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**For the attention of:
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**FLOOD RISK ASSESSMENT
For
LAND OFF BANGOR ROAD,
JOHNSTOWN, WREXHAM**

This report was carried out in accordance with JPB Quality Management procedures.

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1.0 INTRODUCTION

- 1.1 Further to instructions received on 12 March 2012 from Gladman Developments Limited (GDL), Johnson Poole & Bloomer Limited (JPB) is pleased to present a Flood Risk Assessment (FRA) for the proposed mixed end use development site located on the land off Bangor Road, Johnstown. The study location, boundaries and existing site layout are shown on JPB Drawings MB616/01 and MB616/02. This assessment has been carried out to assess all potential sources of flooding and their potential consequences.
- 1.2 This report has been written for GDL, for submission as part of an Outline Planning Application to Wrexham County Borough Council (WCBC). The planning application is for a mixed use development on a 'brownfield' site, occupying an approximate area of 17.34ha (hectares). It is currently proposed that up to 300 dwellings will be constructed together with a local store and commercial/industrial units at the site.
- 1.3 The site has been considered under Technical Advice Note 15: Development and Flood Risk (TAN 15) which provides technical guidance in relation to development and flooding and supplements the policy set out in Planning Policy Wales, 2002 (PPW). It provides a framework within which risks arising from both river and coastal flooding, and from additional run-off from development in any location, can be assessed. PPW and TAN 15 are taken into account by local planning authorities in Wales in the preparation of development plans. They may be material to decisions on individual planning applications and will be taken into account by the National Assembly for Wales and Inspectors in the determination of appeals and called-in planning applications.
- 1.4 JPB has also previously prepared a Phase 1 Desk Study for the site referenced JS700-03/AES/HB/JC and dated 25 August 2009, which was updated in 2012 to account for the changes that had occurred on site i.e. decommissioning works. The updated Phase 1 Desk Study is referenced MB616-35/NM/HBRev A and dated 4 June 2013. Information from these reports (to include the GroundSure EnviroInsight and GeoInsight Reports) has been used in the preparation of this FRA and a list of information consulted is provided in Appendix A. An Envirocheck Flood Screening Report has been purchased as part of the FRA (dated 14 March 2012 and referenced 37986274_1_1) and a full copy is presented in Appendix B.
- 1.5 This report and related documents have been prepared for the sole use of the specified client in response to an agreed brief, for a stated purpose and at a particular time and its application must be made accordingly. No duty of care extends to any other party who may make use of the information contained therein. The information discussed in Section 10.0 – General of this report should be consulted and noted.

2.0 SITE SETTING

2.1 Site Description and History

- 2.1.1 The study area occupies 17.34ha and is located in the outskirts of Johnstown, approximately 4.2km southwest of Wrexham at approximate National Grid Reference SJ 311 461, as shown on JPB Drawing MB616/01. The area being considered for redevelopment comprises an irregularly shaped plot of land in plan view, with its long axis orientated north to south.
- 2.1.2 The site is a former Brick and Tile Works located off Hafod Road in Johnstown, Wrexham. It is understood that the original Hafod Red Brick Works was established in 1893 by Henry Dennis and was more recently known as Dennis Ruabon Limited. The works was supplied with clays from Hafod Quarry, principally the Heatherbrown Formation, part of the underlying Etruria Formation. The quarry was situated immediately south of the site, on the far side of Bangor Road and is now an operational landfill site. The two sites were linked by a steam powered tramway, with the on site brickworks also linked to the local rail network by several railway sidings, which exited the site to the northeast. The Hafod-y-bwch Colliery was located immediately north of the site and it is understood that the on site beehive kilns were once, in part, powered by the methane rich mine gases. The buildings and equipment contained within them have been decommissioned over the past three years with a number of buildings recently demolished to floor slab level, although the majority remain as indicated on JPB Drawing MB616/02. A number of clay stockpiles and waste clay, brick and tile mounds remain across the site and a refuse tip is recorded in the central southern part of the site. The Aberderfyn watercourse trends from northwest to southeast through the southern part of the site.
- 2.1.3 The northern site boundary is formed by a steep slope, which slopes upwards by approximately 3m to 4m, whilst the eastern site boundary is marked by Hafod Road, which was aligned north to south. Bangor Road, aligned west-northwest to east-southeast, is located immediately beyond the southern site boundary, with the junction of these two roads present to the immediate southeast of the site. The western site boundary was predominantly marked by a north to south trending public footpath, with hedges and mature trees.
- 2.1.4 The northern developed part of the site generally slopes down very gradually to the east, with the site's dedicated surface water drainage laid to flow out to the sewers in Hafod Road. The southern undeveloped part of the site slopes down gradually to the south and southeast promoting surface water flows towards the Aberderfyn (watercourse) as shown on JPB Drawing MB616/04. The site slopes down from a maximum level of 108m Above Ordnance Datum (AOD) in the northeast corner of the site (top of embankment) to a minimum level of 101m AOD in the immediately adjacent to Aberderfyn in the southeast of the site. The contours of the site and the overall existing surface water flow pathways are shown on JPB Drawings MB616/02 and MB616/04.

2.2 Geology

- 2.2.1 Made Ground (artificial) deposits are mapped across the site by the British Geological Survey (BGS) in the southwest corner of the site and from the centre of the site trending southwards towards Bangor Road. Information held within the JPB Archive indicates that the artificial

ground mapped in the southwest of the site could possibly relate to an area of sand and gravel extraction, whilst the area in the centre of the site is recorded as a refuse tip in the GroundSure Report and on the available historic and current OS plans. There are no records indicating the types of materials tipped on the site and they are likely to comprise a combination of reworked natural materials, overburden, colliery spoil and industrial waste from the brickworks. As the infilling works appear to have occurred without being recorded, other materials may be present.

- 2.2.2 Information published by the BGS on Sheet 121 indicates the presence of Glacial Till across the entire site. The associated geological memoir indicates the Glacial Till deposits to comprise red calcareous clay that is reported as 'stony' near Hafod-y-bwch. The records also indicate substantial thicknesses of Glacial Till to be present in the area, with thicknesses greater than 19m. Glaciofluvial sand and gravel deposits are mapped immediately beyond the southern site boundary and may also extend across the site's south-western corner, although this coincides with the possible area of sand and gravel extraction on site, discussed in paragraph 2.3.1. These materials have been quarried immediately off site to the south.
- 2.2.3 The underlying solid geology comprises the Carboniferous aged Etruria Formation, which consists of red, purple and mottled clays with occasional thin bands of limestone, shale and coal. The full depth of the Etruria Formation at this location is anticipated to be approximately 150m thick.

2.3 Hydrogeology

- 2.3.1 The Environment Agency's (EA) groundwater vulnerability map – Sheet 16 for West Cheshire and their web site indicates the classification of the aquifers at the site and its environs are as follows:

Table 2.1 Aquifer and Leachability Classification

Inferred Strata	Aquifer	Overlying Soil Leachability
Glaciofluvial sand and gravel	Secondary A ⁽¹⁾	High U ⁽³⁾
Glacial Till	Unproductive ⁽²⁾	Not Classified
Etruria Formation	Secondary A ⁽¹⁾	-

⁽¹⁾ **Unproductive Strata** - rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow. The wider area is also marked as 'low permeability, non water bearing drift deposits'.

⁽²⁾ **Secondary A Aquifer** - permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.

⁽³⁾ **High U** – soils with little ability to attenuate diffuse source pollutants and in which non-adsorbed diffuse source pollutants and liquid discharges have the potential to move rapidly to underlying strata or to shallow groundwater. Soil information for urban areas is less reliable and based on fewer observations than in rural areas, the worst case is assumed until proven otherwise.

- 2.3.2 The Glacial Till deposits across the site are considered to have a generally low permeability and will be present beneath the Glaciofluvial sands and gravels, if present, in the southwest corner of the site. The sand and gravel deposits are anticipated to have a significant porosity and permeability and are recorded as 'water bearing strata'; confined by the presence of the low permeability Glacial Till deposits. This allows the sand and gravels to provide base flow to the on site Aberderfryn watercourse. The permeability of the Etruria Formation is indicated to be low

with any groundwater movement likely to be through fracture flow. Its low permeability is due to the fine grained nature of the mudstone.

- 2.3.3 The site is not located within or in the vicinity of a groundwater Source Protection Zone (SPZ) and there are no potable or non-potable groundwater abstractions within a 1km radius of the site. Groundwaters are considered to be of **low to moderate sensitivity**.

2.4 Hydrology

- 2.4.1 The nearest surface water features, identified during the Phase 1 researches are summarised in Table 2.2, together with their distance and bearing from the study area and their flow direction.

Table 2.2: Location of Surface Water Features

Surface Water Feature	Distance and Bearing from Site	Flow Direction
Water reservoir	0m (within northern half of site)	N/A
Aberderfyn	0m (though southern part of site)	northwest to southeast
Land Drain (tributary of Aberderfyn)	0m (southwest site corner)	south to north
Land Drain	12m north	drains to pond
Land Drain (located along railway line – source of on site Land Drain)	15m south	south to north
Tributary to Aberderfyn	150m and 285m northwest	northeast to southwest
Hafod Woodland Land Drains and tributaries to Aberderfyn	from 132m north	various
Tributary of Black Brook	257m east	west to east
Black Brook	500m southeast	southwest to north
Ponds	10m north, numerous from 60m northwest, 80m and 96m west, 32m southwest, 314m east and 200m northeast.	N/A

- 2.4.2 The Aberderfyn (watercourse) is fed by numerous land drains and tributaries that originate within the Hafod Woodland to the north of the site. The Hafod Woodland is located across a steep mounded hillside. A further tributary also feeds into the Aberderfyn whose source is at a point approximately 1km northwest of the site. This tributary meanders through the edges of the adjacent agricultural land at the base of a hedgerow. The watercourses feeding the Aberderfyn are shown on the EA Detailed River Network Map at 1:10,000 scale in Appendix B.
- 2.4.3 Immediately beyond the point where the tributaries feeding the Aberderfyn converge, the Aberderfyn was noted to have a short culverted section where the watercourse passes beneath a track to Hafod Woodland; located approximately 190m northwest of the site. The Aberderfyn then trends and flows in a general south-easterly direction towards the site within a densely wooded ditch which was not accessible during the site walkover or subsequent topographical survey. Its outfall from a 400mm diameter culvert was observed approximately 10m west of the

site's boundary, at the western edge of the public footpath (Plate 1). The Aberderfyn was only exposed in a shallow open channel for a short section at this location before being culverted beneath the public footpath in a 700mm diameter pipe. Plates 2 and 3 show the western and eastern headwalls, either side of the public footpath.

- 2.4.4 The route of the Aberderfyn through the site is densely wooded with the main channel being approximately 1.5m to 2m wide and generally varying between 0.3m and 0.8m deep, as represented by cross sections B to E on JPB Drawings MB616/05a-c (note vertical exaggeration of scale on cross sections). Plates 4 to 17 show the route of the Aberderfyn through the site until it reaches the internal roadway and their approximate locations are also included on JPB Drawings MB616/05a-c.
- 2.4.5 A culverted / covered section of the Aberderfyn was noted where the watercourse is crossed by the internal roadway. The western side of the culvert was unable to be viewed due to the density of brambles. However, where it emerges on the eastern side of the internal roadway, the watercourse appeared to be flowing through a soil channel that had been covered by concrete and brick (Plates 18 and 19). It was not possible to see if any pipework existed within this structure. In the far southeast corner of the site, the Aberderfyn flowed through a very densely wooded channel (Plate 20).
- 2.4.6 The Aberderfyn is then culverted beneath the crossroads of Bangor Road, Hafod Road and New Hall Road, still trending and flowing in a south-easterly direction. This culverted section is recorded to be greater than 50m in length on the EA Detailed River Network Map. The last section of the Aberderfyn continues to trend and flow in a south-easterly direction through agricultural land, located at the base of hedgerows and trees. The cross sections indicate the watercourse to be between 1m to 2m wide and approximately 0.7m to 0.8m deep prior to a culverted section beneath the main dual carriageway of the A483 road. The culvert beneath the A483 road is approximately 900mm wide. Where the Aberderfyn emerges on the south-eastern side of the A483 road, the channel is slightly wider as it converges with the Black Brook approximately 500m southeast of the site.
- 2.4.7 A land drain was also noted during the site walkover in the far southwest corner, which is a tributary of the Aberderfyn. The land drain is shown to originate alongside the eastern side of the railway line on the EA Detailed River Network Map, at a point approximately 600m southwest of the site. The land drain would appear to trend and flow in a northerly direction along the railway line until it meets with Bangor Road. The land drain then turns 90° to the east and follows the southern edge of Bangor Road for approximately 100m. It is then culverted beneath Bangor Road in a 500mm diameter concrete pipe, where it trends in a northerly direction beneath the road and emerges at the south-western corner of the site, with a brick headwall present (Plate 24). The southern section of the land drain within the site's boundaries was dry (Plate 25) and was formed by a vegetated channel with crushed brick / concrete at the base, which was approximately 1m lower than the adjacent site levels. Towards the northern end of the land drain, the channel was grassed and shallower at approximately 0.5m deep (Plates 26 to 28). This section was water filled, with the resting water level being approximately 0.2m to 0.3m lower than the adjacent site levels.

- 2.4.8 The Aberderfyn is an 'ordinary' watercourse, whilst it's receiving waters, the Black Brook, is classified as a 'main river' by the EA. A review of the River Dee Catchment Flood Management Plan indicates Johnstown, and the site, to be located in the upper catchment of the River Dee in Sub Area 4 – Wrexham. This catchment is classified by the EA as an area where there are low, moderate and high flood risks, and where the EA is already managing flood risk effectively. The EA states that 'flood risk management activity will need to increase to sustain the current level of protection into the future'.
- 2.4.9 Under the Water Framework Directive (WFD), the Black Brook is classified as having a good ecological quality and does not require assessment, under the WFD, for its chemical quality. The Aberderfyn is not assessed under the WFD, as it is not a 'main river'. Surface waters on site are considered to be of **moderate to high sensitivity**, as they feed into the Black Brook.

2.5 Contamination

- 2.5.1 A historical review of the study area and the development of a Conceptual Site Model during the previous Phase 1 researches highlighted that potentially contaminative land uses may have occurred within the site's boundaries, associated with the former Brick and Tile Works and landfilling activities. Should infiltration techniques be utilised on site, where more permeable materials are found to be located on site, an assessment of their chemical nature would be required to ensure that the use of infiltration techniques does not promote the leaching and migration of contamination. This should be addressed during future ground investigation works.

2.6 Existing Site Drainage

- 2.6.1 The Commercial Drainage and Water Enquiry with Welsh Water (WW) confirms that there is a foul sewer trending and flowing from west to east within the northern site boundary. This foul sewer is indicated to have been part of the recent private sewer transfer, becoming the responsibility of Welsh Water on 1st October 2011. There are no public or private surface water sewers marked within, or at, the site's boundaries. The Commercial Drainage and Water Enquiry does not provide confirmation of whether the site connects to the public foul sewer. A copy of the drainage enquiry is provided in Appendix C.
- 2.6.2 In order to further confirm the existing development's on site drainage, a drainage connectivity survey was commissioned by JPB on behalf of GDL. The survey was undertaken week commencing 19th March 2012 by Amethyst Surveys Limited and a copy of their survey is provided in Appendix D. The survey confirms the presence of a live foul sewer in the north of the site, with its diameter recorded at 225mm. It is laid at a depth of approximately 3m below ground level (bgl) within the site's boundaries. With regard to surface waters, the site walkover and drainage connectivity survey indicate the existing buildings and hardstandings to have been served by a dedicated surface water drainage system, with several catch pits and interceptors noted throughout the northern part of the site. The drainage was significantly silted up which made it difficult to prove the routeing of all of the site's private surface water sewers and a number of the manholes covers were unable to be lifted.
- 2.6.3 The route of the private surface water sewers that have been confirmed on site indicate the existing site's drainage to discharge to the east of the site to a private sewer in Hafod Road.

However, it has not been possible to categorically prove this connection, or the size of the private sewer in Hafod Road, due to the issues described above. It would appear that a 300mm diameter sewer is present in the far east of the site, adjacent to Hafod Road. Surface water gully pots were noted along the length of Hafod Road, with some being directly associated with the downspouts of the site's buildings. Further manholes, which were unable to be lifted, were noted at the junction of Hafod Road with Bangor Road and New Hall Road and it is considered likely that the private sewer in Hafod Road will connect to the culverted section of the Aberderfyn watercourse at this location. On this basis, the site's surface waters from the developed part of the site are considered to discharge into the catchment of Aberderfyn.

- 2.6.4 No manhole covers or drainage features, specifically associated with the site, were noted in the undeveloped southern half of the site, with runoff promoted towards the Aberderfyn. Furthermore, no pipework was identified to discharge into the Aberderfyn watercourse from this part of the site. However, buried pipework was identified in the southwest corner of the site which did discharge into the Aberderfyn. The Phase 1 researches identified this to be associated with the Johnstown Combined Sewerage System laid within Bangor Road. The pipe was an overflow pipe from the combined sewer system and the associated discharge consents are now all revoked and this pipework has been capped at its point of discharge to Aberderfyn and is understood to be redundant.
- 2.6.5 The existing surface water flows discharging to the Aberderfyn watercourse have been calculated using the Modified Rationale Method for the existing developed areas of the site, and using R&D Technical Report W5-074/A Preliminary Rainfall Runoff Management for Developments (Revision D) for the existing greenfield areas of the site.
- 2.6.6 The volume of surface waters currently discharging from the roofs and hardstandings of the developed part of the site, to the private sewer in Hafod Road, has been calculated based on the site drainage being designed to accommodate a 1 in 5 year storm without flooding (as per the requirements of Sewers for Adoption at that time). The northern developed area of the site occupies 4.9ha, of which approximately 90% (i.e. 4.4ha) is considered to drain to the site's private surface water drainage network.
- 2.6.7 Using the Modified Rationale Method, the discharge from the developed part of the existing site has been calculated for various storm durations ranging from 1 minute to 7 hours, for both summer and winter rainfall conditions (Table 2.3).

Table 2.3: Existing Site Discharge Rates for the 1 in 5 year storm event

Duration (mins)	Discharge Rate (l/s)	
	Summer	Winter
1	1401.56	1469.72
5	929.70	974.91
10	682.29	715.47
15	550.93	577.72
30	366.01	383.81
60	235.93	247.41
120	147.94	155.13
180	112.23	117.68
240	91.82	96.29
300	79.07	82.91
360	68.87	72.22
420	62.49	65.53

2.6.8 The average discharge to the catchment of the Aberderfyn from the range of storm durations calculated for the 1 in 5 year event is 403.65l/s. The calculation sheets are presented in Appendix E.

2.6.9 The greenfield surface water runoff rates have been calculated based on an existing greenfield area of 12.4ha using QBAR(rural) i.e.

$$QBAR_{rural} = 0.00108 \text{ AREA}^{0.89} \text{ SAAR}^{1.17} \text{ SPR}^{2.17}$$

2.6.10 The runoff for different return periods has been calculated by applying the appropriate regional growth factor. For the Wales (Region 9) these factors are as shown in Table 2.4.

Table 2.4: Growth Curve Factors for Region 9 (FSSR 14)

Return Period (years)	1	2	5	30	100
Growth Factor	0.85	1.0	1.22	1.75	2.18

2.6.11 Table 2.5 indicates the runoff rates for the above return periods, using the given soil class (SPR), average rainfall (SAAR) and AREA input values. The SPR has been selected to reflect the presence of the anticipated low permeability Glacial Till strata at the surface of the site. The calculation sheets are provided in Appendix E.

Table 2.5: Estimated Greenfield Runoff

INPUT PARAMETERS					
SPR	SAAR (mm/year)			AREA (ha)	
0.45 (Class 4)	890			12.4	
GREENFIELD RUNOFF	RETURN PERIODS (YEARS)				
Units	1	2	5	30	100
l/s/ha	5.01	5.89	7.19	10.32	12.85
l/s	62.13	73.10	89.18	127.92	159.35

2.6.12 This method was designed to calculate runoff rates for 'small' catchments, which were still greater than 50ha. Therefore, for development sites that are smaller than 50ha, it is necessary to carry out the calculations using an area of 50ha and then scale the results down by linear interpolation, to provide the reported runoff values.

2.6.13 Overall, the surface water discharges from the existing site (17.34ha) to the catchment of the Aberderfyn are considered to be up to 492.83l/s for the 1 in 5 year event.

3.0 SITE DEVELOPMENT PROPOSALS & JUSTIFICATION TEST

Site Development Proposals

- 3.1 The subject site comprises a former brickworks and associated land, occupying an area of 17.34ha, as shown on JPB Drawing MB616/02. The mixed commercial and residential development will occupy 7.40ha of this area with the remaining 9.94ha forming areas of public open space.
- 3.2 The residential development will be located in the northern half of the site. It will provide up to 300 residential dwellings at a density of 43 dwellings per hectare over approximately 7.0ha. The residential properties will comprise a combination of detached and linked dwellings with the main access route being from Bangor Road in the south of the site. An emergency access route is also proposed in the northeast corner of the site from Hafod Road. No basement structures are proposed as part of the development and front and rear gardens will be provided to each of the properties, together with driveways and garages for vehicle parking.
- 3.3 A Local Store has also been included within the development proposals which is to be located off Bangor Road in the far southwest corner of the site. The Local Store will occupy 0.11ha of the development area. Finally, an Employment Zone has been included in the far south of the site which will again be accessed from Bangor Road. Commercial units are currently proposed which occupy 0.29 ha of the developed area.
- 3.4 The proposed development layout is shown on the FPCR Illustrative Masterplan and on JPB Drawing MB616/07.

Justification Test

- 3.5 The development advice maps which accompany TAN15: Development and Flood Risk are based on the best available information considered sufficient to determine when flood risk issues need to be taken into account in planning future development. Three development advice zones are described on the maps, which are attributed different planning actions. These maps are based on the Environment Agency's extreme flood outlines (Zone C) and the British Geological Survey (BGS) drift data (Zone B). All other areas (Zone A) are considered to be at little or no risk of fluvial or coastal/tidal flooding. Zone C is divided into two sub section C1 and C2, where C1 refers to 'areas of the floodplain which are developed and served by significant infrastructure, including flood defences', whilst C2 refers to 'areas of the floodplain without significant flood defence infrastructure'.
- 3.6 TAN 15: Development and Flood Risk indicates that 'new development should be directed away from Zone C and towards suitable land in Zone A, otherwise to Zone B, where river or coastal flooding will be less of an issue'. Flooding consequences may not be acceptable for some types of development and the vulnerability of different land uses to flooding are divided into three categories in TAN15;
- Emergency Services (hospitals, fire and police stations, emergency depots and shelters);
 - Highly Vulnerable Development (residential premises, waste disposal sites, power stations and public buildings e.g. schools, libraries);
 - Less Vulnerable Development (general industrial, employment, commercial and retail development, transport and utilities infrastructure).

Highly Vulnerable Development and Emergency Services should not be permitted in Zone C2 and all other development should only be permitted in Zones C1 and C2 if determined by the Planning Authority to be justified in that location.

- 3.7 The subject site is identified in development advice maps as being located in Zone A and as such the development is considered to be compliant with the policies set out in TAN15 and Planning Policy Wales. However, the Aberderfyn watercourse, flowing through the southern part of the site, is not mapped by the EA and its flood plain will also need to be taken into account with the layout and form of the development, together with other potential forms of flooding i.e. pluvial, groundwater and flooding from sewers. These issues are discussed in greater detail in Section 5.0.

4.0 OPERATING AUTHORITIES

4.1 Environment Agency

4.1.1 The EA has wide ranging responsibilities which include the management of water courses, control of pollution and flood defence. The Environment Agency has general flood defence and land drainage powers, including a supervisory duty over all flooding. They are responsible for advising the local authorities on planning conditions relating to volumes and rates of runoff. It is therefore essential that the EA is consulted throughout the design process.

4.1.2 A pre planning enquiry has been made with the EA during the preparation of this Flood Risk Assessment (FRA). A copy of the correspondence received from the EA is provided in Appendix F. In summary, the EA have confirmed the following points and require the issues raised to be addressed by the FRA:

- The site is located within Zone A as defined by the development advice maps referred to in TAN15:Development and Flood Risk (July 2004);
- Where infiltration is not practicable and the site is currently undeveloped (greenfield), the EA will usually require that the discharge rate is limited to the greenfield runoff rate with on site attenuation for up to the 1% rainfall event with an appropriate allowance for climate change. For existing developed sites (brownfield) the EA require the developer to calculate the existing brownfield runoff rate and limit the developed runoff rate to two thirds of the existing rate. The EA welcomes the intention indicated to incorporate SuDS components into the drainage design;
- The EA has no record or history of flooding associated with the Aberderfyn at this location. As a non-main river, and for completeness, the EA recommend that the Lead Local Flood Authority (Wrexham CBC) is consulted on this matter;
- As a small catchment ordinary watercourse, flood risk from the Aberderfyn is not mapped by the EA on their national flood maps and given the scale and significance of the development the EA recommend that the potential for flooding from the brook is investigated as part of the FRA. Appropriate mitigation measures may be necessary should a flood risk be apparent;
- Any culverting or works affecting the flow of a watercourse requires the prior written consent of the Lead Local Flood Authority.

4.2 Wrexham County Borough Council

4.2.1 Wrexham County Borough Council (WCBC) is the local planning authority for the area and is responsible for the preparation and development of local plans and controlling development within the area. WCBC will be consulted throughout the design process for the proposed development to ensure that the proposals do not conflict with any existing or proposed developments in terms of flooding and drainage.

4.2.2 WCBC has also become the Lead Local Flood Authority under the Flood Risk Regulations 2009 and is responsible for managing risk from ordinary watercourses, surface run off and groundwater and consent to the piping of watercourses from April 2012, as a result of the implementation of the Flood and Water Management Act 2010 in April 2011. The Lead Local

Flood Authority also has a responsibility and duty to promote 'Sustainable Drainage Systems' (SuDS) on all developments and adopt all SuDS components which drain two properties or more, although the latter has yet to come in effect, at the time of writing. It was originally proposed that SuDS Approval Boards (SAB) would be in place by October 2012, although National Standards for this have yet to be finalised.

4.2.3 A Preliminary Flood Risk Assessment was prepared by WCBC in 2011 and the information contained in this report has been consulted and noted. More recently, WCBC has prepared a Draft Local Flood Risk Management Strategy (October 2012) to further fulfil their responsibilities as the Lead Local Flood Authority and the information in this 'draft' document has been noted.

4.2.4 A copy of the correspondence with WCBC is provided in Appendix G and in summary they have made the following comments:

- The Highways and Street Scene area departments are not aware of any historical flooding events associated with the Aberderfyn and there is no existing modelling work for this section of the brook;
- Data supplied to WCBC by the EA indicates the this area is 'more susceptible to surface water flooding';
- The existing design approach for great crested newt mitigation demonstrates good design principles and should be expanded to include details of proposed ownership and maintenance of the public areas of green infrastructure;
- The Countryside Council for Wales and Welsh Water should be included in future discussions;
- Where an ordinary water consent for the Aberderfyn is required, Charlotte Beattie of the Lead Local Flood Authority should be contacted.

4.3 Welsh Water

4.3.1 Welsh Water is the local sewerage undertaker responsible for all the public foul and surface water infrastructure in the area. WW has been consulted and will continue to be informed throughout the design process regarding existing capacities, as well as any proposed connections to them.

4.3.2 A Pre-Planning Enquiry has been submitted to WW and their response is currently awaited.

5.0 FLOOD RISKS

5.1 Identified Potential Flood Risks

5.1.1 The following table summarises a number of key factors that should be considered for all new developments. Where a risk of flooding is identified further assessment of the hazard and risk is required and this is provided in Sections 5.2 to 5.7 of this report.

Table 5.1: Potential Flood Risk Summary

Question	Flood Hazard						
	Fluvial	Sea	Estuaries	Groundwater	Overland Flow	Artificial Drainage Systems	Infrastructure Failure
✓ = Yes							
✗ = No							
? = Possible (further research required at design stage)							
Is the development next to the sea or any watercourse shown on Ordnance Survey maps?	✓	✗	✗				
Is the development site, or part of the development site, identified as being at risk of flooding within available documentation?	?	✗	✗	?	✓	✗	✗
If a strategic flood risk assessment is available, is the development site, or part of the development site, identified as being at risk of flooding?	?	✗	✗	✗	✓	✗	✗
If a flood zone map is available, is the development, or part of the development site, within a High Risk zone?	✗	✗	✗				
If a flood zone map is available, is the development, or part of the development site, within a Medium Risk zone?	✗	✗	✗				
If a flood zone map is not available, is the development site, or part of the development site, situated on alluvium based on consideration of geological maps of the area?	✓	✗	✗				
If there is an existing property on, or next to the site at the same level, is the property within a flood warning area?	✗	✗	✗	✗			
Are LPA/FDA aware of any existing, historical or potential flooding problems that may affect the site?	✗	✗	✗	✗	✓	✗	✗
Do the physical characteristics of the site suggest that it may be prone to flooding?	✓	✗	✗	✓	✓	✗	✗
If a flood zone map is not available, is the development site below 10mAOD and does the FDA consider the development to be at risk from tidal flooding?		✗	✗				
Is the development located within a natural or artificial hollow, or at the base of a valley or at the bottom of a hillslope?				✓	✓		
Does examination of historical maps indicate any likelihood of flood risk at the site?	✗	✗	✗	✗	✗		
Do the names of surrounding roads, areas or houses suggest the possibility of seasonal or historical flooding?	✗	✗	✗	✗	✗		
Is the site likely to involve excavation / construction below existing ground levels (excluding foundations)?				✗			
Is the land use upslope of the site such that the generation of overland flow may be encouraged, and can water from this area flow onto the site?					✓		
Are there any artificial drainage systems on or next to the site, at the same level, or upslope of, the site?						✓	✗
Is the development site protected by an existing flood defence?	✗	✗	✗			✗	✗
Is the development site protected by a control structure (e.g. flap valve, sluice gate, tidal barrier etc)?	✗	✗	✗			✗	✗
Is the development site located upstream of a culvert which may be prone to blockage?	✓		✗	✗	✗	✗	✗
Are water levels in a watercourse located in or next to a development site controlled by a pumping station?	✗	✗	✗	✗	✗	✗	✗
Is the development site next to or downstream/down slope of a canal?						✗	✗
Is the development site downstream/down slope of a reservoir or other significant water body?						✗	✗

(CIRIA C624 – Table A2.1 Level 1 FRA Summary)

- 5.1.2 The potential flood hazards identified in Table 5.1 are summarised in Table 5.2 below, together with whether the potential risk will affect the development site itself and/or potentially increase the flood risk upstream or downstream of the study area.

Table 5.2: Flood Risk to the Development and its Surroundings

Flood Hazard	Flood Risk to the Development?	Increased Flood Risk Upstream?	Increased Flood Risk Downstream?
Fluvial Flooding	✓	✗	✓ (without surface water runoff management)
Groundwater flooding	?	✗	✗
Overland flooding (pluvial)	✓ (without surface water runoff management)	✗	✓ (without surface water runoff management)
Artificial Drainage Systems	✓	✗	✓ (without surface water runoff management)
Infrastructure Failure	✗	✗	✗

5.2 Fluvial Flooding

- 5.2.1 The site is located entirely within Flood Zone A and is therefore considered to be at low risk from fluvial flooding. The Flood Screening Report indicates that the site is located in a 'low flood insurance claim rating' area and a search of the Chronology of British Hydrological Events has found no results relating to the site. However, a potential risk of fluvial flooding from the Aberderfyn watercourse has been identified, which is not currently modelled by the EA or WCBC. As such, further assessment of flood risk from this watercourse is required.
- 5.2.2 A site specific hydraulic assessment of the Aberderfyn catchment has been made to inform the final development layout. Lees Roxburgh Consulting Engineers were commissioned directly by the Client to undertake this assessment and a copy of their report, drawings and calculations are provided in Appendix H.
- 5.2.3 In summary, the flows rates of the Aberderfyn have been calculated using the Revitalised FSR/FEH spreadsheet to obtain the 1 in 100 year and 1 in 1000 year flows, with the 1 in 1000 year flows derived using a growth factor of 1.7. Data for the Aberderfyn catchment was obtained from the FEH CD (version 3), based on a catchment area of 1.24km², annual average rainfall of 838mm and a value of 32.14% for SPRHOST. The flows utilised by Lees Roxburgh are summarised below.

Table 5.3: Flow Rates for the Aberderfyn

Watercourse	Catchment Area (km ²)	Q100 (m ³ /s)	Q1000 (m ³ /s)
Aberderfyn	1.24	2.1	3.6

- 5.2.4 A hydrodynamic 1-dimensional model has been created by Lees Roxburgh using HEC-RAS 4.0 to generate the anticipated flood levels for up to the 1 in 1000 year flood event. The HEC-RAS model is available for review upon request direct from Lees Roxburgh.
- 5.2.5 Topographical survey data has been used to construct the HEC-RAS model. The top of bank is marked in orange on JPB Drawings MB616/05a-b together with the bed levels and water levels of the Aberderfyn, marked in blue. The water levels were recorded during the topographical survey completed in March 2012. The details of the cross sections used to construct the HEC-RAS model are also provided on JPB Drawing MB616/05. However, it should be noted that there are sections of the channel that are not well defined by the topographical survey due to the overgrown nature of the Aberderfyn leading to access issues. The areas unable to be fully surveyed are indicated on JPB Drawings MB616/05a-c.
- 5.2.6 The flood outlines for the 1 in 100 year and 1 in 1000 year events are shown on Lees Roxburgh Consulting Engineers Drawing 5476/01-01/rev A. In line with the principles of TAN15: Development and Flood Risk, the 1 in 1000 year flood outline (or 0.1% annual exceedance probability) has been used to assess the consequences of fluvial flooding to the proposed development. However, when considering the modelled flood outline, a number of additional factors need to be considered:
- There is a large stockpile comprising clay stock for the brick making process on the southern side of the Aberderfyn watercourse, together with an area that has been the subject of a land raise and disused raised buried pipework in Area 4. A number of stockpiles containing a combination of waste clay, brick and tile are present to the north of the Aberderfyn, located in Areas 3 and 5 (see JPB Drawing MB616/02). These features are currently influencing the extent of the modelled flood plain and will not be present upon development. Therefore, where the flood plain is restricted by these features, the flood plain will widen upon their removal;
 - A culverted section is present in the southeast of the site, where the internal roadway crosses the Aberderfyn watercourse. This feature is shown to constrict the 1 in 1000 year flows with flood waters backing up behind the culvert and flowing over the roadway. The surveyed stream cross sections have been widened, during the modelling exercise, in accordance with the survey levels to represent practical hydraulic conditions of water flowing over the roadway. Upon development, this section of the Aberderfyn will be returned to an open channel, which will reduce the restriction of flow at this location;
 - The proposed development will need to create a new access road across the Aberderfyn and the effects of this have not been modelled to date. This modelling should be completed during the detailed design stages to ensure that the flows within the Aberderfyn are not restricted by the new culvert / bridge structure and that it is sized appropriately.
- 5.2.7 A comparison of the flood outlines with the proposed development layout indicates a number of areas to be sited within the modelled flood plain, which effectively places them within Flood Zone C, or more specifically, C2 i.e. 'areas of the floodplain without significant flood defence infrastructure'. As discussed in Section 3.0, highly vulnerable land uses are not considered acceptable in Flood Zone C2 and less vulnerable development should only proceed subject to justification and acceptability of the consequences. The areas at risk from fluvial flooding are indicated on JPB Drawing MB616/06.

- 5.2.8 The commercial development to the south of the Aberderfyn lies within the flood zones for the 1 in 100 year and 1 in 1000 year events from the current hydraulic modelling and the consequences of flooding are considered to be too significant to allow the development to proceed. However, the levels in this area of the site have been modified in the past by the extraction of sand and gravels, with Area 4 being noted to be approximately 500mm to 900mm lower than the land to the immediate west and south. Restoring the levels of the commercial development area, nearer to the original site levels, would enable safe development of this area, as it would effectively remove the land out of the floodplain. On this basis, it is recommended that the development platform is set at a level of 103.2m AOD for the commercial development, with the finished floor levels set 600mm above the modelled flood level to provide further flood risk mitigation measures. To achieve the level of 103.2m AOD, the area of land within the flood plain and occupied by the commercial development, and situated within the flood plain, would need to be raised by between 100mm and 500mm.
- 5.2.9 The raising of this area of land is considered to be the most effective flood risk solution, particularly given the marginal increases required onsite and the presence of clay stockpiles that could be utilised to facilitate the land raise. The land raise will protect the residential and commercial properties from fluvial flooding on a permanent basis with no risk of failure from flood defences i.e. bunds or barriers. However, the effects of raising these areas would need to be assessed further to ensure that it does not create further fluvial flooding issues elsewhere onsite or potentially off site, as it would force further flood waters to the north of the Aberderfyn.
- 5.2.10 The residential area in the north of Area 5 (see JPB Drawing MB616/02) lies within the 1 in 1000 year modelled flood plain but is confirmed by the hydraulic modelling to be outside of the flood plain for the 1 in 100 year fluvial flood event. The guidance provided in Appendix A of TAN15 (Page 26) indicates that developments should be designed to be flood free during the 1 in 100 year fluvial flood event and that beyond this threshold frequency the proposed development would be expected to flood under extreme conditions. However, it is stated that even with adequate mitigation measures in place it may still not be sensible to build in areas where the velocity and depth of floodwaters is such that structural damage is possible, or that people could be swept away by the flood. The maximum depth of flooding indicated to be 'tolerable' for a residential development is 600mm, with a maximum rate of rise of floodwaters given as 0.1m/hr. The maximum speed of inundation of flood risk areas is 4hrs with the maximum velocity of floodwaters indicated to be between 0.15m/s and 0.3m/s. This is indicative guidance only and site specific conditions should be considered.
- 5.2.11 The depth of floodwaters that is currently modelled to affect the residential properties in the north of Area 5 is generally 200mm across the majority of the area with a thin strip of land adjacent to Hafod Road potentially being inundated by floodwaters up to 500mm. The anticipated flood depths are considered to be in line with the guidance provided in TAN15. However, given the relatively localised area to be developed with residential properties in the north of Area 5, the land could be raised by 200mm to 500mm to ensure that these residential properties remain protected from the extreme events and that the consequences of flooding are removed. Based on the current modelling, it is advisable that the development levels for this area are set at a minimum of 102.2m AOD with the finished floor levels of the properties set at 102.8m AOD i.e. 600mm above the modelled fluvial flood level to provide further protection. As with the land to the south of the Aberderfyn, the effects of raising the residential development

would need to be assessed further to ensure that it does not create further fluvial flooding issues elsewhere onsite or potentially off site. The removal of the existing culvert is also likely to alter the extent of the flood plain and these properties may no longer lie within the 1 in 1000 year flood plain when this is accounted for.

- 5.2.12 All SuDS features for the storage of storm waters should be sited, where possible, outside of the modelled flood plain to ensure that they can still function as required, even during periods of extreme flooding. Where these features lie immediately adjacent to the flood plain it may be advisable to create raised banks along their southern edge to ensure that flood waters from the Aberderfyn cannot inundate the attenuation storage.
- 5.2.13 The main access route to the site, from Bangor Road, will need to be functional at all times and as such it will be necessary to ensure that flood waters do not make this route impassable. From the current hydraulic modelling it would be advisable to ensure that the finished level of the road is constructed at the modelled flood level for the 1 in 100 year event. At this location, the 1 in 100 year event is also the same level as the 1 in 1000 year event i.e. 103.20m AOD. This would mean that the surface of the new access road needs to be approximately 0.5m higher than the existing top of bank and this is considered to be feasible. It will be necessary to build the structure over the Aberderfyn in such a way as to prevent any restriction of flows in the brook and to prevent debris and vegetation backing up behind it, which could result in a flood event. During the detailed design, and as discussed previously, further hydraulic modelling should be completed to assess any changes in the flood levels when the culvert beneath the existing access road in the southeast of the site is removed and to account for the new structure over the Aberderfyn for the new access road. Prior written consent of the Lead Local Flood Authority is required for any proposed works or structures in, under or over an ordinary watercourse.
- 5.2.14 The proposed emergency access route off Hafod Road, in the far northeast corner of the site, lies outside of the Aberderfyn flood plains and will remain functional at all times.
- 5.2.15 The hydraulic modeling has also indicated that the culverted section beneath the Bangor Road / Hafod Road junction is unable to pass the 1 in 1000 year flows, with waters building up behind the culvert and flowing up over the road. As with the existing culvert on site, the surveyed stream cross sections have been widened in accordance with the survey levels to represent practical hydraulic conditions of water flowing over the Bangor Road / Hafod Road junction. The area in the southeast of the site should remain undeveloped, so that it can flood during extreme events without putting people or properties at risk. A public footpath is routed through this area and suitable warnings and signage should be provided to notify the future occupants and users of the public open space of the potential for flooding. The main access route from Bangor Road will remain functional at all times, as an alternative route, as discussed above.
- 5.2.16 The brook is currently heavily overgrown and it is advisable that its route through the development be well maintained to prevent blockages within the channel. The culvert entrance in the far southeast of the site should also be maintained to ensure that it does not become blocked by vegetation etc.

- 5.2.17 A minimum of a 5m easement should be provided along the route of the Aberderfyn to enable future maintenance of the channel. The proposed development does not extend within the 5m easement. It would also be advisable to allow a similar easement along the proposed routes of the swales, again for ease of access during routine maintenance and this is allowed for in the proposed layout.
- 5.2.18 The consequences of fluvial flooding onsite are **considered to be acceptable** when the site levels to Area 4 are restored and flood mitigation measures are put in place to remove the specific areas of development from the modelled flood plain. To further reduce any resultant risks to the development and to address any potential inaccuracies in the flood modelling, the finished floor levels (FFL) of the residential properties currently located within the flood plain should be set at a minimum of 600mm above the 1 in 1000 year flood event. It would be beneficial to construct the properties adjacent to the flood plain using flood resilient methods and materials by providing waterproofing to the walls and floor and raising electrical sockets.

5.3 Overland Flooding (pluvial)

- 5.3.1 Overland flooding (pluvial) generally refers to flood events caused by surface water runoff from short, very intense rainfall events, where the rainfall intensity exceeds the infiltration capacity of the ground, when the soil is so saturated that it cannot accept any more water or when the sewer network is surcharged.
- 5.3.2 The study area occupies 17.34ha of which approximately 12.44ha comprises undeveloped greenfield land, with the remaining 4.9ha being formed by the former brick work. Of the existing brick works development to the north of the Aberderfyn watercourse, approximately 4.4ha is covered by roofs and hard surfaces, which are understood to drain to the catchment of the Aberderfyn via the site's private surface water drainage network. Upon development, this area of the site will be developed with residential dwellings over an area of 7.0ha, of which approximately 4.55ha will be formed roads and roofs i.e. approximately 65% hardcover. The proposed residential development to the north of the Aberderfyn will slightly increase the area of hardcover across this part of the site.
- 5.3.3 To the south of the Aberderfyn watercourse, the land is currently undeveloped and as such is considered to be 'greenfield'. A Local Store will occupy 0.11ha of the development area which will be formed by 100% hardcover with a further 0.29ha set aside as an employment area (commercial development) with approximately 52% of this area being formed by roofs and hardstandings. Therefore, the total area of hardcover to the south of the Aberderfyn will be 0.26ha, which is approximately 65% of the proposed development area. This area of the proposed development will increase the percentage of hardcover across the site which will also increase the volume of surface water runoff generated.
- 5.3.4 The existing surface water runoff routes are shown on JPB Drawing MB616/04. The pluvial flood maps provided in the Flood Screening Report (Appendix B) indicate the southern half of the site to be situated in area that could be potentially affected by surface water flooding for the 1 in 75 year, 1 in 100 year and 1 in 1000 year return periods, with the area affected widening with the greater storm events. The site's topography will promote surface water runoff in this direction upon development of the site.

- 5.3.5 Information with the Preliminary FRA indicates that surface water flooding is the most prominent cause of flooding in the WCBC area, particularly where runoff from paved surfaces flooded properties that were below the level of the adjacent roads. A plan showing the recorded surface water flooding incidents within the WCBC area, included within the Preliminary FRA, does not indicate there to be any recorded incidents on or next to the site.
- 5.3.6 Overland flows within the site should be controlled, to prevent localised flooding issues, by implementing adequate surface water runoff control measures for the proposed residential and commercial development areas, which should include marginally raising the floor levels. This is of particular importance where storm water runoff could be promoted towards the residential properties, both down the embankment along the northern site boundary, and in the south of the site near to the course of the Aberderfyn.
- 5.3.7 The proposals will also need to mitigate the potential increased flood risks to the Aberderfyn watercourse and the potential for overland flows over Bangor Road / Hafod Road to the off site agricultural land to the southeast of the site. Sufficient attenuation storage volumes will be required onsite to contain storm waters from the design storm event, whilst also taking account of climate change. It will be necessary to undertake some re-profiling of the site's surface to form a suitable development platform, which will enable the surface waters being generated from within the development boundary to be managed and controlled by the new infrastructure, with the aim of preventing overland flows off site to the Bangor Road / Hafod Road and agricultural land.
- 5.3.8 The consequences of overland flooding are considered to be **potentially significant** to the proposed development. The proposed surface water drainage system will be designed to manage storm events for a 1 in 100 year event with a factor of 30% allowed for climate change. Consideration should also be given to the design and layout of the development to ensure that the on site properties are sufficiently elevated from surface water flows during rare storm events that may exceed the design storm event i.e. a storm with a 1 in 1000 year return period.

5.4 Groundwater Flooding

- 5.4.1 Groundwater flooding may be a problem where developments are underlain by permeable rocks; for example chalk, limestone and sandstone. Whilst rocks such as these generally have an extensive capacity to receive and store water from rainfall, during heavy rainfall or prolonged periods of rainfall groundwater levels may rise to or near ground level. Groundwater flooding will be more of an issue where groundwater is naturally present at shallow depths.
- 5.4.2 Elevated/shallow groundwater levels will pose a significant risk to basements; will reduce/prevent infiltration to the ground causing waters to pond at the surface or flow overland; and may result in infiltration to sewers and other buried services, reducing their capacity to remove surface water runoff. Once groundwater flooding has occurred, it may take a long time for groundwater levels to fall. This can increase the damage from groundwater flooding.

- 5.4.3 The BGS indicates the main central part of the site to be recorded as having a 'high' susceptibility to groundwater flooding, with the northern and southern parts of the site being recorded as having a 'moderate' susceptibility to groundwater flooding. The BGS recorded groundwater flooding susceptibilities are considered to be associated with the site's topography, and the presence of the Aberderfyn watercourse. The risk of groundwater flooding will be of higher risk where the Glacial sands and gravels are present, which are likely to be in hydraulic continuity with the Aberderfyn. The Soilscales website describes the onsite soils as 'slowly permeable seasonally wet slightly acid but base-rich loamy and clayey with impeded drainage' (Soilscales) and this is considered to refer to the Glacial Till deposits across the majority of the site.
- 5.4.4 There are no records of past groundwater flooding within the area covered by WCBC, which is stated to be due to the topography and geology of the area in the reviewed Preliminary FRA.
- 5.4.5 The consequences of groundwater flooding are **not considered to pose a significant risk** to the proposed development. Notwithstanding this, the depth to groundwater should be confirmed through intrusive ground investigation, particularly where there is potential for permeable sand and gravel deposits along the route of the Aberderfyn watercourse, to ensure that the site's buried services will not be impacted by shallow groundwater. The properties do not include basements and this will reduce the potential risk from groundwater flooding. A freeboard of at least 1m should be present between the resting groundwater level and the base of any foundations across the development site or any underground attenuation storage. The drainage proposals should be designed to ensure that there is not an increased risk to the development from groundwater flooding.

5.5 Flooding from Artificial Drainage Systems

- 5.5.1 Many artificial drainage systems, such as pipes, land drains, sewers and drainage channels exist to manage runoff and effluent from developments and roads. During heavy rainfall, flooding from artificial drainage systems may occur, where the rainfall event exceeds the capacity of the drainage system, or if the system becomes blocked by debris or sediment. This will also occur if the system surcharges due to a high water level in the receiving watercourse. Flooding results, if water overflows from the drainage system, if water is unable to enter a drainage system that is blocked, or if it has inadequate capacity.
- 5.5.2 The reviewed Preliminary FRA report indicates that there are no records of properties affected by past sewer flooding that led to significant consequences. A plan provided in the PRFA indicates the general locations of all sewer flooding incidents over the past 10 years and a review of this information indicates none to have occurred in the vicinity of the site.
- 5.5.3 Buried pipework was identified in the southwest of the site which discharged into the Aberderfyn, shown on JPB Drawing MB616/02 as 'line of buried pipework'. The Phase 1 researches identified this to be associated with the Johnstown Combined Sewerage System laid within Bangor Road, although the associated discharge consents are all revoked. This pipework would appear to no longer be in use and it capped off at the point of discharge to the

Aberderfyn. It will need to be removed as part of the proposed development, as it crosses through the area of proposed residential development to the south of the Aberderfyn.

- 5.5.4 The channel of the land drain located along the western boundary in the far southwest of the site was noted to be predominantly dry at the time of the site walkover, with the water filled section being at the point where it converges with the Aberderfyn. As water levels rise within the Aberderfyn, flood waters are likely to flow further back along this drainage channel. The drainage channel is also linked to the land drain to the south of Bangor Road, via a 500mm diameter concrete culvert, which discharges into the land drain at the site's south-western corner. Therefore, storm waters could also be passed forward into the onsite land drain from off site. However, during extreme storm events, the presence of the 500mm diameter concrete culvert would restrict the flows into the land drain, with flood waters held back on the southern side of Bangor Road.
- 5.5.5 The modelled flood level, for the 1 in 1000 year event, in the Aberderfyn watercourse onsite is 104.1m AOD at a point located immediately upstream of the onsite land drains discharge point. Assuming that flood waters would back up the land drain at this level, a comparison of the modelled flood level for the Aberderfyn and the top of bank levels for the onsite land drain, on the nearside of the development (eastern bank), can be made. This comparison would indicate that the top of bank is generally higher than the modelled flood level of 104.11m AOD, with the exception of one location along the northern part of the land drain, as indicated on JPB Drawing MB616/06. It would be advisable that when creating the development platform for the Local Store adjacent to the land drain that this is set no lower than 104.1m AOD with the finished floor levels of the nearest residential dwellings and Local Store set at 104.7m AOD i.e. 600mm above the modelled flood level.
- 5.5.6 The consequences of flooding from artificial drainage systems i.e. the onsite land drain are considered to be **potentially significant** to the proposed residential development in the southwest of the site. Elsewhere, the consequence of flooding from artificial drainage systems is **not considered to be significant**.

5.6 Flooding due to Infrastructure Failure

- 5.6.1 Flooding from infrastructure failure can be as a result of structural, hydraulic or geotechnical failure of features (canals, dams, pipes etc) that retain, transmit or control the flow of water. The risk of such infrastructure failures increase during flood events, as the conditions put physical pressure on the operation of the system.
- 5.6.2 There are no canals, reservoirs or other significant water bodies located up gradient of the site which pose a significant flood risk. Existing water mains are laid within Hafod Road and Bangor Road to the east and south of the site. Any ruptures of these mains would be channelled along the roads to the southeast of the site, where flood waters would continue to drain away from the site in a south-easterly direction. Access and egress to the proposed development site is considered to still be possible should a water main burst. A new connection to the water main will be required to serve the new development. This is not considered to increase the risk posed to off site properties.

- 5.6.3 The consequences of flooding from infrastructure failure are considered **not significant** to the proposed development.

5.7 Climate Change

- 5.7.1 Global climate is reputed to be changing as a result of human activity. The nature of climate change experienced will vary with location. In the UK, projections for future climate change indicate more frequent short duration, high intensity rainfall together with more frequent periods of long duration rainfall (PPS 25).
- 5.7.2 Observations of climate change to date suggest that the annual mean precipitation for England and Wales has not changed significantly since records began in 1966. However, patterns are emerging that would indicate that seasonal rainfall has varied, decreasing in the summer and increasing in the winter. In addition to changes in the seasonality of precipitation, there are also changes in its characteristics, with a greater number of heavy rainfall events recorded (UKCIP 2008).
- 5.7.3 The type of rainfall events experienced will have implications on flooding, with the potential for more frequent river flooding events and local flash flooding from surface waters. It is important that new developments assess the potential influence climate change may have upon them in the future. It is currently projected that peak rainfall intensity could have increased by 20% by 2085, with up to as much as a 30% increase by 2115 (PPS 25). In the following assessments a climate change value of 30% has been adopted in line with EA requirements for a proposed residential development.

6.0 SURFACE WATER DRAINAGE

6.1 Proposed Development Surface Water Discharge Rates

- 6.1.1 The volume of surface waters requiring disposal from the development site has been calculated using the Modified Rationale Method (Table 6.2). Various storm durations ranging from 1 minute to 7 hours for both summer and winter rainfall conditions have been used for the 1 in 1 year, 1 in 30 and 1 in 100 year events. The rainfall intensities have been increased by 10% in line with the information provided in the reviewed Preliminary FRA.
- 6.1.2 The average discharge from the proposed impermeable areas of the entire developed site (approximately 4.81ha), for the range of storm durations calculated, for the 1 in 1 year event is 297.07l/s, for the 1 in 5 year event is 485.74l/s, whilst for the 1 in 30 year and 1 in 100 year events the average discharges are 693.11l/s and 880.24l/s, respectively. The calculation sheets are presented in Appendix I.
- 6.1.3 It is clear from the calculated discharge rates that the attenuation and storage of peak flows will be required to address the additional runoff from the proposed development, for the storm events equal to and greater than the 1 in 5 year event, when compared with the existing runoff rates for the study area (Section 2.6). However, when the flows from the existing developed area are restricted to two thirds of the existing brownfield runoff rate, as required by the EA, the lower storm events will also require attenuation storage to control storm water flows from the proposed development.
- 6.1.4 Given the anticipated low permeability of the onsite soils i.e. Glacial Till deposits, it is considered unlikely that the site will be suitable for infiltration systems. However, should future intrusive ground investigations prove otherwise, the use of infiltration drainage systems should then be included within the detailed drainage design. If later work indicates infiltration to be feasible on site, the permeability of the ground will need to be fully confirmed using soakaway tests in line with BRE 365: Soakaway Design prior to any detailed drainage design.
- 6.1.5 On this basis, the following assessments have been made assuming that the surface waters from the developed site will continue to drain into the Aberderfyn watercourse on site.

6.2 Preliminary Drainage Design

- 6.2.1 As summarised previously, the Environment Agency will require that for the existing greenfield areas, the discharge rate into a watercourse is limited to the greenfield runoff rate with onsite attenuation for up to the 1% rainfall event (1 in 100 year event) with an appropriate allowance for climate change. For the existing brownfield areas, the EA require the developer to calculate the existing brownfield runoff rate and limit the developed runoff rate to two thirds of the existing rate.
- 6.2.2 On this basis, the discharges from the development area to the south of the Aberderfyn will need to be restricted to the existing greenfield runoff rate of 12.85l/s/ha. The development to the south of the Aberderfyn, to include the Local Store and commercial development, will

occupy a total area of 0.40ha and as such the maximum discharge rate will be 5.14l/s (12.85l/s/ha).

- 6.2.3 The developed area to the north of the site occupies 7.0ha with 3.09ha of this area formed by hard cover. The equivalent existing brownfield discharge rate from this area is calculated at 390.8l/s and two thirds of the existing brownfield runoff rate is 260.5l/s. The residential development to the north of the site should therefore control storm water discharges to a maximum discharge rate of 260.5l/s or 43l/s/ha.
- 6.2.4 The maximum runoff rate for up to the 1 in 100 year event, for the entire site will be controlled to 281.7l/s. This is a significant improvement from the existing runoff rates with a reduction of approximately 43% from the existing 1 in 5 year storm event, which is a further improvement on the required (two thirds or 33%) reduction of the brownfield run off rates.
- 6.2.5 Outline estimates of the required storage volumes for the proposed development have been calculated using the EA/DEFRA guidance (R&D Technical Report W5-074/A/TR/1 Revision D - Preliminary Rainfall Runoff Management for Developments).
- 6.2.6 The required total storage volumes for the development, for the increased run-off, are shown in Table 6.2 for the 1 year, 30 year and 100 year return periods and the calculation sheets are presented in Appendix J.

Table 6.2: Estimate of Required Attenuation Storage Volumes using W5-074A Method for Runoff Generated from Proposed Impervious Development Areas

	Resi-North	Local Store	Commercial	TOTAL
Total Area	7.0ha	0.11ha	0.29ha	7.40ha
Hard Cover	4.55ha	0.11ha	0.15ha	4.81ha
% Hard Cover	65%	100%	52%	65%
Runoff Rate	260.5l/s	1.41l/s	5.14l/s	281.7l/s
Storm Return Period	Storage Volume (m³)			
1 in 1	561.9	14.3	11.6	587.8
1 in 1 + 30%	801.7	20.1	16.6	838.4
1 in 30	1512.8	31.9	32.9	1577.6
1 in 30 + 30%	2161.2	49.2	47.1	2257.5
1 in 100	2118.8	41.2	49.1	2209.1
1 in 100 + 30%	3026.9	66.5	70.2	3163.6

- 6.2.7 A storage volume of approximately 3163.6m³ will be required on site to manage the storm water runoff for the 1 in 100 year storm event plus 30% for climate change. The potential locations for the required attenuation storage are shown on JPB Drawing MB616/07. The calculation sheets are presented in Appendix J.

6.3 Use of Sustainable Drainage Systems (SuDS)

6.3.1 The sustainable management of surface water is paramount in reducing the future risk of flooding on and surrounding the site. TAN15 states that SuDS should be implemented, wherever they will be effective, in all new development proposals, irrespective of the flood zone in which they are located. A combination of SuDS techniques can lower flood risk by reducing the quantity of surface water run off and delaying its discharge to watercourses. Such systems can also provide habitat and amenity enhancements and passive treatment to improve water quality prior to discharge. The EA and Local Water Authorities support this method of dealing with surface waters.

6.3.2 The general principles of Sustainable Drainage Systems (SuDS) are to:

- reduce the volume of storm water runoff;
- reduce the rate of storm water runoff;
- ensure that storm water is treated appropriately, prior to discharge to the receiving watercourse;
- ensure that groundwater is protected.

6.3.3 SuDS techniques can be used to control storm water at the source, through permeable pavements, rainwater harvesting and green roofs; once collected, through storage and attenuation of waters with swales, wetlands, basins, ponds, pipes and subsurface storage; or at the point of discharge through the use of infiltration systems, such as soakaways and infiltration trenches.

6.3.4 The use of permeable paving would help control storm water runoff at the source, with a significant proportion of the developed area hard cover i.e. roadways, pavements, paths and cycleways and driveways. Permeable paving promotes filtration, adsorption, biodegradation and sedimentation, which all help to improve water quality. The void space in the sub-base material of a permeable paving system, or within geo-cellular modular units, can also be used to provide rainwater storage. Given the anticipated presence of a shallow groundwater table in the south of the site, and presence of low permeability clays elsewhere across the site, it is likely any permeable paving systems included on the site, would need to be sealed, passing water forward to other SuDS components for discharge to the watercourse rather than allowing infiltration to occur, although this will be confirmed during future ground investigations works. Permeable paving is generally not considered suitable where the on site gradients are greater than 5% (1 in 20) and this does not present an issue to the proposed development. Permeable paving with subsurface storage is considered to be the most suitable solution for the proposed Local Store and area of commercial development given the vast areas of hardstanding. There is sufficient space on site to incorporate the required volumes of attenuation storage using geocellular blocks as indicated on JPB Drawing MB616/07.

6.3.5 Above ground storm water storage solutions for attenuated increased flows are preferred over sub surface solutions, as they provide improved water quality and increase biodiversity. With this borne in mind, above ground attenuation storage SuDS components are proposed for the residential area to the north of the Aberderfyn. It is proposed that a number of swales will link the development to two balancing ponds and the Aberderfyn, as indicated on JPB Drawing

MB616/07. The swales and pond have been positioned to allow them to be gravity fed by storm waters from their immediate surroundings.

- 6.3.6 Swales provide relatively low maintenance options that provide moderate to high water quality improvements to storm waters, as well as conveying and storing storm waters. They can be used as either the first or second component of the SuDS treatment train. Where swales are used on site, the gradients along their length should be less than 5% (1 in 20) and this is feasible throughout the development.
- 6.3.7 The pond is situated within Flood Zone A and is not at risk from fluvial flooding. However, it will be necessary to ensure that the ponds are designed to prevent waters from overtopping the sides and a bunded area may be advisable along its southern edge. This would also help to ensure that flood waters from the Aberderfyn could not flow into the pond during rare extreme events. The ponds will provide 3857m³ of attenuation storage. The use of ponds will provide water quality benefits as well as providing a diverse habitat for local wildlife and a treatment volume (Vt) of 830m³ will be required to create the permanent pond volume. This is based on 4.55ha of hardcover ultimately draining to the pond. The use of upstream pre-treatment to remove silt and sediment in the form of swales reduces the need to allow for 4xVt in the design.
- 6.3.8 The SuDS components used on site will be maintained and managed, with a SuDS management plan. CIRIA C697 SuDS Manual should be consulted for the design criteria required for each of the possible SuDS components. Furthermore, with the introduction of the SuDS Approval Boards (SAB), it will also be necessary to ensure that they are constructed to National Standards that will allow them to be adopted in the future.

Summary

- 6.3.9 In summary, the proposed discharges for the developed site should be routed to the catchment of the Aberderfyn, with the discharges from the north of the site limited to at least two thirds of the existing brownfield discharge rate, whilst the areas to the south of the Aberderfyn should be limited to the greenfield runoff rate for up to the 1 in 100 year event.
- 6.3.10 Clean surface waters from roofs, paths or roadways can be discharged to watercourses without requiring a discharge consent from the EA, provided that the detailed drainage design demonstrates that sufficient measures are in place to prevent pollutants entering the drainage system or surface waters. The roof water downspouts should be sealed to prevent rogue discharges to the conventional drainage system and the various SuDS components.
- 6.3.11 The use of swales, ponds and permeable paving all provide amenity and biodiversity benefits, with the potential for areas of wetland to be included at the forebay of the ponds, which would again provide enhanced pollution control benefits. Conventional pipework would connect the main site areas to the proposed SuDS components. Further detailed assessment of the attenuation storage volumes should be carried out as part of the detailed drainage design. It will also be necessary to determine the resting groundwater levels across the site, particularly where below ground storage is likely to be used in the south of the site.

- 6.3.12 During construction, it will be essential that the developer ensures that any surface water runoff from the site is controlled to prevent overland flows off site and to prevent silt and sediment from entering the onsite land drain and Aberderfyn watercourse.

7.0 FOUL DRAINAGE

- 7.1 Foul flows from the proposed development will be discharged directly to the existing WW foul and combined sewers located both on site and in Bangor Road. Flows from the development area located to the north of the Aberderfyn will have to be pumped to the sewer running along the northern boundary of the site. Flows from the development area located to the south of the Aberderfyn will flow by gravity to Bangor Road.
- 7.2 Based on the assumptions in Table 7.1, the total foul flows from the development will be 11.67l/s.

Table 7.1: Proposed Foul Flows

Development Use	Criteria for Calculating Foul Flows	Foul Flows (l/s)
300 Residential Houses	4000litres/dwelling/day	13.89
Local Store - 235m ²	1 person/6m ² floor space 50litres/person/day	0.02
Commercial Units – 465m ²	1 person/6m ² floor space 50litres/person/day	0.08

* Foul flow rates taken from British Water Code of Practice (2009) Flows and Loads – 3, Sizing criteria, Treatment Capacity for Small Wastewater Treatment Systems.

- 7.3 A full application for a connection to the public sewer will be made to WW at the appropriate time and all sewers will be constructed to an adoptable standard.

8.0 MAINTENANCE AND ACCESS REQUIREMENTS

- 8.1 SuDS require specialist maintenance schemes and it is recommended that a manual is set up, as per the requirements of CIRIA C697, 2007. The manual should include the following:
- location of all SuDS techniques on site;
 - brief summary of how the techniques work, their purpose and how they can be damaged;
 - maintenance requirements and a maintenance record;
 - explanation of the consequences of not carrying out the maintenance that is specified;
 - identification of areas where certain activities are prohibited;
 - an action plan for dealing with accidental spillages;
 - advice on what to do if alterations are to be made to a development, if service companies undertake excavations or other similar works are carried out that could affect the SuDS.
- 8.2 The maintenance of the on site SuDS will depend on the final methods included in the detailed design and reference to CIRIA C697 should be made for further details. By the time the site is developed, local SuDS Approval Boards (SAB) will have come into effect, through the implementation of the Flood and Water Management Act 2010, and the SuDS used on site will need to be adopted by the SAB, who will also be responsible for their maintenance. Therefore, it will be necessary to ensure that the site's drainage is constructed to National Standards that will allow it to be adopted and additional requirements, in term of the SuDS Manual may be required in the future.
- 8.3 With regard to the maintenance of ponds included within the SuDS treatment train, they should be regularly cleared of leaf litter, aquatic plants should be regularly pruned, pond sediment should be monitored and removed as and when required and the outlets of the pond should remain clear of sediment/litter to enable them to overflow as and when required. Vegetation management to any areas of wetland will also be required.
- 8.4 Swales will require regular litter removal, inlets and outlets cleared, vegetation management including any areas of wetland incorporated into the design, grass cutting and sediment monitoring and removal. A suitable easement (approximately 5m) should be provided along the swales to enable access for maintenance.
- 8.5 Maintenance of permeable pavements will include regular cleaning of silt and other sediments to preserve their infiltration capability. Manufacturers' recommendations as to the frequency of cleaning should be followed.
- 8.6 Maintenance of the watercourse and its culverts will also be required to minimise the risk of flooding on site. A 5m easement should be provided adjacent to the Aberderfyn and proposed SuDS components to allow for access for routine maintenance.
- 8.7 It is anticipated that the foul sewers outside of the curtilage of the private properties will be adopted by WW upon development of the site and the advice and guidelines in Sewers for Adoption should be followed. The foul sewers should be sited to allow easy access and maintenance by WW and they should be sited to avoid disturbance by the maintenance of SuDS.

- 8.8 With regard to site access and egress in the event of emergencies, the emergency access from Hafod Road lies outside of the modelled flood plain. However, the main new access road to the development from Bangor Road does lie within the modelled 1 in 100 year and 1 in 1000 year flood plain and will be constructed so that the finished level is above the modelled flood plain and will remain accessible at all times (as discussed in more detail in Section 5.3). The footpaths routed through the public open space in the southeast of the site also lie within the modelled flood plain and it is likely that these would become inaccessible during extreme flood events, with alternative routes out to both Bangor Road and Hafod Road remaining free from flooding. The maximum depth of flooding in the far southeast of the site, adjacent to Hafod Road, is estimated at approximately 800mm, lessening to approximately 200mm across the remainder of the area.
- 8.9 Flood emergency plans and procedures should be produced by the developer and it is recommended the physical features are incorporated within the development at locations where flood may present a risk in the future i.e. the use of public footpaths in the southeast of the site. This could include indicating the estimated extreme flood levels adjacent to the brook and providing signage to indicate an alternative route of access / egress.

9.0 CONCLUSIONS & RECOMMENDATIONS

Fluvial / Pluvial Flooding & Surface Water Drainage

- 9.1.1 The flood risk assessment demonstrates that the majority of the proposed development lies within Flood Zone A and is **not at risk** from fluvial flooding, which according to TAN15 is where all new developments should be directed.
- 9.1.2 It is **recommended** that further hydraulic modelling is carried out to assess the effects of removing the existing culvert section of the Aberderfyn, to assess the effects of constructing the new access road over the Aberderfyn, to assess the effects of restoring the land to the south of the Aberderfyn nearer to its original levels and to assess the effects of marginally raising the site levels in the north of Area 5 to provide further protection to the proposed residential properties. Permission **will need** to be sought from the Lead Local Flood Authority for any changes on, in or over the Aberderfyn watercourse. The potential rate of flood inundation to the development should also be considered.
- 9.1.3 Maintenance of the watercourse and its culverts will be required to minimise the risk of flooding on site. A 5m easement should be provided adjacent to the Aberderfyn and any SuDS components to allow routine maintenance access.
- 9.1.4 The proposed development will reduce the area of hard cover across the land to the north of the Aberderfyn, which was previously developed as the brick works, whilst the proposed development to the south of the Aberderfyn will substantially increase the area of hard cover. Where the hardcover is increased, there is potential for the risk from pluvial flooding (overland) to increase within the site's boundaries, to the catchment of the Aberderfyn and to off site agricultural land. Sustainable surface water drainage principles will be utilised at the site to assist with controlling this increased risk.
- 9.1.5 The consequences of overland flooding are considered to be **potentially significant** to the proposed development. Surface waters will be controlled at the source by channelling storm waters from roofs, pavements, roads and driveways to above ground and below ground attenuation storage areas. The proposed surface water drainage system will be designed to manage storm events for a 1 in 100 year event with a factor of 30% allowed for climate change. Consideration should also be given to the design and layout of the development to ensure that the on site properties are sufficiently elevated from surface water flows during rare storm events that may exceed the design storm event i.e. a storm with a 1 in 1000 year return period.
- 9.1.6 Attenuation storage will be provided by a combination of swales, two balancing ponds and geocellular storage beneath permeable paving, with conventional pipework to convey the storm waters. Sufficient area is available on site to provide the required storage volumes. Infiltration drainage techniques are not currently considered to be feasible on site. However, should intrusive ground investigation and soakaway testing prove otherwise, the storage volumes required could potentially be reduced.
- 9.1.7 It is currently proposed that all surface waters will be discharged to the catchment of the Aberderfyn. The residential development to the north of the Aberderfyn watercourses, will discharges storm waters at a maximum rate of 43l/s/ha, which equates to less than two thirds of

the existing brownfield development discharge rates. Up to 3163.6m³ attenuation storage will be provided throughout this area in the form of swales and a balancing pond. The balancing pond will have a permanent treatment volume of 830m³. To the south of the Aberderfyn the local store and commercial development will control storm waters to the greenfield runoff rate, with a maximum discharge of 12.85l/s/ha for up to the 1 in 100 year event. Up to 665m³ of attenuation storage will be provided in geocellular blocks beneath permeable paving due to the density of the development.

- 9.1.9 Water quality improvements to storm discharges will be provided by the swales, balancing pond and permeable paving. Pollution control measures such as sediment traps to below ground storage, areas of wetland within the swales and a sediment fore bay/upstream pre-treatment to the pond can be provided to improve water quality and the downspouts from the roofs of residential housing should be sealed to prevent rogue discharges.
- 9.1.10 In summary, the collection and active management of surface waters discharging from the proposed development will negate the risk of pluvial flooding both on and off site. The surface water drainage proposals will control runoff from extreme storm events without putting the public or properties at risk and reduce the risk of overland flooding both on and off site through source control and improved storm water quality before its discharge to controlled waters.

Groundwater Flooding

- 9.1.11 The consequences of groundwater flooding are **not considered to pose a significant risk** to the proposed development. Notwithstanding this, the depth to groundwater should be confirmed through intrusive ground investigation, particularly where there is potential for permeable sand and gravel deposits along the route of the Aberderfyn watercourse, to ensure that the site's buried services will not be impacted by shallow groundwater. The properties do not include basements and this will reduce the potential risk from groundwater flooding. A freeboard of at least 1m should be present between the resting groundwater level and the base of any foundations across the development site or any underground attenuation storage. The drainage proposals should be designed to ensure that there is not an increased risk to the development from groundwater flooding.

Artificial Drainage Systems

- 9.1.12 The consequences of flooding from artificial drainage systems i.e. the onsite land drain are considered to be **potentially significant** to the proposed residential development in the southwest of the site. There is one location where the top of bank could allow flood waters to over top the ditch during extreme events and further assessment to determine the effects of raising this area of the site is recommended. Elsewhere, the consequence of flooding from artificial drainage systems is **not considered to be significant**.

Infrastructure Failure

- 9.1.13 The consequences of flooding from infrastructure failure are considered **not significant** to the proposed development, as there are no canals, reservoirs or other significant water bodies located up gradient of the site which pose a significant flood risk. Existing water mains are laid within Hafod Road and Bangor Road to the east and south of the site. Any ruptures of these mains would be channelled along the roads to the southeast of the site, where flood waters would continue to drain away from the site in a south-easterly direction. Access and egress to

the proposed development site is considered to still be possible should a water main burst. A new connection to the water main will be required to serve the new development. This is not considered to increase the risk posed to off site properties.

Foul Drainage

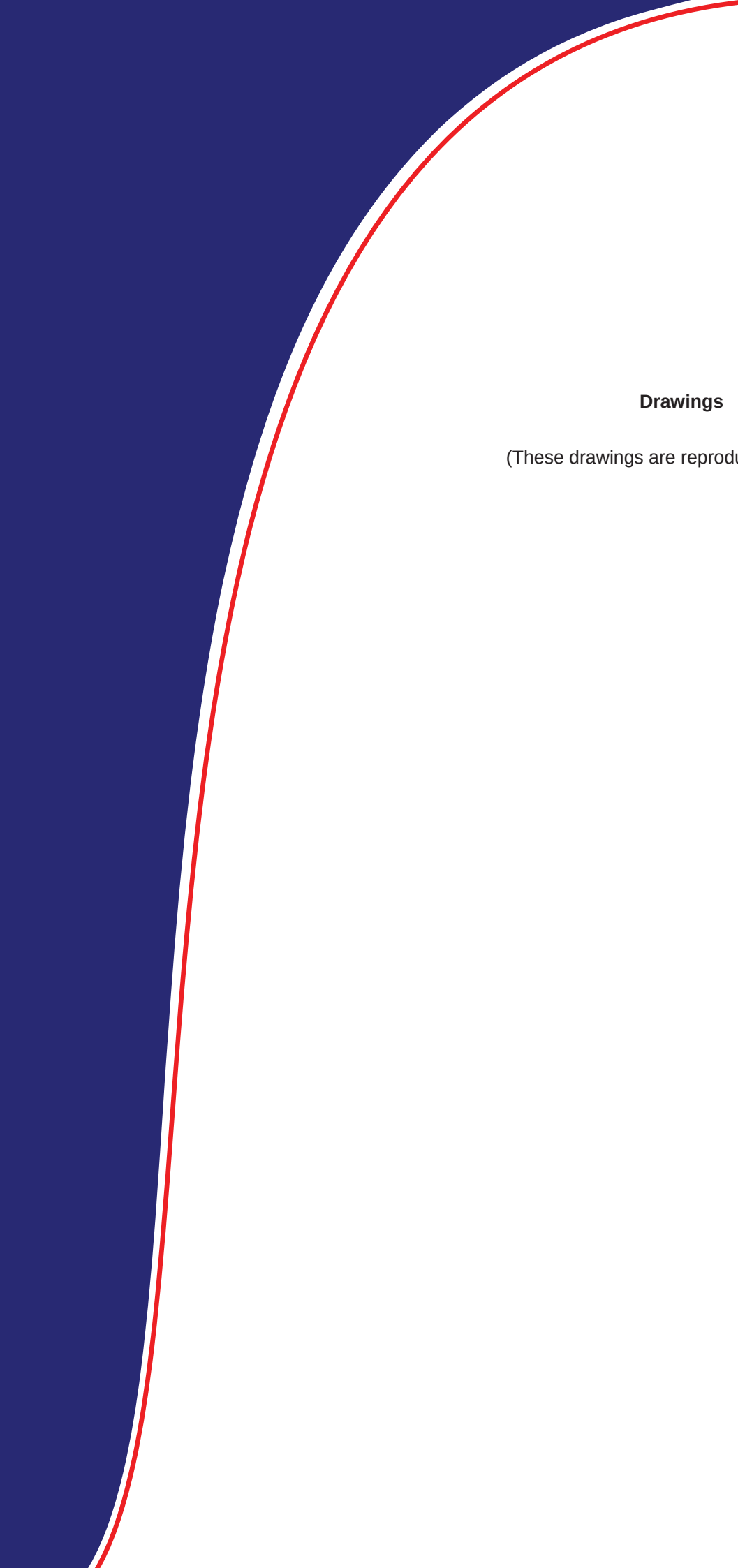
- 9.1.14 The researches to date have not highlighted any significant issues associated with the local foul sewers. The foul drainage from the development will be discharged directly to the existing Welsh Water foul sewer in the north of the site, with an estimated discharge of 11.67l/s. The site will drain to the WW adopted sewers. Connection points and flow rates will need to be discussed with Welsh Water during the detailed drainage design. A Pre-Planning Enquiry has been made and their response is awaited.

Maintenance and Access

- 9.1.15 A SuDS manual should be compiled for the site. By the time the site is developed, local SuDS Approval Boards (SAB) will have come into effect and the SuDS used on site will need to be adopted by the SAB, who should then become responsible for their maintenance. Therefore, it will be necessary to ensure that the site's drainage is constructed to National Standards that will allow it to be adopted.
- 9.1.16 All SuDS features for the storage of storm waters should be sited to allow ease of access for maintenance. Appropriate easements should be maintained along the Aberderfyn, swales and ponds and to allow inspection of below ground storage. The maintenance of the on site SuDS will depend on the final methods included in the detailed drainage design and reference to CIRIA C697 should be made for further details.
- 9.1.17 It is anticipated that the foul sewers outside of the curtilage of the private properties will be adopted by Welsh Water upon development of the site and the advice and guidelines in Sewers for Adoption should be followed.
- 9.1.18 Emergency access from Hafod Road lies outside of the modelled flood plain. The main new access road to the development from Bangor Road will need to be constructed so that the finished level is above the modelled flood plain and will remain accessible at all times (as discussed in more detail in Section 5.3).
- 9.1.19 Flood emergency plans and procedures should be produced by the developer and it is **recommended** the physical features are incorporated within the development at locations where flooding may present a risk in the future.

10.0 GENERAL

- 10.1 Whilst confident in the findings of our report we are unable to give an assurance that they will be accepted by the authorities without question. We therefore advise that where appropriate our report and associated matters are submitted to approving bodies and approval obtained or sought before detailed design, site works or other irrevocable action is embarked upon.
- 10.2 The recommendations contained in this report do not constitute any form of specification for the undertaking of the works required.
- 10.3 The conclusions reached in this report are necessarily restricted to those that can be determined from the information consulted and may be subject to amendment in the light of additional information becoming available.
- 10.4 It should be noted that soil and rock conditions are highly variable and may differ between sampling points and this may affect interpolation. Additionally, features may exist buried at depth and undetected by investigation. Other information may become available on the conditions of the site not available at the date of this report and thus site assessment may be subject to amendment in the light of such additional information becoming available.
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Drawings

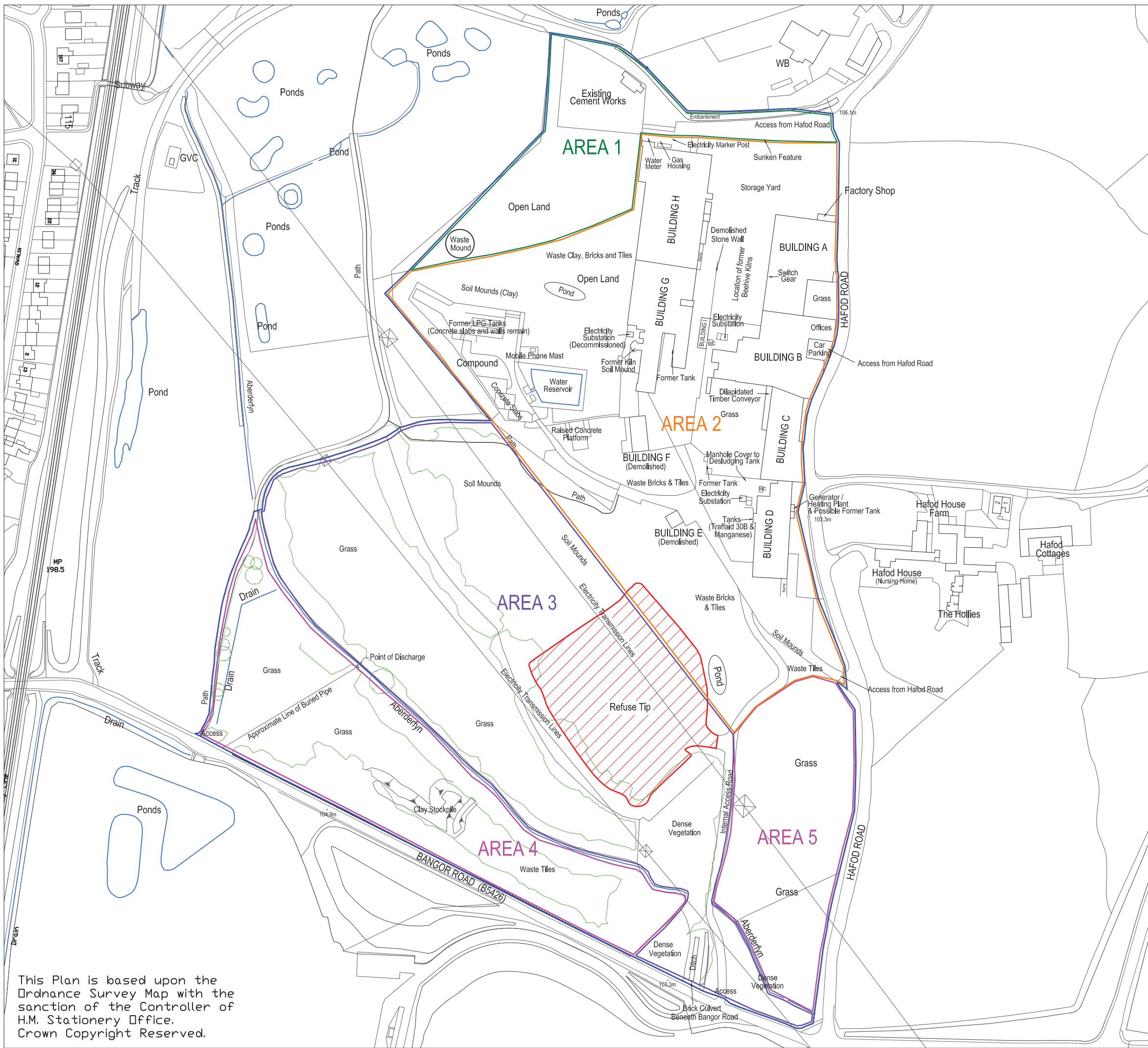
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Key -

 Approximate Site Location

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	Approved ACJ	Date 19/03/2012	Scale SEE SCALE BAR	Drawing MB616/01		



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KEY

Study Boundary

Water Features

Refuse Tip

Area 1 - Cement Works

Area 2 - Residential

Area 3 - Public Open Space

Area 4 & 5 - Commercial

No.	REVISION	Date	Approved
Engineer		Checked	Approved

Client
GLADMAN DEVELOPMENTS LIMITED

Project
LAND OFF BANGOR ROAD, JOHNSTOWN, WREXHAM

Title
EXISTING SITE LAYOUT

JOHNSON
POOLE &
BLOOMER
CONSULTANTS

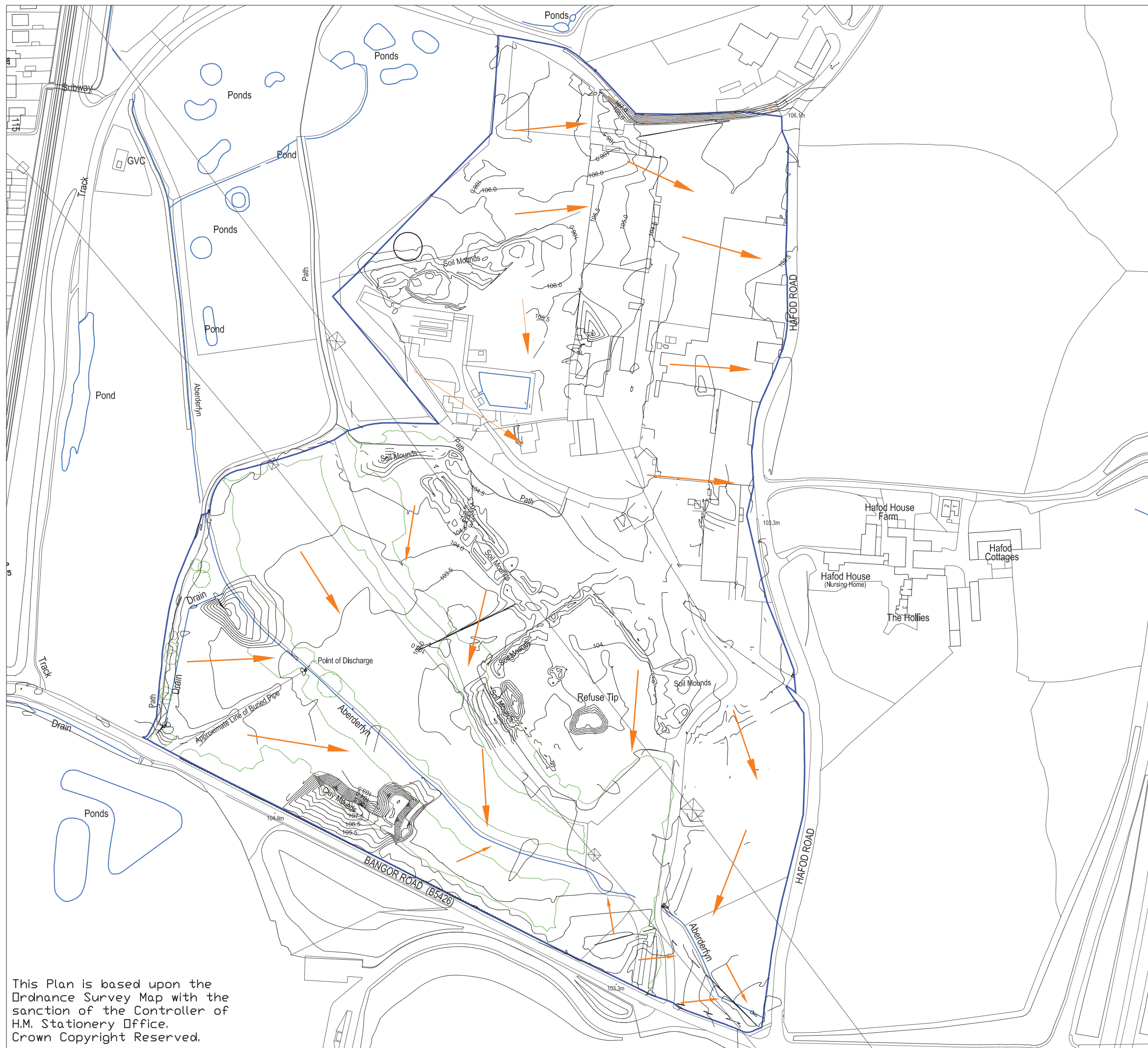


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KEY

-  Study Boundary
-  Water Features
-  Surface Water Flow Pathways

No.	REVISION	Date	Approved
Engineer	Checked	Approved	

Client
GLADMAN DEVELOPMENTS LIMITED

Project
LAND OFF BANGOR ROAD, JOHNSTOWN, WREXHAM

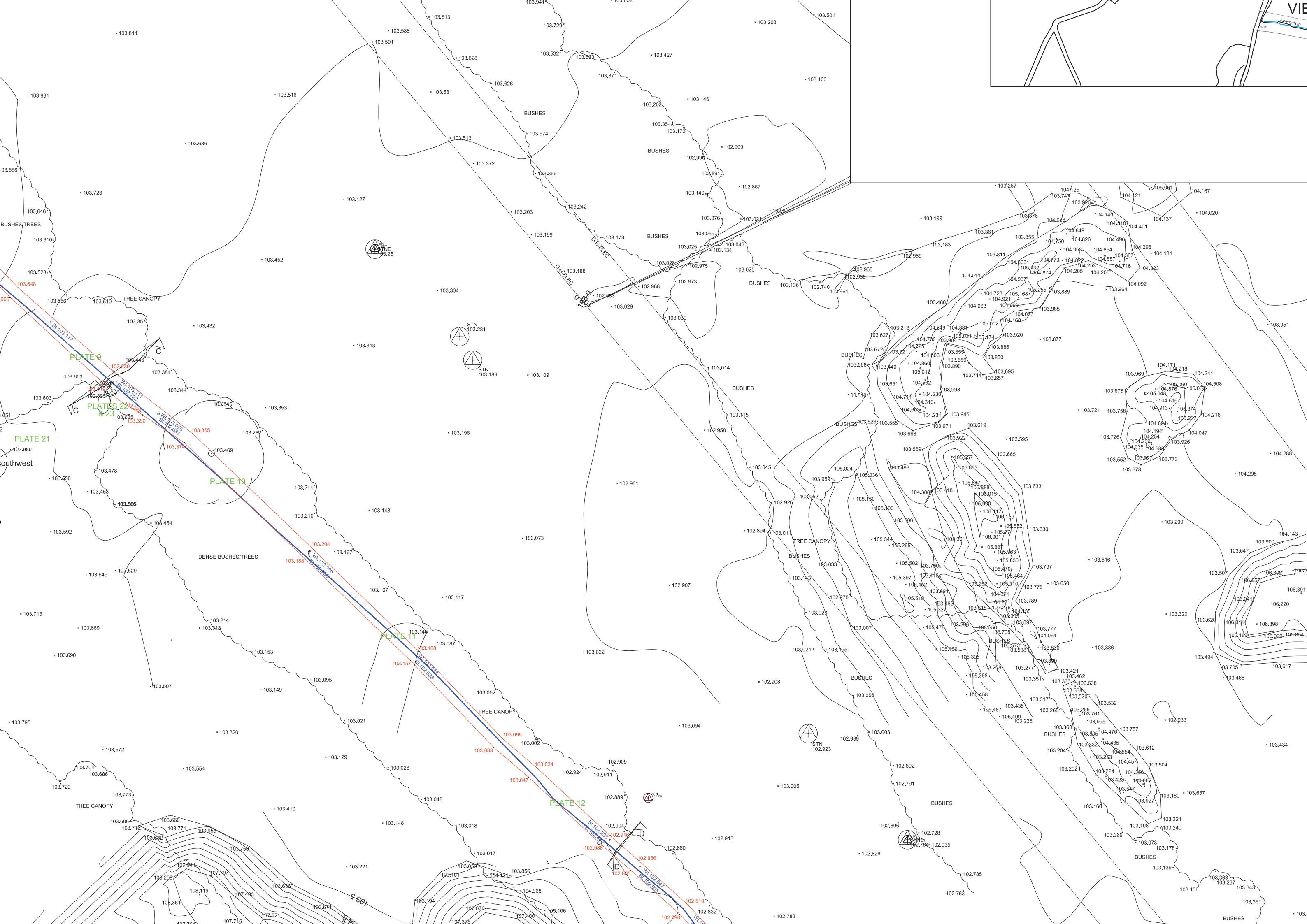
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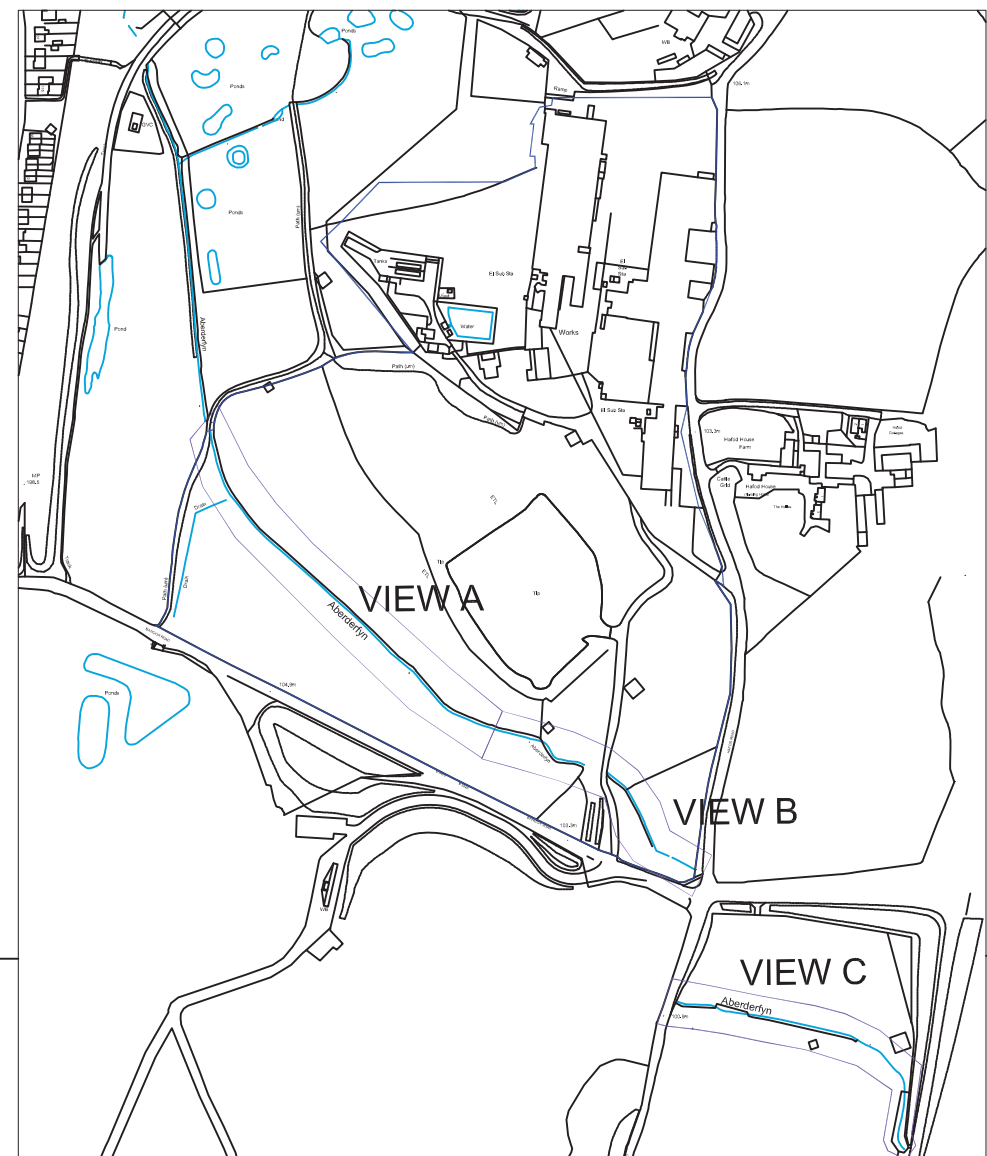
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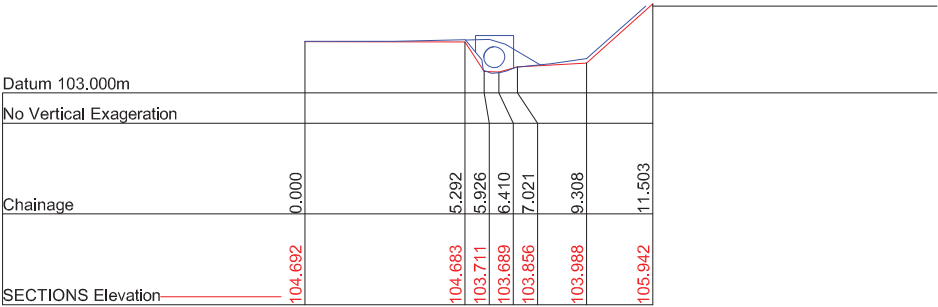
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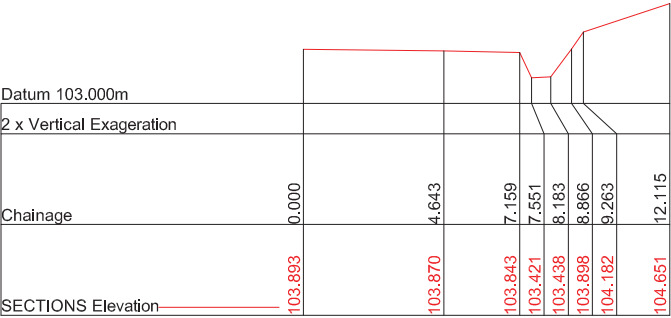




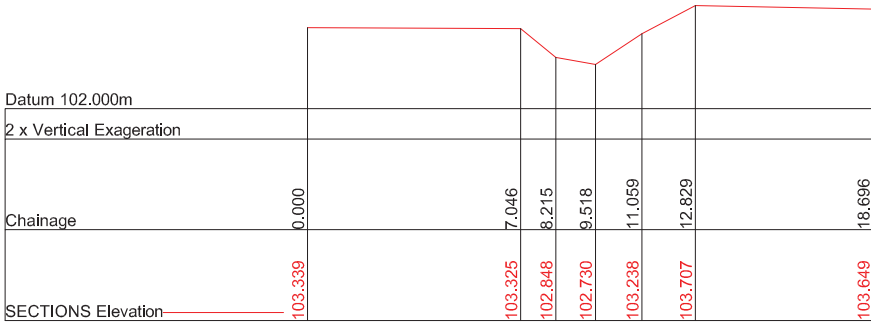
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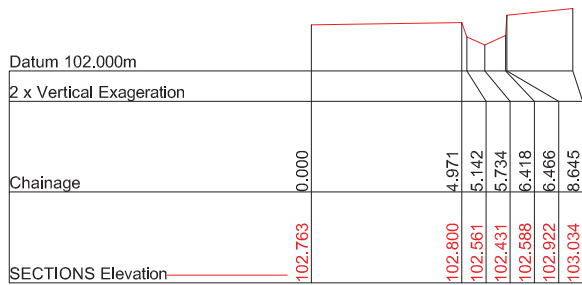
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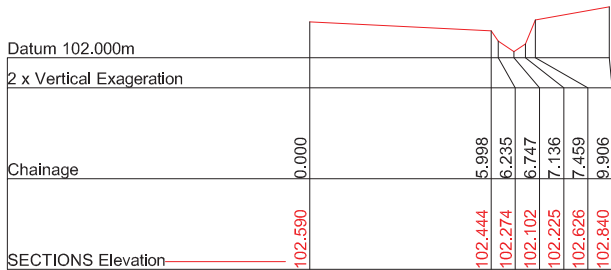
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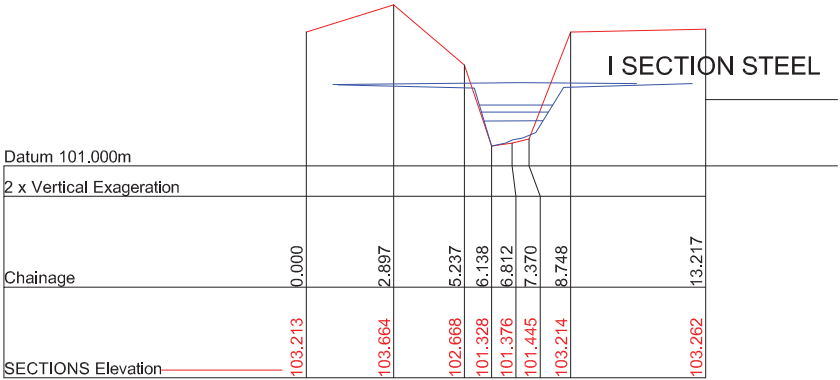
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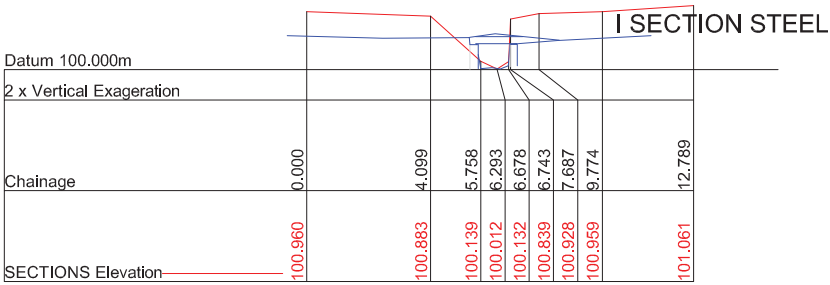
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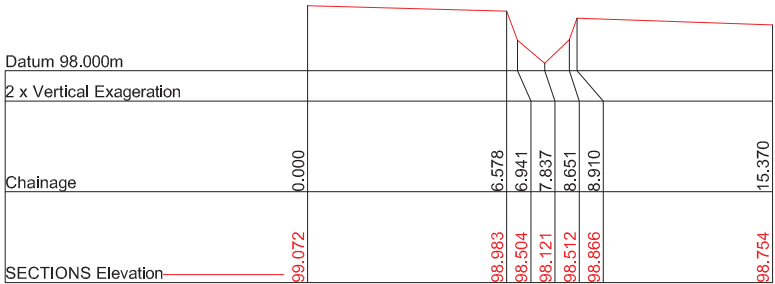
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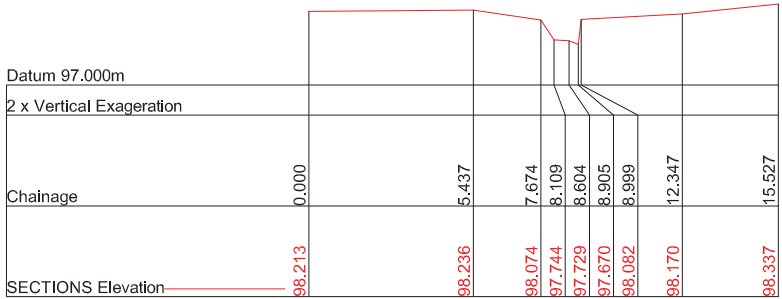
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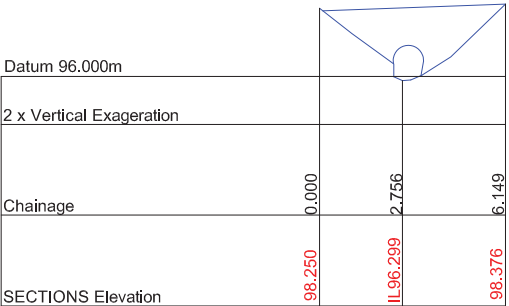
SECTION G-G



SECTION H-H



SECTION I-I



SECTION J-J

NOTE

CROSS SECTIONS TAKEN
FROM JPB DRAWINGS
MB616/05a and MB616/05b

No.	REVISION	Date	Approved

Engineer HB	Checked HB	Approved ACJ
----------------	---------------	-----------------

Client Gladman Developments Limited
Project Land off Bangor Road, Johnstown

Title Route of Aberderfyn and watercourse cross sections

JOHNSON POOLE & BLOOMER CONSULTANTS			
Land Engineering • The Environment • Mining and Quarrying			
Scale 1:250 © A3		Date 15/01/13	
		Drawn HB	
Drawing MB616/05c			
Plan laid out by HB		Office STOURBRIDGE	
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CONSULTANTS



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Engineer
GP

Checked
FT

Approved
ACJ

Client

GLADMAN DEVELOPMENTS
LIMITED

Project

LAND OFF BANGOR ROAD,
JOHNSTOWN, WREXHAM

Date

10/06/2013

Scale

1:2000 @ A3

Title

FLUVIAL FLOODING
ISSUES

Drawing

MB616/06



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Engineer
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Checked
FT

Approved
ACJ

Client **GLADMAN DEVELOPMENTS
LIMITED**

Project **LAND OFF BANGOR ROAD,
JOHNSTOWN, WREXHAM**

Date
10/06/2013

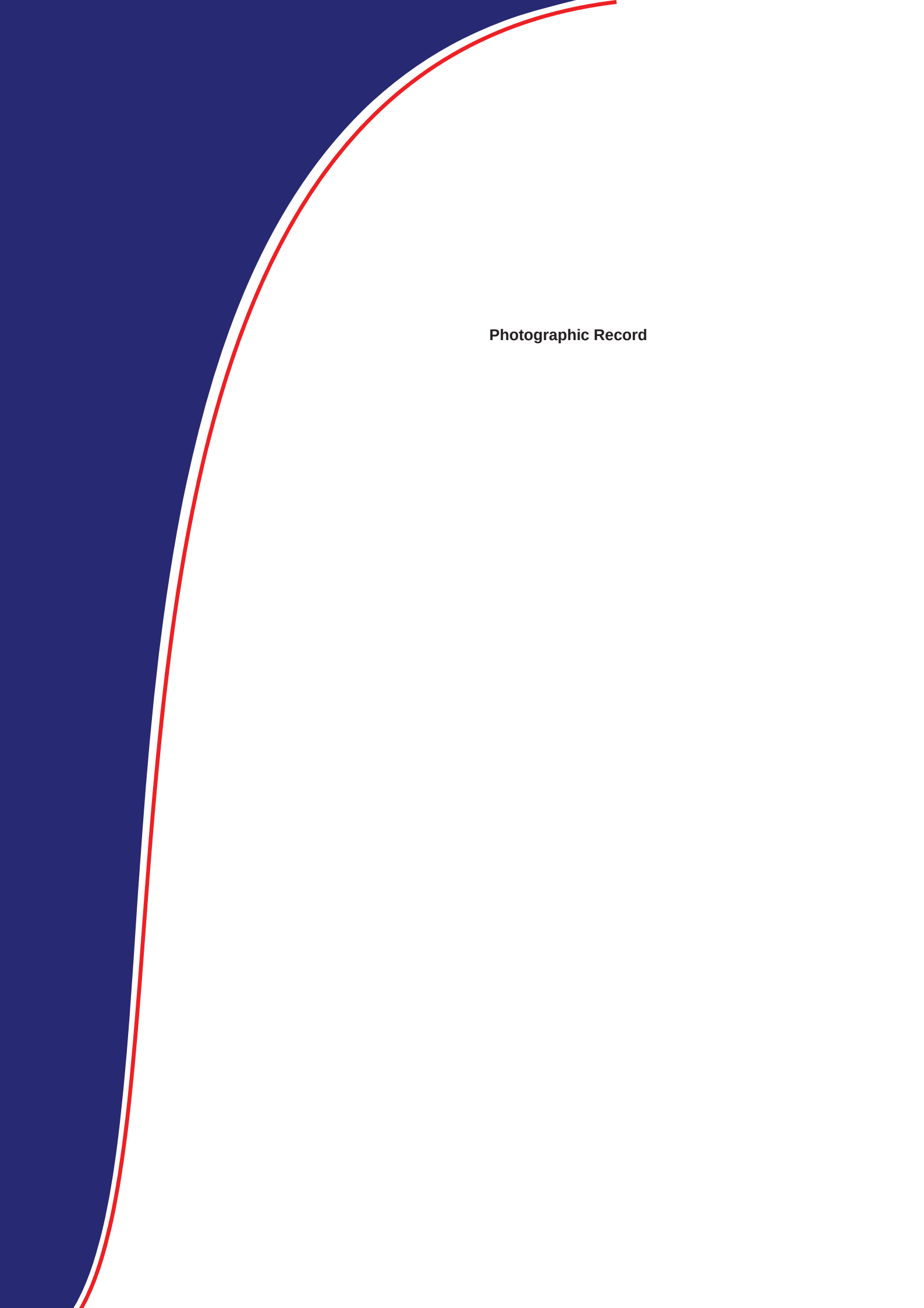
Scale
1:2000 @ A3

Title

**POTENTIAL SuDS
COMPONENTS**

Drawing

MB616/07



Photographic Record

PHOTOGRAPHIC RECORD



Project Ref: MB616

Site: Land off Bangor Road, Johnstown

Plate Number: 1



Outfall of Aberderfyn 10m west of site, beyond public footpath.

Plate Number: 2



Western headwall at point where Aberderfyn is culverted beneath public footpath to the west of the site. (Pipework diameter 600mm)

Plate Number: 3



Eastern headwall at point where Aberderfyn emerges from 600mm diameter culvert beneath public footpath immediately west of the site.

Plate Number: 4



Route of Aberderfyn along site's western boundary.

Plate Number: 5



Route of Aberderfyn flowing south-easterly into site's boundaries.

Plate Number: 6



Route of Aberderfyn in far west of site prior to converging with land drain.

PHOTOGRAPHIC RECORD



Project Ref: MB616

Site: Land off Bangor Road, Johnstown

Plate Number: 7



Route of Aberderfyn between the outfalls of land drain and buried pipework in west of site.

Plate Number: 8



Route of Aberderfyn between the outfalls of land drain and buried pipework in west of site.

Plate Number: 9



Route of Aberderfyn between the outfalls of land drain and buried pipework in west of site.

Plate Number: 10



Route of Aberderfyn through central section of site.

Plate Number: 11



Route of Aberderfyn through central section of site.

Plate Number: 12



Route of Aberderfyn through central section of site.

PHOTOGRAPHIC RECORD



Project Ref: MB616

Site: Land off Bangor Road, Johnstown

Plate Number: 13



Route of Aberderfyn through central section of site.

Plate Number: 14



Route of Aberderfyn through central section of site.

Plate Number: 15



Route of Aberderfyn through central section of site.

Plate Number: 16



Route of Aberderfyn through central section of site.

Plate Number: 17



Route of Aberderfyn towards internal roadway.

Plate Number: 18



Eastern side of internal roadway with Aberderfyn emerging from beneath. Appeared to be constructed as a wide covered channel with soil side walls.

PHOTOGRAPHIC RECORD



Project Ref: MB616

Site: Land off Bangor Road, Johnstown

Plate Number: 19



Close up of Aberderfyn at eastern site of internal roadway.

Plate Number: 20



Densely vegetated route of Aberderfyn in southeast corner of the site.

Plate Number: 21



Route of buried pipework looking from discharge point towards Bangor Road.

Plate Number: 22



Point of discharge to Aberderfyn for buried pipework.

Plate Number: 23



Point of discharge to Aberderfyn for buried pipework.

Plate Number: 24



Headwall of land drain in southwest corner of site.

PHOTOGRAPHIC RECORD



Project Ref: MB616

Site: Land off Bangor Road, Johnstown

Plate Number: 25



Section of land drain along site's western boundary in southwest corner of site. Land drain noted to be dry.

Plate Number: 26



Section of land drain routed towards Aberderfyn (waterfilled).

Plate Number: 27

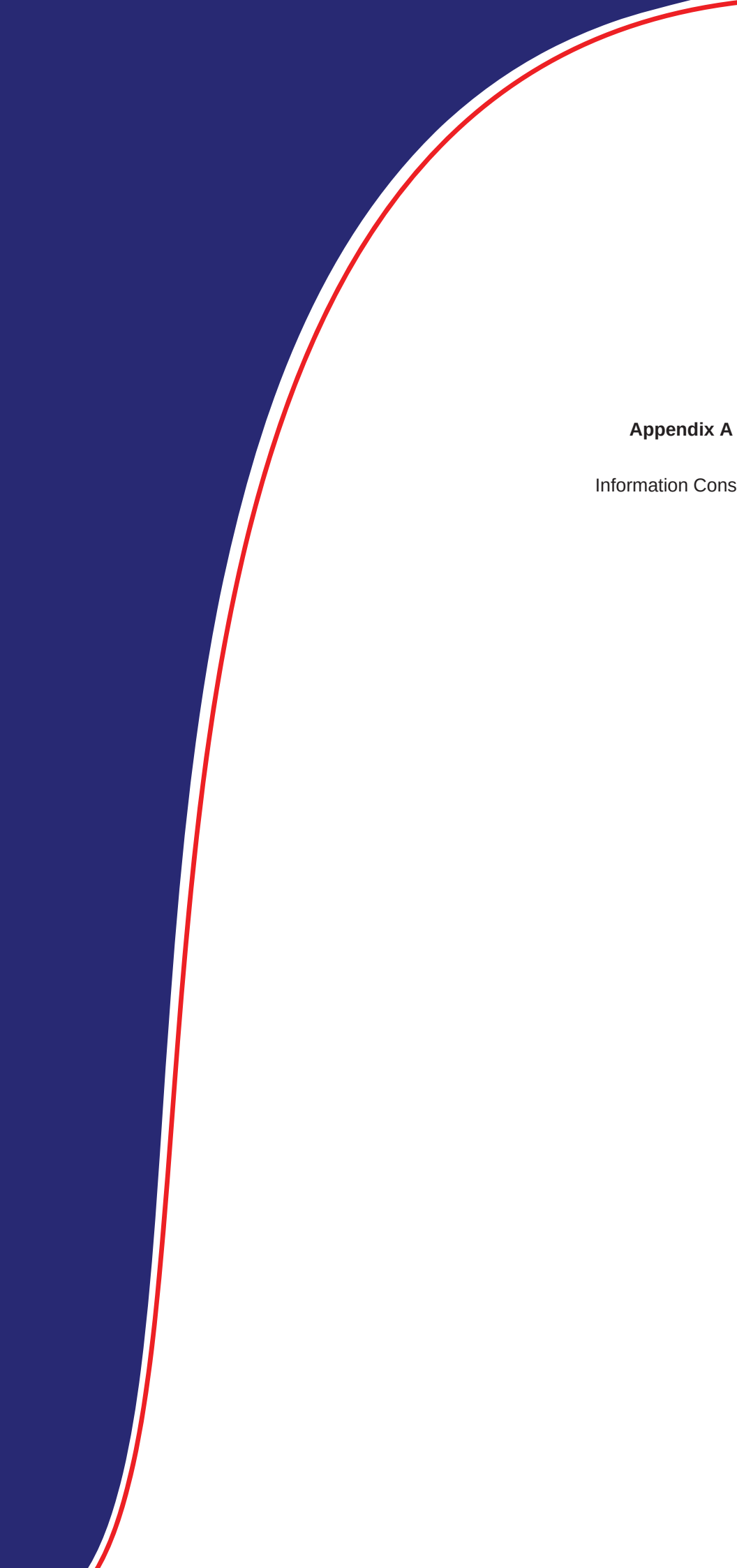


Section of land drain routed towards Aberderfyn (waterfilled).

Plate Number: 28



Section of land drain prior to converging with Aberderfyn.



Appendix A

Information Consulted

INFORMATION CONSULTED:

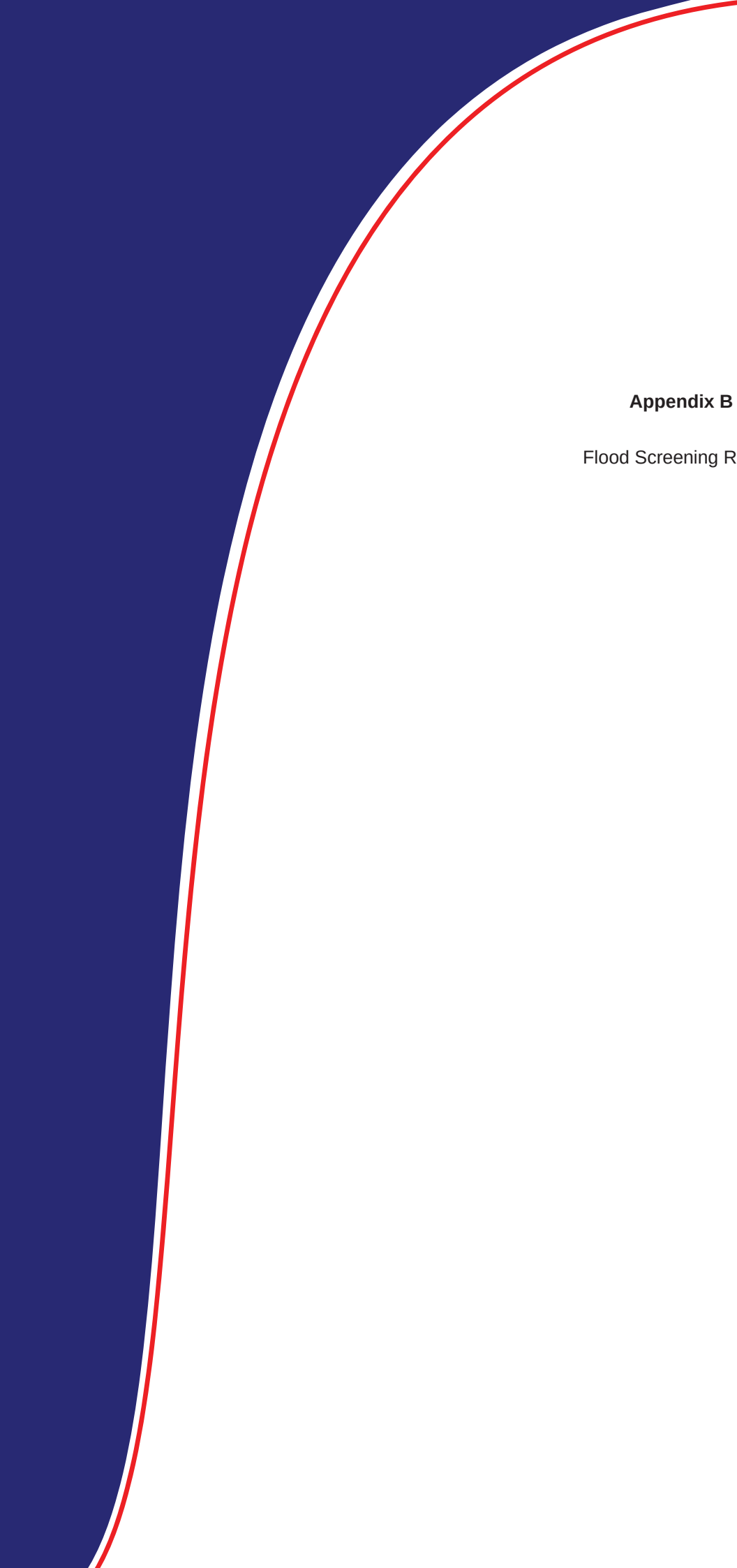
In preparation of this report, the following information has been consulted:

General

- JPB Archive
- Environment Agency Website: <http://www.environment-agency.gov.uk/>
- Envirocheck Flood Screening Report dated 14 March 2012 and referenced 37986274_1_1
- Wrexham County Borough Council - Preliminary Flood Risk Assessment, Preliminary Assessment Report
- Wrexham County Borough Council (October 2012) Draft Local Flood Risk Management Strategy

Flood and Drainage Assessments

- Planning Policy Wales (November 2012) Edition 5
- Planning Policy Wales - Technical Advice Note 15: Development and Flood Risk (July 2004) National Assembly for Wales
- British Water Code of Practice (2005) Flows and Loads – 2, Sizing criteria, Treatment Capacity for Small Wastewater Treatment Systems.
- Chronology of British Hydrological Events website <http://www.dundee.ac.uk/geography/cbhe/>
- CIRIA R156 (1996) Infiltration drainage – Manual of good practice
- CIRIA X108 and Wallingford, H.R. (2004) Drainage of development sites – a guide
- CIRIA C609 (2004) Sustainable drainage systems – Hydraulic, structural and water quality advice
- CIRIA C624 (2004) Development and flood risk – guidance for the construction industry
- CIRIA C635 (2006) Designing for exceedance in urban drainage – good practice
- CIRIA C697 (2007) The SUDS manual
- CIRIA SUDS website <http://www.ciria.org/suds/>
- CIRIA C687 (2010) Planning for SuDS – Making it happen
- DEFRA / EA (June 2007) Preliminary rainfall runoff management for developments, R&D Technical Report W5-074/A/TR/1 Revision D
- Environment Agency (January 2010) River Dee Catchment Flood Management Plan – Summary Report
- Environment Agency Wales (2009) Flooding in Wales: A National Assessment of Flood Risk
- Flood Estimation Handbook (1999)
- Soilsclapes website <http://www.landis.org.uk/soilsclapes/>
- UK Climate Impacts Programme (2008) website <http://www.ukcip.org.uk>
- Wallingford, H.R. (1983) The Wallingford Procedure, Design and analysis of urban storm drainage, Volume 1 Principles, methods and practice



Appendix B

Flood Screening Report

Envirocheck[®] Report:

Flood Screening Report Datasheet

Order Details:

Order Number:

37986274_1_1

Customer Reference:

MB616

National Grid Reference:

331040, 346090

Slice:

A

Site Area (Ha):

0.01

Search Buffer (m):

1000

Site Details:

Hafod Tileries, Hafod

Ruabon

Wrexham

LL14 6ET

Client Details:

Ms F Townley

Johnson Poole & Bloomer Ltd

Harris & Pearson Building

56 Brettell Lane

Brierley Hill

West Midlands

DY5 3LH

Report Section and Details	Page Number
Summary	-
The Summary section provides an overview of the data contained within the report, detailing the number of data set features or the existence of a data set in relation to the buffer(s) selected. For ease of reference, the report is broken down into seven sections of data.	
EA / CEH Flood Data	-
This section details data from the Environment Agency and the Centre for Ecology and Hydrology. The EA data is reported to a distance of 250m from the edge of the site polygon and details both Zone 2 (extreme) and Zone 3 flood extents, as well as flood defences, flood water storage areas and areas benefiting from flood defences. The CEH data is reported to a distance of 250m from the edge of the site polygon and covers flood data for Scotland, divided into levels based on the frequency and magnitude of a predicted 100 year term. All data sets within this section are plotted and feature on the EA / CEH Flood Data (1:10,000) map. For added value, OS Contour data is also plotted, detailing contours, spot heights and air heights.	
RMS Flood Data	1
This section contains the Risk Management Solutions flood data. The data is based upon the likelihood of a flood occurrence for 3 flood return periods; these being 75 years, 100 years and 1000 years. Each return period is depicted on a separate 1:10,000 scale map and reports features to a distance of 250m from the edge of the site polygon. Each return period can detail both defended and/or undefended flood features, with each feature also reporting an associated flood depth. In addition pluvial flood features are also detailed where applicable, but tidal flooding is not included. For added value, OS Contour data is also plotted, detailing contours, spot heights and air heights.	
BGS Flood Data	2
This section contains two BGS data sets; namely Geological Indicators of Flooding and Groundwater Flooding Susceptibility, both of which report features out to a possible 1000m, with coverage in England, Wales and Scotland. Each data set is plotted on a separate BGS Flood Data (1:50,000) map.	
EA Detailed River Network Data	6
This section details 3 sources of data that depict and detail the river network of England and Wales, captured primarily from the water features theme of Ordnance Survey's OS MasterMap Topography Layer. The DRN Lines data set details all the types of rivers, drains and streams which can be found in England and Wales. The DRN Nodes data set details the river, drain and stream node intersections which divide the detailed river network data. All nodes are defined as being one of the following: A source, sink, junction, or pseudo node, interactions or not assigned. The DRN Offline Drainage dataset details water features from OS MasterMap that do not connect into the river network and are generally limited in length. All data sets within this section are plotted and feature on the EA Detailed River Network (1:10,000) map. For added value, OS Contour data is also plotted, detailing contours, spot heights and air heights.	
EA Historic Flood Events Data	-
This section details Historic Flood data sourced from the Environment Agency and from data held by Landmark. The EA Historic Flood Events data is reported to a distance of 1000m from the edge of the site polygon and details recorded historic flood events from 1703 to October 2008. The data also contains information on the source and cause of the flood, and how the flood outline was established. Also included in this section is Landmark's Historical Flood Liabilities data set, which identifies areas that are liable to flood based on systematic analysis of historical mapping dating back to the mid 19th century. Both data sets within this section are plotted and feature on the EA Historical Flood (1:10,000) map. For added value, OS Contour data is also plotted, detailing contours, spot heights and air heights.	

EA NaFRA Data	18
This section details the National Flood Risk Assessment (NaFRA) data sourced from the Environment Agency and is reported to a distance of 1000m from the edge of the site polygon. The NaFRA data provides an indication of flood risk at a national level. The data has been created by calculating the actual likelihood of flooding to areas of land within the flood plain of an extreme flood (0.1% or 1 in 1000 chance in any year). The method considers the probability that the flood defences will overtop or breach, and the distance of the impact cell from the river or the sea. It enables a comparison of the relative risks and their distribution within each of these catchments, rather than a detailed, local assessment of the risk at a specific location. EA do not hold information on properties (including floor levels). NaFRA data can therefore only be assessed if there are properties within the impact cells where EA have assessed the flood risk. The data within this section is plotted and featured on the EA NaFRA Data (1:50,000) map.	
Flood Insurance Risk Data	20
This section contains two sources of flood risk data from Aviva and Crawford and Company. Neither data sets are plotted on any of the associated Flood maps. Aviva has generated a detailed flood risk assessment to accurately evaluate the flood risk for individual customers. The information from this assessment has been used to define a risk model detailing 5 levels of flood risk, based on the individual properties rather than the postcode. The flood risk assessment undertaken by Aviva is for river flooding and coastal flooding only, and does not include groundwater, flash or sewerage flooding. Only the worst case flood risk is reported for the site. Crawford & Co have generated an Insurance Claims rating for Flood Risk. The risk is determined by comparing the number of flood insurance claims made to the number of properties in the postcode sector. The data will also include flood claims from domestic accidents or blocked drains, as well as flooding from river or tidal events. Flood insurance claim ratings are reported for the site only.	
Data Currency	21
Data Suppliers	22
Useful Contacts	23

Report Version v47.0

Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m
EA / CEH Flood Data					
Extreme Flooding from Rivers or Sea without Defences				n/a	n/a
Flooding from Rivers or Sea without Defences				n/a	n/a
Areas Benefiting from Flood Defences				n/a	n/a
Flood Water Storage Areas				n/a	n/a
Flood Defences				n/a	n/a
RMS Flood Data					
RMS 75 year Flood Return	pg 1		4	n/a	n/a
RMS 100 year Flood Return	pg 1		2	n/a	n/a
RMS 1000 year Flood Return	pg 1	1		n/a	n/a
BGS Flood Data					
BGS Geological Indicators of Flooding	pg 2				1
BGS Groundwater Flooding Susceptibility	pg 2	1	7	28	49
EA Detailed River Network Data					
Detailed River Network Lines	pg 6		3	15	33
Detailed River Network Nodes	pg 14		1	13	31
Detailed River Network Offline Drainage	pg 16			3	19
EA Historic Flood Events Data					
Historic Flood Events					
Historical Flood Liabilities					
EA National Flood Risk Assessment Data					
National Flood Risk Assessment	pg 18				23
Flood Insurance Risk Data					
Property-based Flood Risk			n/a	n/a	n/a
Postcode Sector Flood Insurance Claim Ratings	pg 20	1	n/a	n/a	n/a

Report Version v47.0

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
	RMS 75 year Flood Return Flood Type/Depth: 75 year pluvial flood, depth is not applicable Flood Hazard: Pluvial & Minor River Flood Risk	A13SW (W)	56	2	330985 346072
	RMS 75 year Flood Return Flood Type/Depth: 75 year pluvial flood, depth is not applicable Flood Hazard: Pluvial & Minor River Flood Risk	A13NW (W)	154	2	330885 346091
	RMS 75 year Flood Return Flood Type/Depth: 75 year pluvial flood, depth is not applicable Flood Hazard: Pluvial & Minor River Flood Risk	A13NW (NW)	173	2	330954 346239
	RMS 75 year Flood Return Flood Type/Depth: 75 year pluvial flood, depth is not applicable Flood Hazard: Pluvial & Minor River Flood Risk	A13SW (W)	201	2	330851 346018
	RMS 100 year Flood Return Flood Type/Depth: 100 year pluvial flood, depth is not applicable Flood Hazard: Pluvial & Minor River Flood Risk	A13SW (W)	56	2	330985 346072
	RMS 100 year Flood Return Flood Type/Depth: 100 year pluvial flood, depth is not applicable Flood Hazard: Pluvial & Minor River Flood Risk	A13NW (NW)	173	2	330954 346239
	RMS 1000 year Flood Return Flood Type/Depth: 1000 year pluvial flood, depth is not applicable Flood Hazard: Pluvial & Minor River Flood Risk	A13NE (N)	0	2	331038 346088

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
	BGS Geological Indicators of Flooding Flooding Type: Inland Flooding Flood Potential: Higher flood potential from rivers: the first areas to experience the effects of inland flooding in a river catchment. Code:	A9SW (SE)	847	3	331437 345342
	BGS Groundwater Flooding Susceptibility Flooding Type: High Susceptibility to Groundwater Flooding	A13NE (N)	0	3	331038 346088
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderately High Susceptibility to Groundwater Flooding	A13NE (NE)	129	3	331100 346201
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderately High Susceptibility to Groundwater Flooding	A13SE (S)	138	3	331038 345951
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderately High Susceptibility to Groundwater Flooding	A13SE (E)	167	3	331200 346051
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderate Susceptibility to Groundwater Flooding	A13SW (S)	192	3	331000 345901
	BGS Groundwater Flooding Susceptibility Flooding Type: Low Susceptibility to Groundwater Flooding	A13SE (S)	238	3	331038 345851
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderate Susceptibility to Groundwater Flooding	A13SE (S)	238	3	331050 345851
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderately High Susceptibility to Groundwater Flooding	A13SE (S)	246	3	331100 345851
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderate Susceptibility to Groundwater Flooding	A13SW (SW)	275	3	330900 345851
	BGS Groundwater Flooding Susceptibility Flooding Type: Low Susceptibility to Groundwater Flooding	A13SE (S)	288	3	331050 345801
	BGS Groundwater Flooding Susceptibility Flooding Type: Negligible Susceptibility to Groundwater Flooding	A13SE (S)	288	3	331038 345801
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderate Susceptibility to Groundwater Flooding	A13NE (N)	313	3	331050 346401
	BGS Groundwater Flooding Susceptibility Flooding Type: Low Susceptibility to Groundwater Flooding	A13SW (SW)	319	3	330900 345801
	BGS Groundwater Flooding Susceptibility Flooding Type: Low Susceptibility to Groundwater Flooding	A18SE (N)	363	3	331038 346451
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderate Susceptibility to Groundwater Flooding	A18SW (N)	365	3	331000 346451
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderately High Susceptibility to Groundwater Flooding	A18SW (N)	374	3	330950 346451
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderate Susceptibility to Groundwater Flooding	A8NE (S)	388	3	331050 345701
	BGS Groundwater Flooding Susceptibility Flooding Type: Negligible Susceptibility to Groundwater Flooding	A18SE (N)	413	3	331038 346501
	BGS Groundwater Flooding Susceptibility Flooding Type: Low Susceptibility to Groundwater Flooding	A18SW (N)	422	3	330950 346501
	BGS Groundwater Flooding Susceptibility Flooding Type: Low Susceptibility to Groundwater Flooding	A18SE (N)	428	3	331150 346501
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderately High Susceptibility to Groundwater Flooding	A13SE (SE)	428	3	331300 345751

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
	BGS Groundwater Flooding Susceptibility Flooding Type: High Susceptibility to Groundwater Flooding	A8NW (SW)	431	3	330850 345701
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderate Susceptibility to Groundwater Flooding	A18SW (N)	436	3	330900 346501
	BGS Groundwater Flooding Susceptibility Flooding Type: High Susceptibility to Groundwater Flooding	A8NE (S)	438	3	331050 345651
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderately High Susceptibility to Groundwater Flooding	A8NE (S)	442	3	331100 345651
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderate Susceptibility to Groundwater Flooding	A8NE (S)	452	3	331150 345651
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderately High Susceptibility to Groundwater Flooding	A18SW (NW)	454	3	330850 346501
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderately High Susceptibility to Groundwater Flooding	A8NW (SW)	455	3	330800 345701
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderately High Susceptibility to Groundwater Flooding	A14NW (E)	463	3	331500 346101
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderately High Susceptibility to Groundwater Flooding	A8NE (S)	467	3	331200 345651
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderately High Susceptibility to Groundwater Flooding	A14SW (SE)	476	3	331450 345851
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderate Susceptibility to Groundwater Flooding	A18SE (NE)	479	3	331350 346451
	BGS Groundwater Flooding Susceptibility Flooding Type: Low Susceptibility to Groundwater Flooding	A18SW (N)	483	3	330900 346551
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderate Susceptibility to Groundwater Flooding	A8NW (SW)	483	3	330750 345701
	BGS Groundwater Flooding Susceptibility Flooding Type: Low Susceptibility to Groundwater Flooding	A18SE (N)	491	3	331200 346551
	BGS Groundwater Flooding Susceptibility Flooding Type: Low Susceptibility to Groundwater Flooding	A8NE (S)	492	3	331100 345601
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderately High Susceptibility to Groundwater Flooding	A12NE (W)	501	3	330550 346201
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderate Susceptibility to Groundwater Flooding	A8NE (SE)	532	3	331250 345601
	BGS Groundwater Flooding Susceptibility Flooding Type: Low Susceptibility to Groundwater Flooding	A8NE (S)	538	3	331050 345551
	BGS Groundwater Flooding Susceptibility Flooding Type: Negligible Susceptibility to Groundwater Flooding	A8NE (S)	541	3	331100 345551
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderate Susceptibility to Groundwater Flooding	A18SW (N)	547	3	330850 346601
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderately High Susceptibility to Groundwater Flooding	A8NE (SE)	554	3	331300 345601
	BGS Groundwater Flooding Susceptibility Flooding Type: Low Susceptibility to Groundwater Flooding	A18SE (N)	555	3	331250 346601

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
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	BGS Groundwater Flooding Susceptibility Flooding Type: Low Susceptibility to Groundwater Flooding	A18SW (N)	594	3	330850 346651
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderate Susceptibility to Groundwater Flooding	A18SE (NE)	621	3	331300 346651
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderately High Susceptibility to Groundwater Flooding	A8NW (S)	634	3	330800 345501
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderate Susceptibility to Groundwater Flooding	A18SW (N)	641	3	330850 346701
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderately High Susceptibility to Groundwater Flooding	A12SE (W)	645	3	330400 346001
	BGS Groundwater Flooding Susceptibility Flooding Type: Low Susceptibility to Groundwater Flooding	A18SE (NE)	667	3	331300 346701
	BGS Groundwater Flooding Susceptibility Flooding Type: Low Susceptibility to Groundwater Flooding	A8NW (S)	681	3	330800 345451
	BGS Groundwater Flooding Susceptibility Flooding Type: Negligible Susceptibility to Groundwater Flooding	A12NW (W)	689	3	330350 346101
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderately High Susceptibility to Groundwater Flooding	A18SW (N)	689	3	330850 346751
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderately High Susceptibility to Groundwater Flooding	A8NW (SW)	700	3	330750 345451
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderate Susceptibility to Groundwater Flooding	A8SE (S)	720	3	331250 345401
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderately High Susceptibility to Groundwater Flooding	A14NW (NE)	733	3	331700 346401
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderately High Susceptibility to Groundwater Flooding	A18SE (NE)	733	3	331350 346751
	BGS Groundwater Flooding Susceptibility Flooding Type: Negligible Susceptibility to Groundwater Flooding	A8SE (S)	738	3	331050 345351
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderate Susceptibility to Groundwater Flooding	A8SW (SW)	746	3	330750 345401
	BGS Groundwater Flooding Susceptibility Flooding Type: Low Susceptibility to Groundwater Flooding	A17SE (NW)	760	3	330400 346501
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderately High Susceptibility to Groundwater Flooding	A7SE (SW)	767	3	330700 345401
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderate Susceptibility to Groundwater Flooding	A8SW (S)	775	3	330800 345351
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderate Susceptibility to Groundwater Flooding	A18NE (NE)	778	3	331350 346801
	BGS Groundwater Flooding Susceptibility Flooding Type: Low Susceptibility to Groundwater Flooding	A8SE (S)	788	3	331050 345301
	BGS Groundwater Flooding Susceptibility Flooding Type: Negligible Susceptibility to Groundwater Flooding	A8SE (S)	790	3	331100 345301

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderate Susceptibility to Groundwater Flooding	A8SE (S)	804	3	331200 345301
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderate Susceptibility to Groundwater Flooding	A8SW (S)	810	3	330850 345301
	BGS Groundwater Flooding Susceptibility Flooding Type: Low Susceptibility to Groundwater Flooding	A18NE (N)	824	3	331350 346851
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderately High Susceptibility to Groundwater Flooding	A14NE (E)	824	3	331800 346401
	BGS Groundwater Flooding Susceptibility Flooding Type: Low Susceptibility to Groundwater Flooding	A12SW (W)	824	3	330250 345851
	BGS Groundwater Flooding Susceptibility Flooding Type: Low Susceptibility to Groundwater Flooding	A18NW (N)	825	3	330900 346901
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderately High Susceptibility to Groundwater Flooding	A19SW (NE)	838	3	331550 346751
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderate Susceptibility to Groundwater Flooding	A8SE (S)	864	3	331250 345251
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderately High Susceptibility to Groundwater Flooding	A18NW (N)	874	3	330900 346951
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderate Susceptibility to Groundwater Flooding	A8SE (S)	902	3	331200 345201
	BGS Groundwater Flooding Susceptibility Flooding Type: Negligible Susceptibility to Groundwater Flooding	A12SW (W)	904	3	330200 345751
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderately High Susceptibility to Groundwater Flooding	A8SE (S)	913	3	331250 345201
	BGS Groundwater Flooding Susceptibility Flooding Type: Low Susceptibility to Groundwater Flooding	A18NE (N)	918	3	331350 346951
	BGS Groundwater Flooding Susceptibility Flooding Type: High Susceptibility to Groundwater Flooding	A19NW (NE)	936	3	331400 346951
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderate Susceptibility to Groundwater Flooding	A8SE (S)	944	3	331150 345151
	BGS Groundwater Flooding Susceptibility Flooding Type: Low Susceptibility to Groundwater Flooding	A18NE (N)	950	3	331300 347001
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderately High Susceptibility to Groundwater Flooding	A9SW (SE)	957	3	331500 345251
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderate Susceptibility to Groundwater Flooding	A18NE (N)	965	3	331350 347001
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderate Susceptibility to Groundwater Flooding	A8SW (S)	997	3	330900 345101
	BGS Groundwater Flooding Susceptibility Flooding Type: Moderate Susceptibility to Groundwater Flooding	A18NE (N)	998	3	331300 347051

EA Detailed River Network Data

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
1	Detailed River Network Lines River Type: Tertiary River River Name: Aberderfyn Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A13SW (SW)	180	1	330918 345955
2	Detailed River Network Lines River Type: Tertiary River River Name: Aberderfyn Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A13SW (W)	214	1	330829 346042
3	Detailed River Network Lines River Type: Tertiary River River Name: Drain Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Drain (ditch, Reen, Rhyne, Drain) Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A13SW (W)	214	1	330829 346042
4	Detailed River Network Lines River Type: Tertiary River River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A13NW (NW)	298	1	330901 346353
5	Detailed River Network Lines River Type: Secondary River River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A13NW (NW)	302	1	330862 346333
6	Detailed River Network Lines River Type: Tertiary River River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A13NW (NW)	302	1	330862 346333

EA Detailed River Network Data

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
7	Detailed River Network Lines River Type: Tertiary River River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A13NW (NW)	328	1	330788 346300
8	Detailed River Network Lines River Type: Extended Culvert (greater than 50m) River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Below Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A13SE (SE)	367	1	331188 345754
9	Detailed River Network Lines River Type: Tertiary River River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A14NW (E)	401	1	331439 346097
10	Detailed River Network Lines River Type: Tertiary River River Name: Drain Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Drain (ditch, Reen, Rhyne, Drain) Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A18SW (NW)	436	1	330861 346486
11	Detailed River Network Lines River Type: Tertiary River River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A18SW (NW)	445	1	330808 346469
12	Detailed River Network Lines River Type: Secondary River River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A18SW (NW)	445	1	330808 346469

EA Detailed River Network Data

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
13	Detailed River Network Lines River Type: Secondary River River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A18SW (NW)	446	1	330815 346473
14	Detailed River Network Lines River Type: Tertiary River River Name: Aberderfyn Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A8NE (S)	457	1	331174 345652
15	Detailed River Network Lines River Type: Tertiary River River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A18SW (NW)	459	1	330779 346466
16	Detailed River Network Lines River Type: Tertiary River River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A18SW (NW)	467	1	330755 346459
17	Detailed River Network Lines River Type: Tertiary River River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A18SW (NW)	468	1	330752 346458
18	Detailed River Network Lines River Type: Tertiary River River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A18SW (NW)	470	1	330757 346464

EA Detailed River Network Data

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
19	Detailed River Network Lines River Type: Tertiary River River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A18SW (NW)	505	1	330720 346480
20	Detailed River Network Lines River Type: Tertiary River River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A18SW (NW)	505	1	330720 346480
21	Detailed River Network Lines River Type: Tertiary River River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A18SE (N)	510	1	331065 346597
22	Detailed River Network Lines River Type: Tertiary River River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A18SE (N)	510	1	331065 346597
23	Detailed River Network Lines River Type: Tertiary River River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A18SE (N)	519	1	331071 346606
24	Detailed River Network Lines River Type: Tertiary River River Name: Drain Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Drain (ditch, Reen, Rhyne, Drain) Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A18SE (N)	519	1	331071 346606

EA Detailed River Network Data

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
25	Detailed River Network Lines River Type: Tertiary River River Name: Drain Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Drain (ditch, Reen, Rhyne, Drain) Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A18SE (N)	564	1	331113 346647
26	Detailed River Network Lines River Type: Tertiary River River Name: Drain Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Drain (ditch, Reen, Rhyne, Drain) Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A18SE (N)	564	1	331113 346647
27	Detailed River Network Lines River Type: Secondary River River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A18SW (NW)	572	1	330774 346595
28	Detailed River Network Lines River Type: Tertiary River River Name: Drain Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Drain (ditch, Reen, Rhyne, Drain) Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A18SW (NW)	582	1	330739 346587
29	Detailed River Network Lines River Type: Tertiary River River Name: Aberderfyn Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A18SW (NW)	582	1	330739 346587
30	Detailed River Network Lines River Type: Tertiary River River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A18SW (NW)	587	1	330773 346612

EA Detailed River Network Data

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
31	Detailed River Network Lines River Type: Secondary River River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A18SW (NW)	602	1	330772 346627
32	Detailed River Network Lines River Type: Tertiary River River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A18SW (NW)	606	1	330771 346632
33	Detailed River Network Lines River Type: Extended Culvert (greater than 50m) River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Below Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A8NE (SE)	633	1	331349 345538
34	Detailed River Network Lines River Type: Tertiary River River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A18SW (N)	650	1	331012 346737
35	Detailed River Network Lines River Type: Tertiary River River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A18SW (N)	656	1	330994 346742
36	Detailed River Network Lines River Type: Tertiary River River Name: Aberderfyn Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A9NW (SE)	691	1	331392 345495

EA Detailed River Network Data

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
37	Detailed River Network Lines River Type: Tertiary River River Name: Drain Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Drain (ditch, Reen, Rhyne, Drain) Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A18SW (N)	712	1	330789 346755
38	Detailed River Network Lines River Type: Tertiary River River Name: Drain Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Drain (ditch, Reen, Rhyne, Drain) Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A18SW (N)	712	1	330789 346755
39	Detailed River Network Lines River Type: Secondary River River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A18NE (N)	793	1	331294 346839
40	Detailed River Network Lines River Type: Tertiary River River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A18NE (N)	803	1	331298 346847
41	Detailed River Network Lines River Type: Tertiary River River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A19NW (NE)	815	1	331479 346773
42	Detailed River Network Lines River Type: Tertiary River River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A19SE (NE)	891	1	331796 346556

EA Detailed River Network Data

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
43	Detailed River Network Lines River Type: Primary River River Name: Black Brook Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A9SW (SE)	900	1	331466 345297
44	Detailed River Network Lines River Type: Primary River River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A9SW (SE)	903	1	331448 345284
45	Detailed River Network Lines River Type: Secondary River River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A18NW (N)	906	1	330845 346973
46	Detailed River Network Lines River Type: Tertiary River River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A19SE (NE)	940	1	331838 346580
47	Detailed River Network Lines River Type: Secondary River River Name: Drain Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Drain (ditch, Reen, Rhyne, Drain) Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A8SW (S)	945	1	330746 345190
48	Detailed River Network Lines River Type: Tertiary River River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A8SW (S)	948	1	330730 345192

EA Detailed River Network Data

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
49	Detailed River Network Lines River Type: Tertiary River River Name: Drain Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Drain (ditch, Reen, Rhyne, Drain) Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A18NW (N)	959	1	330860 347031
50	Detailed River Network Lines River Type: Primary River River Name: Not Supplied Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Not a Drain Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A9NE (SE)	995	1	331836 345495
51	Detailed River Network Lines River Type: Tertiary River River Name: Drain Hydrographic Area: D010 River Flow Type: Primary Flow Path River Surface Level: Surface Drain Feature: Drain (ditch, Reen, Rhyne, Drain) Flood Risk: Other Rivers Management Status: Water Course: Not Supplied Name: Water Course: Not Supplied Reference:	A9NE (SE)	995	1	331836 345495
52	Detailed River Network Nodes River Node Type: Junction Hydrographic Area: D010	A13SW (W)	214	1	330829 346042
53	Detailed River Network Nodes River Node Type: Pseudo (OS MasterMap polygon boundary) Hydrographic Area: D010	A13NW (NW)	302	1	330862 346333
54	Detailed River Network Nodes River Node Type: Pseudo (OS MasterMap polygon boundary) Hydrographic Area: D010	A13NW (NW)	306	1	330868 346343
55	Detailed River Network Nodes River Node Type: Junction Hydrographic Area: D010	A13NW (NW)	328	1	330788 346300
56	Detailed River Network Nodes River Node Type: Source Hydrographic Area: D010	A13NW (N)	334	1	330912 346397
57	Detailed River Network Nodes River Node Type: Pseudo (general) Hydrographic Area: D010	A13SE (SE)	367	1	331188 345754
58	Detailed River Network Nodes River Node Type: Source Hydrographic Area: D010	A14NW (E)	401	1	331439 346097
59	Detailed River Network Nodes River Node Type: Pseudo (OS MasterMap polygon boundary) Hydrographic Area: D010	A18SW (NW)	445	1	330808 346469
60	Detailed River Network Nodes River Node Type: Pseudo (OS MasterMap polygon boundary) Hydrographic Area: D010	A18SW (NW)	446	1	330822 346478
61	Detailed River Network Nodes River Node Type: Pseudo (OS MasterMap polygon boundary) Hydrographic Area: D010	A18SW (NW)	446	1	330815 346473

EA Detailed River Network Data

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
62	Detailed River Network Nodes River Node Type: Pseudo (general) Hydrographic Area: D010	A8NE (S)	457	1	331174 345652
63	Detailed River Network Nodes River Node Type: Pseudo (OS MasterMap polygon boundary) Hydrographic Area: D010	A18SW (NW)	459	1	330779 346466
64	Detailed River Network Nodes River Node Type: Junction Hydrographic Area: D010	A18SW (NW)	468	1	330752 346458
65	Detailed River Network Nodes River Node Type: Junction Hydrographic Area: D010	A18SW (NW)	470	1	330757 346464
66	Detailed River Network Nodes River Node Type: Junction Hydrographic Area: D010	A18SW (NW)	505	1	330720 346480
67	Detailed River Network Nodes River Node Type: Junction Hydrographic Area: D010	A18SE (N)	510	1	331065 346597
68	Detailed River Network Nodes River Node Type: Source Hydrographic Area: D010	A18SW (NW)	510	1	330713 346481
69	Detailed River Network Nodes River Node Type: Junction Hydrographic Area: D010	A18SE (N)	519	1	331071 346606
70	Detailed River Network Nodes River Node Type: Source Hydrographic Area: D010	A18SE (N)	541	1	331038 346628
71	Detailed River Network Nodes River Node Type: Junction Hydrographic Area: D010	A18SE (N)	564	1	331113 346647
72	Detailed River Network Nodes River Node Type: Pseudo (OS MasterMap polygon boundary) Hydrographic Area: D010	A18SW (NW)	572	1	330774 346595
73	Detailed River Network Nodes River Node Type: Junction Hydrographic Area: D010	A18SW (NW)	582	1	330739 346587
74	Detailed River Network Nodes River Node Type: Pseudo (OS MasterMap polygon boundary) Hydrographic Area: D010	A18SW (NW)	587	1	330773 346612
75	Detailed River Network Nodes River Node Type: Pseudo (OS MasterMap polygon boundary) Hydrographic Area: D010	A18SW (NW)	602	1	330772 346627
76	Detailed River Network Nodes River Node Type: Pseudo (OS MasterMap polygon boundary) Hydrographic Area: D010	A18SW (NW)	606	1	330771 346632
77	Detailed River Network Nodes River Node Type: Pseudo (general) Hydrographic Area: D010	A8NE (SE)	633	1	331349 345538
78	Detailed River Network Nodes River Node Type: Source Hydrographic Area: D010	A18SW (N)	650	1	331012 346737
79	Detailed River Network Nodes River Node Type: Junction Hydrographic Area: D010	A18SW (N)	656	1	330994 346742
80	Detailed River Network Nodes River Node Type: Source Hydrographic Area: D010	A18NW (N)	690	1	330992 346776
81	Detailed River Network Nodes River Node Type: Pseudo (general) Hydrographic Area: D010	A9NW (SE)	691	1	331392 345495
82	Detailed River Network Nodes River Node Type: Junction Hydrographic Area: D010	A18SW (N)	712	1	330789 346755

EA Detailed River Network Data

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
83	Detailed River Network Nodes River Node Type: Source Hydrographic Area: D010	A18NE (N)	781	1	331297 346825
84	Detailed River Network Nodes River Node Type: Pseudo (OS MasterMap polygon boundary) Hydrographic Area: D010	A18NE (N)	793	1	331294 346839
85	Detailed River Network Nodes River Node Type: Pseudo (OS MasterMap polygon boundary) Hydrographic Area: D010	A18NE (N)	803	1	331298 346847
86	Detailed River Network Nodes River Node Type: Source Hydrographic Area: D010	A18NW (N)	812	1	330877 346884
87	Detailed River Network Nodes River Node Type: Source Hydrographic Area: D010	A19NW (NE)	815	1	331479 346773
88	Detailed River Network Nodes River Node Type: Source Hydrographic Area: D010	A7SE (SW)	858	1	330565 345373
89	Detailed River Network Nodes River Node Type: Source Hydrographic Area: D010	A19SE (NE)	891	1	331796 346556
90	Detailed River Network Nodes River Node Type: Junction Hydrographic Area: D010	A9SW (SE)	905	1	331462 345289
91	Detailed River Network Nodes River Node Type: Pseudo (OS MasterMap polygon boundary) Hydrographic Area: D010	A18NW (N)	906	1	330845 346973
92	Detailed River Network Nodes River Node Type: Source Hydrographic Area: D010	A18NE (N)	934	1	331244 346999
93	Detailed River Network Nodes River Node Type: Junction Hydrographic Area: D010	A19SE (NE)	940	1	331838 346580
94	Detailed River Network Nodes River Node Type: Pseudo (OS MasterMap polygon boundary) Hydrographic Area: D010	A8SW (S)	948	1	330730 345192
95	Detailed River Network Nodes River Node Type: Pseudo (OS MasterMap polygon boundary) Hydrographic Area: D010	A18NW (N)	959	1	330860 347031
96	Detailed River Network Nodes River Node Type: Junction Hydrographic Area: D010	A9NE (SE)	995	1	331836 345495
97	Detailed River Network Offline Drainage River Type: Tertiary River Hydrographic Area: D010	A13NE (N)	334	1	331047 346422
98	Detailed River Network Offline Drainage River Type: Tertiary River Hydrographic Area: D010	A13NE (N)	335	1	331056 346422
99	Detailed River Network Offline Drainage River Type: Tertiary River Hydrographic Area: D010	A18SE (N)	343	1	331061 346430
100	Detailed River Network Offline Drainage River Type: Tertiary River Hydrographic Area: D010	A18SE (N)	522	1	331213 346580
101	Detailed River Network Offline Drainage River Type: Tertiary River Hydrographic Area: D010	A18SE (NE)	628	1	331295 346661
102	Detailed River Network Offline Drainage River Type: Tertiary River Hydrographic Area: D010	A18SE (N)	659	1	331104 346744
103	Detailed River Network Offline Drainage River Type: Tertiary River Hydrographic Area: D010	A18SE (N)	666	1	331154 346744

EA Detailed River Network Data

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
104	Detailed River Network Offline Drainage River Type: Tertiary River Hydrographic Area: D010	A18NE (N)	707	1	331093 346793
105	Detailed River Network Offline Drainage River Type: Tertiary River Hydrographic Area: D010	A18SE (NE)	721	1	331316 346754
106	Detailed River Network Offline Drainage River Type: Tertiary River Hydrographic Area: D010	A18SE (NE)	723	1	331316 346755
107	Detailed River Network Offline Drainage River Type: Tertiary River Hydrographic Area: D010	A18NE (N)	726	1	331115 346810
108	Detailed River Network Offline Drainage River Type: Tertiary River Hydrographic Area: D010	A18NE (N)	744	1	331105 346829
109	Detailed River Network Offline Drainage River Type: Tertiary River Hydrographic Area: D010	A18NW (N)	770	1	330977 346855
110	Detailed River Network Offline Drainage River Type: Tertiary River Hydrographic Area: D010	A18NW (N)	791	1	330987 346877
111	Detailed River Network Offline Drainage River Type: Tertiary River Hydrographic Area: D010	A18NW (N)	844	1	330987 346930
112	Detailed River Network Offline Drainage River Type: Tertiary River Hydrographic Area: D010	A18NE (N)	848	1	331060 346935
113	Detailed River Network Offline Drainage River Type: Tertiary River Hydrographic Area: D010	A18NE (N)	868	1	331056 346956
114	Detailed River Network Offline Drainage River Type: Tertiary River Hydrographic Area: D010	A18NE (N)	874	1	331051 346962
115	Detailed River Network Offline Drainage River Type: Tertiary River Hydrographic Area: D010	A18NE (N)	911	1	331045 346999
116	Detailed River Network Offline Drainage River Type: Tertiary River Hydrographic Area: D010	A18NE (N)	942	1	331221 347012
117	Detailed River Network Offline Drainage River Type: Tertiary River Hydrographic Area: D010	A18NE (N)	965	1	331218 347036
118	Detailed River Network Offline Drainage River Type: Tertiary River Hydrographic Area: D010	A18NW (N)	976	1	330973 347061

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
	National Flood Risk Assessment (NaFRA) Flood Risk: Moderate Assessment Code: Source: Environment Agency, Head Office Catchment Area: Dee	A9SW (SE)	862	4	331420 345316
	National Flood Risk Assessment (NaFRA) Flood Risk: Significant Assessment Code: Source: Environment Agency, Head Office Catchment Area: Dee	A9SW (SE)	867	4	331450 345326
	National Flood Risk Assessment (NaFRA) Flood Risk: Moderate Assessment Code: Source: Environment Agency, Head Office Catchment Area: Dee	A9SW (SE)	889	4	331450 345301
	National Flood Risk Assessment (NaFRA) Flood Risk: Moderate Assessment Code: Source: Environment Agency, Head Office Catchment Area: Dee	A9SW (SE)	911	4	331395 345251
	National Flood Risk Assessment (NaFRA) Flood Risk: Moderate Assessment Code: Source: Environment Agency, Head Office Catchment Area: Dee	A9SW (SE)	912	4	331497 345301
	National Flood Risk Assessment (NaFRA) Flood Risk: Moderate Assessment Code: Source: Environment Agency, Head Office Catchment Area: Dee	A9SW (SE)	914	4	331585 345356
	National Flood Risk Assessment (NaFRA) Flood Risk: Moderate Assessment Code: Source: Environment Agency, Head Office Catchment Area: Dee	A9SW (SE)	920	4	331595 345356
	National Flood Risk Assessment (NaFRA) Flood Risk: Moderate Assessment Code: Source: Environment Agency, Head Office Catchment Area: Dee	A9SW (SE)	932	4	331600 345345
	National Flood Risk Assessment (NaFRA) Flood Risk: Low Assessment Code: Source: Environment Agency, Head Office Catchment Area: Dee	A9SW (SE)	934	4	331450 345251
	National Flood Risk Assessment (NaFRA) Flood Risk: Moderate Assessment Code: Source: Environment Agency, Head Office Catchment Area: Dee	A9SW (SE)	940	4	331645 345371
	National Flood Risk Assessment (NaFRA) Flood Risk: Low Assessment Code: Source: Environment Agency, Head Office Catchment Area: Dee	A9SW (SE)	944	4	331695 345411
	National Flood Risk Assessment (NaFRA) Flood Risk: Moderate Assessment Code: Source: Environment Agency, Head Office Catchment Area: Dee	A9NW (SE)	944	4	331700 345416
	National Flood Risk Assessment (NaFRA) Flood Risk: Significant Assessment Code: Source: Environment Agency, Head Office Catchment Area: Dee	A9NE (SE)	949	4	331750 345461
	National Flood Risk Assessment (NaFRA) Flood Risk: Moderate Assessment Code: Source: Environment Agency, Head Office Catchment Area: Dee	A9SW (SE)	965	4	331700 345387

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
	National Flood Risk Assessment (NaFRA) Flood Risk: Moderate Assessment Code: Source: Environment Agency, Head Office Catchment Area: Dee	A9NE (SE)	975	4	331820 345506
	National Flood Risk Assessment (NaFRA) Flood Risk: Moderate Assessment Code: Source: Environment Agency, Head Office Catchment Area: Dee	A9SE (SE)	976	4	331736 345406
	National Flood Risk Assessment (NaFRA) Flood Risk: Significant Assessment Code: Source: Environment Agency, Head Office Catchment Area: Dee	A9NE (SE)	976	4	331750 345421
	National Flood Risk Assessment (NaFRA) Flood Risk: Moderate Assessment Code: Source: Environment Agency, Head Office Catchment Area: Dee	A9SE (SE)	979	4	331745 345411
	National Flood Risk Assessment (NaFRA) Flood Risk: Significant Assessment Code: Source: Environment Agency, Head Office Catchment Area: Dee	A9SW (SE)	980	4	331419 345186
	National Flood Risk Assessment (NaFRA) Flood Risk: Significant Assessment Code: Source: Environment Agency, Head Office Catchment Area: Dee	A9NE (SE)	980	4	331759 345426
	National Flood Risk Assessment (NaFRA) Flood Risk: Moderate Assessment Code: Source: Environment Agency, Head Office Catchment Area: Dee	A9SW (SE)	984	4	331425 345184
	National Flood Risk Assessment (NaFRA) Flood Risk: Low Assessment Code: Source: Environment Agency, Head Office Catchment Area: Dee	A8SE (S)	990	4	331355 345151
	National Flood Risk Assessment (NaFRA) Flood Risk: Significant Assessment Code: Source: Environment Agency, Head Office Catchment Area: Dee	A9SW (S)	998	4	331415 345165

Flood Insurance Risk Data

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
	Postcode Sector Flood Insurance Claim Ratings Insurance Rating: Low Flood Insurance Claim Rating Postcode Sector: LL14 6	A13NE (N)	0	4	331038 346088

EA / CEH Flood Data	Version	Update Cycle
Extreme Flooding from Rivers or Sea without Defences Environment Agency - Head Office	February 2012	Quarterly
Flooding from Rivers or Sea without Defences Environment Agency - Head Office	February 2012	Quarterly
Areas Benefiting from Flood Defences Environment Agency - Head Office	February 2012	Quarterly
Flood Water Storage Areas Environment Agency - Head Office	February 2012	Quarterly
Flood Defences Environment Agency - Head Office	February 2012	Quarterly
RMS Flood Data	Version	Update Cycle
RMS 75 year Flood Return Risk Management Solutions - Dee Catchment	December 2008	As notified
RMS 100 year Flood Return Risk Management Solutions - Dee Catchment	December 2008	As notified
RMS 1000 year Flood Return Risk Management Solutions - Dee Catchment	December 2008	As notified
BGS Flood Data	Version	Update Cycle
BGS Geological Indicators of Flooding British Geological Survey - National Geoscience Information Service	February 2011	Annually
BGS Groundwater Flooding Susceptibility British Geological Survey - National Geoscience Information Service	February 2011	Annually
EA Detailed River Network Data	Version	Update Cycle
Detailed River Network Lines Environment Agency - Head Office	April 2010	As notified
Detailed River Network Nodes Environment Agency - Head Office	April 2010	As notified
Detailed River Network Offline Drainage Environment Agency - Head Office	April 2010	As notified
EA Historic Flood Events Data	Version	Update Cycle
Historic Flood Events Environment Agency - Head Office	January 2012	Quarterly
Historical Flood Liabilities Landmark Information Group Limited	December 1999	Not Applicable
EA National Flood Risk Assessment Data (NaFRA)	Version	Update Cycle
National Flood Risk Assessment Environment Agency - Head Office	October 2011	Annually
Flood Insurance Risk Data	Version	Update Cycle
Property-based Flood Risk Aviva - Dataservice	January 2010	Not Applicable
Postcode Sector Flood Insurance Claim Ratings Crawford and Company	November 2011	Quarterly

A selection of organisations who provide data within this report

Data Supplier	Data Supplier Logo
Ordnance Survey	
Environment Agency	
Centre for Ecology and Hydrology	
British Geological Survey	
Aviva	
Risk Management Solutions	

Contact	Name and Address	Contact Details
1	Environment Agency - National Customer Contact Centre (NCCC) PO Box 544, Templeborough, Rotherham, S60 1BY	Telephone: 08708 506 506 Email: enquiries@environment-agency.gov.uk
2	Landmark Information Group Limited Legal and Financial, The Smith Centre, Fairmile, Henley-on-Thames, Oxon, RG9 6AB	Telephone: 0844 844 9966 Fax: 0844 844 9980 Email: info@landmarkinfo.co.uk Website: www.landmarkinfo.co.uk
3	British Geological Survey - Enquiry Service British Geological Survey, Kingsley Dunham Centre, Keyworth, Nottingham, Nottinghamshire, NG12 5GG	Telephone: 0115 936 3143 Fax: 0115 936 3276 Email: enquiries@bgs.ac.uk Website: www.bgs.ac.uk
4	Landmark Information Group Limited 5 - 7 Abbey Court, Eagle Way, Sowton, Exeter, Devon, EX2 7HY	Telephone: 01392 441761 Fax: 01392 441709 Email: cssupport@landmarkinfo.co.uk Website: www.landmarkinfo.co.uk
-	Landmark Information Group Limited The Smith Centre, Henley On Thames, Oxfordshire, RG9 6AB	Telephone: 0844 844 9952 Fax: 0844 844 9951 Email: customerservices@landmarkinfo.co.uk Website: www.landmarkinfo.co.uk

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EA Flood Data Map (1:10,000)

General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

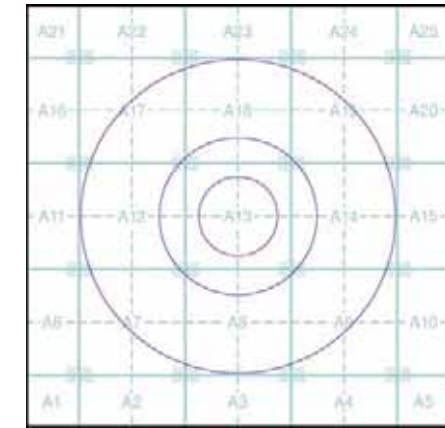
Environment Agency Flood Data

- Extreme Flooding from Rivers or Sea without Defences (Zone 2)
- Flooding from Rivers or Sea without Defences (Zone 3)
- Area Benefiting from Flood Defence
- Flood Water Storage Areas
- Flood Defence

Contours (height in metres)

- Standard Contour: 105, 100, 95
- Index Contour: 105, 100, 95
- Spot Height: 167.8
- Air Height: 45.8

EA Flood Data Map - Slice A



Order Details

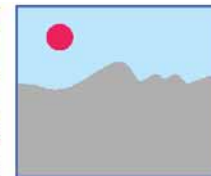
Order Number: 37986274_1_1
 Customer Ref: MB616
 National Grid Reference: 331040, 346090
 Slice: A
 Site Area (Ha): 0.01
 Search Buffer (m): 1000

Site Details

Hafod Tileries, Hafod, Ruabon, Wrexham, LL14 6ET



Tel: 0844 844 9952
 Fax: 0844 844 9951
 Web: www.envirocheck.co.uk



RMS 75 year Return Flood Map (1:10,000)

General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

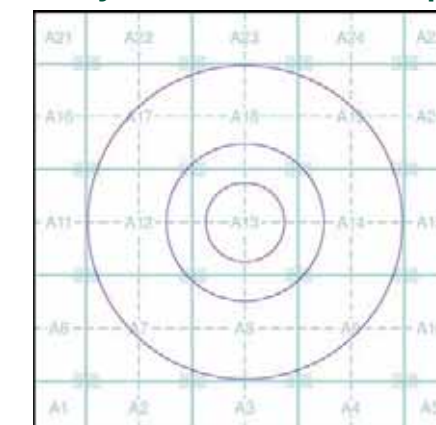
RMS 75 year Return Flood Data

Flood Depth (mm)	Flood Type		
	Defended Flood	Undefended Flood	Pluvial & Minor River Flood (flood depth n/a)
0 - 200			
201 - 500			
501 - 2000			
2001 +			

Contours (height in metres)

Standard Contour			Spot Height
Index Contour			Air Height

RMS 75 year Return Flood Map - Slice A



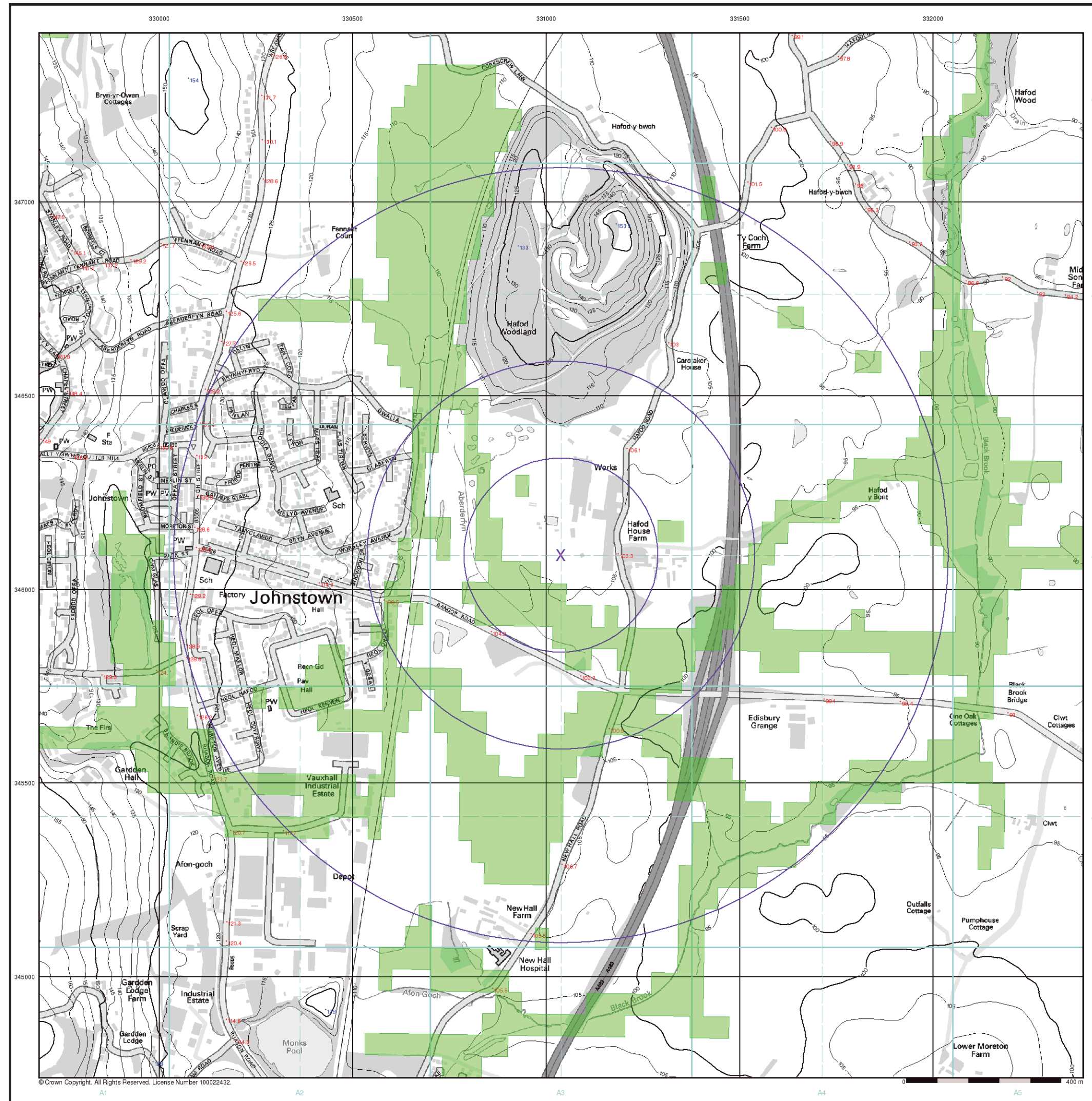
Order Details

Order Number: 37986274_1_1
 Customer Ref: MB616
 National Grid Reference: 331040, 346090
 Slice: A
 Site Area (Ha): 0.01
 Search Buffer (m): 1000

Site Details

Hafod Tileries, Hafod, Ruabon, Wrexham, LL14 6ET





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LAND CONSULTANTS

RMS 100 year Return Flood Map (1:10,000)

General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

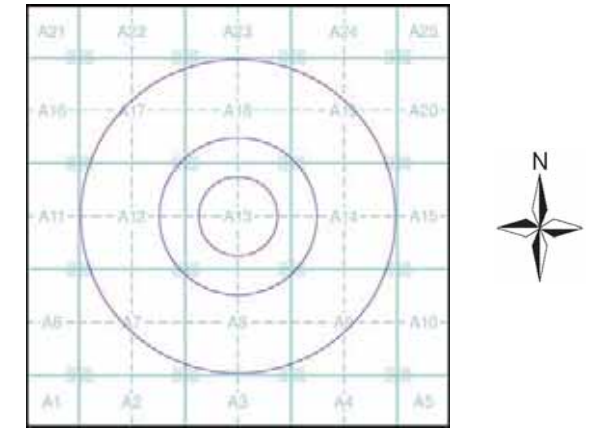
RMS 100 year Return Flood Data

Flood Depth (mm)	Flood Type		
	Defended Flood	Undefended Flood	Pluvial & Minor River Flood (flood depth n/a)
0 - 200			
201 - 500			
501 - 2000			
2001 +			

Contours (height in metres)

- Standard Contour
- Index Contour
- Spot Height
- Air Height

RMS 100 year Return Flood Map - Slice A

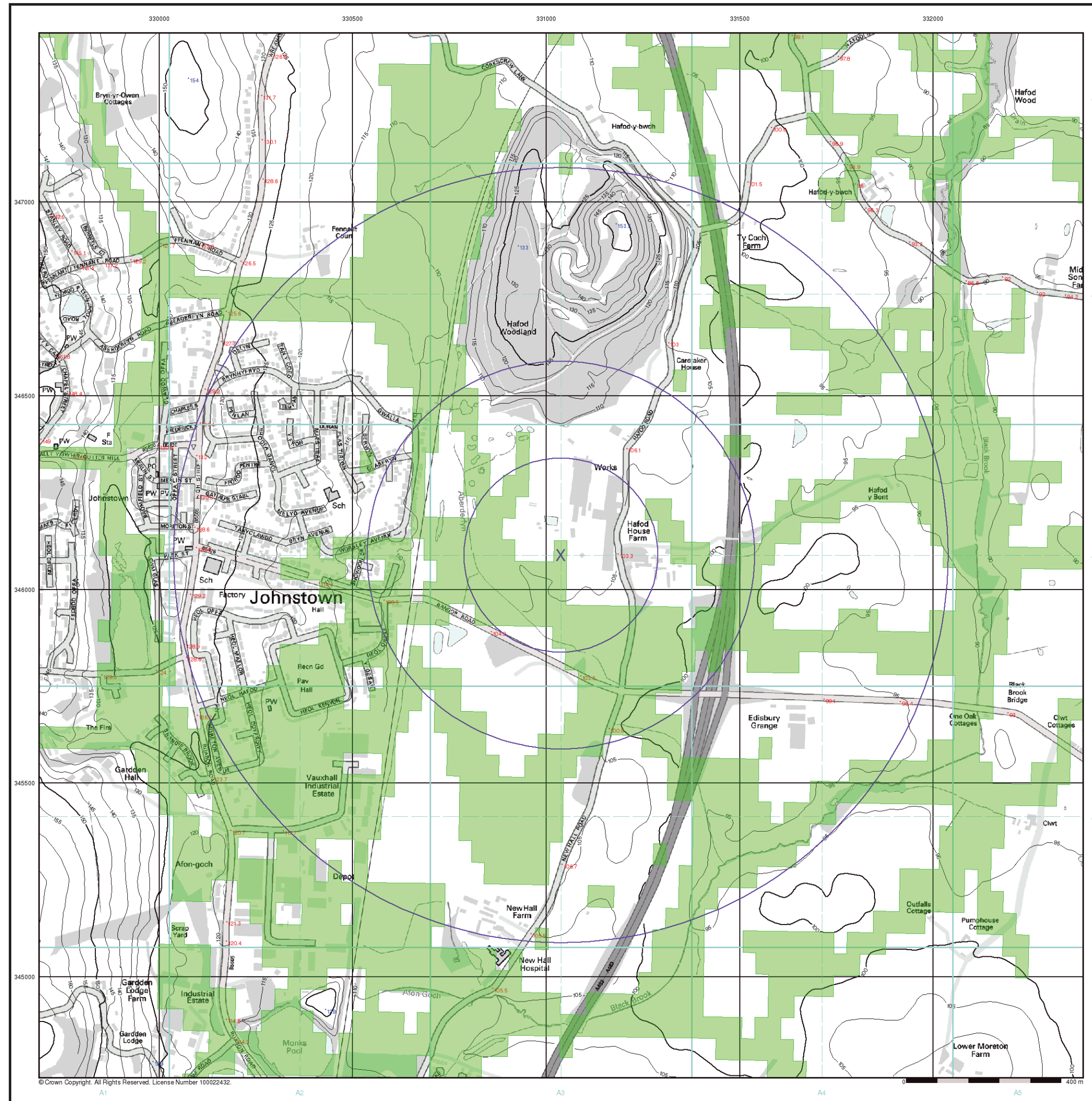


Order Details

Order Number: 37986274_1_1
Customer Ref: MB616
National Grid Reference: 331040, 346090
Slice: A
Site Area (Ha): 0.01
Search Buffer (m): 1000

Site Details

Hafod Tileries, Hafod, Ruabon, Wrexham, LL14 6ET



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RMS 1000 year Return Flood Map (1:10,000)

- General**
- Specified Site
 - Specified Buffer(s)
 - Bearing Reference Point

RMS 1000 year Return Flood Data

Flood Depth (mm)	Defended Flood	Undefended Flood	Flood Type
0 - 200			Pluvial & Minor River Flood (flood depth n/a)
201 - 500			
501 - 2000			
2001 +			

Contours (height in metres)

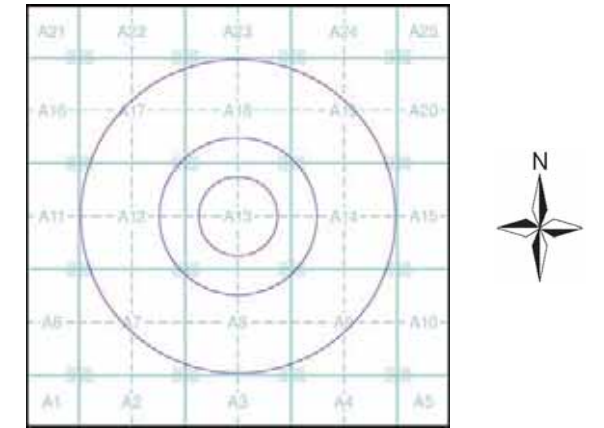
Standard Contour 105

Index Contour 100

Spot Height 167.3

Air Height 45.8

RMS 1000 year Return Flood Map - Slice A



Order Details

Order Number: 37986274_1_1
Customer Ref: MB616
National Grid Reference: 331040, 346090
Slice: A
Site Area (Ha): 0.01
Search Buffer (m): 1000

Site Details

Hafod Tileries, Hafod, Ruabon, Wrexham, LL14 6ET



EA Detailed River Network Map (1:10,000)

General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Map ID

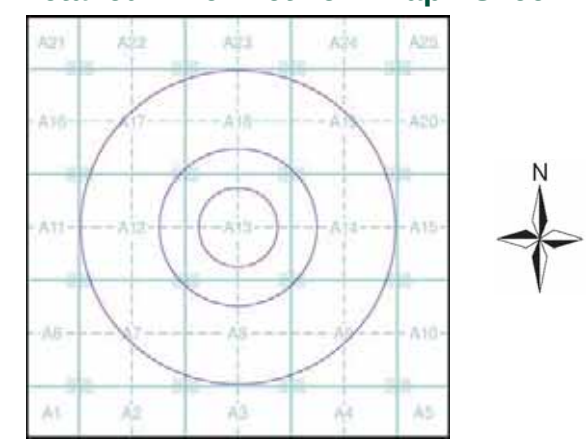
EA Detailed River Network Data

- | | |
|-----------------|-------------------------------------|
| Primary River | Extended Culvert (greater than 50m) |
| Secondary River | Underground River (inferred) |
| Tertiary River | Underground River (local knowledge) |
| Canal | Downstream of High Water Mark |
| Canal Tunnel | Downstream of Seaward Extension |
| Undefined River | Not assigned River feature |
| Lake/Reservoir | |
-
- | | |
|----------------------|---|
| Source | Not assigned River feature |
| Junction | Pseudo Node (general) |
| Sink | Pseudo Node (High Water Mark) |
| Non-interactive Node | Pseudo Node (OS MasterMap polygon boundary) |
-
- Offline Drainage Feature

Contours (height in metres)

- Standard Contour 105 167.3 Spot Height
- Index Contour 100 45.8 Air Height

EA Detailed River Network Map - Slice A

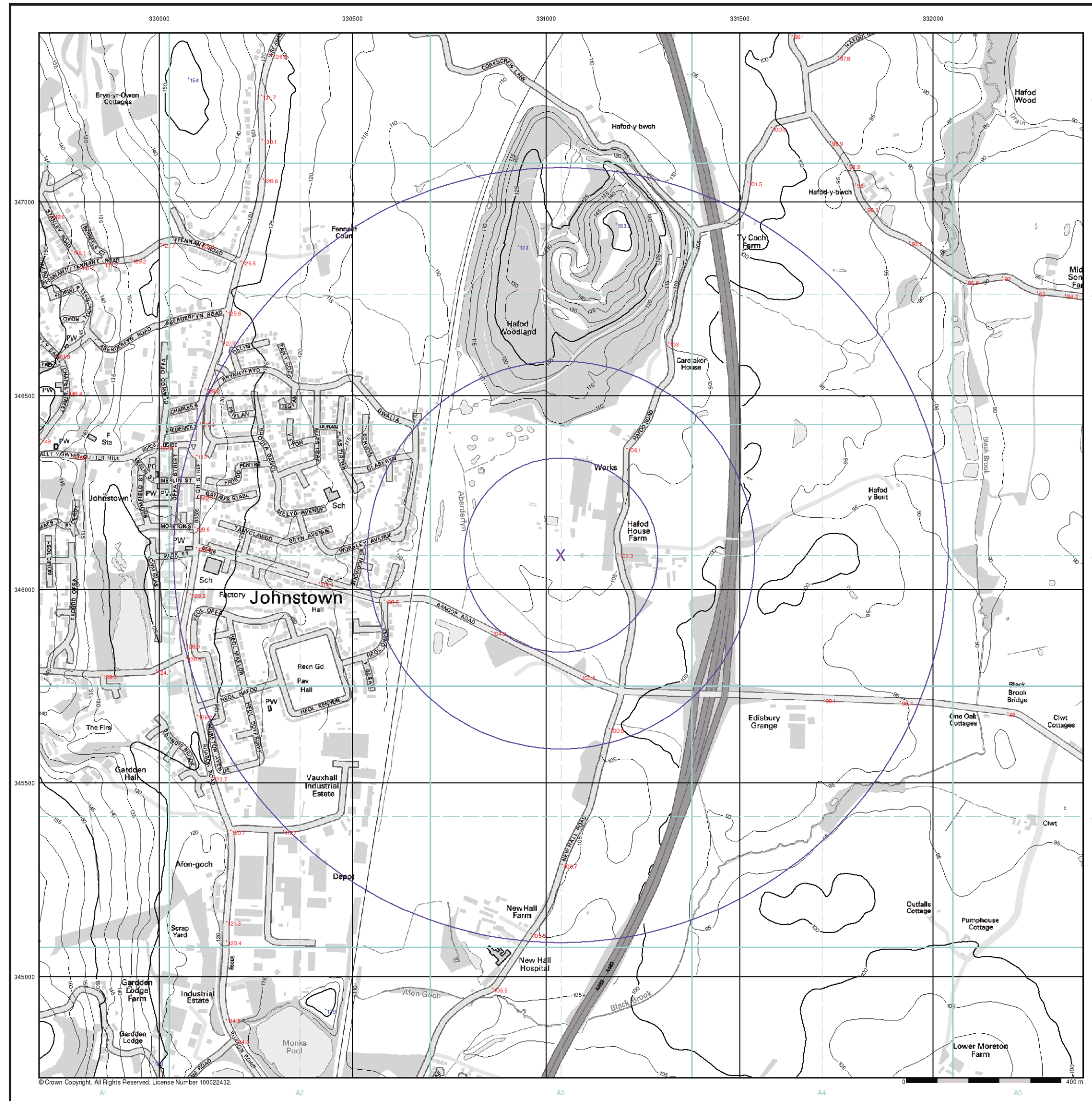


Order Details

Order Number: 37986274_1_1
Customer Ref: MB616
National Grid Reference: 331040, 346090
Slice: A
Site Area (Ha): 0.01
Search Buffer (m): 1000

Site Details

Hafod Tileries, Hafod, Ruabon, Wrexham, LL14 6ET



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EA Historic Flood Map (1:10,000)

General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Map ID

EA Historic Flood Events Data

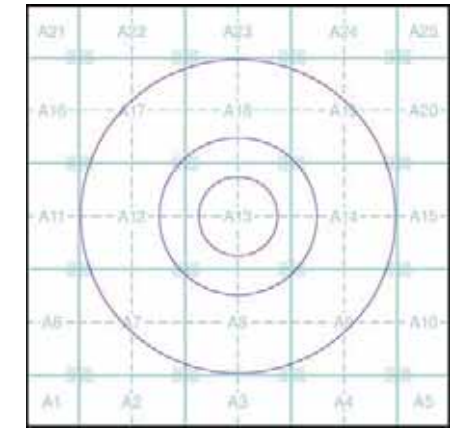
- | | |
|--|--|
| Channel Capacity Exceeded (no raised defences) | Obstruction/Blockage - Culvert |
| Groundwater/High Water Table | Obstruction/Blockage - Debris Screen |
| Local Drainage/Surface Water | Operational Failure/ Breach of Defence |
| Mechanical Failure | Other |
| Obstruction/Blockage - Bridge | Overtopping of Defences |
| Obstruction/Blockage - Channel | Unknown |

- Historical Flood Liabilities

Contours (height in metres)

- Standard Contour — 105 — 100 — 95 —
- Index Contour — 105 — 100 — 95 —
- *167.3 Spot Height
- *45.8 Air Height

EA Historic Flood Map - Slice A

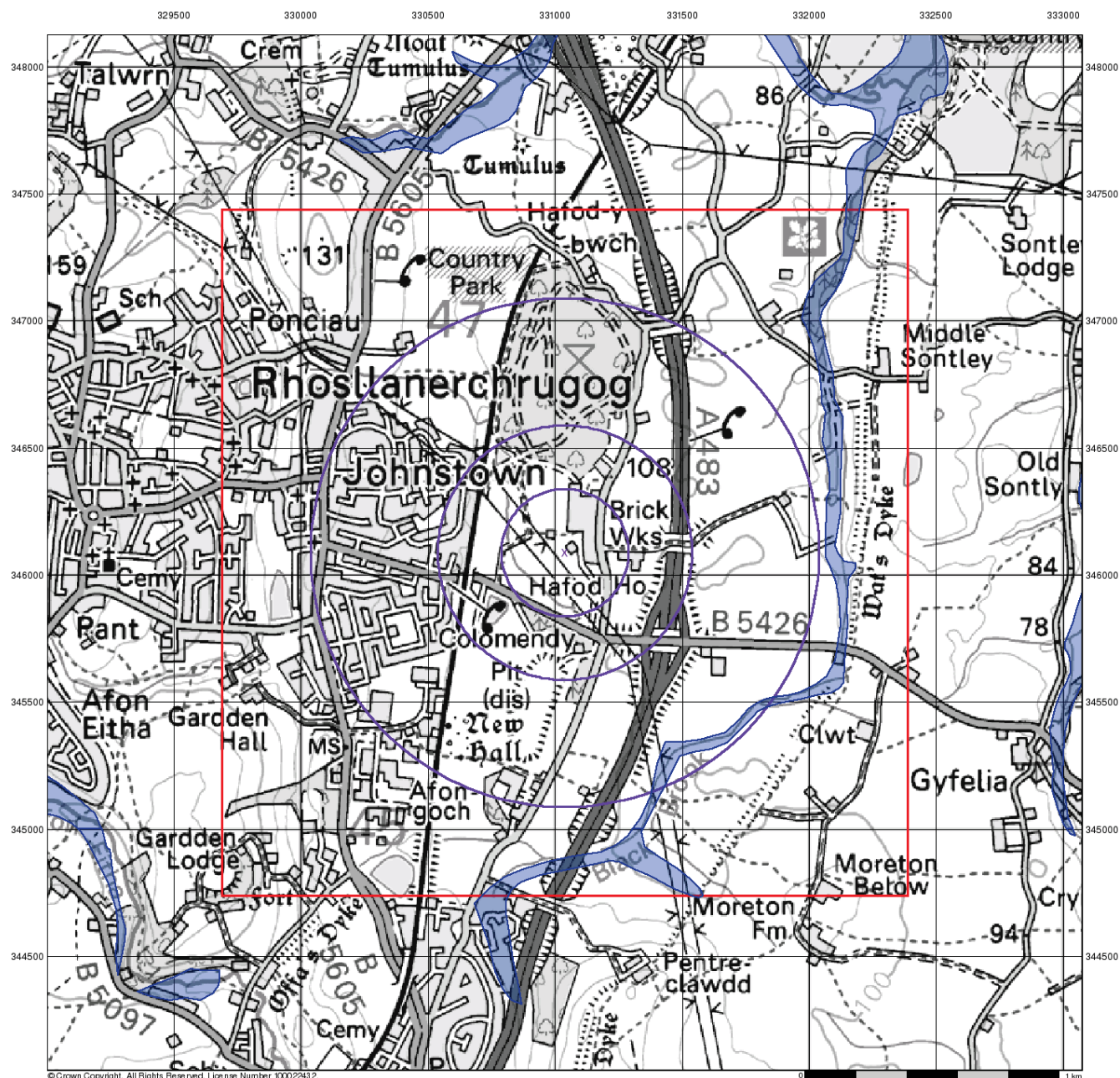


Order Details

Order Number: 37986274_1_1
Customer Ref: MB616
National Grid Reference: 331040, 346090
Slice: A
Site Area (Ha): 0.01
Search Buffer (m): 1000

Site Details

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BGS Flood Data (1:50,000)

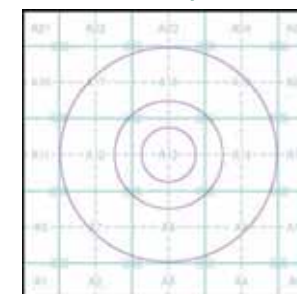
General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Slice
- Map ID

BGS Geological Indicators of Flooding

- Coastal
- Inland
- Bodies of Water

BGS Flood Data Map - Slice A



Order Details

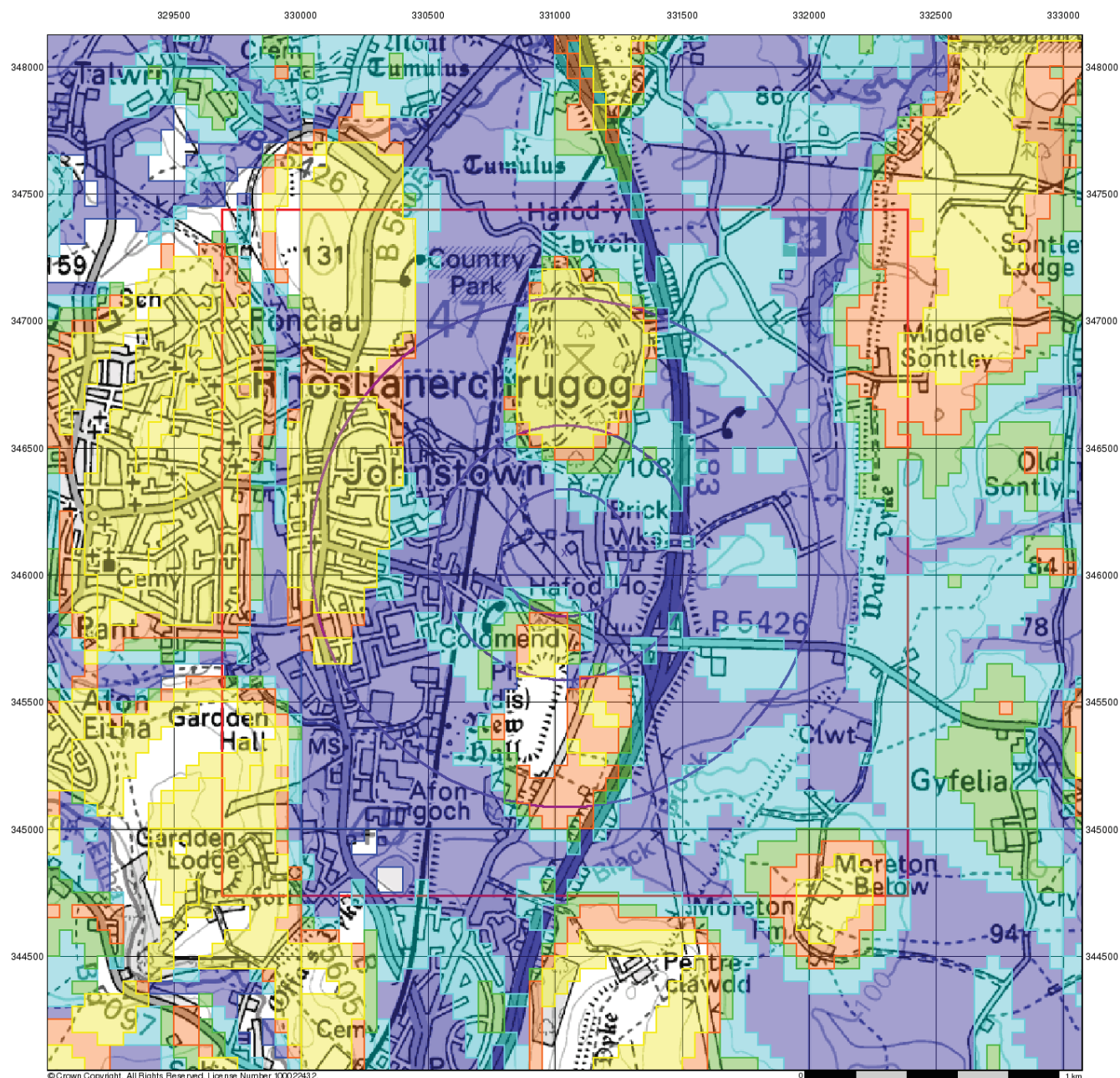
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 National Grid Reference: 331040, 346090
 Slice: A
 Site Area (Ha): 0.01
 Search Buffer (m): 1000

Site Details

Hafod Tileries, Hafod, Ruabon, Wrexham, LL14 6ET



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BGS Flood Data (1:50,000)

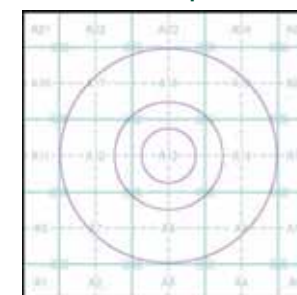
General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Slice
- Map ID

BGS Groundwater Flooding Susceptibility

- High Susceptibility
- Moderately High Susceptibility
- Moderate Susceptibility
- Low Susceptibility
- Negligible Susceptibility

BGS Flood Data Map - Slice A



Order Details

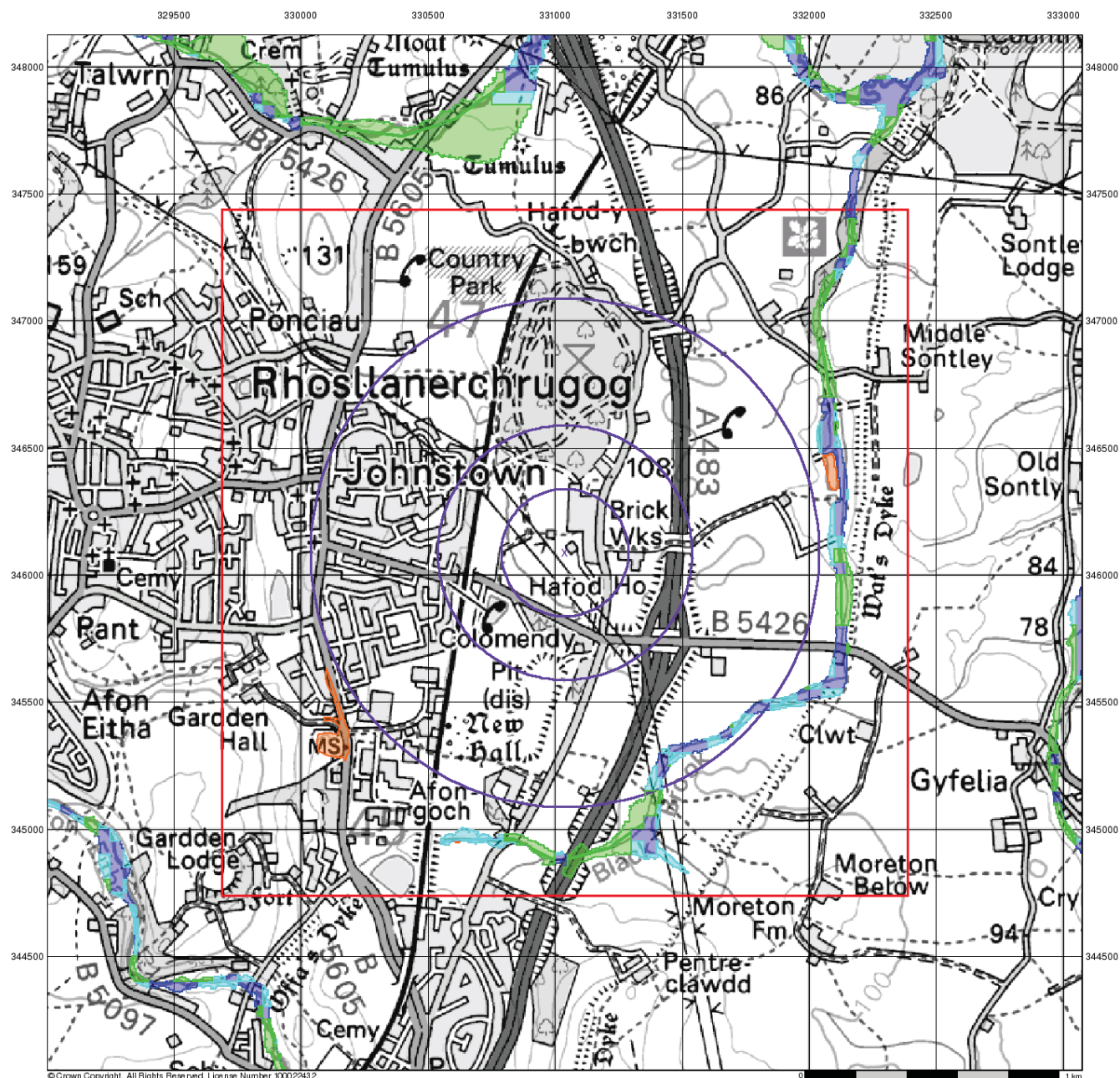
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 Slice: A
 Site Area (Ha): 0.01
 Search Buffer (m): 1000

Site Details

Hafod Tileries, Hafod, Ruabon, Wrexham, LL14 6ET



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EA NaFRA Data (1:50,000)

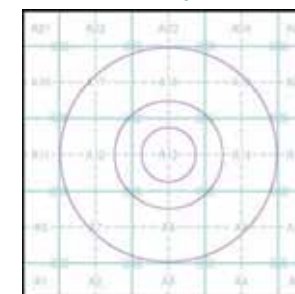
General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Slice
- Map ID

National Flood Risk Assessment (NaFRA)

- Significant Risk
- Moderate Risk
- Low Risk
- No Result

EA NaFRA Data Map - Slice A



Order Details

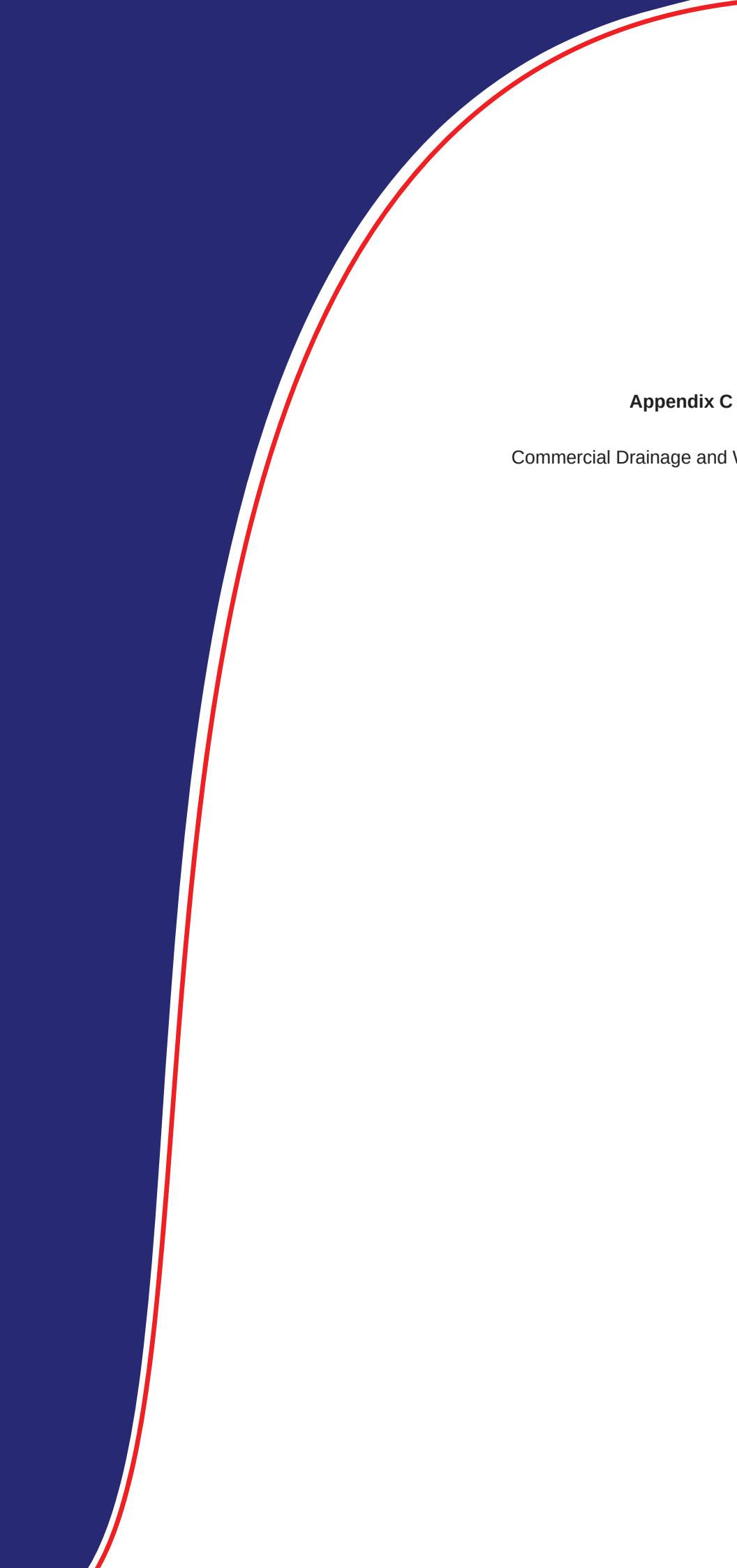
Order Number: 37986274_1_1
 Customer Ref: MB616
 National Grid Reference: 331040, 346090
 Slice: A
 Site Area (Ha): 0.01
 Search Buffer (m): 1000

Site Details

Hafod Tileries, Hafod, Ruabon, Wrexham, LL14 6ET



Tel: 0844 844 9952
 Fax: 0844 844 9951
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Appendix C

Commercial Drainage and Water Enquiry

01 May 2012

Searchflow (Account)
42 Kings Hill Avenue
West Malling
Kent
ME19 4AJ

Drainage and Water Enquiry

Responses as required by the Home Information Pack Regulations

The information contained within this report refers to the existing property at:	LAND NORTH OF BANGOR ROA JOHNSTOWN LL14 6HF
Search report produced by:	Dwr Cymru Welsh Water Pentwyn Road Nelson Treharris Mid Glamorgan CF46 6LY Tel 01443 331 155 www.dwrcymru.com www.dwrcymrusearches.com enquiries@dwrcymru.com Water supply - Call 0800 052 0130 Sewerage services - Call 0800 085 3968
Our reference:	381855
Your reference:	17350714

The following records were referenced in compiling this search report

Customer Account System
Asset Information System
Water Quality Database

Any enquiries relating to this report should be addressed to our Customer Support Searches Team at the above address. Please quote one of the above references.

Q 1 Interpretation of Drainage and Water Enquiry

Response *Appendix 1 contains definitions of terms and expressions identified within this report.*

Informative Not Applicable.

Q 2 Enquiries and Responses

Response *1. The records were searched by Jonathan Evans who has no nor not likely to have, any personal or business relationship with any person involved in the sale of the property.
2. This search report was prepared by Jonathan Evans who have no nor not likely to have any personal or business relationship with any person involved in the sale of the property.*

Informative For the Residential Drainage & Water Search Complaint Procedure please see Appendix 6.

Q 3 Where relevant, please include a copy of an extract from the public sewer map.

Response *A copy of an extract from the public sewer map is included in which the location of the property is identified.*

Informative Public Sewers are defined as those for which the Company holds statutory responsibility under the Water Industry Act 1991.
The company is not responsible for rivers, watercourses, ponds, culverts or highway drains. If any of these are shown on the copy extract they are shown for information only.
Sewers indicated on the extract of the public sewer map as being subject to an agreement under section 104 of the Water Industry Act 1991 are not an 'as constructed' record. It is recommended that these details are checked with the developer, if any.
Assets other than public sewers may be shown on the copy extract, for information only.
The presence of a public sewer located within the boundary of the property may restrict further development within it.
The sewerage undertaker has a statutory right of access to carry out work on its assets, subject to notice. This may result in employees of the sewerage undertaker or its contractors needing to enter the property to carry out works.

Q 4 Does foul water from the property drain to a public sewer?

Response *This enquiry appears to relate to a plot of land or a recently built property. It is recommended that drainage proposals are checked with the developer.*

Informative Water companies are not responsible for any private drains and sewers that connect the property to the public sewerage system, and do not hold details of these. The property owner will normally have sole responsibility for private drains serving the property and may have shared responsibility, with other users, if the property is served by a private sewer which also serves other properties. These may pass through land outside of the control of the seller and the buyer may wish to investigate whether separate rights or easements are needed for their inspection, repair or renewal.
If foul water does not drain to the public sewerage system the property may have private facilities in the form of a cesspit, septic tank or other type of treatment plant.

Q	5	Does surface water from the property drain to a public sewer?
Response		<i>This enquiry appears to relate to a plot of land or a recently built property. It is recommended that drainage proposals are checked with the developer.</i>
Informative		Sewerage undertakers are not responsible for private drains and sewers that connect the property to the public sewerage system and do not hold details of these. The property owner will normally have sole responsibility for private drains serving the property and may have shared responsibility with other users, if the property is served by a private sewer which also serves other properties. These may pass through land outside of the control of the seller and the buyer may wish to investigate whether separate rights or easements are needed for their inspection, repair or renewal. In some cases, sewerage undertakers' records do not distinguish between foul and surface water connections to the public sewerage system. If on inspection the buyer finds that the property is not connected for surface water drainage, the property may be eligible for a rebate of the surface water drainage charge. Details can be obtained from the sewerage undertaker. If surface water does not drain to the public sewerage system the property may have private facilities in the form of a soakaway or private connection to a watercourse.
Q	6	Are any sewers or lateral drains serving or which are proposed to serve the property the subject of an existing adoption agreement or an application for such an agreement?
Response		<i>The property is part of an established development and is not subject to an adoption agreement.</i>
Informative		This enquiry is of interest to purchasers of new homes who will want to know whether or not the property will be linked to a public sewer. Where the property is part of a very recent or ongoing development and the sewers are not the subject of an adoption application, buyers should consult with the developer to ascertain the extent of private drains and sewers for which they will hold maintenance and renewal liabilities. Final adoption is subject to the developer complying with the terms of the adoption agreement under Section 104 of the Water Industry Act 1991.
Q	7	Does the public sewer map indicate any public sewer, disposal main or lateral drain within the boundaries of the property?
Response		<i>The public sewer map included indicates that there is a public sewer, disposal main or lateral drain within the boundaries of the property. However, from 1st October 2011 there may be additional public sewers, disposal mains or lateral drains which are not recorded on the public sewer map. For further information please contact Dwr Cymru Welsh Water on Tel: 0800 917 2652</i>
Informative		The boundary of the property has been determined by reference to the Ordnance Survey record. The presence of a public sewer running within the boundary of the property may restrict further development. The company has a statutory right of access to carry out work on its assets, subject to notice. This may result in employees of the company or its contractors needing to enter the property to carry out work. Sewers indicated on the extract of the public sewer map as being subject to an agreement under section 104 of the Water Industry Act 1991 are not an 'as constructed' record. It is recommended that these details be checked with the developer, if any. Assets other than public sewers may be shown on the copy extract, for information only.

Q	8	Does the public sewer map indicate any public sewer within 30.48 metres (100 feet) of any buildings within the property?
Response		<i>The public sewer map included indicates that there is a public sewer within 30.48 metres (100 feet) of a building within the property.</i>
Informative		1. The presence of a public sewer within 30.48 metres (100 feet) of the building(s) within the property can result in the local authority requiring a property to be connected to the public sewer. 2. The measure is estimated from the Ordnance Survey record, between the building(s) within the boundary of the property and the nearest public sewer. 3. Sewers indicated on the extract of the public sewer map as being subject to an agreement under section 104 of the Water Industry Act 1991 are not an 'as constructed' record. It is recommended that these details are checked with the developer. 4. Assets other than public sewers may be shown on the copy extract, for information only. 5. It is recommended that investigations are made into the drainage arrangements of the property as the owner may be liable for repairs to the drainage system.
Q	9	Has a sewerage undertaker approved or been consulted about any plans to erect a building or extension on the property over or in the vicinity of a public sewer, disposal main or drain?
Response		<i>There are no records in relation to any approval or consultation about plans to erect a building or extension on the property over or in the vicinity of a public sewer, disposal main or drain. However, the sewerage undertaker might not be aware of a building or extension on the property over or in the vicinity of a public sewer, disposal main or drain.</i>
Informative		1. Buildings or extensions erected over a sewer in contravention of building controls may have to be removed or altered. 2. From the 1st October 2011 private sewers, disposal mains and lateral drains transferred into public ownership and the sewerage undertaker may not have approved or been consulted about plans to erect a building or extension on the property over or in the vicinity of these.
Q	10	Where relevant, please include a copy of an extract from the map of waterworks.
Response		<i>A copy of an extract of the map of waterworks is included, showing water mains, resource mains or discharge pipes in the vicinity of the property.</i>
Informative		The "water mains" in this context are those which are vested in and maintainable by the water company under statute. The purchaser should carry out a physical inspection of the property. Assets other than public water mains may be shown on the plan, for information only. Water undertakers are not responsible for private supply pipes connecting the property to the public water main and do not hold details of these. These may pass through land outside of the control of the seller, or may be shared with adjacent properties. The buyer may wish to investigate whether separate rights or easements are needed for their inspection, repair or renewal. The presence of a public water main located within the boundary of the property may restrict further development within it. Water Undertakers have rights of access to carry out work on their assets, subject to notice (except in the event of an emergency). This may result in employees of the water undertaker or its contractors needing to enter the property to carry out work.
Q	11	Is any water main or service pipe serving or which is proposed to serve the property the subject of an existing adoption agreement or an application for such an agreement?
Response		<i>Records confirm that water mains or service pipes serving the property are not the subject of an existing adoption agreement or an application for such an agreement.</i>
Informative		This enquiry is of interest to purchasers of new homes who will want to know whether or not the property will be linked to the mains water supply.

- Q 12 Who are the sewerage and water undertakers for the area?**
- Response** *The sewerage undertaker is Dwr Cymru Cyfyngedig, Pentwyn Road, Nelson, Treharris, CF46 6LY and the water undertaker is Dee Valley Water plc., Packsaddle, Wrexham Road, Rhostyllen, Wrexham, LL14 4EH.*
- Informative** Not applicable.
- Q 13 Is the property connected to mains water supply?**
- Response** *This enquiry relates to a plot of land or a recently built property. It is recommended that the water supply proposals are checked with the developer.*
- Informative** Details of private supplies are not kept by the water undertaker. The situation regarding sources of supply and supply arrangements should be checked with the current owner of the property and a physical inspection should be carried out.
- Q 14 Are there any water mains, resource mains or discharge pipes within the boundaries of the property?**
- Response** *The map of waterworks indicates that there are water mains, resource mains or discharge pipes within the boundaries of the property.*
- Informative** The boundary of the property has been determined by reference to the Ordnance Survey record.
The presence of a public water main within the boundary of the property may restrict further development within it. Water companies have statutory rights of access to carry out work on their assets, subject to notice (except in the event of an emergency). This may result in employees of the company or its contractors needing to enter the property to carry out work. If the map of waterworks indicates that there is a public water main drain located within the development site, dependant on the actual plot layout(s), protection measures and/or diversion of these water mains may be required and agreed with the water undertaker.
- Q 15 What is the current basis for charging for sewerage and water services at the property?**
- Response** *Records indicate that this enquiry relates to a plot of land or a recently built property.*
- Informative** Water and sewerage undertakers' full charges are set out in their charges schemes which are available from the company free of charge upon request.
It is policy to meter all new water connections - this would result in charges being levied according to the measured tariff.
The water undertaker may install a meter at the premises where a buyer makes a change of use of the property. The Water Industry Act 1991 Section 150, The Water Resale Order 2001 provides protection for people who buy their water or sewerage services from a person or company instead of directly from a water or sewerage company. Details are available from the Office of Water Services (OFWAT) at www.ofwat.gov.uk

Q	16	Will the basis for charging for sewerage and water services at the property change as a consequence of a change of occupation?
Response		<i>Records indicate that this enquiry relates to a plot of land or a recently built property. It is recommended that the charging proposals are checked with the developer.</i>
Informative		Water and sewerage undertakers' full charges are set out in their charges schemes which are available from the company free of charge upon request. It is policy to meter all new water connections this would result in charges being levied according to the measured tariff. The water undertaker may install a meter at the premises where a buyer makes a change of use of the property.
Q	17	Is a surface water drainage charge payable?
Response		<i>Records confirm that a surface water drainage charge is not payable for the property.</i>
Informative		Where surface water from a property does not drain to the public sewerage system no surface water drainage charges are payable. Where surface water charges are payable but upon inspection the buyer finds that the property is not connected to the public sewerage system, the property may be eligible for a rebate of the surface water drainage charge. Details can be obtained from the Sewerage Undertaker. The charge for unmeasured surface water drainage for 2010-2011 is £43. The charge for measured surface water drainage is included in the volumetric rate charged for measured sewerage and is therefore dependant upon the volume used by each customer. For 2009-2010, if the premises is connected for surface water the volumetric rate will be £1.5210 per m3. If the premises is not connected then the volumetric rate will be £1.1996 per m3. Where the enquiry relates to a plot of land or development site, it is recommended that the charging proposals are checked with the developer.
Q	18	Please include details of the location of any water meter serving the property.
Response		<i>Records indicate that the property is not served by a water meter.</i>
Informative		Where the property is not served by a meter and the customer wishes to consider this method of charging they should contact the appropriate water company. Where the enquiry relates to a plot of land or development site, it is recommended that the charging proposals are checked with the developer.
Q	19	Who bills the property for sewerage services?
Response		<i>The property is not billed for sewerage services.</i>
Informative		Where the enquiry relates to a plot of land or development site, it is recommended that the charging proposals are checked with the developer.
Q	20	Who bills the property for water services?
Response		<i>The property is not billed for water services.</i>
Informative		This is the Water Undertaker to notify the change of occupant to, on completion of sale. Where the enquiry relates to a plot of land or development site, it is recommended that the charging proposals are checked with the developer.

Q 21 Is the dwelling-house which is or forms part of the property at risk of internal flooding due to overloaded public sewers?

Response *The property is not recorded as being at risk of internal flooding due to overloaded public sewers. From the 1st October 2011 private sewers, disposal mains and lateral drains were transferred into public ownership. It is therefore possible that a property may be at risk of internal flooding due to an overloaded public sewer which the sewerage undertaker is not aware of. For further information it is recommended that enquiries are made of the vendor.*

Informative

1. A sewer is "overloaded" when the flow from a storm is unable to pass through it due to a permanent problem (e.g. flat gradient, small diameter). Flooding as a result of temporary problems such as blockages, siltation, collapses and equipment or operational failures are excluded.
2. Internal flooding" from public sewers is defined as flooding which enters a building or passes below a suspended floor. For reporting purposes, buildings are restricted to those normally occupied and used for residential, public, commercial, business or industrial purposes.
3. At Risk" properties are those that the Sewerage Undertaker is required to include in the Regulatory Register that is reported annually to the Director General of Water Services. These are defined as properties that have suffered or are likely to suffer internal flooding from public foul, combined or surface water sewers due to overloading of the sewerage system more frequently than the relevant reference period (either once or twice in ten years) as determined by the Sewerage Undertaker's reporting procedure.
4. Flooding as a result of storm events proven to be exceptional and beyond the reference period of one in ten years are not included on the at Risk register.
5. Properties may be at risk of flooding but not included on the Register where flooding incidents have not been reported to the Sewerage Undertaker.
6. Public sewers are defined as those for which the Sewerage Undertaker holds statutory responsibility under the Water Industry Act 1991.
7. It should be noted that flooding can occur from private sewers and drains which are not the responsibility of the Sewerage Undertaker. This report excludes flooding from private sewers and drains and the Sewerage Undertaker makes no comment upon this matter.

Response

Records confirm that the property is not recorded on a register kept by the water undertaker as being at risk of receiving low water pressure or flow.

Informative

The boundary of the property has been determined by reference to the Ordnance Survey record.

"Low water pressure" means water pressure below the regulatory reference level which is the minimum pressure when demand on the system is not abnormal.

Water undertakers are required to include in the Regulatory Register that is reported annually to the Director General of Water Services, properties receiving pressure below the reference level, provided that allowable exclusions do not apply (i.e. Events which can cause pressure to temporarily fall below the reference level).

The reference level of service is a flow of 9 litres/minute at a pressure of 10 metres head on the customer's side of the main stop tap. The reference level of service must be applied on the customer's side of a meter or any other company fittings that are on the customers side of the main stop tap. The reference level applies to a single property. Where more than one property is served by a common service pipe, the flow assumed in the reference level must be appropriately increased to take account of the total number of properties served. For two properties, a flow of 18 litres/minute at a pressure of 10 metres head on the customer's side of the main stop tap is appropriate.

For three or more properties the appropriate flow should be calculated from the standard loadings provided in BS6700 or Institute of Plumbing handbook.

Allowable exclusions:

The Water Undertaker is required to include in the Regulatory Register properties receiving pressure below the reference level, provided that allowable exclusions listed below do not apply.

Abnormal demand:

This exclusion is intended to cover abnormal peaks in demand and not the daily, weekly or monthly peaks in demand which are normally expected. Water Undertakers should exclude from the reported DG2 figures properties which are affected by low pressure only on those days with the highest peak demands. During the report year Water Undertakers may exclude, for each property, up to five days of low pressure caused by peak demand.

Planned maintenance:

Water Undertakers should not report under DG2 low pressures caused by planned maintenance. It is not intended that companies identify the number of properties affected in each instance. However, Water Undertakers must maintain sufficiently accurate records to verify that low pressure incidents that are excluded from DG2 because of planned maintenance are actually caused by maintenance.

One-off incidents:

This exclusion covers a number of causes of low pressure; mains bursts; failures of company equipment (such as PRVs or booster pumps); firefighting; and action by a third party.

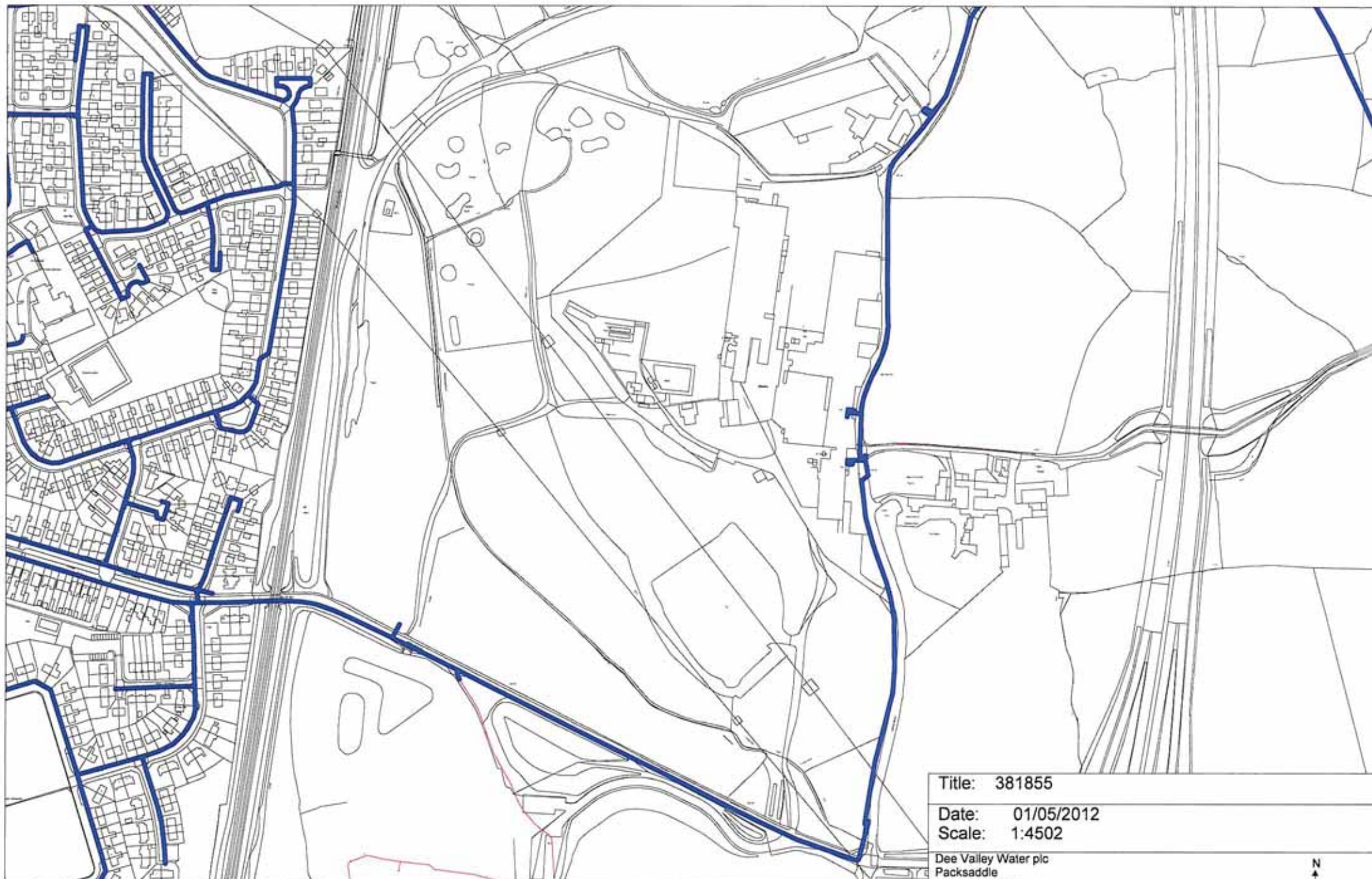
However, if problems of this type affect a property frequently, they cannot be classed as one-off events and further investigation will be required before they can be excluded.

Low pressure incidents of short duration:

Properties affected by low pressures which only occur for a short period, and for which there is evidence that incidents of a longer duration would not occur during the course of the year, may be excluded from the reported DG2 figures.

The buyer should also make enquiries with the seller.

- Q 23** Please include details of a water quality analysis made by the water undertaker for the water supply zone in respect of the most recent calendar year.
- Response** *The analysis records confirmed that tests failed to meet the standards of the 2000 Regulations or the 2001 Regulations in relation to another substance or substances, and these details are included in the attached report.*
- Informative** Drinking water quality in England and Wales is regulated by the Government through the Drinking Water Inspectorate (DWI). Drinking Water Supplies are of a very high standard and the legal requirements are set out in the Water Supply (Water Quality) Regulations 2001 (Wales).
- Last year Dwr Cymru Welsh Water carried out over 100,000 water quality tests of which 99.9% showed that the drinking water produced by Welsh Water met the required standards.
- Each Water Quality Zone covers a population of up to 100,000, sampling address are generated on a random basis. Distribution sampling is conducted to assess the quality of drinking water throughout Dwr Cymru Welsh Water's distribution network and not as an indicator of the condition of an individual property. Therefore Dwr Cymru Welsh Water will not disclose the sampled address.
- If you have specific concerns regarding an individual property relating to water quality (e.g. Lead) then we would suggest you instruct your surveyor accordingly.
- Some standards relate to the appearance of the water rather than to health. Where a standard has been set for health reasons, this is normally based on a lifetime exposure and there is a wide margin of safety. It should also be noted that most failures are of short duration and are satisfactory on resample.
- All exceedences of the regulatory standard are reported to the Drinking Water Inspectorate along with details of any remedial work undertaken.
- Q 24** Please include details of any departures authorised by the Secretary of State under Part 6 of the 2000 Regulations from the provisions of Part 3 of those Regulations; or authorised by the National Assembly for Wales under Part 6 of the 2001 Regulations from the provisions of Part 3 of those Regulations.
- Response** *There are no such authorised departures for the water supply zone*
- Informative** Authorised departures are not permitted if the extent of the departure from the standard is likely to constitute a potential danger to human health.
- Please contact your water undertaker if you require further information.
- Q 25** Please state the distance from the property to the nearest boundary of the nearest sewage treatment works
- Response** *The nearest sewage treatment works is 5.3km to the ENE of the property. The name of the nearest sewage treatment works is Fivefords.*
- Informative** The nearest sewage treatment works will not always be the sewage treatment works serving the catchment within which the property is situated. The Sewerage undertaker's records were inspected to determine the nearest sewage treatment works. It should be noted therefore that there may be a private sewage treatment works closer than the one detailed above that have not been identified.



Based upon the Ordnance Survey map by Dee Valley Water plc by permission of Ordnance Survey and on behalf of the Controller of Her Majesty's Stationary Office

**PLEASE NOTE - The information given here on the routes and locations of mains is indicative only and no warranty is given or implied
More precise information can be given by prior arrangement although the depth of any apparatus may not be ascertainable**

Title: 381855

Date: 01/05/2012

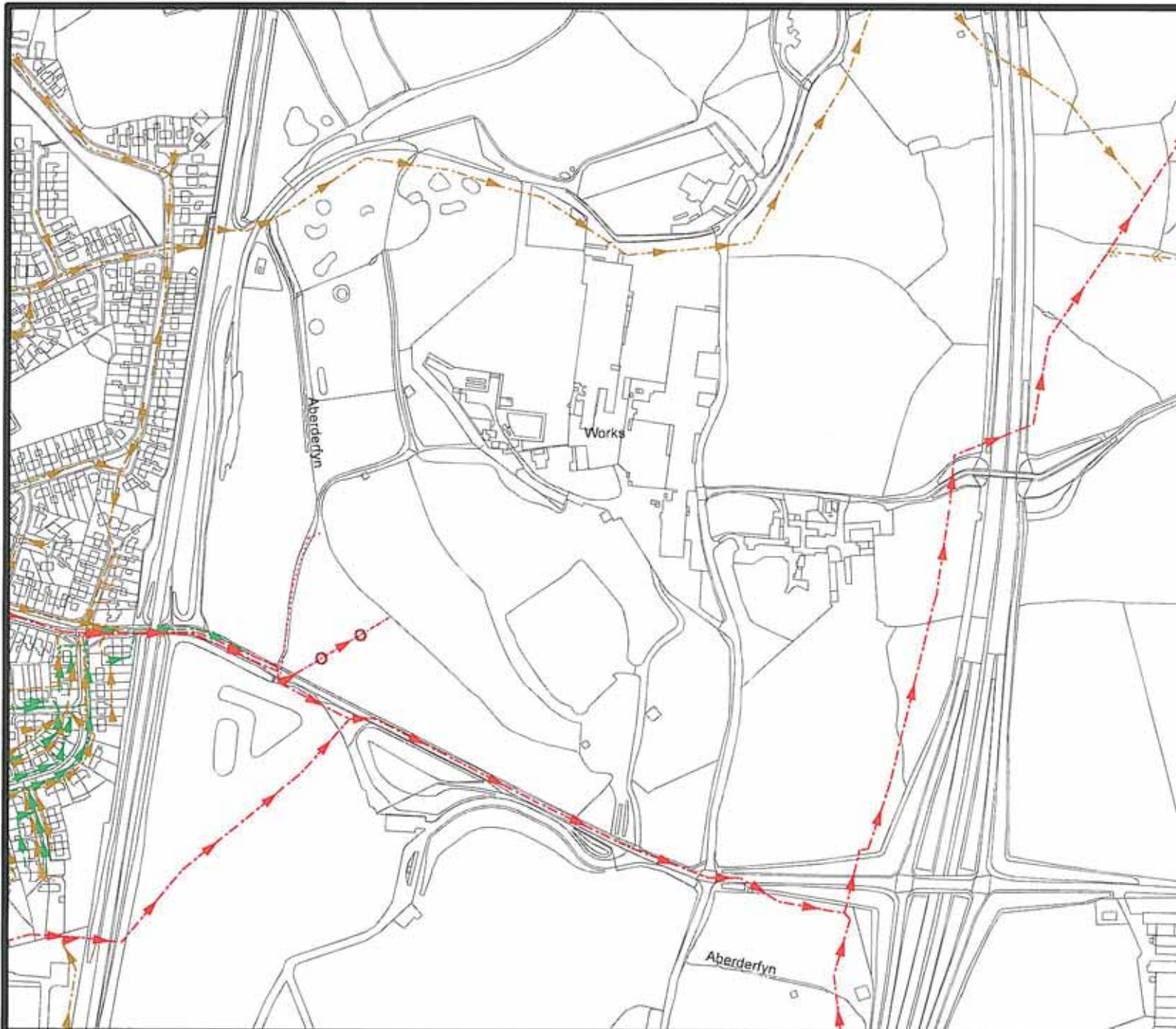
Scale: 1:4502

Dee Valley Water plc
Packsaddle
Wrexham Road
Rhostyllen
Wrexham LL14 4EH

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Dŵr Cymru
Welsh Water

LAND NORTH OF BANGOR ROAD, JOHNSTOWN



LEGEND (Representative of most common features)

	Full chamber		Stiff wall
	Surface water chamber		Long pipe
	Combined chamber		Storm overflow
	Combined sewer overflow		Along main
	Special purpose chamber		Directly sewer
	Access point		Private sewer
	Pumping station		Private sewer adjacent to footpath or road
	1:100		100% adoption agreement
	1:100		Private Sewer Transfer
	1:100		Adopted Sewer
	1:100		Inspection Chamber

Notes:

Dŵr Cymru Ltd gives this information as to the position of its underground apparatus as a series of general guidelines only, on the understanding that it is liable for the cost of any information available and its accuracy as to its position is not guaranteed. It is the responsibility of the user of this information to ensure that it is accurate and to ensure that it is used for the purposes for which it is intended. It is the responsibility of the user of this information to ensure that it is accurate and to ensure that it is used for the purposes for which it is intended.

Service pipes are not generally shown but their position should be ascertained.

**EXACT LOCATIONS OF ALL APPARATUS
TO BE DETERMINED ON SITE.**

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Map Ref: 331032.346116
Map scale: 1:5,000
Printed by: NP
Printed on: 30th april 2012

Name of Water Supply Zone - Legacy zone

Schedule 1 Parameters

Parameter	Units	PCV	Number of Samples	Number of Samples > PCV	% > PCV	Number of Samples above Auth dep	% > Auth dep	Min	Mean	Max
COLOUR	mg/l Pt/Co	20	36	0	0	-	-	0.5	1.5	2.9
TURBIDITY	N.T.U.	4	36	0	0	-	-	<0.09	0.18	0.54
ODOUR (QUANTITATIVE)	DIL. NO.	0	36	0	0	-	-	0	0	0
TASTE (QUANTITATIVE)	DIL. NO.	0	36	0	0	-	-	0	0	0
SODIUM	mg Na/l	200	8	0	0	-	-	4.4	9.75	14.7
NITRATE	mg NO3/l	50	8	0	0	-	-	1.51	2.99	5.18
NITRITE IN ZONES	mg NO2/l	0.5	8	0	0	-	-	<0.006	<0.009	<0.010
NO3 NO2 CALCULATION		1	8	0	0	-	-	0.03	0.06	0.11
ALUMINIUM	ug Al/l	200	36	0	0	-	-	4.9	21.3	57.9
IRON	ug Fe/l	200	36	0	0	-	-	2	23	148
MANGANESE	ug Mn/l	50	36	1	2.78	-	-	1	10	133
COPPER	mg Cu/l	2	8	0	0	-	-	0.002	0.046	0.099
ARSENIC	ug As/l	10	8	0	0	-	-	0.2	0.3	0.4
CADMIUM	ug Cd/l	5	8	0	0	-	-	<0.04	0.07	0.13
CHROMIUM	ug Cr/l	50	8	0	0	-	-	<0.2	0.3	0.4
NICKEL	ug Ni/l	20	8	1	12.5	-	-	<0.3	4.6	23.6
LEAD	ug Pb/l	25	8	0	0	-	-	<0.2	0.6	2.9
ANTIMONY	ug Sb/l	5	8	0	0	-	-	<0.1	0.1	0.2
SELENIUM	ug Se/l	10	8	0	0	-	-	<0.3	0.3	0.6
P.A.H (TOTAL)	ug/l	0.1	8	0	0	-	-	0	0	0
E.COLI	CFU/100ml	0	83	0	0	-	-	N/A	N/A	N/A
ENTEROCOCCI	CFU/100ml	0	8	0	0	-	-	N/A	N/A	N/A
BENZO (a) PYRENE	ug/l	0.01	9	0	0	-	-	<0.0020	<0.0020	<0.0020
TOTAL TRIHALOMETHANES	ug/l	100	8	0	0	-	-	26.2	38.73	49.2
BROMATE	ug BrO3/l	10	8	0	0	-	-	<0.3	0.5	0.5

Indicator Parameters

Parameter	Units	Specification	Number of samples	Number of samples > specification	% > specification	Min	Mean	Max
HYDROGEN ION	pH value	9.5	36	0	0	6.5	7.21	7.95
AMMONIUM	mg NH4/l	0.5	36	0	0	<0.004	0.015	<0.026
TOTAL COLIFORMS	CFU/100ml	0	83	0	0	0	0	0
COLONY COUNTS(22C)	CFU/1ml	>300	36	0	0	0	4	71
FREE CHLORINE	mg/l	10	83	0	0	0.03	0.13	0.36
TOTAL CHLORINE	mg/l	10	83	0	0	0.03	0.17	0.38
COLONY COUNTS(37C)	CFU/1ml	50	36	1	2.78	0	2	72

Explanation of Exceedences in Legacy Zone

A manganese sample taken from Legacy Zone demonstrated a level of 133 µg Mn/l. An investigation was undertaken and showed all resamples to be satisfactory. The regulatory limit is based on aesthetic qualities but no discoloured water contacts were received from the area around the time of the failure.

A nickel sample taken from Legacy Zone demonstrated a level of 23.6 µg Ni/l. An investigation showed that the failure was caused by the customer's kitchen tap which was not WRAS approved. The failure was specific to this property and does not reflect water quality in the zone as a whole.

Appendix 1 - General Interpretation

1. In this Schedule-

"the 1991 Act" means the Water Industry Act 1991(a);

"the 2000 Regulations" means the Water Supply (Water Quality) Regulations 2000(b);

"the 2001 Regulations" means the Water Supply (Water Quality) Regulations 2001(c);

"adoption agreement" means an agreement made or to be made under section 51A(1) or 104(1) of the 1991 Act(d);

"bond" means a surety granted by a developer who is a party to an adoption agreement;

"bond waiver" means an agreement with a developer for the provision of a form of financial security as a substitute for a bond;

"calendar year" means the twelve months ending with 31st December;

"discharge pipe" means a pipe from which discharges are made or are to be made under section 165(1) of the 1991 Act;

"disposal main" means (subject to section 219(2) of the 1991 Act) any outfall pipe or other pipe which—
(a) is a pipe for the conveyance of effluent to or from any sewage disposal works, whether of a sewerage undertaker or of any other person; and
(b) is not a public sewer;

"drain" means (subject to section 219(2) of the 1991 Act) a drain used for the drainage of one building or of any buildings or yards appurtenant to buildings within the same curtilage;

"effluent" means any liquid, including particles of matter and other substances in suspension in the liquid;

"financial year" means the twelve months ending with 31st March;

"lateral drain" means—

- (a) that part of a drain which runs from the curtilage of a building (or buildings or yards within the same curtilage) to the sewer with which the drain communicates or is to communicate; or
- (b) (if different and the context so requires) the part of a drain identified in a declaration of vesting made under section 102 of the 1991 Act or in an agreement made under section 104 of that Act(e);

"licensed water supplier" means a company which is the holder for the time being of a water supply licence under section 17A(1) of the 1991 Act(f);

"maintenance period" means the period so specified in an adoption agreement as a period of time—

- (a) from the date of issue of a certificate by a sewerage undertaker to the effect that a developer has built (or substantially built) a private sewer or lateral drain to that undertaker's satisfaction; and
- (b) until the date that private sewer or lateral drain is vested in the sewerage undertaker;

"map of waterworks" means the map made available under section 198(3) of the 1991 Act(g) in relation to the information specified in subsection (1A);

"private sewer" means a pipe or pipes which drain foul or surface water, or both, from premises, and are not vested in a sewerage undertaker;

"public sewer" means, subject to section 106(1A) of the 1991 Act(h), a sewer for the time being vested in a sewerage undertaker in its capacity as such, whether vested in that undertaker—

- (a) by virtue of a scheme under Schedule 2 to the Water Act 1989(i);
- (b) by virtue of a scheme under Schedule 2 to the 1991 Act(j);
- (c) under section 179 of the 1991 Act(k); or
- (d) otherwise;

"public sewer map" means the map made available under section 199(5) of the 1991 Act(I);

"resource main" means (subject to section 219(2) of the 1991 Act) any pipe, not being a trunk main, which is or is to be used for the purpose of—

- (a) conveying water from one source of supply to another, from a source of supply to a regulating reservoir or from a regulating reservoir to a source of supply; or
- (b) giving or taking a supply of water in bulk;

"sewerage services" includes the collection and disposal of foul and surface water and any other services which are required to be provided by a sewerage undertaker for the purpose of carrying out its functions;

"sewerage undertaker" means the company appointed to be the sewerage undertaker under section 6(1) of the 1991 Act for the area in which the property is or will be situated;

"surface water" includes water from roofs and other impermeable surfaces within the curtilage of the property;

"water main" means (subject to section 219(2) of the 1991 Act) any pipe, not being a pipe for the time being vested in a person other than the water undertaker, which is used or to be used by a water undertaker or licensed water supplier for the purpose of making a general supply of water available to customers or potential customers of the undertaker or supplier, as distinct from for the purpose of providing a supply to particular customers;

"water meter" means any apparatus for measuring or showing the volume of water supplied to, or of effluent discharged from any premises;

"water supplier" means the company supplying water in the water supply zone, whether a water undertaker or licensed water supplier;

"water supply zones" in relation to a calendar year means the names and areas designated by a water undertaker within its area of supply that are to be its water supply zones for that year; and

"water undertaker" means the company appointed to be the water undertaker under section 6(1) of the 1991 Act for the area in which the property is or will be situated.

2. In this Schedule, references to a pipe, including references to a main, a drain or a sewer, shall include references to a tunnel or conduit which serves or is to serve as the pipe in question and to any accessories for the pipe.

Note:

- (a) 1991 c. 56
- (b) S.I. 2000/3184. These Regulations apply in relation to England.
- (c) S.I. 2001/3911. These Regulations apply in relation to Wales.
- (d) Section 51A is inserted by section 92(2) of the Water Act 2003 (c.37). Section 104(1) is amended by section 96(4) of that Act.
- (e) To which there are various amendments made to sections 102 and 104 by section 96 of the Water Act 2003.
- (f) Inserted by section 56 of and Schedule 4 to the Water Act 2003.
- (g) Subsection (1A) is inserted by section 92(5) of the Water Act 2003.
- (h) Section 106(1A) is inserted by section 99 of the Water Act 2003.
- (i) 1989 c.15.
- (j) To which there are various amendments made by section 101(1) of and Schedule 8 to the Water Act 2003.
- (k) To which there are various amendments made by section 101(1) of and Schedule 8 to the Water Act 2003.
- (l) Section 199 is amended by section 97(1) and (8) of the Water Act 2003.

Appendix 2 – DRAINAGE & WATER ENQUIRY (RESIDENTIAL) TERMS AND CONDITIONS

The Customer, the Client and the Purchaser are asked to note these terms, which govern the basis on which this drainage and water report is supplied

Definitions

'Company' means Dwr Cymru Cyf who produces the Report.

'Order' means any request completed by the Customer requesting the Report.

'Report' means the drainage and/or water report prepared by The Company in respect of the Property.

'Property' means the address or location supplied by the Customer in the Order.

'Customer' means the person, company, firm or other legal body placing the Order, either on their own behalf as Client, or, as an agent for a Client.

'Client' means the person, company or body who is the intended recipient of the Report with an actual or potential interest in the Property.

'Purchaser' means the actual or potential purchaser of an interest in the Property including the mortgage lender.

Agreement

1. The Company agrees to supply the Report to the Customer and to allow it to be provided to the Client and the Purchaser subject, in each case, to these terms. The scope and limitations of the Report are described in paragraph 2 of these terms. Where the Customer is acting as an agent for the Client then the Customer shall be responsible for bringing these terms to the attention of the Client.

1.1 The Customer, the Client and Purchaser agree that the placing of an Order for a Report and the subsequent provision of a copy the Report to the Purchaser indicates their acceptance of these terms.

The Report

2. Whilst The Company will use reasonable care and skill in producing the Report, it is provided to the Customer, the Client and Purchaser on the basis that they acknowledge and agree to the following:-

2.1 The information contained in the Report can change on a regular basis so The Company cannot be responsible to the Customer, the Client and Purchaser for any change in the information contained in the Report after the date on which the Report was first produced and sent to the Customer.

2.2 The Report does not give details about the actual state or condition of the Property nor should it be used or taken to indicate or exclude actual suitability or unsuitability of the Property for any particular purpose, or relied upon for determining saleability or value, or used as a substitute for any physical investigation or inspection. Further advice and information from appropriate experts and professionals should always be obtained.

2.3 The information contained in the Report is based upon the accuracy of the address and plan supplied to the Company.

2.4 The Report provides information as to the location & connection of existing services and other information in relation to drainage and water enquiries and should not be relied on for any other purpose. The Report may contain opinions or general advice to the Customer, the Client and Purchaser which The Company cannot ensure that any such opinion or general advice is accurate, complete or valid and accepts no liability therefore.

2.5 The position and depth of apparatus shown on any maps attached to the Report are approximate, and are furnished as a general guide only, and no warranty as to its correctness is given or implied. The exact positions and depths should be obtained by excavation trial holes and the maps must not be relied on in the event of excavation or other works made in the vicinity of The Company's apparatus.

Liability

3. The Company shall not be liable to the Customer, the Client and Purchaser for any failure defect or non-performance of its obligations arising from any failure of or defect in any machine, processing system or transmission link or anything beyond The Company's reasonable control or the acts or omissions of any party for whom The Company are not responsible.

3.1 Where a report is requested for an address falling within a geographical area where two different Companies separately provide Water and Sewerage Services, then it shall be deemed that liability for the information given by either Company will remain with that Company in respect of the accuracy of the information supplied. A Company supplying information which has been provided to it by another Company for the purposes outlined in this agreement will therefore not be liable in any way for the accuracy of that information and will supply that information as agent for the Company from which the information was obtained.

3.2 The Report is produced for use in relation to individual domestic property transactions and cannot be used for commercial developments of domestic properties or commercial properties for intended occupation by third parties.

3.3 The Company shall accept liability for death or personal injury arising from its negligence but in any other case, the Company's liability for negligence shall be limited to £5000.000. Such liability will be met by the Company or its insurers and the Company has and will maintain an appropriate contract of insurance.

Copyright and Confidentiality

4. The Customer, the Client and Purchaser acknowledge that the Report is confidential and is intended for the personal use of the Client and Purchaser. The copyright and any other intellectual property rights in the Report shall remain the property of The Company. No intellectual or other property rights are transferred or licensed to the Customer, the Client or the Purchaser except to the extent expressly provided.

4.1 The Customer or Client is entitled to make copies of the Report but may only copy the Ordnance Survey mapping or data contained in the, or attached to the Report, if they have an appropriate licence from the originating source of that mapping or data.

4.2 The Customer, the Client and Purchaser agree (in respect of both the original and any copies made) to respect and not to alter any trademark, copyright notice or other property marking which appears on the Report.

4.3 The maps contained in the Report are protected by Crown Copyright and must not be used for any purpose outside the context of the Report.

4.4 The Customer, the Client and Purchaser agree on a joint and several basis to indemnify The Company against any losses, costs, claims and damage suffered by The Company as a result of any breach by either of them of the terms of paragraphs 4.1 to 4.4 inclusive.

Payment

5. Unless otherwise stated all prices are inclusive of VAT. The Customer shall pay for the price of the Report specified by The Company, without any set off, deduction or counterclaim. Unless the Customer or Client has an account with The Company for payment for Reports, The Company must receive payments for Reports in full before the Report is produced. For Customers or Clients with accounts, payment terms will be as agreed with The Company.

General

6. If any provision of these terms is or becomes invalid or unenforceable, it will be taken to be removed from the rest of

these terms to the extent that it is invalid or unenforceable. No other provision of these terms shall be affected.

- 6.1 These terms shall be governed by English law and all parties submit to the exclusive jurisdiction of the English courts.
- 6.2 Nothing in these terms and conditions shall in any way restrict the Customer, the Clients or the Purchasers statutory or any other rights of access to the information contained in the Report.
- 6.3 We may disclose personal data you provide about yourself, or your clients, to other companies within our group in accordance with Data Protection Act 1998 and other applicable laws. We will analyse and utilise any information we collect so that we are able to correctly administer, develop and improve our business and services,
- 6.4 The terms and conditions may be enforced by the Customer, the Client and Purchaser.

5 – Additional Information

Appendix 6 – Residential Drainage & Water Search Complaint Procedure

The Law Society endorses the use of a residential drainage and water enquiry on all occasions where a property is being sold. With our unique knowledge of the water industry, Dwr Cymru Welsh Water is best placed to identify any risks relating to the location and ownership of public water mains and sewers within our operational area, before property purchases are completed.

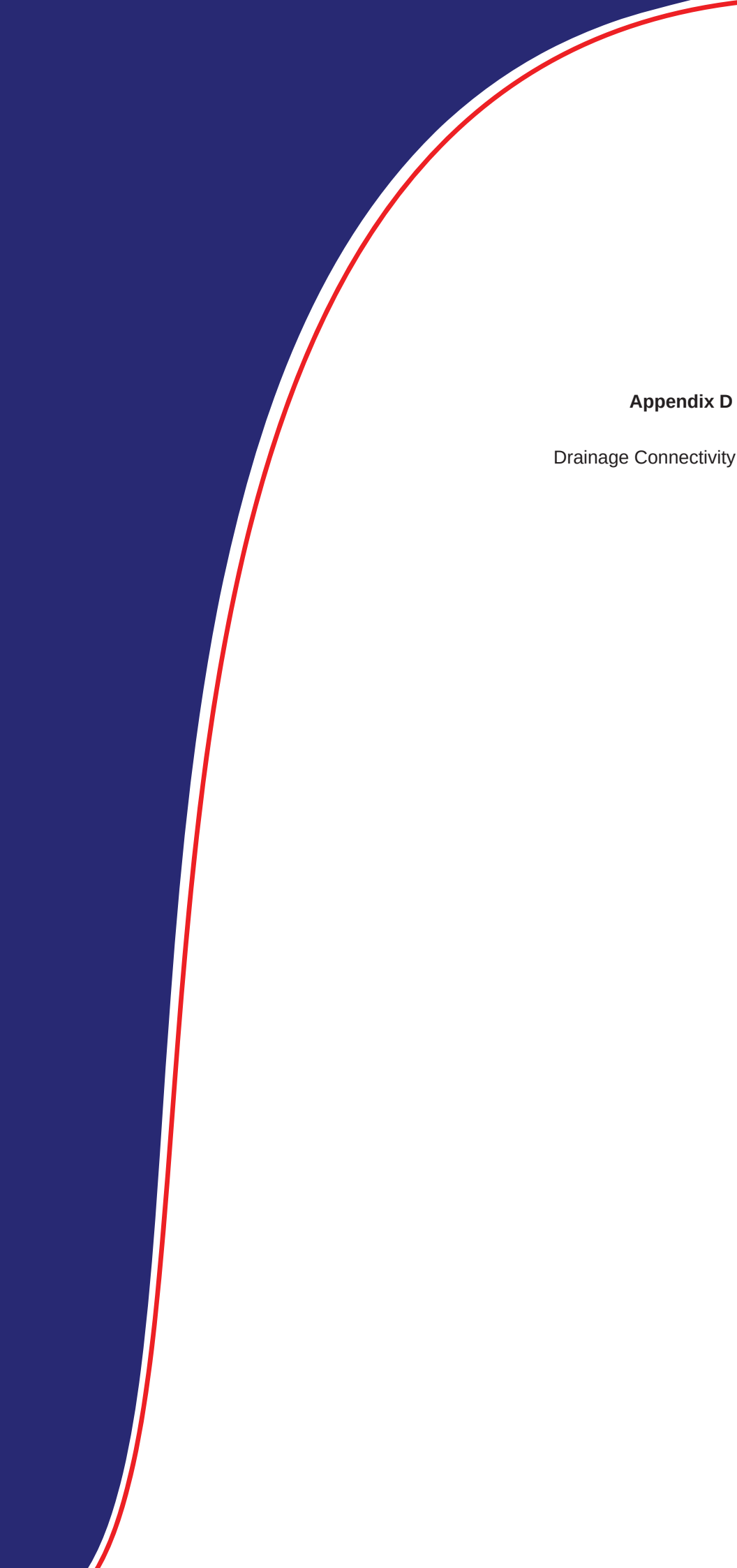
Should you wish to contact us about the service provided then our preferred method of dealing with your complaint is by telephone during office hours, Monday – Friday 09.00am – 4.30pm, tel no. 01443 331155. We will always aim to deal with your telephone complaint the first time you call us, however, if that isn't possible, we will advise you on how soon we can respond.

If you are not happy with our initial response, we will advise you to write to us at Dwr Cymru Welsh Water, Network Development Consultant, P.O. Box 10, Treharris, CF46 6XZ or email us at searches@dwrcymru.com outlining the reasons for your complaint.

We will investigate and research the matter in detail and provide a written substantive response within 10 working days of receipt of your written complaint.

If you remain dissatisfied with the response you have received, or the way your complaint was handled, you can ask for a Director to carry out a formal review of your complaint. To do this, please contact Head of Customer Relations, Dwr Cymru Welsh Water, P.O. Box 8, Nelson, CF46 6YH.

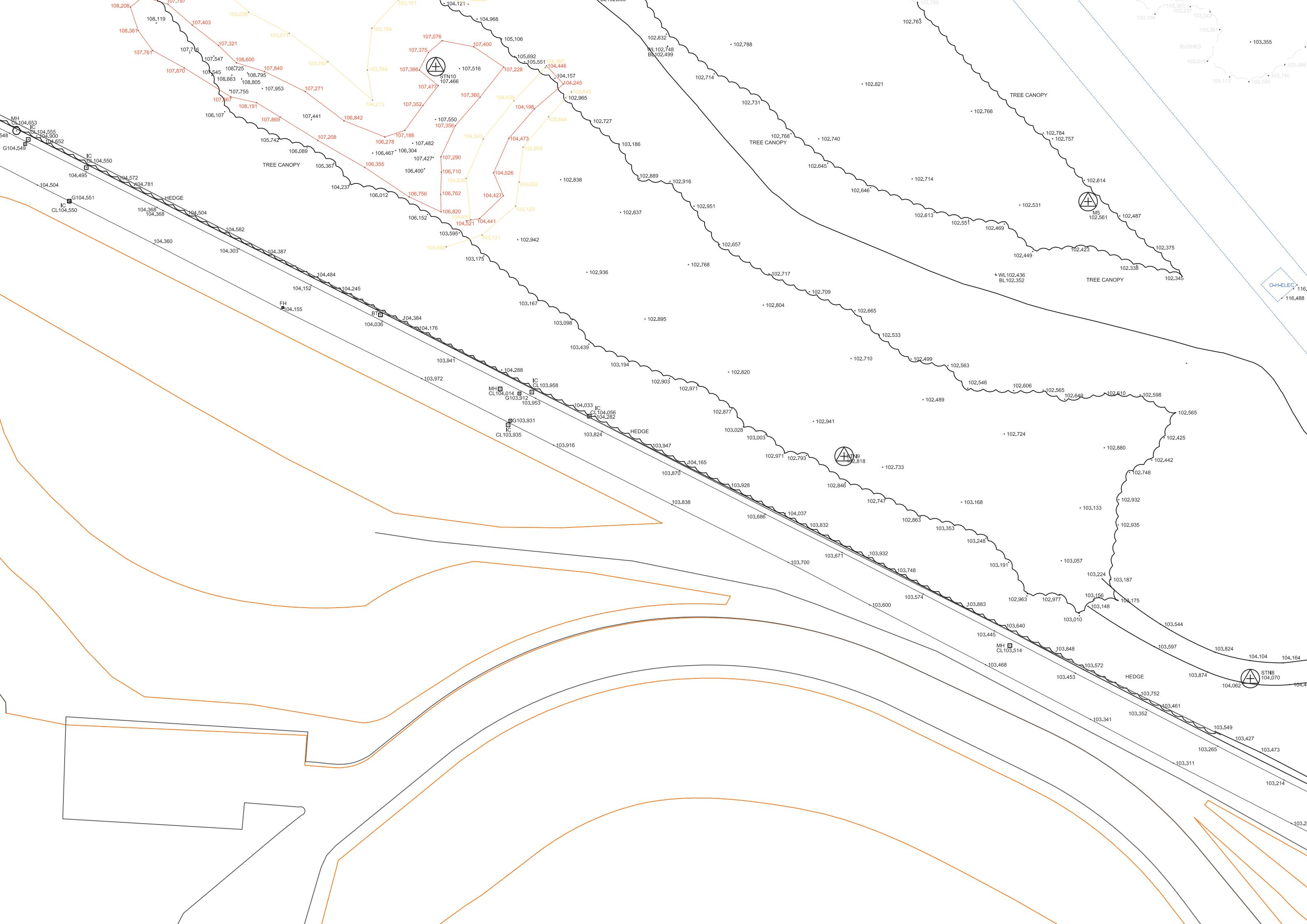
A response from a director will be sent within 10 working days. If we have fully reviewed your complaint and you remain dissatisfied, you can refer your complaint to the Consumer Council for Water. This is an independent body which represents customers' interests and investigates complaints. Their address is Consumer Council for Water Wales, Room 140 Caradog House, 1-6 St Andrews Place, Cardiff, CF10 3BE.

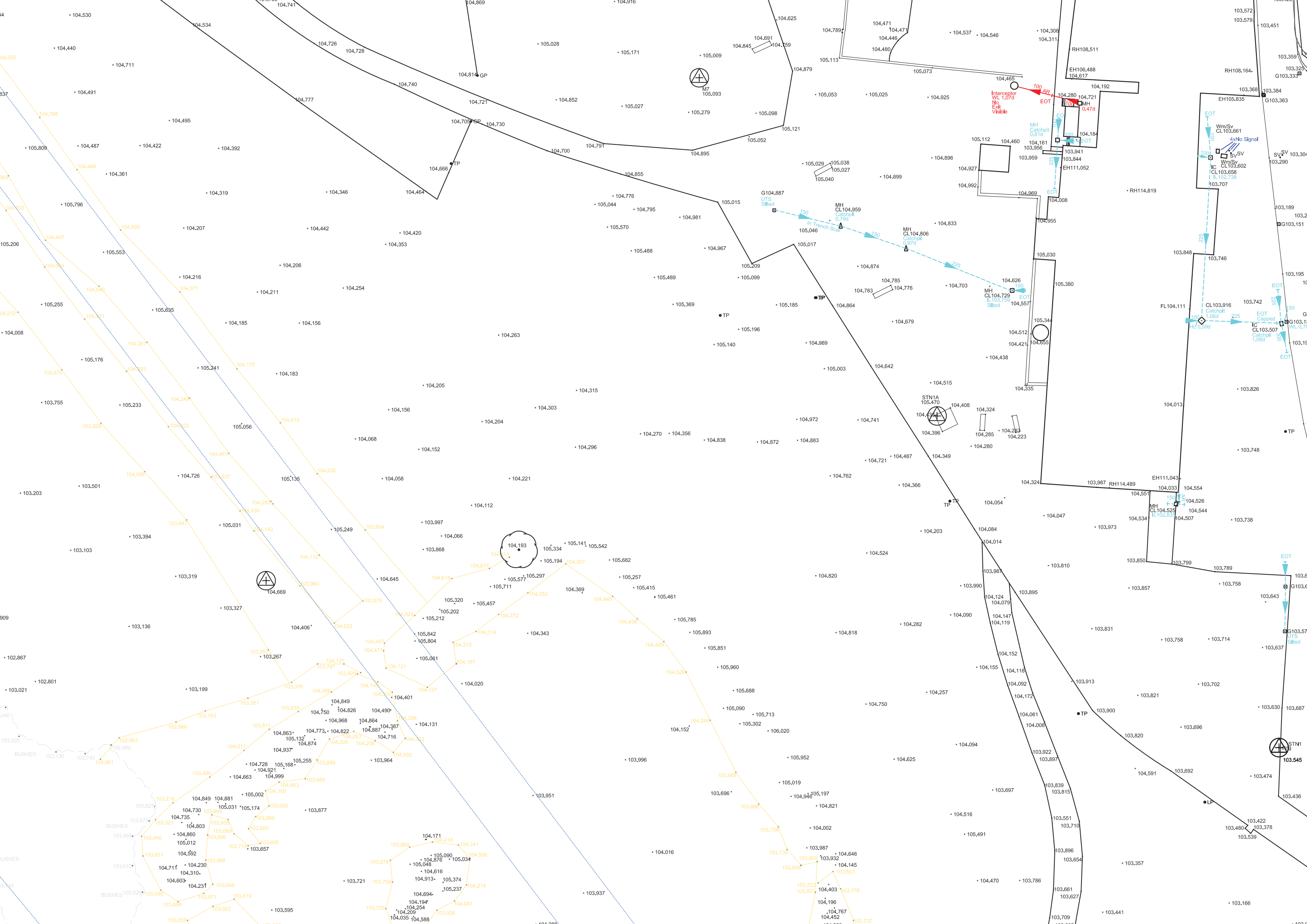


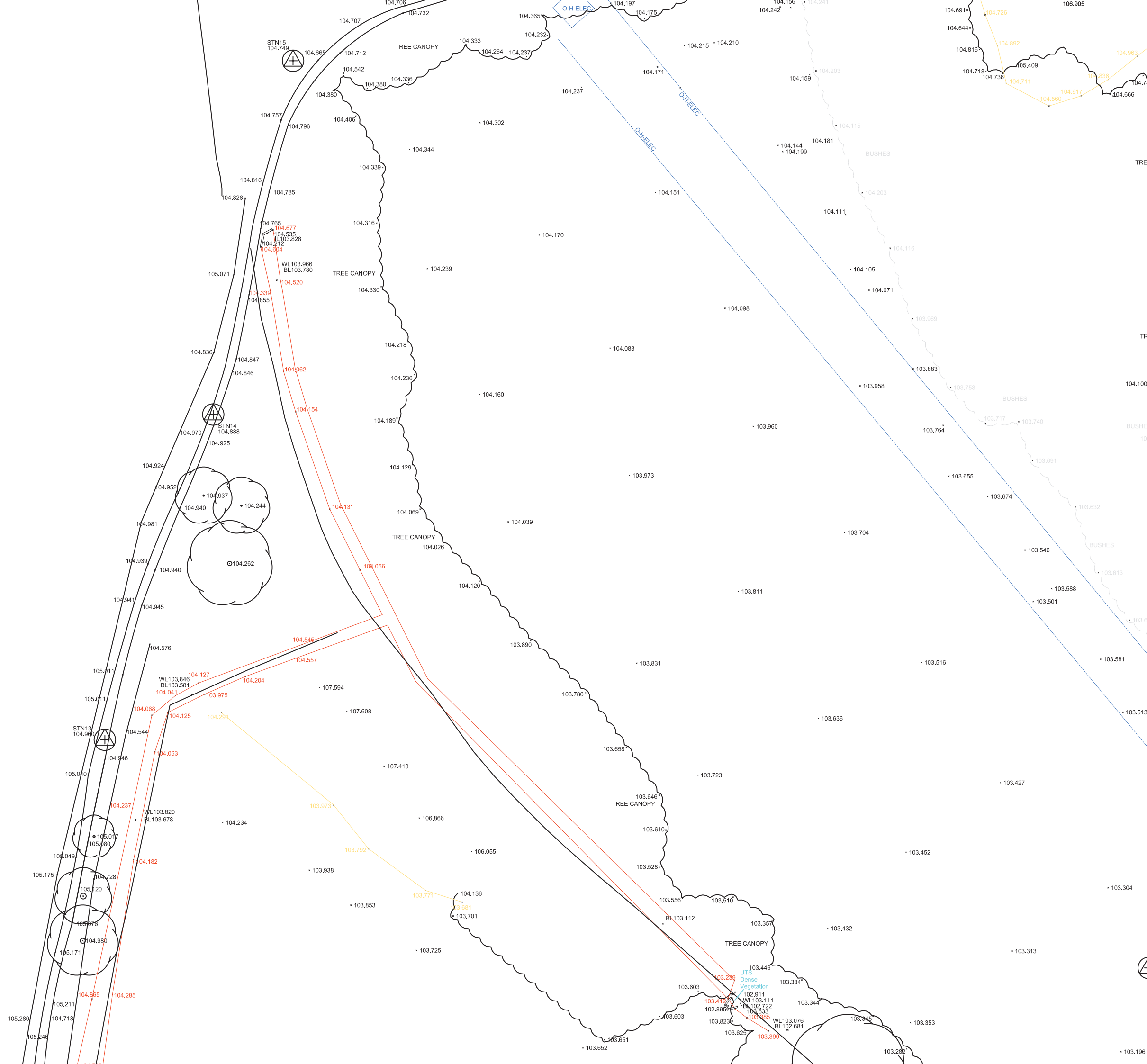
Appendix D

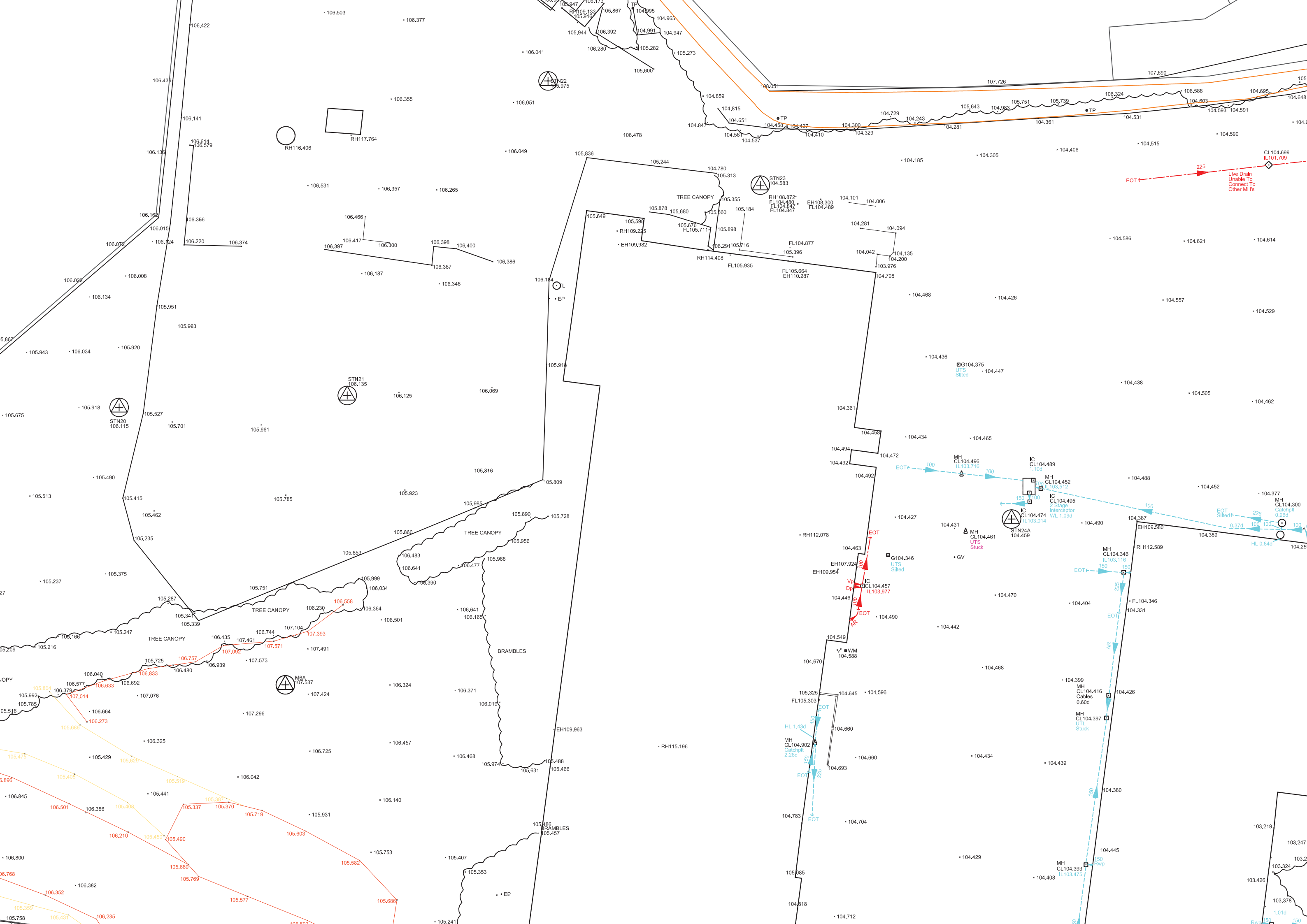
Drainage Connectivity Survey

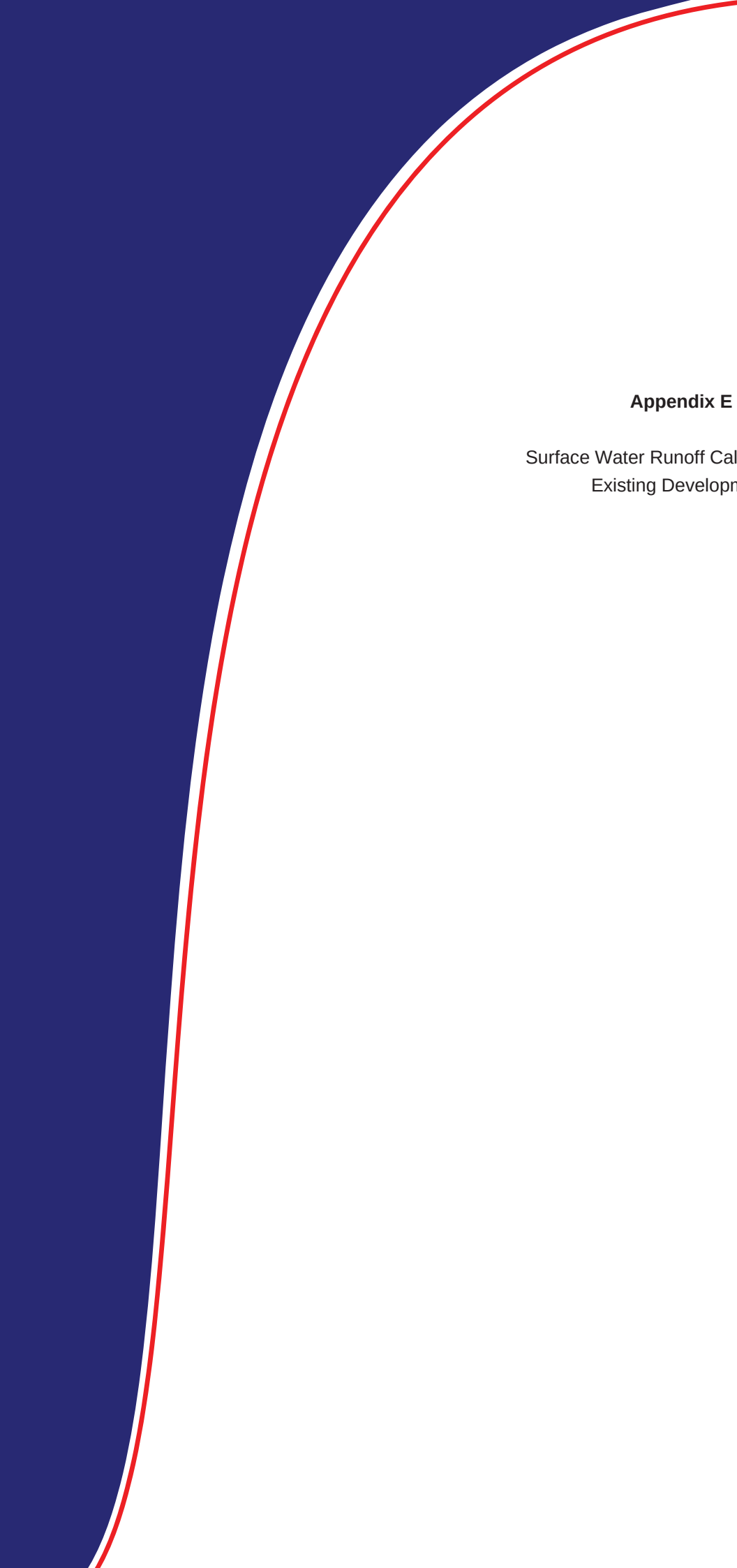






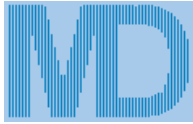






Appendix E

Surface Water Runoff Calculations – Existing Development



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Job No. MB616		
Sheet no. 1		
Date 10/01/13		
By HB	Checked	Reviewed

Project Land off Bangor Road		
Title Hydrological data for Johnstown		

Data:-

FSR values

Location	= Johnstown	Grid reference	= SJ3146
M5-60 (mm)	= 18.0	SAAR (mm/yr)	= 900
r	= 0.32	Soil	= 0.45
Long reference	= 331346	Area	= England and Wales
Hydrological area	= 9	Hydrological zone	= 4

Soil classification for WRAP type 4
Clayey, or loamy over clayey soils with an impermeable layer at shallow depth.

FEH values

No FEH data available in this file.



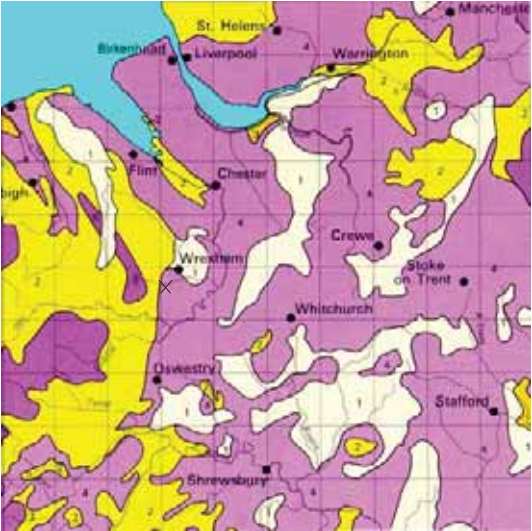
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Job No. MB616		
Sheet no. 2		
Date 10/01/13		
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Project **Land off Bangor Road**
Title **Hydrological data for Johnstown**



<- Soil

M5-60 ->



<- SAAR

r x 100 ->





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Job No. MB616		
Sheet no. 1		
Date 10/01/13		
By HB	Checked	Reviewed

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HY 8.21

Project **Land off Bangor Road**
Title **FSR Rainfall intensities for Johnstown**

Mins\Yrs	1	2	5	10	20	30	50	100	200	500
1	66.8	85.2	109.9	124.1	140.1	150.4	164.5	185.8	209.8	246.3
2	58.8	74.9	96.7	109.6	124.1	133.5	146.4	165.8	187.8	221.5
3	52.8	67.2	86.8	98.7	112.1	120.7	132.6	150.7	171.1	202.5
4	47.3	61.2	79.1	90.1	102.6	110.7	121.8	138.7	157.9	187.5
5	43.5	56.4	72.9	83.1	94.9	102.5	113.0	128.9	147.2	175.2
6	40.4	52.3	67.7	77.4	88.5	95.7	105.7	120.8	138.2	165.0
7	37.8	49.0	63.3	72.5	83.1	90.0	99.5	113.9	130.5	156.2
8	35.6	46.1	59.6	68.4	78.5	85.0	94.1	108.0	123.9	148.7
9	33.6	43.5	56.3	64.8	74.4	80.7	89.5	102.8	118.2	142.1
10	31.9	41.3	53.5	61.6	70.9	77.0	85.4	98.3	113.1	136.2
11	30.4	39.4	51.0	58.8	67.7	73.6	81.7	94.2	108.6	131.0
12	29.1	37.6	48.7	56.2	64.9	70.6	78.5	90.6	104.5	126.4
13	27.8	36.1	46.7	54.0	62.4	67.9	75.5	87.3	100.9	122.2
14	27.2	35.1	44.9	51.9	60.0	65.4	72.8	84.2	97.4	118.0
15	26.2	33.8	43.2	50.0	57.9	63.1	70.2	81.3	94.1	114.2
16	25.3	32.6	41.7	48.3	55.9	60.9	67.9	78.6	91.1	110.6
17	24.4	31.5	40.3	46.7	54.1	59.0	65.7	76.2	88.3	107.3
18	23.6	30.5	39.0	45.2	52.4	57.2	63.8	73.9	85.7	104.2
19	22.9	29.5	37.8	43.9	50.9	55.5	61.9	71.8	83.3	101.4
20	22.2	28.7	36.7	42.6	49.4	53.9	60.2	69.8	81.1	98.7
21	21.6	27.9	35.7	41.4	48.1	52.5	58.6	68.0	79.0	96.2
22	21.0	27.1	34.7	40.3	46.8	51.1	57.1	66.3	77.0	93.8
23	20.5	26.4	33.8	39.3	45.6	49.8	55.6	64.7	75.1	91.6
24	19.9	25.7	32.9	38.3	44.5	48.6	54.3	63.1	73.4	89.5
25	19.5	25.1	32.1	37.4	43.5	47.5	53.0	61.7	71.7	87.6
26	19.0	24.5	31.4	36.5	42.5	46.4	51.9	60.3	70.2	85.7
27	18.6	24.0	30.7	35.7	41.5	45.4	50.7	59.0	68.7	83.9
28	18.2	23.4	30.0	34.9	40.6	44.4	49.7	57.8	67.3	82.2
29	17.8	22.9	29.4	34.2	39.8	43.5	48.6	56.6	65.9	80.6
30	17.4	22.5	28.7	33.5	39.0	42.6	47.7	55.5	64.7	79.1
31	17.0	22.0	28.2	32.8	38.2	41.8	46.8	54.5	63.4	77.6
32	16.7	21.6	27.6	32.2	37.5	41.0	45.9	53.5	62.3	76.2
33	16.4	21.2	27.1	31.6	36.8	40.2	45.0	52.5	61.2	74.9
34	16.1	20.8	26.6	31.0	36.1	39.5	44.2	51.6	60.1	73.6
35	15.8	20.4	26.1	30.4	35.5	38.8	43.5	50.7	59.1	72.4
36	16.0	20.3	25.7	29.9	34.9	38.2	42.7	49.8	58.1	71.2
37	15.7	19.9	25.2	29.4	34.3	37.5	42.0	49.0	57.2	70.1
38	15.5	19.6	24.8	28.9	33.7	36.9	41.4	48.2	56.3	69.0
39	15.2	19.3	24.4	28.4	33.2	36.3	40.7	47.5	55.4	67.9
40	15.0	19.0	24.0	28.0	32.7	35.8	40.1	46.8	54.6	66.9
41	14.8	18.7	23.6	27.6	32.2	35.2	39.5	46.1	53.8	65.9
42	14.5	18.4	23.3	27.1	31.7	34.7	38.9	45.4	53.0	65.0
43	14.3	18.1	22.9	26.7	31.2	34.2	38.3	44.7	52.2	64.1
44	14.1	17.8	22.6	26.4	30.8	33.7	37.8	44.1	51.5	63.2
45	13.9	17.6	22.3	26.0	30.3	33.2	37.2	43.5	50.8	62.3
46	13.7	17.3	21.9	25.6	29.9	32.8	36.7	42.9	50.1	61.5
47	13.5	17.1	21.6	25.3	29.5	32.3	36.2	42.3	49.5	60.7
48	13.3	16.9	21.3	24.9	29.1	31.9	35.8	41.8	48.8	59.9
49	13.2	16.6	21.1	24.6	28.7	31.5	35.3	41.3	48.2	59.2
50	13.0	16.4	20.8	24.3	28.4	31.1	34.9	40.7	47.6	58.5
51	12.8	16.2	20.5	24.0	28.0	30.7	34.4	40.2	47.0	57.8
52	12.7	16.0	20.3	23.7	27.7	30.3	34.0	39.7	46.4	57.1
53	12.5	15.8	20.0	23.4	27.3	29.9	33.6	39.3	45.9	56.4
54	12.3	15.6	19.8	23.1	27.0	29.6	33.2	38.8	45.4	55.8
55	12.2	15.4	19.5	22.8	26.7	29.2	32.8	38.4	44.8	55.1
56	12.1	15.3	19.3	22.6	26.4	28.9	32.4	37.9	44.3	54.5
57	11.9	15.1	19.1	22.3	26.1	28.6	32.1	37.5	43.8	53.9
58	11.8	14.9	18.9	22.1	25.8	28.3	31.7	37.1	43.4	53.3
59	11.6	14.7	18.7	21.8	25.5	28.0	31.4	36.7	42.9	52.8
60	11.5	14.6	18.5	21.6	25.2	27.7	31.0	36.3	42.4	52.2
61	11.4	14.4	18.3	21.3	25.0	27.4	30.7	35.9	42.0	51.7
62	11.3	14.3	18.1	21.1	24.7	27.1	30.4	35.5	41.6	51.1
63	11.2	14.1	17.9	20.9	24.4	26.8	30.1	35.2	41.1	50.6
64	11.0	14.0	17.7	20.7	24.2	26.5	29.8	34.8	40.7	50.1
65	10.9	13.8	17.5	20.5	24.0	26.3	29.5	34.5	40.3	49.6
66	10.8	13.7	17.3	20.3	23.7	26.0	29.2	34.1	39.9	49.1
67	10.7	13.6	17.2	20.1	23.5	25.7	28.9	33.8	39.6	48.7



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Mins\Yrs	1	2	5	10	20	30	50	100	200	500
68	10.6	13.4	17.0	19.9	23.3	25.5	28.6	33.5	39.2	48.2
69	10.5	13.3	16.8	19.7	23.0	25.3	28.3	33.2	38.8	47.8
70	10.4	13.2	16.7	19.5	22.8	25.0	28.1	32.9	38.5	47.3
71	10.3	13.0	16.5	19.3	22.6	24.8	27.8	32.6	38.1	46.9
72	10.2	12.9	16.4	19.1	22.4	24.6	27.6	32.3	37.8	46.5
73	10.1	12.8	16.2	19.0	22.2	24.3	27.3	32.0	37.4	46.1
74	10.0	12.7	16.1	18.8	22.0	24.1	27.1	31.7	37.1	45.7
75	9.9	12.6	15.9	18.6	21.8	23.9	26.8	31.4	36.8	45.3
76	9.8	12.5	15.8	18.5	21.6	23.7	26.6	31.1	36.5	44.9
77	9.8	12.4	15.6	18.3	21.4	23.5	26.4	30.9	36.1	44.5
78	9.7	12.3	15.5	18.1	21.2	23.3	26.2	30.6	35.8	44.1
79	9.6	12.1	15.4	18.0	21.1	23.1	25.9	30.4	35.5	43.8
80	9.5	12.0	15.2	17.8	20.9	22.9	25.7	30.1	35.3	43.4
81	9.4	11.9	15.1	17.7	20.7	22.7	25.5	29.9	35.0	43.1
82	9.4	11.8	15.0	17.6	20.6	22.5	25.3	29.6	34.7	42.7
83	9.6	11.9	14.9	17.4	20.4	22.4	25.1	29.4	34.4	42.4
84	9.5	11.8	14.8	17.3	20.2	22.2	24.9	29.2	34.1	42.0
85	9.4	11.7	14.6	17.1	20.1	22.0	24.7	28.9	33.9	41.7
86	9.4	11.6	14.5	17.0	19.9	21.8	24.5	28.7	33.6	41.4
87	9.3	11.5	14.4	16.9	19.8	21.7	24.3	28.5	33.4	41.1
88	9.2	11.4	14.3	16.7	19.6	21.5	24.1	28.3	33.1	40.8
89	9.1	11.4	14.2	16.6	19.5	21.3	24.0	28.1	32.9	40.5
90	9.1	11.3	14.1	16.5	19.3	21.2	23.8	27.9	32.6	40.2
91	9.0	11.2	14.0	16.4	19.2	21.0	23.6	27.7	32.4	39.9
92	8.9	11.1	13.9	16.3	19.0	20.9	23.4	27.4	32.1	39.6
93	8.9	11.0	13.8	16.1	18.9	20.7	23.3	27.3	31.9	39.3
94	8.8	10.9	13.7	16.0	18.8	20.6	23.1	27.1	31.7	39.0
95	8.7	10.9	13.6	15.9	18.6	20.4	22.9	26.9	31.5	38.8
96	8.7	10.8	13.5	15.8	18.5	20.3	22.8	26.7	31.2	38.5
97	8.6	10.7	13.4	15.7	18.4	20.1	22.6	26.5	31.0	38.2
98	8.6	10.6	13.3	15.6	18.2	20.0	22.5	26.3	30.8	38.0
99	8.5	10.6	13.2	15.5	18.1	19.9	22.3	26.1	30.6	37.7
100	8.4	10.5	13.1	15.4	18.0	19.7	22.2	26.0	30.4	37.4
110	7.9	9.8	12.3	14.4	16.9	18.5	20.8	24.3	28.5	35.1
120	7.5	9.3	11.6	13.6	15.9	17.4	19.6	22.9	26.9	33.1
130	7.1	8.8	11.0	12.9	15.1	16.5	18.5	21.7	25.4	31.3
140	6.7	8.4	10.4	12.2	14.3	15.7	17.6	20.6	24.1	29.7
160	6.1	7.6	9.5	11.2	13.0	14.3	16.1	18.8	22.0	27.0
180	5.8	7.1	8.8	10.3	12.0	13.2	14.8	17.3	20.2	24.8
210	5.2	6.4	7.9	9.2	10.8	11.8	13.2	15.5	18.1	22.2
240	4.8	5.8	7.2	8.4	9.8	10.7	12.0	14.0	16.4	20.0
270	4.4	5.4	6.6	7.7	9.0	9.9	11.0	12.8	15.0	18.3
300	4.2	5.1	6.2	7.2	8.4	9.1	10.2	11.9	13.8	16.9
330	3.9	4.7	5.8	6.7	7.8	8.5	9.5	11.1	12.9	15.7
360	3.7	4.5	5.4	6.3	7.3	8.0	8.9	10.4	12.1	14.7
390	3.5	4.2	5.1	6.0	6.9	7.6	8.4	9.8	11.4	13.8
420	3.3	4.0	4.9	5.7	6.6	7.2	8.0	9.3	10.7	13.1

Rainfall depths for Johnstown at standard return periods in mm

Time\Yrs	1	2	5	10	20	30	50	100	200	500
3 min	2.6	3.4	4.3	4.9	5.6	6.0	6.6	7.5	8.6	10.1
30 min	8.7	11.2	14.4	16.7	19.5	21.3	23.8	27.8	32.3	39.5
1 hr	11.5	14.6	18.5	21.6	25.2	27.7	31.0	36.3	42.4	52.2
2 hr	14.9	18.6	23.2	27.2	31.8	34.9	39.2	45.9	53.7	66.2
5 hr	21.1	25.3	30.9	35.9	41.8	45.7	51.0	59.4	69.1	84.4
10 hr	26.1	31.3	38.1	44.0	50.8	55.3	61.5	71.1	82.2	99.5
24 hr	34.9	41.2	49.5	56.6	64.7	70.0	77.2	88.3	101.0	120.5
48 hr	45.3	51.9	60.8	68.8	77.9	83.8	91.8	103.9	117.7	138.6
5 day	61.1	69.0	79.7	88.9	99.2	105.7	114.5	127.7	142.4	164.5

The above figures are calculated in accordance with the protocol set out in the 'Wallingford Procedure' from data derived from the Wallingford maps :-

M5-60min	=	18.00	r	=	0.32
WRAP	=	4	SAAR	=	900
NG ref	=	SJ3146	Soil index	=	0.45

Data printed on 10/01/13 from Masterdrain Hydrology program



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Job No.
MB616

Sheet no. **1**

Date **10/01/13**

MasterDrain
HY 8.21

Project **Land off Bangor Road**

Title **IoH 124 Runoff calcs for Johnstown**

By

HB

Checked

Reviewed

Hydrological Data:-

FSR Hydrology:-

Location = Johnstown

M5-60 (mm) = 18

Soil runoff = 0.45

WRAP = 4

Hydrological area = 9

Grid reference = SJ3146

r = 0.32

SAAR (mm/yr) = 900

Area = England & Wales

Hydrological zone = 4

Soil classification for WRAP type 4

Clayey, or loamy over clayey soils with an impermeable layer at shallow depth.

Design data:-

Area = 0.124 Km² - 12.4 Ha - 124000 m²

Calculation method:-

Runoff is calculated from:-

$$Q_{\text{BAR(rural)}} = 0.00108 \text{ AREA}^{0.89} \cdot \text{SAAR}^{1.17} \cdot \text{SOIL}^{2.17}$$

where

AREA = Site area in Km²

SAAR = Standard Average Annual Rainfall (mm/yr)

SOIL = Soil value derived from Winter Rainfall Acceptance Potential

$Q_{\text{BAR(rural)}}$ = Runoff (cumecs)

$Q_{\text{BAR(rural)}}$ is then multiplied by a growth factor - GC(T) - for different storm return periods derived from EA publication W5-074/A.

Calculated data:-

For areas less than 50Ha, a modified calculation which multiplies the 50Ha runoff value by the ratio of the site area to 50Ha is used
Reducing factor used for these calculations is 0.248

Mean Annual Peak Flow $Q_{\text{BAR(rural)}}$ = 73.10 l/s

Values for $Q_{\text{BAR(rural)}}$

1 year	2 year	5 year	30 year	100 year	200 year	Units
0.062	0.073	0.089	0.128	0.159	0.183	cumecs
62.13	73.10	89.18	127.92	159.35	182.74	l/s
5.01	5.89	7.19	10.32	12.85	14.74	l/s/Ha
0.850	1.000	1.220	1.750	2.180	2.500	GC(T)

The above is based on the Institute of Hydrology Report 124 to which you are referred for further details (see Sect 7).
Note that the 200 year growth curve was taken from W5-074/A.