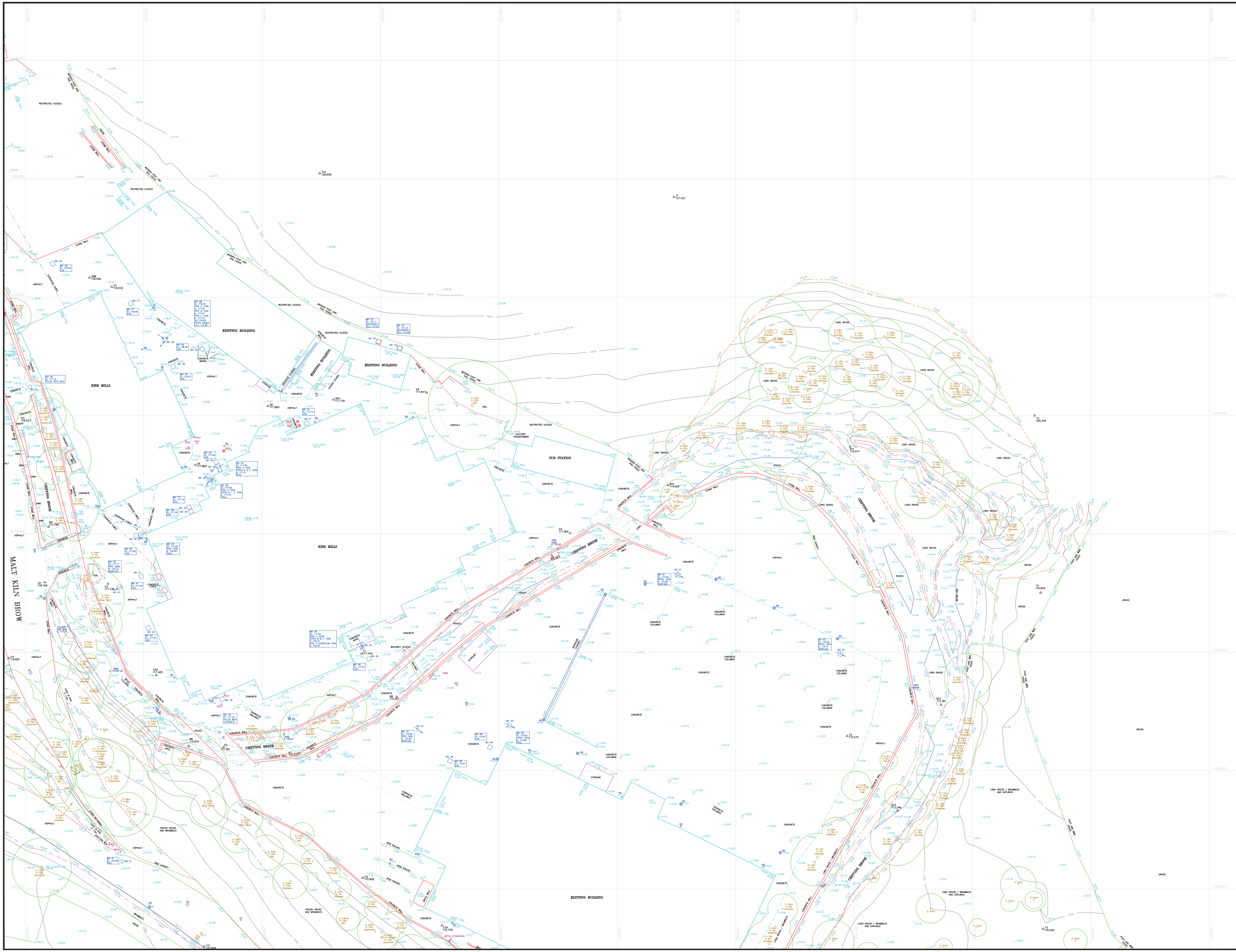
Site: HJ BERRY & SONS, KIRK MILLS, CHIPPING, PRESTON

Title: TOPOGRAPHICAL SURVEY 2D

Surveyed	CC IG	Drawn	CC IG
Chk.	DA	Date	11/07/2011

Scale [A0 Sheet]	DWG Ref (Layout No)	Status
1/200	12624-108-2_2DT (2)	REV

Job No	Rev
12624-108-2	A



N
Direction of North

Grid : OS National Grid.
Using the OS GPS Network and applying OSTN02 transformation and then removing the scale factor for true distances with a one-step transformation centred on S1

Datum : OS Level Datum.
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Station Listing

Station	Easting	Northing	Level
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B2	361971.395	443593.866	117.939
B3	362019.442	443558.684	116.527
B4	362023.903	443541.205	117.744
B5	362037.408	443514.971	115.958
B6	362047.575	443504.153	115.819
B7	362066.296	443502.894	115.522
B8	362082.743	443512.461	115.201
B9	362108.919	443536.371	114.963
B10	362128.538	443548.229	114.628
B11	362159.299	443554.749	115.077
B12	362174.652	443511.138	113.781
B13	362167.332	443493.254	113.246
B14	362146.002	443455.454	112.837
B15	362159.319	443452.239	113.537
B16	362180.784	443435.763	113.065
B17	362218.398	443435.061	113.061
B18	362262.137	443421.483	111.363
C1	362076.815	443519.796	117.419
C2	362158.823	443505.854	115.675
C3	362133.182	443452.992	115.625
C4	362076.977	443481.864	115.808
C5	362033.936	443531.582	117.738
C6	362048.697	443551.662	117.860
C2A	362140.256	443465.723	115.546
C3A	362090.370	443473.828	115.739
C3B	362105.790	443466.622	115.702
C3C	362118.963	443460.075	115.665
G1	361941.848	443663.546	126.086
G2	361893.287	443698.095	125.968
G3	361918.678	443524.885	130.950
G4	361843.469	443472.682	131.087
G1A	361968.879	443641.061	124.606
I1	361967.119	443519.179	126.857
I2	361894.565	443571.979	121.391
I3	361990.694	443527.899	124.876
I4	362013.381	443569.325	118.301
I5	361808.220	443440.708	135.944
I6	361860.540	443464.165	130.936
I7	361840.426	443417.021	135.991
I8	361906.552	443449.104	132.884
I9	361904.399	443367.140	131.783
I10	361903.753	443480.011	129.464
I11	361955.011	443486.245	126.610
I12	361997.595	443503.024	125.139
I13	362050.183	443470.283	123.654
I14	362017.182	443519.012	119.681
I15	362093.064	443436.198	122.433
I16	362074.508	443445.676	122.822
I17	362136.820	443389.847	120.906
I18	362152.990	443410.950	120.763
I19	362157.576	443411.991	120.379
I20	362227.116	443379.120	118.349
I21	362135.044	443416.389	121.121
L1	361974.923	443577.202	119.780
L2	361975.200	443557.658	120.186
S1	362009.053	443588.846	119.606
S2	362023.260	443531.814	118.709
S3	362053.462	443503.953	117.391
S4	362112.022	443540.124	117.060
S5	362087.789	443563.880	117.647
S6	362060.986	443561.615	117.883
S7	362034.576	443581.755	118.532
S8	362007.366	443613.048	119.712
S9	361992.558	443630.424	121.552
S10	361980.784	443624.431	121.685
S11	361974.484	443626.974	121.942
S12	361963.746	443620.887	122.359
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K1	362596.498	442917.776	101.821
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Layout Key

(1) (2) (3) (4) (5) (6) (7) (8)

KEY

AIR VALVE	AV	KERB OUTLET	KO
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Rev	Date	Drawn	Description	Check
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Client
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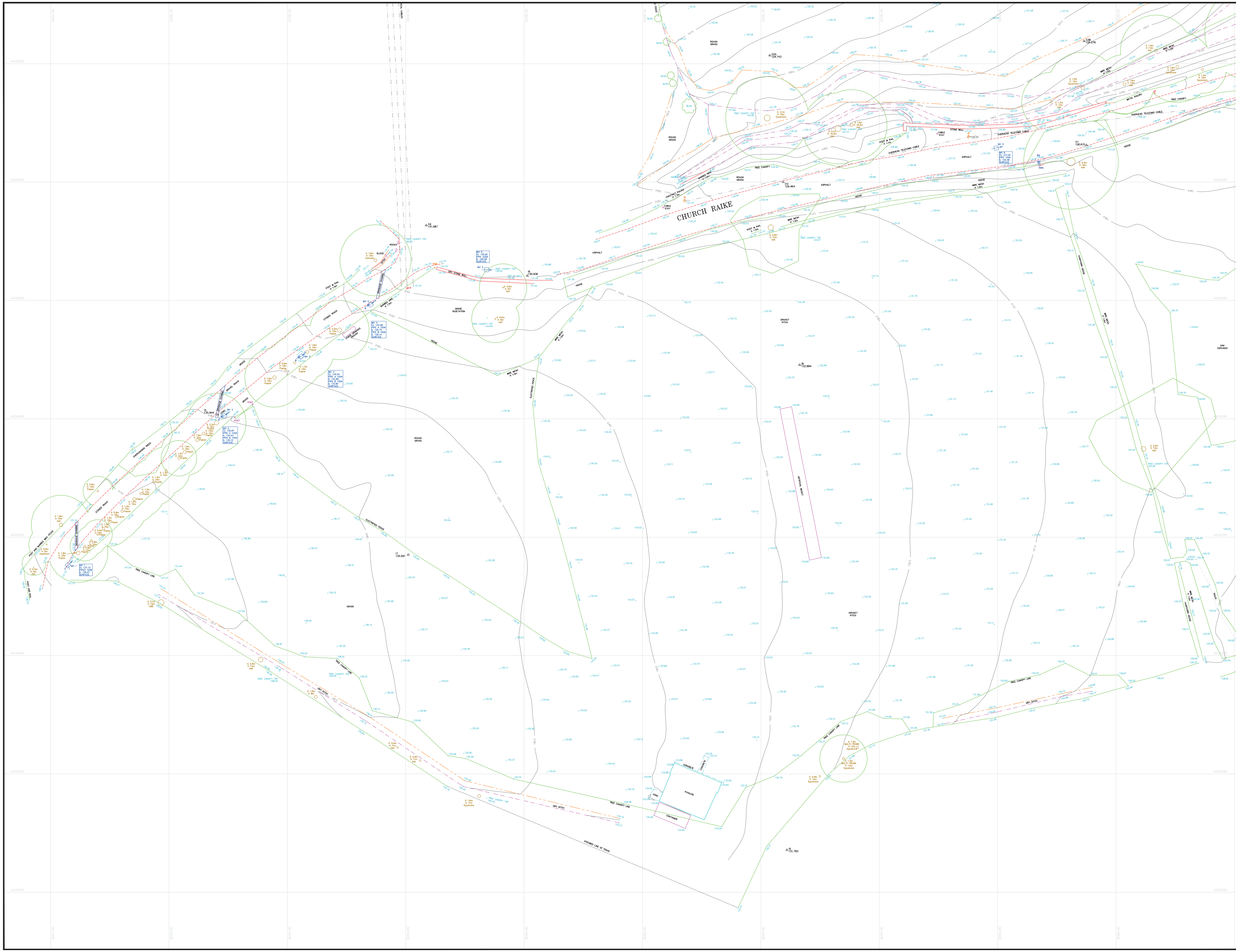
Site
HJ BERRY & SONS, KIRK MILLS, CHIPPING, PRESTON

Title
TOPOGRAPHICAL SURVEY
2D

Surveyed	CC IG	Drawn	CC IG
Chk.	DA	Date	11/07/2011

Scale [A0 Sheet]	DWG Ref (Layout No)	Status
1/200	12624-108-2_2DT (3)	REV

Job No	Rev
12624-108-2	A



Notes

Direction of North

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Title: TOPOGRAPHICAL SURVEY 2D

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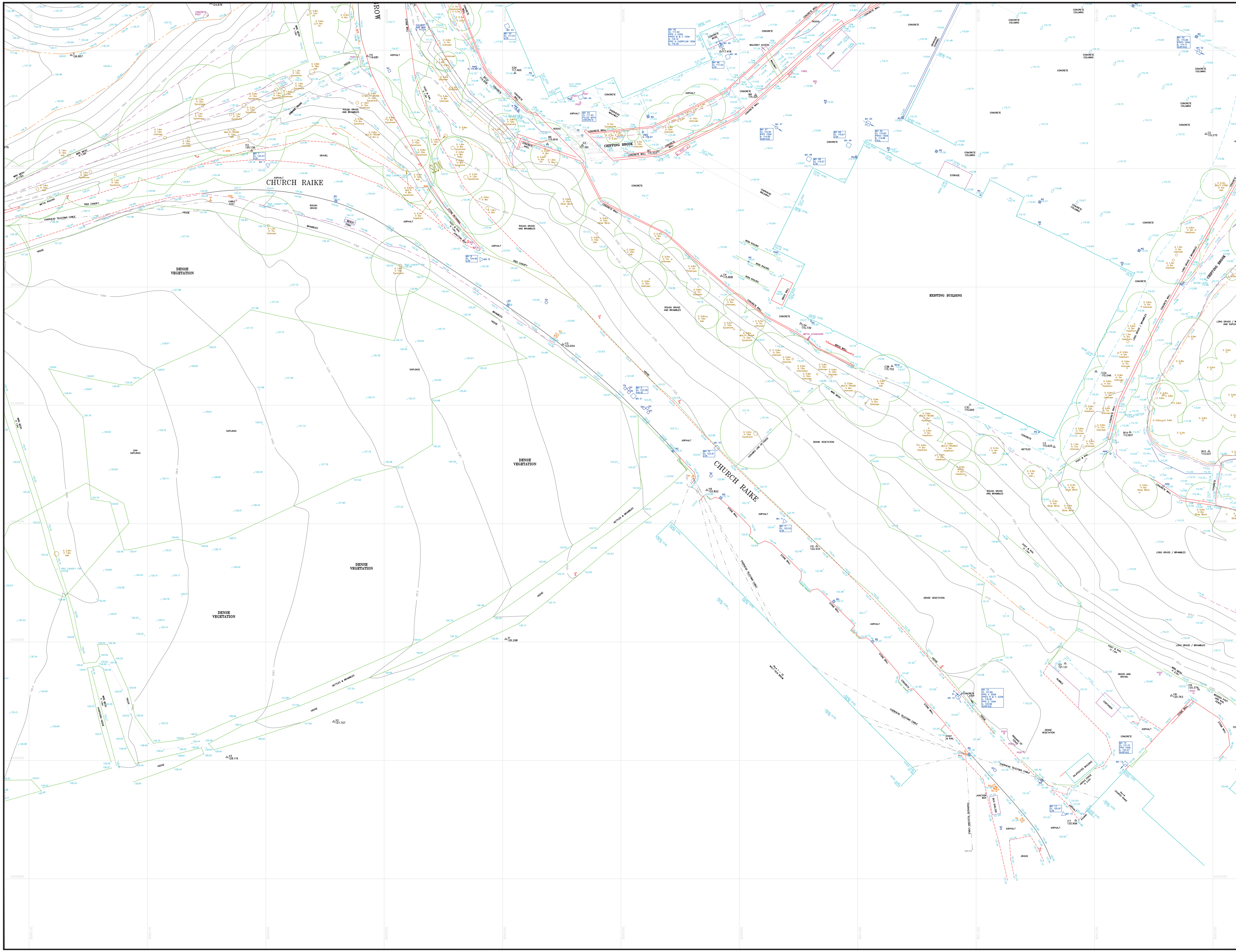
Scale [A0 Sheet]	DWG Ref (Layout No)	Status
1/200	12624-108-2_2DT (4)	REV

Job No	Rev
12624-108-2	A



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B3	362019.442	443558.684	116.527	I13	362050.183	443470.283	123.654
B4	362023.903	443541.205	117.744	I14	362017.182	443519.012	119.681
B5	362037.408	443514.971	115.958	I15	362093.064	443436.198	122.433
B6	362047.575	443504.153	115.819	I16	362074.508	443445.676	122.822
B7	362066.296	443502.894	115.522	I17	362136.820	443389.847	120.906
B8	362082.743	443512.461	115.201	I18	362152.990	443410.950	120.763
B9	362108.919	443536.371	114.963	I19	362157.576	443411.991	120.379
B10	362128.538	443548.229	114.628	I20	362227.116	443379.120	118.349
B11	362159.299	443554.749	115.077	I21	362135.044	443416.389	121.121
B12	362174.652	443511.138	113.781	L1	361974.923	443577.202	119.780
B13	362167.332	443493.254	113.246	L2	361975.200	443557.658	120.186
B14	362146.002	443455.454	112.837	S1	362009.053	443588.846	119.606
B15	362159.319	443452.239	113.537	S2	362023.260	443531.814	118.709
B16	362180.784	443435.763	113.065	S3	362053.462	443503.953	117.391
B17	362218.398	443435.061	113.061	S4	362112.022	443540.124	117.060
B18	362262.137	443421.483	111.363	S5	362087.789	443563.880	117.647
C1	362076.815	443519.796	117.419	S6	362060.986	443561.615	117.883
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C5	362033.936	443531.582	117.738	S10	361980.784	443624.431	121.685
C6	362048.697	443551.662	117.860	S11	361974.484	443626.974	121.942
C2A	362140.256	443465.723	115.546	S12	361963.746	443620.887	122.359
C3A	362090.370	443473.828	115.739	S13	361969.131	443618.920	121.139
C3B	362105.790	443466.622	115.702	S14	361957.333	443612.004	119.187
C3C	362118.963	443460.075	115.665	S15	361966.550	443598.465	119.162
G1	361941.848	443663.546	126.086	S16	361990.910	443607.427	119.524
G2	361893.287	443698.095	125.968	S11A	361960.249	443618.564	122.460
G3	361918.678	443524.885	130.950	S1A	361983.649	443589.375	119.565
G4	361843.469	443472.682	131.087	S1C	361992.757	443608.818	119.593
G1A	361968.879	443641.061	124.606	S1D	361974.713	443601.906	119.206
I1	361967.119	443519.179	126.857	S3A	362042.089	443516.163	117.465
I2	361894.565	443571.979	121.391	S6A	362072.044	443562.692	117.719
I3	361990.694	443527.899	124.876	S6B	362030.833	443583.301	118.559
I4	362013.381	443569.325	118.301	S8A	362012.166	443601.047	119.278
I5	361808.220	443440.708	135.944	S9A	362003.035	443619.892	120.288
I6	361860.540	443464.165	130.936	T1	362129.563	443596.927	127.021
I7	361840.426	443417.021	135.991	T2	362190.475	443560.007	120.318
I8	361906.552	443449.104	132.884	T3	362191.921	443473.255	116.092
I9	361904.399	443367.140	131.783	T4	362191.506	443530.074	116.605
I10	361903.753	443480.011	129.464	T1A	362069.731	443600.928	126.656
				T4A	362227.351	443490.015	119.940
				K1	362596.498	442917.776	101.821
				K2	362584.599	442949.978	102.247
				K3	362609.627	443008.992	102.730

Layout Key

(1) (2) (3) (4) (5) (6) (7) (8)

KEY

AIR VALVE	AV	KERB OUTLET	KO
BENCH MARK	BM	LAMP POST	LP
BIN	BIN	MANHOLE (CIRCULAR)	MH
BOLLARD	BOL	MANHOLE (RECTANGULAR)	MH
BORE HOLE	BH	MANHOLE (TRIANGULAR)	MH
BRITISH TELECOM COVER	BT	MARKER POST	MKR
BUS STOP	BUS	ROAD GULLY	RG
CABLE TV COVER	CATV	RODDING EYE	RE
CABLE TV SUPPLY	CA	SIGN POST	SIGN
COLUMN	COL	TELECOM COVER	TEL
EARTHING POINT	ER	TELEGRAPH POLE	TP
ELECTRICITY COVER	ELEC	THRESHOLD LEVEL	THL
ELECTRICITY POLE	EP	TRAFFIC LIGHT	TL
FIRE HYDRANT	FH	TRIAL PIT	PIT
GAS VALVE	GAS	WASH OUT	WO
GATE		WATER METER	WM
INSPECTION COVER (CIRCULAR)	IC	WATER STOP COCK	SC
INSPECTION COVER (RECTANGULAR)	IC	WATER STOP VALVE	SV
COVER LEVEL	CL	CHAMBER BASE LEVEL	Ch.L
INVERT LEVEL	IL	WATER SURFACE LEVEL	WL
UNABLE TO RAISE	UTR	UNABLE TO MEASURE	UTM
GIRTH OF TREE TRUNK	G	DIAMETER OF TREE TRUNK	D
HEIGHT TO TOP OF TREE CANOPY	H	MULTI BOLE TREE	MB

Rev	Date	Drawn	Description	Check
A	20/05/2013	KZ	Additional area surveyed.	DA

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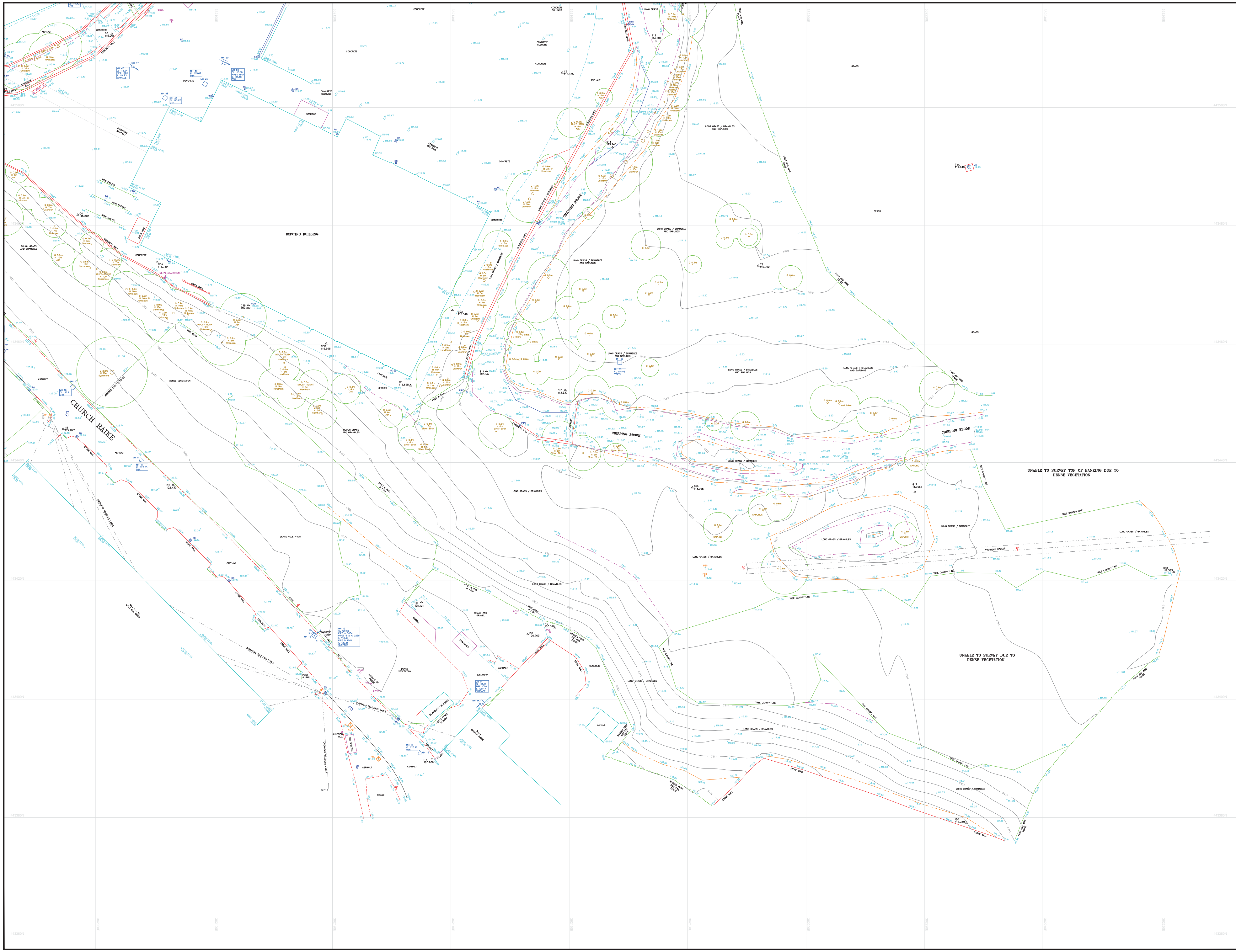
Client
Till Assett Management LLP

Site
HJ BERRY & SONS, KIRK MILLS, CHIPPING, PRESTON

Title
TOPOGRAPHICAL SURVEY
2D

Surveyed: CC IG		Drawn: CC IG	
Chk: DA		Date: 11/07/2011	
Scale: 1/200	[A0 Sheet]	DWG Ref (Layout No): 12624-108-2_2DT (5)	Status: REV
Job No: 12624-108-2			Rev: A



Notes
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Direction of North

Grid : OS National Grid.
Using the OS GPS Network and applying OSTN02 transformation and then removing the scale factor for true distances with a one-step transformation centred on S1

Datum : OS Level Datum.
Using the OS GPS Network and applying OSGM02 National Geoid Model to obtain local area corrections.

Station Listing

Station	Easting	Northing	Level	Station	Easting	Northing	Level
B1	361990.872	443600.341	117.503	I11	361955.011	443486.245	126.610
B2	361971.395	443593.866	117.939	I12	361997.595	443503.024	125.139
B3	362019.442	443558.684	116.527	I13	362050.183	443470.283	123.654
B4	362023.903	443541.205	117.744	I14	362017.182	443519.012	119.681
B5	362037.408	443514.971	115.958	I15	362093.064	443436.198	122.433
B6	362047.575	443504.153	115.819	I16	362074.508	443445.676	122.822
B7	362066.296	443502.894	115.522	I17	362136.820	443389.847	120.906
B8	362082.743	443512.461	115.201	I18	362152.990	443410.950	120.763
B9	362108.919	443536.371	114.963	I19	362157.576	443411.991	120.379
B10	362128.538	443548.229	114.628	I20	362227.116	443379.120	118.349
B11	362159.299	443554.749	115.077	I21	362135.044	443416.389	121.121
B12	362174.652	443511.138	113.781	L1	361974.923	443577.202	119.780
B13	362167.332	443493.254	113.246	L2	361975.200	443557.658	120.186
B14	362146.002	443455.454	112.837	S1	362009.053	443588.846	119.606
B15	362159.319	443452.239	113.537	S2	362023.260	443531.814	118.709
B16	362180.784	443435.763	113.065	S3	362053.462	443503.953	117.391
B17	362218.398	443435.061	113.061	S4	362112.022	443540.124	117.060
B18	362262.137	443421.483	111.363	S5	362087.789	443563.880	117.647
C1	362076.815	443519.796	117.419	S6	362060.986	443561.615	117.883
C2	362158.823	443505.854	115.675	S7	362034.576	443581.755	118.532
C3	362133.182	443452.992	115.625	S8	362007.366	443613.048	119.712
C4	362076.977	443481.864	115.808	S9	361992.558	443630.424	121.552
C5	362033.936	443531.582	117.738	S10	361980.784	443624.431	121.685
C6	362048.697	443551.662	117.860	S11	361974.484	443626.974	121.942
C2A	362140.256	443465.723	115.546	S12	361963.746	443620.887	122.359
C3A	362090.370	443473.828	115.739	S13	361969.131	443618.920	121.139
C3B	362105.790	443466.622	115.702	S14	361957.333	443612.004	119.187
C3C	362118.963	443460.075	115.665	S15	361966.550	443598.465	119.162
G1	361941.848	443663.546	126.086	S16	361990.910	443607.427	119.524
G2	361893.287	443698.095	125.968	S11A	361960.249	443618.564	122.460
G3	361918.678	443524.885	130.950	S1A	361983.649	443589.375	119.565
G4	361843.469	443472.682	131.087	S1C	361992.757	443608.818	119.593
G1A	361968.879	443641.061	124.606	S1D	361974.713	443601.906	119.206
I1	361967.119	443519.179	126.857	S3A	362042.089	443516.163	117.465
I2	361894.565	443571.979	121.391	S6A	362072.044	443562.692	117.719
I3	361990.694	443527.899	124.876	S6B	362030.833	443583.301	118.559
I4	362013.381	443569.325	118.301	S8A	362012.166	443601.047	119.278
I5	361808.220	443440.708	135.944	S9A	362003.035	443619.892	120.288
I6	361860.540	443464.165	130.936	T1	362129.563	443596.927	127.021
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I10	361903.753	443480.011	129.464	T1A	362069.731	443600.928	126.656
				T4A	362227.351	443490.015	119.940
				K1	362596.498	442917.776	101.821
				K2	362584.599	442949.978	102.247
				K3	362609.627	443008.992	102.730

Layout Key

(1) (2) (3) (4) (5) (6) (7) (8)

KEY

AIR VALVE	AV	KERB OUTLET	KO
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BIN	BIN	MANHOLE (CIRCULAR)	MH
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BRITISH TELECOM COVER	BT	MARKER POST	MKR
BUS STOP	BUS	ROAD GULLY	RG
CABLE TV COVER	CATV	RODDING EYE	RE
CABLE TV SUPPLY	CA	SIGN POST	SIGN
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EARTHING POINT	ER	TELEGRAPH POLE	TP
ELECTRICITY COVER	ELEC	THRESHOLD LEVEL	THL
ELECTRICITY POLE	EP	TRAFFIC LIGHT	TL
FIRE HYDRANT	FH	TRIAL PIT	PIT
GAS VALVE	GAS	WASH OUT	WO
GATE		WATER METER	WM
INSPECTION COVER (CIRCULAR)	IC	WATER STOP COCK	SC
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UNABLE TO RAISE	UTR	UNABLE TO MEASURE	UTM
GIRTH OF TREE TRUNK	G	DIAMETER OF TREE TRUNK	D
HEIGHT TO TOP OF TREE CANOPY	H	MULTI BOLE TREE	MB

Rev	Date	Drawn	Description	Check
A	20/05/2013	KZ	Additional area surveyed.	DA

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Client
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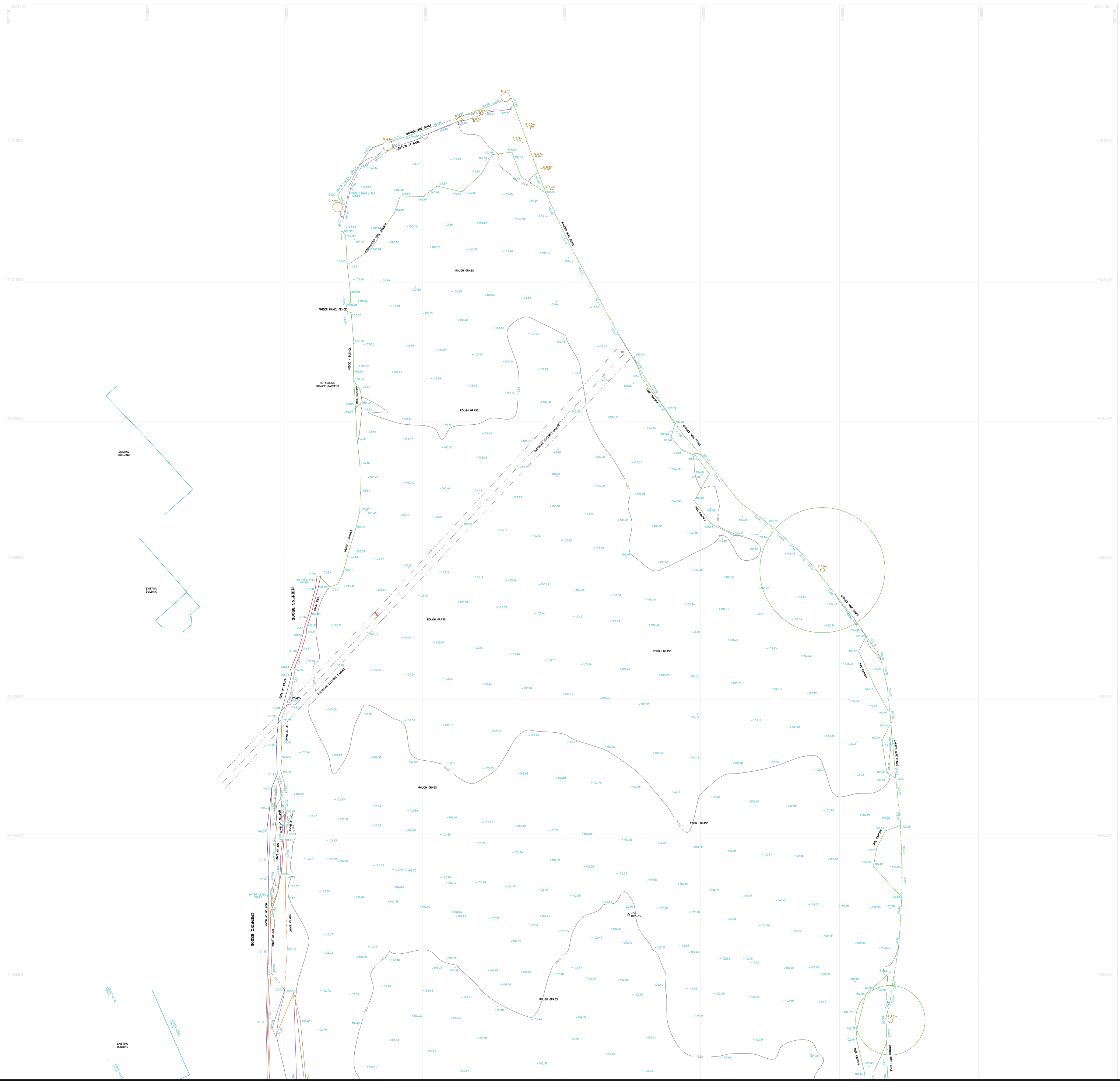
HJ BERRY & SONS, KIRK MILLS, CHIPPING, PRESTON

Title
TOPOGRAPHICAL SURVEY
2D

Surveyed	CC IG	Drawn	CC IG
Chk.	DA	Date	11/07/2011
Scale [A0 Sheet] 1/200	DWG Ref (Layout No) 12624-108-2_2DT (6)	Status REV	
Job No 12624-108-2		Rev A	



Notes

Direction of North

Grid : OS National Grid.
Using the OS GPS Network and applying OSTN02 transformation and then removing the scale factor for true distances with a one-step transformation centred on S1

Datum : OS Level Datum.
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B3	362019.442	443558.684	116.527	I13	362050.183	443470.283	123.654
B4	362023.903	443541.205	117.744	I14	362017.182	443519.012	119.681
B5	362037.408	443514.971	115.958	I15	362093.064	443436.198	122.433
B6	362047.575	443504.153	115.819	I16	362074.508	443445.676	122.822
B7	362066.296	443502.894	115.522	I17	362136.820	443389.847	120.906
B8	362082.743	443512.461	115.201	I18	362152.990	443410.950	120.763
B9	362108.919	443536.371	114.963	I19	362157.576	443411.991	120.379
B10	362128.538	443548.229	114.628	I20	362227.116	443379.120	118.349
B11	362159.299	443554.749	115.077	I21	362135.044	443416.389	121.121
B12	362174.652	443511.138	113.781	L1	361974.923	443577.202	119.780
B13	362167.332	443493.254	113.246	L2	361975.200	443557.658	120.186
B14	362146.002	443455.454	112.837	S1	362009.053	443588.846	119.606
B15	362159.319	443452.239	113.537	S2	362023.260	443531.814	118.709
B16	362180.784	443435.763	113.065	S3	362053.462	443503.953	117.391
B17	362218.398	443435.061	113.061	S4	362112.022	443540.124	117.060
B18	362262.137	443421.483	111.363	S5	362087.789	443563.880	117.647
C1	362076.815	443519.796	117.419	S6	362060.986	443561.615	117.883
C2	362158.823	443505.854	115.675	S7	362034.576	443581.755	118.532
C3	362133.182	443452.992	115.625	S8	362007.366	443613.048	119.712
C4	362076.977	443481.864	115.808	S9	361992.558	443630.424	121.552
C5	362033.936	443531.582	117.738	S10	361980.784	443624.431	121.685
C6	362048.697	443551.662	117.860	S11	361974.484	443626.974	121.942
C2A	362140.256	443465.723	115.546	S12	361963.746	443620.887	122.359
C3A	362090.370	443473.828	115.739	S13	361969.131	443618.920	121.139
C3B	362105.790	443466.622	115.702	S14	361957.333	443612.004	119.187
C3C	362118.963	443460.075	115.665	S15	361966.550	443598.465	119.162
G1	361941.848	443663.546	126.086	S16	361990.910	443607.427	119.524
G2	361893.287	443698.095	125.968	S11A	361960.249	443618.564	122.460
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FIRE HYDRANT	FH	TRIAL PIT	PIT
GAS VALVE	GAS	WASH OUT	WO
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GIRTH OF TREE TRUNK	G	DIAMETER OF TREE TRUNK	D
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Rev	Date	Drawn	Description	Check
A	20/05/2013	KZ	Additional area surveyed.	DA

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Client: Till Assett Management LLP

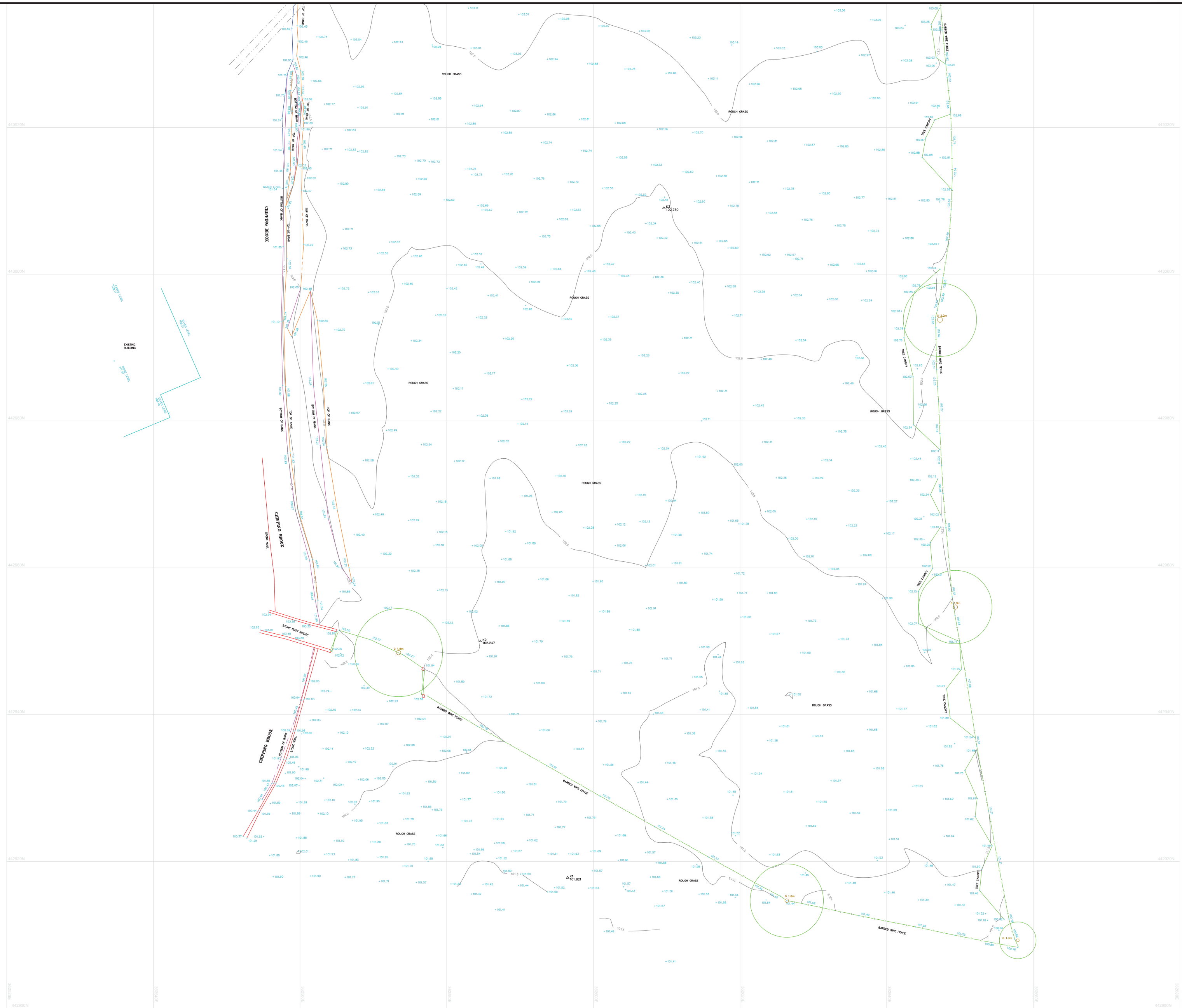
Site: HJ BERRY & SONS, KIRK MILLS, CHIPPING, PRESTON

Title: TOPOGRAPHICAL SURVEY 2D

Surveyed	CC IG	Drawn	CC IG
Chk.	DA	Date	11/07/2011

Scale [A0 Sheet]	DWG Ref (Layout No)	Status
1/200	12624-108-2_2DT (7)	REV

Job No	Rev
12624-108-2	A



N

Direction of North

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B9	362108.919	443536.371	114.963	I19	362157.576	443411.991	120.379
B10	362128.538	443548.229	114.628	I20	362227.116	443379.120	118.349
B11	362159.299	443554.749	115.077	I21	362135.044	443416.389	121.121
B12	362174.652	443511.138	113.781	L1	361974.923	443577.202	119.780
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B16	362180.784	443435.763	113.065	S3	362053.462	443503.953	117.391
B17	362218.398	443435.061	113.061	S4	362112.022	443540.124	117.060
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C4	362076.977	443481.864	115.808	S9	361992.558	443630.424	121.552
C5	362033.936	443531.582	117.738	S10	361980.784	443624.431	121.685
C6	362048.697	443551.662	117.860	S11	361974.484	443626.974	121.942
C2A	362140.256	443465.723	115.546	S12	361963.746	443620.887	122.359
C3A	362090.370	443473.828	115.739	S13	361969.131	443618.920	121.139
C3B	362105.790	443466.622	115.702	S14	361957.333	443612.004	119.187
C3C	362118.963	443460.075	115.665	S15	361966.550	443598.465	119.162
G1	361941.848	443663.546	126.086	S16	361990.910	443607.427	119.524
G2	361893.287	443698.095	125.968	S11A	361960.249	443618.564	122.460
G3	361918.678	443524.885	130.950	S1A	361983.649	443589.375	119.565
G4	361843.469	443472.682	131.087	S1C	361992.757	443608.818	119.593
G1A	361968.879	443641.061	124.606	S1D	361974.713	443601.906	119.206
I1	361967.119	443519.179	126.857	S3A	362042.089	443516.163	117.465
I2	361894.565	443571.979	121.391	S6A	362072.044	443562.692	117.719
I3	361990.694	443527.899	124.876	S6B	362030.833	443583.301	118.559
I4	362013.381	443569.325	118.301	S8A	362012.166	443601.047	119.278
I5	361808.220	443440.708	135.944	S9A	362003.035	443619.892	120.288
I6	361860.540	443464.165	130.936	T1	362129.563	443596.927	127.021
I7	361840.426	443417.021	135.991	T2	362190.475	443560.007	120.318
I8	361906.552	443449.104	132.884	T3	362191.921	443473.255	116.092
I9	361904.399	443367.140	131.783	T4	362191.506	443530.074	116.605
I10	361903.753	443480.011	129.464	T1A	362069.731	443600.928	126.656
				T4A	362227.351	443490.015	119.940
				K1	362596.498	442917.776	101.821
				K2	362584.599	442949.978	102.247
				K3	362609.627	443008.992	102.730

Layout Key

(1) (2) (3) (4) (5) (6) (7) (8)

KEY

AIR VALVE	AV	KERB OUTLET	KO
BENCH MARK	BM	LAMP POST	LP
BIN	BIN	MANHOLE (CIRCULAR)	MH
BOLLARD	BOL	MANHOLE (RECTANGULAR)	MH
BORE HOLE	BH	MANHOLE (TRIANGULAR)	MH
BRITISH TELECOM COVER	BT	MARKER POST	MKR
BUS STOP	BUS	ROAD GULLY	RG
CABLE TV COVER	CATV	RODDING EYE	RE
CABLE TV SUPPLY	CA	SIGN POST	SIGN
COLUMN	COL	TELECOM COVER	TEL
EARTHING POINT	ER	TELEGRAPH POLE	TP
ELECTRICITY COVER	ELEC	THRESHOLD LEVEL	THL
ELECTRICITY POLE	EP	TRAFFIC LIGHT	TL
FIRE HYDRANT	FH	TRIAL PIT	PIT
GAS VALVE	GAS	WASH OUT	WO
GATE		WATER METER	WM
INSPECTION COVER (CIRCULAR)	IC	WATER STOP COCK	SC
INSPECTION COVER (RECTANGULAR)	IC	WATER STOP VALVE	SV
COVER LEVEL	CL	CHAMBER BASE LEVEL	Ch.L
INVERT LEVEL	IL	WATER SURFACE LEVEL	WL
UNABLE TO RAISE	UTR	UNABLE TO MEASURE	UTM
GIRTH OF TREE TRUNK	G	DIAMETER OF TREE TRUNK	D
HEIGHT TO TOP OF TREE CANOPY	H	MULTI BOLE TREE	MB

Rev	Date	Drawn	Description	Check
A	20/05/2013	KZ	Additional area surveyed.	DA

Met® GEO ENVIRONMENTAL

Southgate House
Pontefract Road
Stourton
Leeds
West Yorkshire
LS10 1SW

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F: +44 [0] 1132 008 901
E: admin@metgeoenvironmental.com
W: www.metgeoenvironmental.com

Client
Till Assett Management LLP

Site
HJ BERRY & SONS, KIRK MILLS, CHIPPING, PRESTON

Title
TOPOGRAPHICAL SURVEY
2D

Surveyed: CC IG		Drawn: CC IG	
Chk: DA		Date: 11/07/2011	
Scale [A0 Sheet]: 1/200	DWG Ref (Layout No): 12624-108-2_2DT (8)	Status: REV	
Job No: 12624-108-2		Rev: A	

APPENDIX C: Modelling Study Report

Provided separately

APPENDIX D: Correspondence with Environment Agency

Mrs Jenny Cavill
Weetwood Services Ltd
4 Queen Street
Leeds
West Yorkshire
LS1 2TW

Our ref: NO/2012/103767/01-L01
Your ref:

Date: 08 June 2012

Dear Mrs Cavill

CHIPPING BROOK MODELLING STUDY FINAL REPORT V1.1
KIRK MILL, CHIPPING

I refer to the above and the report that you submitted to us for our consideration. I apologise for our delayed response.

The results of the modelling study coincide very closely to the on-site assessment that we made during a recent site meeting. As such we fully concur with the model results.

Yours sincerely

Philip Carter
Planning Liaison Officer

Direct dial 01772 714219
Direct fax 01772 697032
Direct e-mail nwnorthplanning@environment-agency.gov.uk

APPENDIX E: Modified Rational Method Calculation

The Modified Rational Method[14] has been used to calculate the runoff from the impermeable surfaces at the existing site.

The following parameters have been obtained from the maps in Volume 3 of the Wallingford Procedure:

M5-60 minute rainfall depth:		22.5 mm
Ratio of M5-60 to M5-2 day rainfall:		19.5
Average Annual Rainfall:		1350 mm
Winter Rain Acceptance Potential/ Soil Type	:	4
The Urban Catchment Wetness Index (UCWI) value:	138	

A time of concentration of 4.5 minutes has been used comprising a time of entry of 4.0 minutes and a time of flow of 0.5 minutes.

A rainfall estimation calculation has been carried out to convert the M5-60 minute rainfall to the 5-minute duration rainfall for the 1 in 1, 1 in 2 year, 1 in 30 year and 1 in 100 year (including and allowance for climate change) return period events. The calculated rainfall intensities for these events are 48.0, 61.1, 110.4, 138.5 and 180.1 mm/hr respectively.

The flow rate as given by the Modified Rational Method is:

$$\mathbf{Q=2.78 \times C_v \times C_r \times \text{rainfall intensity} \times \text{impermeable area}}$$

where:

C_v is the volumetric runoff coefficient = P_r/PIMP = 0.84
where P_r is Percentage Runoff and PIMP is Percentage Impermeable Area
C_r is the routing coefficient = 1.30

[14] The Wallingford Procedure, Volume 4, 1981

APPENDIX F: Greenfield Runoff Calculations

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.450
Area (ha)	1.000	Urban	0.000
SAAR (mm)	1350	Region Number	Region 10

Results	**l/s**
QBAR Rural	9.5
QBAR Urban	9.5
Q100 years	19.7
Q1 year	8.2
Q30 years	16.1
Q100 years	19.7

APPENDIX G: Storage Volume Calculation – Malt Kiln House

No 2 Smithy Farm
Bruera
Chester CH3 6EW

Date 24/09/2013 14:02 | Designed By JamesAldridge
File 1790 130924 MKH 5... | Checked By
Micro Drainage | Source Control W.12.1

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.241	0.241	4.8	40.0	O K
30 min Summer	0.349	0.349	4.8	58.0	O K
60 min Summer	0.472	0.472	4.8	78.4	O K
120 min Summer	0.575	0.575	4.8	95.4	O K
180 min Summer	0.617	0.617	4.8	102.5	O K
240 min Summer	0.641	0.641	4.8	106.4	O K
360 min Summer	0.663	0.663	4.8	110.1	O K
480 min Summer	0.668	0.668	4.8	110.8	O K
600 min Summer	0.663	0.663	4.8	110.1	O K
720 min Summer	0.653	0.653	4.8	108.5	O K
960 min Summer	0.627	0.627	4.8	104.0	O K
1440 min Summer	0.567	0.567	4.8	94.1	O K
2160 min Summer	0.472	0.472	4.8	78.3	O K
2880 min Summer	0.380	0.380	4.8	63.1	O K
4320 min Summer	0.244	0.244	4.8	40.5	O K
5760 min Summer	0.179	0.179	4.7	29.8	O K
7200 min Summer	0.149	0.149	4.4	24.8	O K
8640 min Summer	0.132	0.132	4.0	22.0	O K
10080 min Summer	0.120	0.120	3.7	20.0	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	113.532	18
30 min Summer	84.085	32
60 min Summer	59.302	62
120 min Summer	39.358	120
180 min Summer	30.583	168
240 min Summer	25.479	198
360 min Summer	19.601	264
480 min Summer	16.218	334
600 min Summer	13.975	404
720 min Summer	12.359	474
960 min Summer	10.166	614
1440 min Summer	7.742	882
2160 min Summer	5.912	1276
2880 min Summer	4.902	1644
4320 min Summer	3.808	2332
5760 min Summer	3.201	3000
7200 min Summer	2.796	3680
8640 min Summer	2.502	4408
10080 min Summer	2.277	5136

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Winter	0.272	0.272	4.8	45.1	O K
30 min Winter	0.395	0.395	4.8	65.6	O K
60 min Winter	0.535	0.535	4.8	88.8	O K
120 min Winter	0.656	0.656	4.8	109.0	O K
180 min Winter	0.710	0.710	4.9	117.8	O K
240 min Winter	0.734	0.734	5.0	121.9	O K
360 min Winter	0.756	0.756	5.0	125.5	O K
480 min Winter	0.756	0.756	5.0	125.5	O K
600 min Winter	0.744	0.744	5.0	123.5	O K
720 min Winter	0.725	0.725	4.9	120.4	O K
960 min Winter	0.677	0.677	4.8	112.4	O K
1440 min Winter	0.573	0.573	4.8	95.2	O K
2160 min Winter	0.407	0.407	4.8	67.6	O K
2880 min Winter	0.258	0.258	4.8	42.8	O K
4320 min Winter	0.150	0.150	4.4	25.0	O K
5760 min Winter	0.123	0.123	3.8	20.4	O K
7200 min Winter	0.108	0.108	3.3	17.9	O K
8640 min Winter	0.098	0.098	3.0	16.3	O K
10080 min Winter	0.091	0.091	2.7	15.0	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Winter	113.532	18
30 min Winter	84.085	32
60 min Winter	59.302	60
120 min Winter	39.358	118
180 min Winter	30.583	174
240 min Winter	25.479	224
360 min Winter	19.601	280
480 min Winter	16.218	358
600 min Winter	13.975	436
720 min Winter	12.359	514
960 min Winter	10.166	664
1440 min Winter	7.742	952
2160 min Winter	5.912	1360
2880 min Winter	4.902	1672
4320 min Winter	3.808	2252
5760 min Winter	3.201	2944
7200 min Winter	2.796	3672
8640 min Winter	2.502	4400
10080 min Winter	2.277	5136

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)	22.500	Shortest Storm (mins)	15
Ratio R	0.195	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 0.202

Time (mins)	Area (ha)
0-4	0.202

Model Details

Storage is Online Cover Level (m) 1.000

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)
0.000	166.0

Hydro-Brake® Outflow Control

Design Head (m) 0.790 Diameter (mm) 100
Design Flow (l/s) 5.0 Invert Level (m) 0.000
Hydro-Brake® Type Md6 SW Only

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.0	1.200	6.2	3.000	9.8	7.000	15.0
0.200	4.7	1.400	6.7	3.500	10.6	7.500	15.6
0.300	4.6	1.600	7.2	4.000	11.4	8.000	16.1
0.400	4.4	1.800	7.6	4.500	12.1	8.500	16.6
0.500	4.4	2.000	8.0	5.000	12.7	9.000	17.0
0.600	4.6	2.200	8.4	5.500	13.3	9.500	17.5
0.800	5.1	2.400	8.8	6.000	13.9		
1.000	5.7	2.600	9.2	6.500	14.5		

APPENDIX H: Storage Volume Calculation – The Hive

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.209	0.209	7.6	186.1	O K
30 min Summer	0.306	0.306	7.8	273.1	O K
60 min Summer	0.426	0.426	7.8	379.8	O K
120 min Summer	0.552	0.552	7.8	491.6	O K
180 min Summer	0.628	0.628	7.8	559.6	O K
240 min Summer	0.682	0.682	7.8	607.4	O K
360 min Summer	0.752	0.752	7.8	670.3	O K
480 min Summer	0.795	0.795	7.8	708.1	O K
600 min Summer	0.821	0.821	7.9	731.2	O K
720 min Summer	0.836	0.836	7.9	744.8	O K
960 min Summer	0.855	0.855	8.0	762.2	O K
1440 min Summer	0.876	0.876	8.1	780.5	O K
2160 min Summer	0.881	0.881	8.1	785.3	O K
2880 min Summer	0.874	0.874	8.1	779.1	O K
4320 min Summer	0.853	0.853	8.0	760.2	O K
5760 min Summer	0.824	0.824	7.9	734.3	O K
7200 min Summer	0.786	0.786	7.8	700.8	O K
8640 min Summer	0.745	0.745	7.8	663.5	O K
10080 min Summer	0.700	0.700	7.8	624.1	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	113.532	19
30 min Summer	84.085	33
60 min Summer	59.302	64
120 min Summer	39.358	122
180 min Summer	30.583	182
240 min Summer	25.479	242
360 min Summer	19.601	362
480 min Summer	16.218	480
600 min Summer	13.975	600
720 min Summer	12.359	686
960 min Summer	10.166	800
1440 min Summer	7.742	1066
2160 min Summer	5.912	1472
2880 min Summer	4.902	1904
4320 min Summer	3.808	2728
5760 min Summer	3.201	3576
7200 min Summer	2.796	4392
8640 min Summer	2.502	5184
10080 min Summer	2.277	5952

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Winter	0.234	0.234	7.8	208.7	O K
30 min Winter	0.344	0.344	7.8	306.8	O K
60 min Winter	0.479	0.479	7.8	427.2	O K
120 min Winter	0.622	0.622	7.8	553.8	O K
180 min Winter	0.709	0.709	7.8	631.4	O K
240 min Winter	0.770	0.770	7.8	686.5	O K
360 min Winter	0.853	0.853	8.0	760.5	O K
480 min Winter	0.905	0.905	8.2	806.8	O K
600 min Winter	0.939	0.939	8.3	836.8	O K
720 min Winter	0.961	0.961	8.4	856.1	O K
960 min Winter	0.982	0.982	8.5	875.0	O K
1440 min Winter	1.000	1.000	8.5	891.1	O K
2160 min Winter	0.997	0.997	8.5	888.2	O K
2880 min Winter	0.975	0.975	8.4	869.1	O K
4320 min Winter	0.920	0.920	8.2	819.9	O K
5760 min Winter	0.857	0.857	8.0	763.4	O K
7200 min Winter	0.785	0.785	7.8	699.4	O K
8640 min Winter	0.708	0.708	7.8	631.2	O K
10080 min Winter	0.628	0.628	7.8	559.5	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Winter	113.532	18
30 min Winter	84.085	33
60 min Winter	59.302	62
120 min Winter	39.358	120
180 min Winter	30.583	180
240 min Winter	25.479	238
360 min Winter	19.601	354
480 min Winter	16.218	468
600 min Winter	13.975	578
720 min Winter	12.359	688
960 min Winter	10.166	896
1440 min Winter	7.742	1124
2160 min Winter	5.912	1596
2880 min Winter	4.902	2048
4320 min Winter	3.808	2944
5760 min Winter	3.201	3856
7200 min Winter	2.796	4688
8640 min Winter	2.502	5536
10080 min Winter	2.277	6352

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)	22.500	Shortest Storm (mins)	15
Ratio R	0.195	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time / Area Diagram

Total Area (ha) 0.895

Time (mins)	Area (ha)
0-4	0.895

Model Details

Storage is Online Cover Level (m) 1.500

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)
0.000	891.0

Hydro-Brake® Outflow Control

Design Head (m) 1.000 Diameter (mm) 122
Design Flow (l/s) 8.5 Invert Level (m) 0.000
Hydro-Brake® Type Md6 SW Only

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.9	1.200	9.3	3.000	14.6	7.000	22.3
0.200	7.5	1.400	10.0	3.500	15.8	7.500	23.1
0.300	7.7	1.600	10.7	4.000	16.9	8.000	23.9
0.400	7.4	1.800	11.3	4.500	17.9	8.500	24.6
0.500	7.2	2.000	11.9	5.000	18.9	9.000	25.3
0.600	7.2	2.200	12.5	5.500	19.8	9.500	26.0
0.800	7.7	2.400	13.1	6.000	20.7		
1.000	8.5	2.600	13.6	6.500	21.5		

APPENDIX I: Long Term Storage

The formula for Long Term Storage is given in CIRIA C697 The SuDS Manual as follows:

$$Vol = RD.A.10\left[\frac{PIMP}{100}(\alpha\ 0.8) + 1 - \frac{PIMP}{100}(\beta.SPR) - SPR\right]$$

Where:

Vol	= the extra runoff volume (m^3) of development runoff over greenfield runoff
RD	= rainfall depth for 100 year, 6 hour event (mm)
PIMP	= Impermeable area as a percentage of total area
A	= area of site (ha)
SPR	= standard percentage runoff index for the soil type
α	= proportion of impermeable surface draining to network / receiving waterbody
β	= proportion of permeable surface draining to network / receiving waterbody

Malt Kiln House

RD = 90.48 mm
Area = 0.104 ha
PIMP = 100%
SPR = 0.45
β = 1
α = 1

Vol = 33 m^3

The Hive

RD = 90.48 mm
Area = 0.610 ha
PIMP = 100%
SPR = 0.45
β = 1
α = 1

Vol = 193 m^3

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Foul Water Drainage
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