

DRAINAGE STRATEGY

PROPOSED DEVELOPMENT OF BRYMBO HERITAGE PROJECT



Prepared on Behalf of:

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1.1 Introduction

1.2 Project Background

- 121 Bingham Rawlings Partnership Ltd have been appointed by TACP Architects to provide a drainage strategy for surface water run-off generated for the proposed development of the Brymbo Heritage Site, Off Gwalia Road, Brymbo, Wrexham, LL11 5AX (National Grid Reference: **SJ 29454 53526**). Refer to the drawing enclosed in **Appendix A** for the proposed site location plan.
- 122 Bingham Rawlings Partnership Ltd reserve the right to undertake further investigation into the adequacy of the recommendations made within this report, if works on site have not commenced within twelve months of the issuing of this report.

1.3 Scope of Proposed Drainage Strategy

- 131 This report aims to provide a suitable drainage strategy for the discharge of surface water run-off and foul effluent generated by the proposed development.
- 132 The purpose of the calculations enclosed within this report and accompanying details are to produce a drainage layout that complies with the relevant legislation of the Tan 15, CIRIA C753 '*The SuDS Manual*', The Welsh ministers standards and Approved Document H of the Building Regulations 2010.

1.4 Proposed Development

- 141 The proposed scheme involves the development of the Brymbo Heritage Site. The proposed development involves improvements and repurposing of a number of existing buildings, construction of 2no additional extensions to an existing building and improving the existing hardstanding areas. The proposed layout is contained within **Appendix B**.
- 142 The previous site drainage strategy proposed by Wardell Armstrong proposed to control Surface water runoff on site to reduce the risk of flooding to areas downstream of the site. To help to achieve this, Sustainable Drainage Systems (SuDS) was be incorporated into the development to provide attenuation. The proposed was to discharge surface water runoff from the site into the culverted

watercourse via the existing drainage network. This drainage strategy formed part of a wider site design for the re-design of the former Brymbo Steelworks. The Flood Consequence Assessment can be found in **Appendix I**.

1.5 Existing Land Drainage Features / Watercourses.

- 1.5.1 There is an existing land drainage feature within the site boundary comprising of a stone culvert, located beneath the existing Machine shop. The culvert conveys land drainage from site, exiting site to the southeastern boundary. Existing land drainage features such as this culvert were formed as part of the original industrial development of the site and convey drainage from areas to the west in a southern direction to ultimately connect to a river at the lodge which in turn conveys flows to the river Gwenfro. The existing drainage layout is contained within **Appendix D**.

1.6 Site Hydrology

- 1.6.1 The site generally falls west to east away from the vegetated embankment, down towards the development site. The site is also affected by flows from beyond the site boundary to the west and north. All surface water which does not communicate into the industrial land drainage system is eventually directed towards the existing swales occupying the proposed car park location before being discharged into the existing surface water drainage under the highway to the east of site. The proposed layout is contained within **Appendix B**.

1.7 Existing Nearby Drainage

- 1.7.1 The Dwr Cymru / Welsh Water (DCWW) apparatus map contained within **Appendix D** indicates there is an existing 150mm Vitrified Clay (VC) combined drainage system to the southeast of site.
- 1.7.2 Although not highlighted in the The Dwr Cymru / Welsh Water (DCWW) apparatus map, there are separate foul and surface water drainage systems within the existing highway to the east of site. The existing site drainage arrangement has been illustrated on the attached layout contained within **Appendix C**.

2.0 Design Criteria

2.1.1 The following design criteria will apply to the surface water run-off and foul discharge design for the site:

- Approved Document H, Building Regulations.
- BRE Digest 365;
- BS EN 752:2017;
- CIRIA C753 'The SuDS Manual' 2015;
- DEFRA / Environment Agency 'Preliminary Rainfall Runoff Management for Developments' Technical Report;
- Discharge Units from BS EN 12056: Part 2;
- Flood & Water Management Act 2010;
- Highways Act 1991;
- Institute of Hydrology Report (IHR) 124;
- Land Drainage Act 1991;
- Modified Rational Method;
- Sewers for Adoption 7th Edition;
- Statutory standards for sustainable drainage systems – designing, constructing, operating and maintaining surface water drainage systems
- Technical Advice Note (TAN) 15: Development and Flood Risk;
- Wallingford Procedure;
- Water Industries Act 1991.

3.1 Surface Water Drainage Design

3.2 Guiding Principles

- 32.1 The disposal of surface water has been designed in strict accordance with the provision of TAN 15, the Flood and Water Management Act 2010 and other best practice documents, such as CIRIA C753 ‘SuDS Manual’ 2015.

3.3 Method of discharge

- 33.1 In accordance with the SuDS Manual 2015 and the Welsh ministers standards surface water should be managed and discharged from a new development in line with the following hierarchy:

- Priority level 1: Re-use of water;
- Priority level 2: Infiltration into ground;
- Priority level 3: Discharge to a water body;
- Priority level 4: Discharge to a surface water run-off drain;
- Priority level 5: Discharge to a combined surface water run-off and foul drain.

- 33.2 Re-use of surface water cannot be considered as the sole method of surface water disposal for this site due to its massing and potential for contamination or pollution transfer due to its former industrial processes., Paragraph G1.1 The Statutory SuDS Guidance for Wales states “As much of the runoff as possible (subject to technical or cost constraints) should be discharged to each destination before a lower priority destination (level) is considered.” Therefore, attempts must be made to reuse as much surface water as possible. As such, it is proposed to provide a 5000 litre above ground rainwater harvesting tank which captures roof water from one of the principal buildings on site. To service the proposed toilet block.

- 3.3.3 Due to the historical land use at the previous steelworks location and the significant volumes of made ground below the surface (comprising discarded iron and steel slags), the implementation of infiltration drainage within the site's area is deemed unviable. Allowing surface water to permeate the subsurface materials would potentially lead to undesirable ground subsidence and increase the likelihood of infiltration flows becoming a receptor for contamination transportation. As such all proposed drainage systems within the confines of the site are to be wrapped in a non-permeable membrane to prevent surface water getting into the ground.
- 3.3.4 Although not feasible within the site, the area for the proposed car park is composed of inert graded imported granular fill, and can be considered for infiltration. Therefore infiltration testing has been undertaken by 'BRP' (contained in **Appendix K**), the result of this concludes that the site is not suitable for the use of infiltration systems, therefore an alternative method of disposal should be considered, in order to meet the criteria of paragraph G1.1 all storage structures are to be wrapped in geotextile membranes to allow for potential losses in surface water.
- 3.3.5 As noted in **Section 1.4**, the site contains an existing land drainage feature in the form of a stone culvert. It is proposed to continue to utilize the existing culvert to allow unquantified land drainage flows from beyond site to flow freely through site as they currently do.
- 3.3.6 As noted in **Section 1.6.2** there is an existing surface water drainage system contained in the Highway to the east of site. Therefore it is proposed to attenuate the surface water and communicate flows from the site to this system. To maintain the originally approved disposal strategy as referred to within the former drainage strategy contained in **Appendix I**.

3.4 Climate Change

- 3.4.1 TAN 15 states that an allowance for climate change should be provided within the on-site attenuation, without specifying what allowance should be made. The NPPF, which is the English equivalent of TAN 15, does however provide guidance derived from DEFRA FCDPAG3 'Economic Appraisal Supplementary Note to Operating Authorities – Climate Change Impacts'

October 2006 (see **Table 1**). This document considers the effects of climate change for different design criteria.

- 342 The proposed development will have a design life of 100 years; based on the NPPF's guidance, the development therefore requires an allowance of 30% for climate change to be applied to the peak rainfall intensity.

Table 1. Climate Change Requirements.

Parameter	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Peak Rainfall Intensity	+5%	+10%	+20%	+30%
Peak River Flow	+10%	+20%		
Offshore Wind Speed	+5%		+10%	
Extreme Wave Height	+5%		+10%	

3.5 Design Philosophy

3.5.1 The tables below summarize the existing effective areas with their corresponding run-off coefficients, as per the Wallingford procedure, IHR 124.

3.5.2 The existing areas for both systems area provided within **Tables 2 & 4** are provided on the existing area drawing contained within **Appendix F**, which are summarized as follows:

Table 2. Existing Brownfield Areas.

Surface	Total Area	Coefficient	Effective Area
Hardstanding Area	5,597.625 m ²	1.00	5,597.625 m ²
Blast Wall	92.493 m ²	1.00	92.493 m ²
Sub-Station	62.502 m ²	1.00	62.502 m ²
Furnace	123.057 m ²	1.00	123.057 m ²
Foundary Area	1,036.777 m ²	1.00	1,036.777 m ²
Agents House	101.037 m ²	1.00	101.037 m ²
Iron Line	194.684 m ²	0.75	146.013 m ²
Machine Shop	702.931 m ²	0.75	527.198 m ²
Pattern Store	244.478 m ²	0.75	183.358 m ²
Grassed Embankment	888.628 m ²	0.35	311.019 m ²
Grass (proposed car park)	3234.805 m ²	0.35	1,132.182 m ²
Track into site	502.385 m ²	1.00	502.385 m ²
Total	12,781.402 m ²		9,815.465 m ²

3.5.3 Due to the site being a brownfield site, run-off has been calculated using the

modified rational method, using the brownfield method. The results of this are confirmed within **Table 3** below.

Table 3. Brownfield Run-off rates for different return periods.

Reference	1 in 1 Year	1 in 30 Year	1 in 100 Year
Brownfield Rate	21.1 l/s	51.2 l/s	65.6 l/s

- 3.54 The Statutory SuDS guidance for Wales requests all development to be restricted to greenfield run-off rates or when analysing Brownfield sites, to impose a significant improvement, therefore a vortex flow control device is proposed restricting flow to the following discharge rates in order to meet the quoted figures in **Table 3**.

System One proposed discharge rate 22 l/s

System Two proposed discharge rate 36 l/s

Combined proposed discharge rate 58 l/s which represents 88% of the 1 in 100 year brownfield run off rate.

3.6 Method of Storage

- 3.6.1 Surface water run-off generated from all proposed hardstanding areas for the 1 in 100-year return period plus an allowance of 30% for climate change is to be attenuated onsite within a below ground storage structures and the below ground piped drainage network. This section of the report should be read in conjunction with the proposed on-site drainage arrangement enclosed in **Appendix G**.
- 3.6.2 The site drainage system is split into two in order to collect surface water run-off effectively. System one collects surface water through a filter drain under the proposed Amphitheatre. This is to be collected and stored in an attenuation granular storage under the surface of the proposed car park, and discharged at a controlled rate of 22 l/s to existing the existing surface water system to the east of site.
- 3.6.3 System two will accommodate the existing track and proposed extensions by collecting surface water into filter drains and directing it into existing surface water systems, where it will be collected in an attenuation tank, adjacent to the

existing machine shop, and is discharged at a controlled rate of 36l/s. The proposed drainage layout is contained within **Appendix G**.

3.64 The Statutory SuDS Guidance for Wales document requires green SuDS features to be used where possible to help provide treatment and improve biodiversity and ecology of the site though the management of surface water which lands on the site.

3.65 The proposed measured hardstanding areas accounted for within each attenuation structure summarised within **Table 6 & 7** and illustrated on the proposed area plan contained within **Appendix H**.

Table 4. Proposed Areas. (System One)

Surface	Total Area	Coefficient	Effective Area
Roofs	405.388 m ²	1.00	405.388 m ²
Hardstanding Gravel	3,519.623 m ²	0.75	2,639.717 m ²
Gravel Car Park	3,234.805 m ²	1.00	3,234.805 m ²
Total	7,159.816 m ²		6,269.61 m ²

Table 5. Proposed Areas. (System Two)

Surface	Total Area	Coefficient	Effective Area
Roofs	746.835 m ²	1.00	746.835 m ²
Hardstanding Gravel	1,894.323 m ²	0.75	1,420.742 m ²
Grassed Embankment	888.628 m ²	0.35	311.019 m ²
Total	3,529.786 m ²		2,478.597 m ²

3.66 As the hydraulic model accounts for grassed areas that have the potential to enter the proposed system, no allowance has been made at this time for urban creep

3.7 Drainage System Maintenance

- 3.7.1 The SuDS Manual 2015 requires appropriate measures to be in place for the maintenance of surface water drainage systems and sustainable drainage features.
- 3.7.2 The maintenance schedule shown in **Tables 8 & 9** have been derived in strict accordance with the SuDS Manual 2015 and from a risk-assessed approach during the design stage. These schedules are not exhaustive and should be reassessed at regular intervals to determine if any additional maintenance is required to preserve the performance and condition of the site drainage system.
- 3.7.3 The surface water drainage system is to remain private within its entirety and the management and maintenance of the system will be under the responsibility of the site leaseholders. The maintenance schedule for each component of the proposed drainage network is contained within **Table 8 – 10**.
- 3.7.4 Provided preventive maintenance measures are undertaken in accordance with the frequencies recommended in **Tables 8 - 10**, the need for corrective maintenance should rarely arise.
- 3.7.5 Maintenance activities should be detailed in the Principal Contractor's Health and Safety Plan and Risk Assessments and should be updated on a regular basis to ensure the continued performance and long-term condition of the drainage system.

Table 6. Operation and maintenance requirements for filter drains in line with table 16.1 of the CIRIA C753 ‘The SuDS Manual 2015.

Maintenance Schedule	Required Action	Typical Frequency
Monitoring	Inspect filter drain surface, inlet/outlet pipework and control systems for blockages, clogging, standard water, and structural damage.	Six Monthly
	Inspect pre-treatment systems, inlets, and perforated pipework for silt accumulation, and establish appropriate silt removal frequencies.	Six Monthly
	Inspect filter drain for tree roots encroaching sides.	
Regular Maintenance	Remove litter (including leaf litter) and debris from filter drain surface, access chambers and pre-treatment devices	Six Monthly
	Inspect filter drain surface, inlet/outlet pipework and control systems for blockages, clogging, standard water, and structural damage.	Six Monthly
	Inspect pre-treatment systems, inlets, and perforated pipework for silt accumulation, and establish appropriate silt removal frequencies.	Six Monthly
	Remove Sediment from pre-treatment devices	Six Monthly or as required.
Occasional Maintenance	Remove or control tree roots where they are encroaching the side of the filter drain, using recommended methods (eg NJUG, 2007 or SB 3998:2010)	As required.
	In locations where high level of pollutants are anticipated, remove surface geotextile and replace or wash, and replace overlaying filter medium.	As required.
	Clear perforated pipework of blockages	As required.
Remedial Actions/ Corrective Maintenance	Reconstruct filter drain (replacing the all geotextile/membrane and granular medium) if not maintained in line with the above recommendations and is completely clogged up.	As required.

Table 7. Operation and maintenance requirements for pipework & chambers.

Maintenance Schedule	Required Action	Typical Frequency
Monitoring	Inspect using CCTV drain surveys to ensure they are in good condition and operating as designed.	Every 5 years (or as required)
	Inspect chambers to ensure they are in good condition and that accumulation of sediment, debris etc. is not preventing them from operating as designed.	Annually
Regular Maintenance	Remove any accumulation of silt, sediment, leaves, debris etc.	Bi-annually
Occasional Maintenance	High-pressure water jet for removal of silt builds up and avoid blockages, particularly at bends or changes in direction.	Every 5 years (or as required)
Remedial Actions/ Corrective Maintenance	High-pressure water jet to remove blockages.	As Required.

*Hydrobrake flow control device to be maintained in accordance with hydro international's recommendations.

3.7 Surface Water Treatment

3.7.1 In accordance with the SuDS Manual 2015, Table 26.2, Industrial sites are classified as having a 'high' pollution hazard level. **Table 10** shows the pollution hazard indices for the land use.

Table 8. Pollution Hazard Indices

Land Use	Pollution Hazard Level	Total Suspended Soils (PMI _{TSS})	Hydrocarbons (PMI _{HM})	Heavy Metals (PMI _{PAH})
Industrial Site	High	0.8	0.9	0.8

3.72 The SuDS Manual 2015 also provides pollution mitigation indices for different SuDS drainage features, as detailed in **Table 11**. The increase in surface water pollution resulting from the hardstanding areas during normal conditions is likely to be negligible. However, this risk increases during rainfall events of greater intensity.

Table 9. Pollution Mitigation Indices

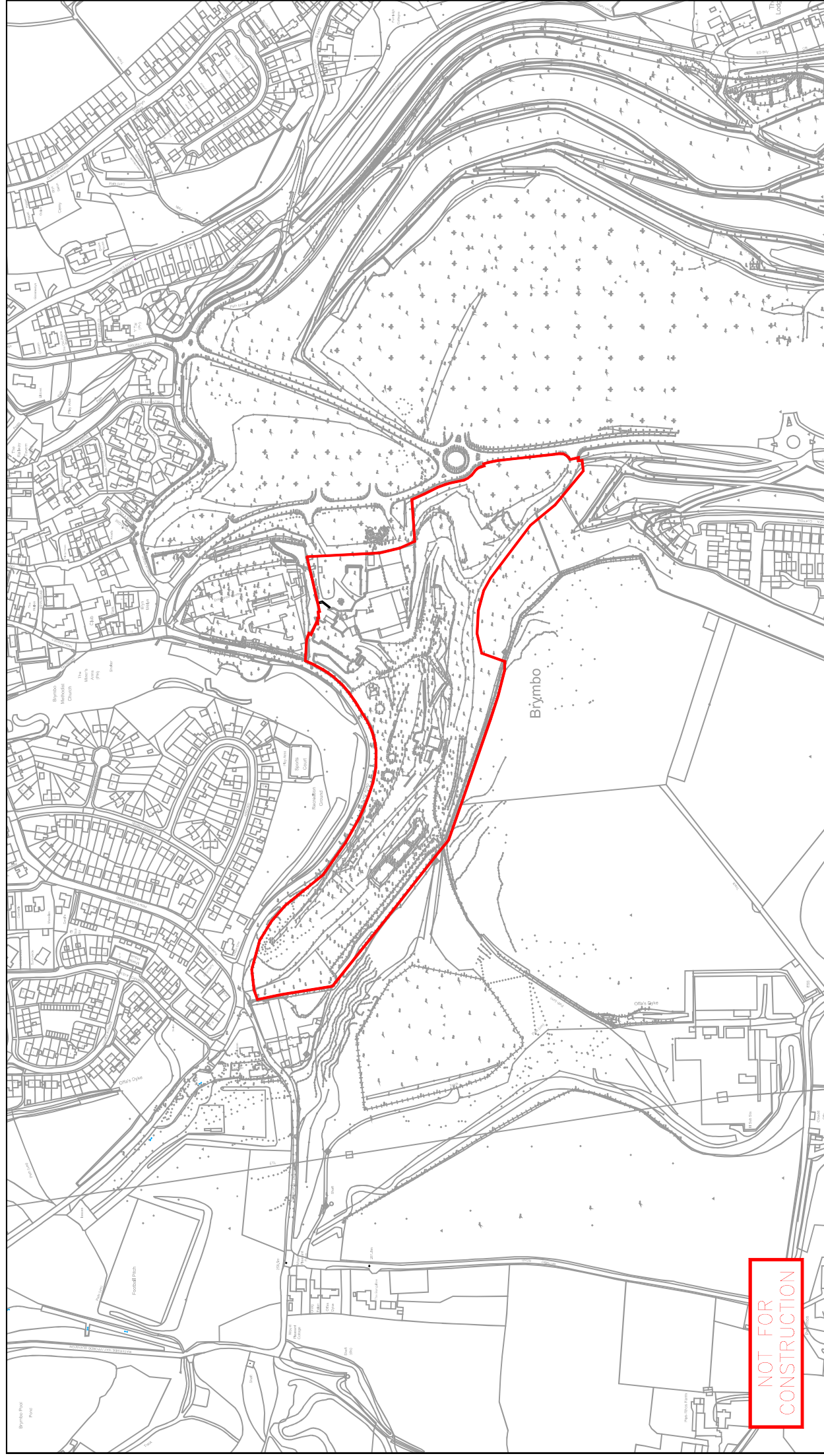
SuDS Component	Pollution Mitigation Indices		
	Total Suspended Soils (PMI _{TSS})	Hydrocarbons (PMI _{HM})	Heavy Metals (PMI _{PAH})
Filter Strip	0.9	0.8	0.7
Filter Drain	0.6	0.8	0.7
Swale	0.7	0.6	0.4
Bioretention System	0.8	0.8	0.8
Porous Paving	0.2	0.3	0.3
Infiltration Basin	0.05	0.05	0.05
Detention Basin	0.7	0.7	0.6
Pond	0.7	0.7	0.5
Wet Land	0.8	0.8	0.8
Proprietary Treatment Systems	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the 1 in 1-year return period event, for inflow concentrations relevant to the contributing drainage.		

3.73 The sum of the highlighted mitigation values (Bold) within each column of **Table 12** surpass the hazard values within **Table 12**, therefore suitable treatment of the surface water run-off from the site is provided.

APPENDICES

APPENDIX A

Proposed Site Location Plan



This drawing is to be read in conjunction with all relevant architects drawings and specifications.

Do not scale – use written dimensions only !

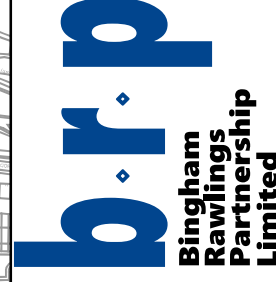
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Project:	BRYMBO HERITAGE PROJECT
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Detail:
LOCATION PLAN

Project No.	Drawing No.
4866	0001



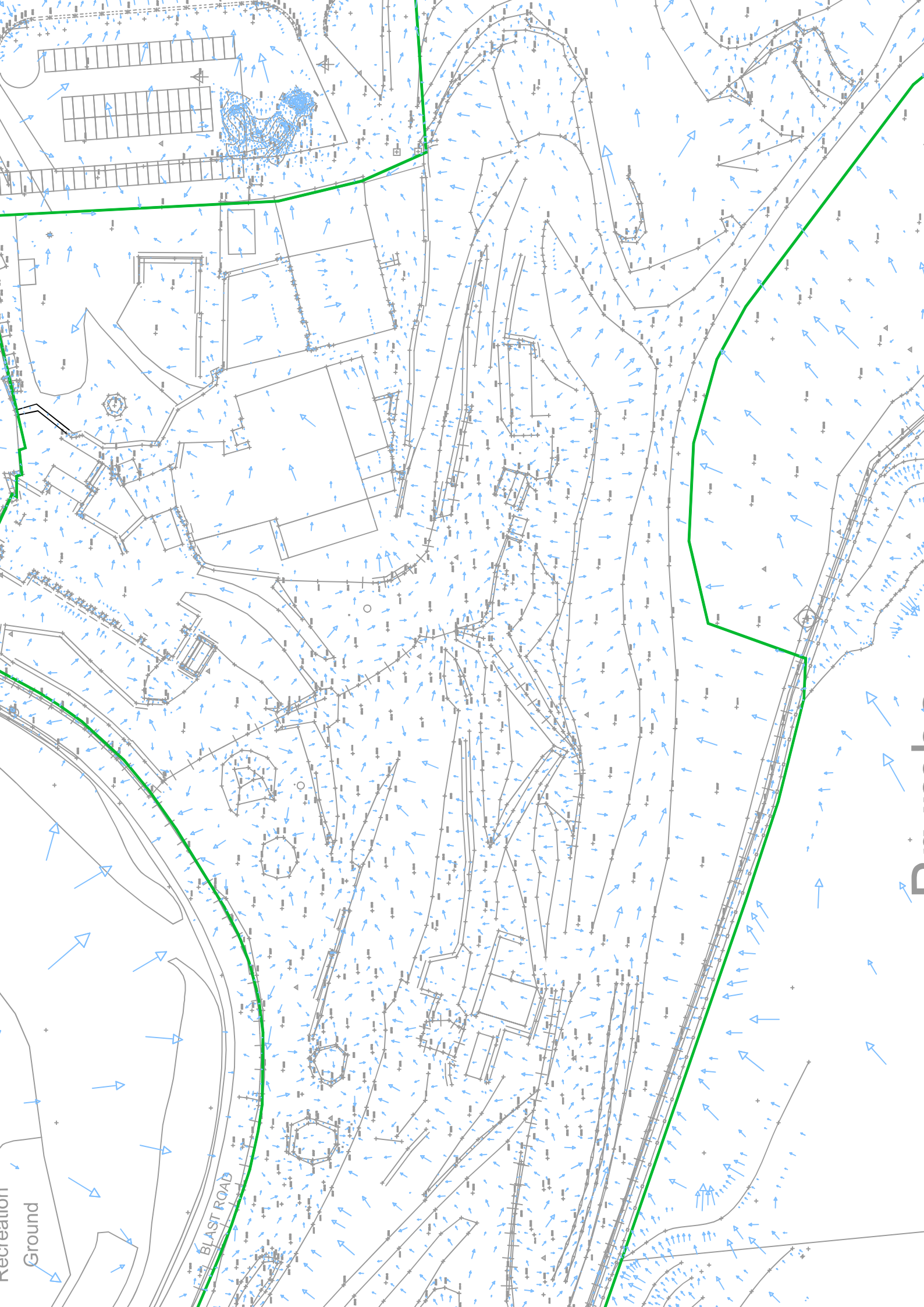
APPENDIX B

Proposed Site Layout



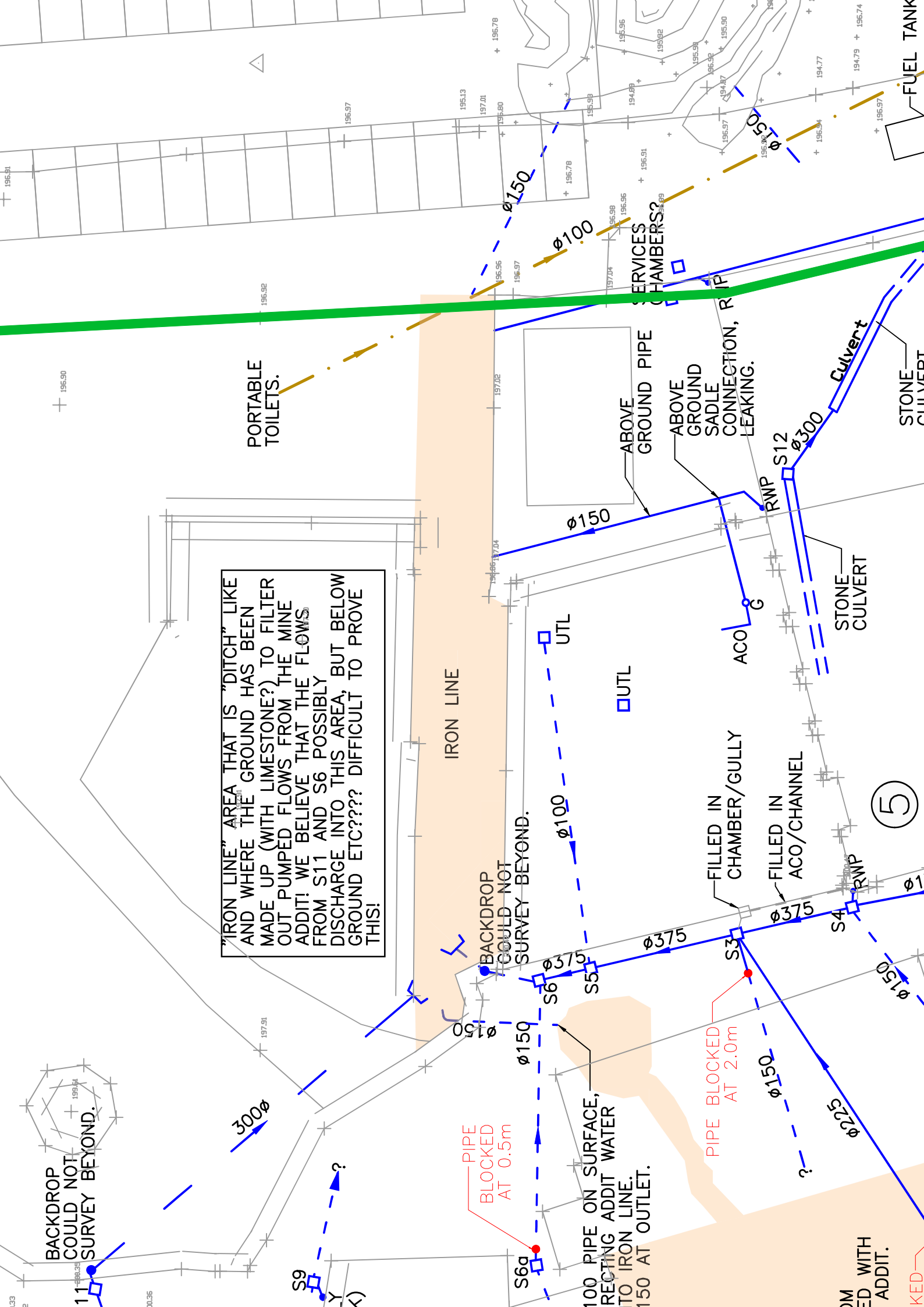
APPENDIX C

Existing Flood Routing



APPENDIX D

Existing Topographic Survey and Drainage Layout



BACKDROP
COULD NOT
SURVEY BEYOND.

"IRON LINE" AREA THAT IS "DITCH" LIKE
AND WHERE THE GROUND HAS BEEN
MADE UP (WITH LIMESTONE?) TO FILTER
OUT PUMPED FLOWS FROM THE MINE
ADDIT! WE BELIEVE THAT THE FLOWS
FROM S11 AND S6 POSSIBLY
DISCHARGE INTO THIS AREA, BUT BELOW
GROUND ETC??? DIFFICULT TO PROVE
THIS!

IRON LINE

PIPE
BLOCKED
AT 0.5m

PIPE ON SURFACE,
RECTIFYING ADDIT WATER
TO IRON LINE.
150 AT OUTLET.

PIPE BLOCKED
AT 2.0m

FILLED IN
CHAMBER/GULLY

FILLED IN
ACO/CHANNEL

ABOVE
GROUND PIPE

ABOVE
GROUND
SADDLE
CONNECTION, RIP
LEAKING.

SERVICES
CHAMBERS?

PORTABLE
TOILETS.

DM
ED WITH
ADDIT.

(5)

FUEL TANK

STONE
CULVERT

Culvert

STONE
CULVERT

RWP S12

ACO

RWP

S3

S4

S6

S5

S6

S9

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APPENDIX E

Dŵr Cymru / Welsh Water Apparatus Map



Scale: 1: 1033



329529,353519

- LEGEND**
- Clean Water
 - Sluice Val
 - Air Val, SINGLE
 - Tap
 - Pressure Reducing Valve
 - Meter
 - BULK Meter
 - FH
 - Cap
 - Existing Main
 - NON COMPANY
 - Sewerage External
 - Foul
 - Surface Water
 - Combined
 - Rising Main
 - Private
 - Treatment Works
 - Pumping Station
 - Special Purpose
 - Unknown End
 - Change, Combined Overflow
 - Outfall, FOUL
 - Lamp Hole, Foul
 - Private Sewer Transfer
 - Lateral Drain
 - Inspection Chamber

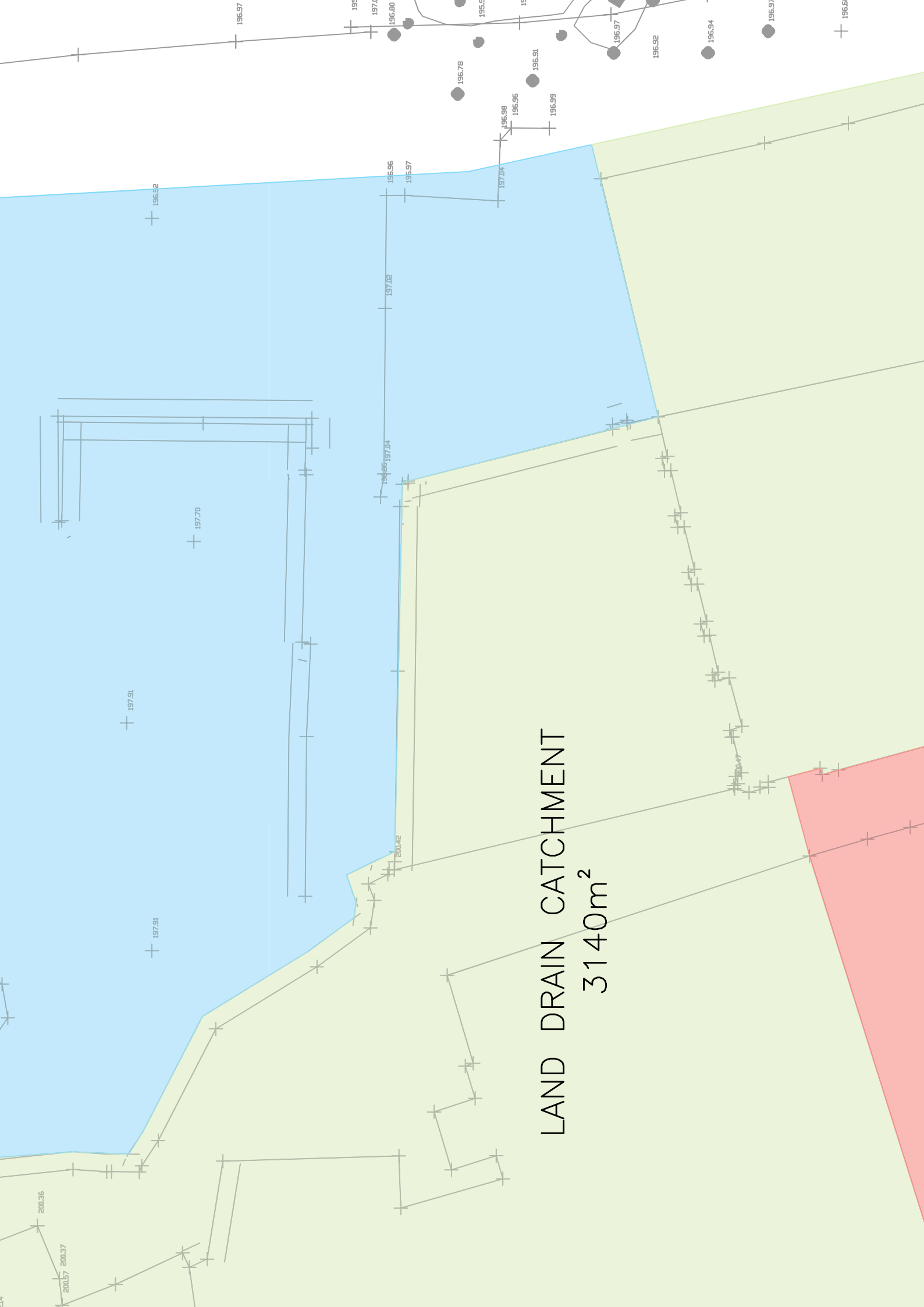
Dŵr Cymru Cyfyngedig ('the Company') gives this information as to the position of its underground apparatus by way of general guidance only, and on the strict understanding that it is based on the best information available and no warranty as to its correctness is relied upon. In the event of excavations or other works made in the vicinity of the company's apparatus and any onus of locating the apparatus before carrying out any excavations rests entirely on you. The information which is supplied hereby the company, is done so in accordance with statutory requirements of sections 198 and 199 of the Water Industry Act 1991 based upon the best information available and in particular, but without prejudice to the generality of the foregoing, it should be noted that the records that are available to the Company may not disclose the existence of a drain sewer or disposal main laid before 1 September 1989, or if they do, the particulars thereof including their position underground may not be accurate. It must be understood that the furnishing of this information is entirely without prejudice to the provision of the New Roads and Street Works Act 1991 and the company's right to be compensated for any damage to its apparatus.

EXACT LOCATION OF ALL APPARATUS TO BE DETERMINED ON SITE

Reproduced from the Ordnance Survey's Whistler every reasonable effort has been taken to maps with the permission of the Controller of Her Majesty's Stationery Office, Crown Copyright. Licence No. WU298565. It is therefore advisable that the possible presence of AC or PF pipes be anticipated and considered as part of any risk assessment prior to excavation.

APPENDIX F

Existing Area Plan



LAND DRAIN CATCHMENT
3140m²

196.52

197.70

197.51

197.51

196.96

195.97

197.02

197.04

200.42

197.04

196.98

196.96

196.99

196.78

196.91

196.92

196.94

196.97

196.55

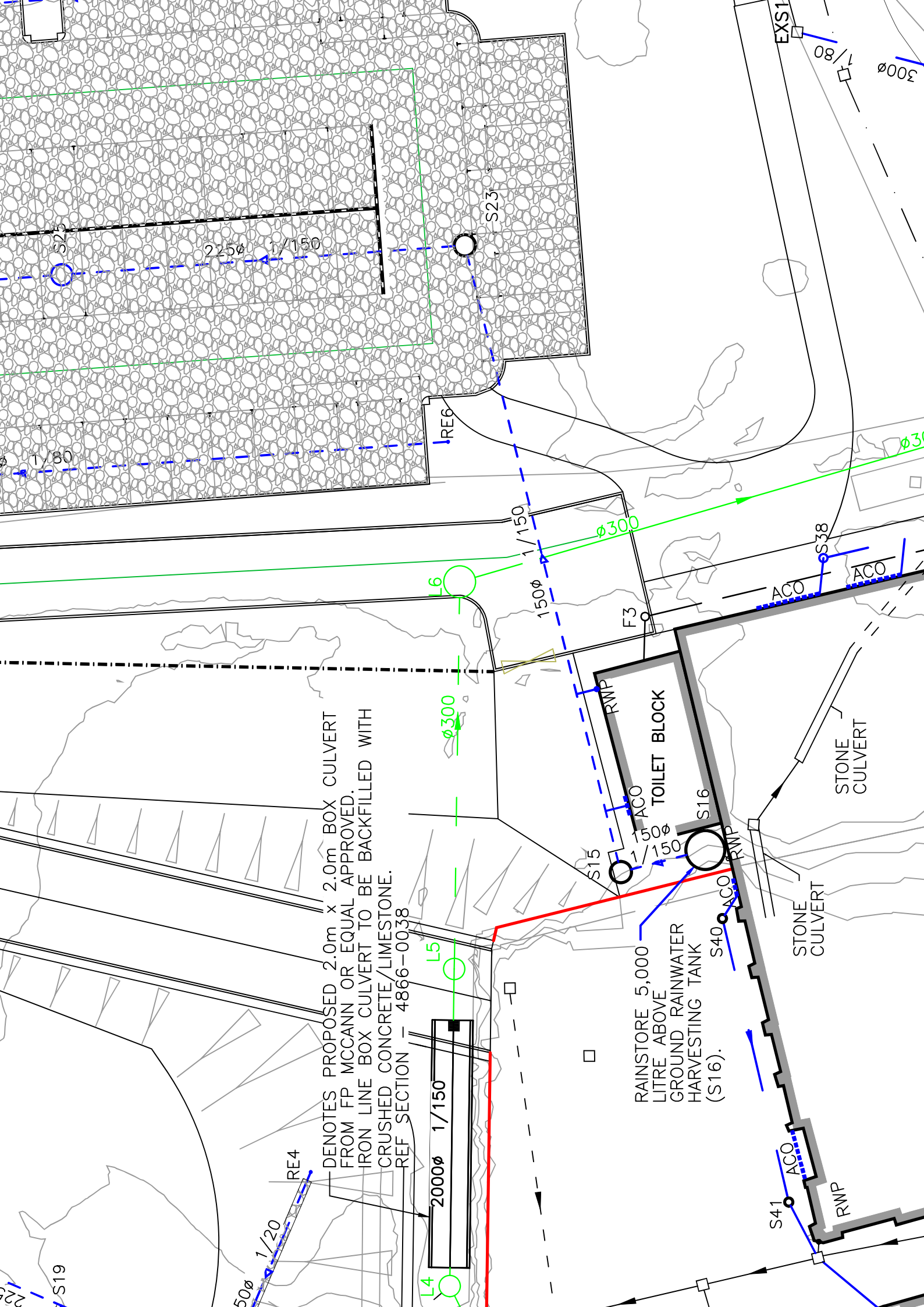
200.36

200.37

200.57

APPENDIX G

Proposed Drainage Layout



APPENDIX H

Proposed Areas



DISABLED PARKING(9)

MAIN CAR PA

TOILET BLOCK

INE SHOP

APPENDIX I

Wardell Armstrong Flood consequence assessment



BRYMBO DEVELOPMENTS LTD

FORMER BRYMBO STEELWORKS, WREXHAM

FLOOD CONSEQUENCE ASSESSMENT

AUGUST 2020

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BRYMBO DEVELOPMENTS LTD

FORMER BRYMBO STEELWORKS, WREXHAM

FLOOD CONSEQUENCE ASSESSMENT

AUGUST 2020

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ENERGY AND CLIMATE CHANGE
ENVIRONMENT AND SUSTAINABILITY
INFRASTRUCTURE AND UTILITIES
LAND AND PROPERTY
MINING AND MINERAL PROCESSING
MINERAL ESTATES
WASTE RESOURCE MANAGEMENT

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Appendix 2	TAN15 Development Advice Map
Appendix 3	Lead Local Flood Authority Correspondence
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DRAWINGS

ST16882-008 B	Site Location Plan
ST16882-006	Topographic Survey (Sheet 1 – 3)
ST16882-007 B	Indicative Surface Water Management Plan
ST16882-060	Overland Flow Routes
RG-M-04	Site Boundary (Revision B)
RG-M-05-1	Land Use Plan (Revision K)
P 47067923/43 Rev G	Site Wide Drainage Proposals

1 INTRODUCTION

1.1 General

1.1.1 Wardell Armstrong LLP has been commissioned to undertake a Flood Consequence Assessment (FCA) on behalf of Brymbo Developments Ltd, relating to the proposed mixed development of residential and commercial properties and a primary school along with areas of public open space at Brymbo, Wrexham as shown on Drawing No ST16882-008 '*Site Location Plan*'.

1.1.2 This assessment has been carried out in accordance with the guidance set out in the Welsh Government Technical Advice Note 15 '*Development and Flood Risk*' (TAN15).

1.2 Methodology

1.2.1 The methodology for this FCA has comprised a desktop study supplemented by liaison with the Lead Local Flood Authority (Wrexham County Borough Council) and Natural Resources Wales.

1.2.2 In accordance with TAN15, the following has been carried out in preparing this assessment:

- an assessment of the consequences of flooding to the development from a range of sources;
- an assessment of the consequences of flooding from the proposed development site; and
- consideration of recommendations for the management of the identified consequences.

1.2.3 In carrying out this assessment, reference has been made to relevant plans and documents, including:

- Planning Policy Wales (2004) *Technical Advice Note 15: Development and Flood Risk*;
- Wrexham Borough Council (2011) *Preliminary Flood Risk Assessment*;
- Wrexham Borough Council (2013) *Local Flood Risk Management Strategy*; and
- Wrexham County Borough Council (2016) *Flood Risk Management Plan 2016 – 2021*.

Planning Policy Wales

- 1.2.4 Technical Advice Note 15 (TAN15) “Development and Flood Risk” was published in July 2004 by the Welsh Assembly Government (WAG) and supplements the policy set out in Planning Policy Wales (PPW), 2016 (Edition 9). It gives guidance to planning authorities in Wales on how to respond on flood risk grounds to development proposals. TAN15 expects planning authorities to apply a risk-based approach to development planning and control through a Sequential Test involving location justification, type of development and flooding consequences.
- 1.2.5 In October 2017, the Welsh Government published the latest TAN15 Development Advice Maps (DAM’s) which show areas potentially at risk from flood events of a 0.1% annual probability for river, tidal or coastal areas (ie 1 in 1,000 year). The Development Advice Maps divide the land area of Wales into three flood risk zones. These are denoted A, B and C, with Zone C further sub-divided into Zones C1 and C2. The Flood Zones are described in further detail in Table 1 below.

Table 1: TAN15 Development Advice Map Flood Zones		
Zone	Description	Use within the precautionary framework
A	Considered to be at little or no risk of fluvial or tidal/coastal flooding.	Used to indicate that Justification Test is not applicable and no need to consider flood risk further.
B	Areas known to have been flooded in the past evidenced by sedimentary deposits.	Used as part of a precautionary approach to indicate where site levels should be checked against the extreme (0.1%) flood level. If site levels are greater than the flood levels used to define adjacent extreme flood outline there is no need to consider flood risk further.
C	Based on Environment Agency extreme flood outline, equal to or greater than 0.1% (river, tidal or coastal).	Used to indicate that flooding issues should be considered as an integral part of decision making by the application of the Justification Test including assessment of consequences.
C1	Areas of the floodplain which are developed and served by significant infrastructure, including flood defences.	Used to indicate that development can take place subject to application of Justification Test, including acceptability of consequences.
C2	Areas of the floodplain without significant flood defence infrastructure.	Used to indicate that only less vulnerable development should be considered subject to application of Justification Test, including acceptability of consequences. Emergency services and highly vulnerable development should not be considered.

- 1.2.6 Section 5 of TAN15 categorises development according to its vulnerability to flooding. There are three categories: emergency services; highly vulnerable development; and less vulnerable development. All residential premises and vulnerable industrial developments are categorised as highly vulnerable developments. Commercial, retail and general industrial development are categorised as less vulnerable developments.

Wrexham County Borough Council Preliminary Flood Risk Assessment

- 1.2.7 A Preliminary Flood Risk Assessment (PFRA) is a high-level screening exercise to identify areas where there is significant flood risk from local sources, namely ordinary watercourses, surface water runoff and groundwater. It does not directly consider flooding from main rivers or from sewers. PFRAs have been produced by Lead Local Flood Authorities (LLFAs) to fulfil statutory requirements in the Flood Risk Regulations 2009. In this case the LLFA is the Wrexham County Borough Council and the PFRA¹ was published in 2011.

Wrexham County Borough Council Local Flood Risk Management Strategy

- 1.2.8 The Local Flood Risk Management Strategy (LFRMS) report sets out the principles, objectives and measures for the management of local flood risk by Wrexham County Borough Council as the LLFA (where “local flood risk” is defined as “*surface water runoff, ground water and ordinary watercourses and included any lake, pond or other body of water that feeds from an ordinary watercourse*”). The report was published in April 2013.

Wrexham County Borough Council Local Flood Risk Management Plan 2016-2021

- 1.2.9 The Local Flood Risk Management Plan (LFRMP) was produced by Wrexham County Borough Council to build on the 2013 LFRMS report and aims to quantify the scale of the risk of local flooding across the County Borough and the relevant actions and measures required to reduce this within communities at risk. The plan was produced in July 2016.

¹ WREXHAM COUNTY BOROUGH COUNCIL (2011) *Preliminary Assessment Report*

2 SITE AND CATCHMENT CHARACTERISTICS

2.1 Site Description and Location

The site forms part of the wider land holding associated with the former Brymbo Steelworks in the village of Brymbo near Wrexham, some of which has already been significantly redeveloped. The site location is as shown on Drawing No ST16882-008 'Site Location Plan'.

Table 2: Site Summary	
Site Name	Iron Park (Former Brymbo Steelworks)
Site Address	Off Phoenix Drive, Brymbo, Wrexham, LL11 5BT
Site Area	13.41ha
National Grid Reference	329743, 353316 (approximate centre of site)
Proposed Development	Redevelopment of former steelworks
Local Planning Authority	Wrexham County and Borough Council
Lead Local Flood Authority	Wrexham County and Borough Council
Sewerage Undertaker	Welsh Water

- 2.1.1 The site area is approximately 13.41ha in size and irregular in shape. The former steelworks buildings which previously occupied this area have now been demolished and the land was the subject of a major land reclamation project from 2003 to 2005. The reclaimed area now generally consists of open ground and areas of rough vegetation.
- 2.1.2 The area is bounded to the north and east by open ground falling away from the site to the B5101 (New Road/Kent Road) and to the south by residential areas. Two link roads, Phoenix Drive and Blast Road run adjacent to the western boundary, meeting at a roundabout, with Phoenix Drive crossing the site area in a north-eastwards direction to join the B5101.
- 2.1.3 To the west of the site is the Ty Cerrig area separated from the site by an area of woodland. This area was formerly an opencast coal site during 1970s which was backfilled with the natural excavated materials and restored to open fields and hedgerows. Whilst Ty Cerrig formed part of the former steelworks development, this area is not included within the planning application and is not assessed further in this FCA.

- 2.1.4 This area of the site consists primarily of two gently-sloping plateaux separated by the Phoenix Drive link road (the “northern plateau” and “southern plateau”). The larger southern plateau falls generally northwards from a maximum elevation of approximately 203.40mAOD at the southern boundary to a minimum elevation of approximately 193.65mAOD at its northern extent at an approximate gradient of 1 in 60. At the northern and eastern extents, ground levels slope steeply away from the plateaux areas.
- 2.1.5 The northern plateau area is situated up to 2.0m lower than the unnamed adjacent access road to the west. Ground levels fall in a south-eastwards direction from a maximum elevation of 204.92mAOD adjacent to the unnamed access road in the north-western corner, down a 1 in 2.5 slope to a flatter area. Ground levels in this area also fall in a south-eastwards direction at a gradient of approximately 1 in 50 to a minimum elevation of 193.03mAOD adjacent to Phoenix Drive.
- 2.1.6 The topography of the site is shown on Drawing No ST16882-006 (Sheet 1 – 3) ‘*Topographic Survey*’.

2.2 Existing Drainage Regime

- 2.2.1 There are no Main Rivers within the site area. The nearest Main River is the River Cegidog (Afon Cegidog) located approximately 1.3km to the north of the site at its closest point. There are also no Ordinary Watercourses within the site areas.
- 2.2.2 Welsh Water’s public sewer records (see Appendix 1) show a public combined sewer flowing in a south-eastwards direction from an access road adjacent to the steelworks’ ‘heritage site’ buildings, crossing both plateaux areas and discharging to a public combined sewer in the B5101 approximately 300m to the east of the site.
- 2.2.3 The sewer is understood to have previously linked the former steelworks’ buildings within the heritage site to a sewage treatment plant located within the main steelworks’ site. The buildings of the Enterprise Centre to the north of the heritage site are served by a separate public combined sewer in Blast Road. The sewage treatment plant was demolished along with the steelworks and this sewer is considered to be redundant. There are no manholes or gullies shown along the route of the sewer on the topographic survey of the site (see Drawing No ST16882-006 (Sheet 1 – 3) ‘*Topographic Survey*’) and it is not known whether the sewer is still present following the reclamation works.

- 2.2.4 It is assumed that any private drainage network serving the former steelworks was removed during the reclamation works and it is considered, therefore, that these previously developed areas of the site now have characteristics similar to that of a greenfield site with surface water runoff dispersing by a combination of infiltration and evapotranspiration with no discharge to a private or public drainage network.
- 2.2.5 Public surface water, foul water sewers and highway drains are located along Phoenix Drive which runs adjacent to, and subsequently crosses, the site area as shown on Drawing No P 47067923/43 Rev G '*Site Wide Drainage Proposals*'. The sewers flow generally in a northwards direction within the road, with the surface water sewer discharging to an existing culvert flowing in a south-eastwards direction adjacent to the B5101. This culvert formerly received flows from the Brymbo Steelworks but this upstream catchment was closed off during the reclamation of the steelworks and it no longer receives flows from this catchment. The foul sewer connects to the existing public foul sewer flowing in a south-eastwards direction along the B5101.
- 2.2.6 Surface water and foul water stub connections in Phoenix Drive have been provided on the sewers in anticipation of the adjacent future development and do not currently accept any flows other than surface water road drainage. Following development at the site it is proposed that these are adopted by Welsh Water.

2.3 Ground Conditions

- 2.3.1 The British Geological Survey 'Geology of Britain Viewer', available online², shows that the majority of the site area is underlain by mudstone, siltstone and sandstone of the Pennine Lower Coal Measures Formation. Small areas in the north-eastern and south-western parts of the site are underlain by sandstone of the Pennine Lower Coal Measures Formation. The online DEFRA 'Magic' Map Application³ shows the bedrock is classified as a 'Secondary A' aquifer, defined as '*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*'.
- 2.3.2 A narrow section of superficial alluvium deposits is aligned along a north-west/south-east axis and extends into the north-eastern corner of the site area. These deposits are classified as a 'Secondary A' aquifer.

² BRITISH GEOLOGICAL SURVEY *Geology of Britain Viewer*. Available from <http://mapapps.bgs.ac.uk/geologyofbritain/home.html>

³ DEFRA *Magic Map Application* Available from: <http://magic.defra.gov.uk/MagicMap.aspx>

- 2.3.3 The online Cranfield Soil and Agrifood Institute 'Soilscales' viewer ⁴shows that soils at the site area are '*slowly permeable, seasonably wet acid loamy and clayey soils*'.
- 2.3.4 During the 240 years development of the Steelworks site, the natural strata were overtipped with waste iron/steel-making slags to create development plateaux for the expanding operations. The mudstones, siltstones excavated during the recent reclamation works, in particular an excavation in the central area of the site to recover the shallow residual coal and remove the risk of ground instability, were used subsequently to cover the slag wastes with a minimum of 5m cover of compacted material to facilitate subsequent built development. This has formed a relatively impermeable cover across the site such that it is considered that surface rainwater disperses more by runoff and evapotranspiration rather than infiltration.

⁴ CRANFIELD SOIL AND AGRIFOOD INSTITUTE *Soilscales*. Available from <http://www.landis.org.uk/soilscales/>
ST16882/0002/FINAL
AUGUST 2020

3 DEVELOPMENT PROPOSALS

3.1 Description of Proposals

- 3.1.1 Outline planning permission for up to 300 dwellings (Class C3 use), provision of a primary school (2-form entry), small district centre comprising up to 1,395sqm of Class A1 Retail, up to 372sqm of Class A3 Restaurant/Public House, up to 465sqm of Class D1 use, multi-functional green infrastructure, including children's play areas and informal open space, surface water attenuation, vehicle accesses, car parking, engineering works, public footpaths and hard and soft landscaping, underground services, and all ancillary and enabling works, with all matters reserved except for vehicular access from Brymbo Road.
- 3.1.2 The proposed layout is as shown on Drawing No RG-M-05 (Revision K) '*Land Use Plan*'.
- 3.1.3 In Figure 2 of TAN15, residential developments and public buildings such as schools are both categorised as '*Highly Vulnerable*' developments'. Commercial and retail developments are categorised as a '*Less Vulnerable*' development'.
- 3.1.4 The 'Development Advice Map' for flood risk obtained from the Natural Resources Wales website (see Appendix 2) shows that the majority of the site is located within Zone A, described in TAN15 as an area '*considered to be at little or no risk of fluvial or tidal/coastal flooding*'. A small section of the eastern boundary is shown to be located within Zone B, described in TAN15 as '*areas known to have been flooded in the past evidenced by sedimentary deposits*'.

3.2 Flood Risk Vulnerability

- 3.2.1 The nature of the proposed development, which includes residential premises and public buildings, is classified as a '*Highly Vulnerable*' development based on Section 5 of TAN15.

3.3 Justification Test

- 3.3.1 The Justification Test aims to direct new development away from Zone C and towards land in Zone A (or otherwise Zone B). A new '*Highly Vulnerable*' development would only be permitted within Zone C) if it is deemed to be justified in that location.
- 3.3.2 The majority of land within the site is located within Zone A. A small area of residential development in the eastern part of the site will, however, extend into the area of Zone B.

3.3.3 As all development will be located outside of Zone C, the Justification Test is considered to be passed.

4 FLOOD CONSEQUENCE ASSESSMENT

4.1 Historical Flooding

4.1.1 Historical flood mapping in the Wrexham County Borough Council LFRMS and PFRA reports and on the Natural Resource Wales Flood Risk website⁵ do not show any historic flooding incidents in the vicinity of the site.

4.1.2 Wrexham County Borough Council state in response to the enquiry submitted as part of this assessment (see Appendix 3) that they hold no information of any flooding events within the site boundary.

4.2 Consequences of Flooding to the Development

4.2.1 Flooding can occur from a range of sources including, but not limited to rivers, tidal waters and the sea, surface water runoff, groundwater, sewers and drains, and artificial sources such as canals and reservoirs. The presence of a potential flooding source does not, however, necessarily translate into a high risk of flooding. Following the source-pathway-receptor approach, flooding can only affect the site (receptor) if there is a pathway from the identified sources.

4.3 Flooding Consequences to the Proposed Development

Fluvial Flooding

4.3.1 The site is not located in the vicinity of a Main River or Ordinary Watercourse. The closest Main River to the site is located approximately 1.3km to the north of the site at its closest point and is situated approximately 100m lower than the lowest elevation of the site. Consequently, this watercourse is not considered to pose a risk of flooding to the site. The Natural Resources Wales 'Flood Risk Map' for fluvial flooding (see Figure 1) shows that an area of Flood Zone 3 is located adjacent to the River Gwenfrom approximately 1km to the south of the site. Areas of Flood Zone 3 are defined as land with a greater than 1 in 100 year annual probability of fluvial flooding. Due to the distance from the site and that the site is approximately 50m higher than the area of Flood Zone 3, it is not considered to pose a risk of flooding.

4.3.2 As shown on the Development Advice Map (see Appendix 2), a small area near the eastern boundary is shown to be located within Zone B. This is coincident with a section of alluvium bedrock extending to the River Gwenfro/Afon Gwenfro, located

⁵ NATIONAL RESOURCES WALES *Flood Risk Map* Available from: <https://www.naturalresources.wales/our-evidence-and-reports/maps/flood-risk-map/?lang=en>

approximately 1km to the south of the site. Based on the definition of Zone B in TAN15 'Areas known to have been flooded in the past evidenced by sedimentary deposits' it is considered that the Zone B classification is based on the presence of alluvium deposits only. As the River Gwenfro is situated approximately 30m lower than the site, it is not considered to pose a risk of fluvial flooding to the site.

Tidal Flooding

- 4.3.3 Due to the distance of the site from the sea and tidally-influenced watercourses, the risk of tidal flooding is discounted.

Surface Water Flooding

- 4.3.4 The Natural Resources Wales 'Flood Risk Map' for surface water flooding (see Figure 2) shows the majority of the site is not at risk of surface water flooding. Areas in the north are shown to be at risk of surface water flooding.

Groundwater Flooding

- 4.3.5 The Wrexham County Borough Council PFRA identifies no record of past groundwater flooding incidents and states that information ascertained from the British Geological Survey and Environment Agency shows the Wrexham County Borough Council area is not susceptible to groundwater flooding due to its geology.

Sewer Flooding

- 4.3.6 It is considered that any sewers serving the former steelworks in the site area have been removed during the reclamation works. Sewers and highway drainage are present in Phoenix Drive which runs adjacent to the western boundary as shown on Drawing No P 47067923/43 Rev G 'Site Wide Drainage Proposals'. Public sewer records (see Appendix 1) also show a public sewer crossing the site area from the former steelworks' buildings of the 'heritage site' to the B5101.

Artificial Flooding

- 4.3.7 The Natural Resources Wales 'Flood Risk Map' shows the site is not located in an area considered to be at risk from reservoir flooding. There are no canals or impounded bodies of water in the vicinity of the site.



Figure 1. Fluvial Flood Risk



Figure 2. Surface Water Runoff (Overland Flow) Flooding Extent



Figure 3. Surface Water Runoff (Overland Flow) Flooding Velocities

4.4 Potential Sources of Flooding

4.4.1 Table 2 summarises the flood consequences to the proposed development.

Table 2: Summary of Flood Consequences to the Site			
Type	Source	Pathway	Risk
Fluvial Flooding (Rivers)	N	N	n/a
Tidal Flooding	N	N	n/a
Surface Water Runoff	Y	Y	Low
Groundwater Flooding	Y	N	n/a
Sewer/Drain Flooding	Y	Y	Low
Artificial Flooding	N	N	n/a

4.4.2 The potential sources with a pathway to the site are, therefore, as follows:

- surface water; and
- sewers.

Surface Water Runoff (Overland Flow) Flooding

4.4.3 On land where there is impermeable surfacing or where the ground infiltration capacity is exceeded there is the potential for surface water runoff to occur.

4.4.4 Based on National Resources Wales mapping (see Figure 2), the majority of this area of the site and its vicinity are shown to be at a Very Low risk of surface water flooding (defined as an annual probability of flooding of less than 1 in 1000 (0.1%)). Small isolated areas in central and southern areas are shown to be at Low risk (defined as an annual probability of flooding between 1 in 1000 (0.1%) and 1 in 100 (1%)) and are considered to be coincident with low-lying areas and do not represent a risk of flooding to the wider site area.

4.4.5 An area at the northern extent of the southern plateau is shown to be at Low risk and is the upstream extent of a small valley-like feature extending northwards from the site to the B5101. Any surface water runoff accumulating in this area would flow away from the site following the topography as indicated by the flow direction arrows on Figure 3.

- 4.4.6 A second area in the northern plateau is shown to be at Medium to High risk (where Medium risk is defined as an annual probability of flooding of between 1 in 100 (1%) and 1 in 30 (3.3%), and High risk is defined as an annual probability of greater than 1 in 30 (3.3%)). This area extends eastwards from Blast Road, to the west of the site, through the area of historic buildings to the B5101 via Phoenix Drive crossing a narrow section of the northern plateau area of the site. The mapping would suggest that this is part of a wider overland flow route which follows the natural topography.
- 4.4.7 To confirm the presence of any overland flow routes crossing the site, a survey of the area between Blast Road and the site was undertaken in January 2020. The survey (see Drawing No ST16882-026 '*Overland Flow Routes*') indicates that based on topography, surface water runoff could accumulate to the rear of the existing buildings within the 'heritage site' and progress around the northern extent of the buildings onto land adjacent to Phoenix Drive as indicated on Figure 3. As this land is marginally lower than land to the east, there would be minimal opportunity for runoff to progress further into the wider site area in the majority of storm events. A bund could be constructed in this area to further limit pathways into the wider site area.
- 4.4.8 As shown on Drawing No ST16882-060 '*Overland Flow Routes*', a second potential pathway could exist for runoff to continue eastwards along a track towards an area of woodland. It is proposed that a soft landscape barrier is constructed in this area to divert flows northwards towards the heritage site.
- 4.4.9 The risk of surface water flooding in this area of the site is, therefore, considered to be **LOW**.

Sewer Flooding

- 4.4.10 Welsh Water's public sewer records (see Appendix 1) show a public combined sewer crossing in a south-eastwards direction from the heritage site through the site area. The depth of the sewer is not shown on the sewer records. The sewer previously served the buildings within the heritage site, connecting these to a sewage treatment plant within the main steelworks site. The status of this sewer is not known following the demolition and remediation works at the site. It is assumed that there are no remaining private sewers within the former steelworks area.
- 4.4.11 No manholes were recorded on the topographic survey of the site and it is considered that there would be no pathways for any flooding from sewers to emerge within the site area.

- 4.4.12 As shown on Drawing No P 47067923/43 Rev G '*Site Wide Drainage Proposals*', surface water and foul water sewers are present within Phoenix Drive which runs adjacent to the western boundary of the site area and crosses between the two plateau areas to join the B5101.
- 4.4.13 It is understood that these surface water sewers are over 1.2m below ground level. They are considered to be at a sufficient depth to assume that the risk of flooding from surcharged manholes is minimal. Furthermore, it is understood that the sewer network has been designed to receive flows from developed areas and highways within the site area only and has been suitably-sized (based on MicroDrainage modelling undertaken at the design stage) to accommodate all flows up to and including the 1 in 100 year storm event (including an allowance for climate change).
- 4.4.14 It is understood that the foul water sewers are over 1.4m below ground level. They are considered to be at a sufficient depth to assume that the risk of flooding is minimal. As with the surface water network, it is understood that the foul water sewer network will receive flows from the proposed development only and has been suitably-sized (based on MicroDrainage modelling).
- 4.4.15 Based on the available information, the risk of sewer flooding in this area is considered to be **LOW**.

4.5 **Flooding Consequences from the Proposed Development**

- 4.5.1 New development can pose a risk of flooding to neighbouring properties and areas downstream of the site often as a result of the loss of floodplain storage, an increase in impermeable area which has the effect of increasing the rate and volume of surface water runoff, or alterations to the surface water flow regime.

Fluvial Flooding

- 4.5.2 The proposed development is not located in the vicinity of a Main River and there will be no loss of floodplain storage or diversion of flood flows as a result of the proposed development.

Surface Water Flooding

- 4.5.3 The site currently consists of large areas of open ground and rough vegetation. Despite the brownfield nature of the site, it is considered that the site currently displays the characteristics of a 'greenfield' site in terms of surface water drainage, with surface water dispersing by a combination of infiltration and evapotranspiration.

- 4.5.4 As a result of the proposed development, the impermeable area of the site will increase and, as a result, the rate and volume of surface water runoff generated during storm events could also be expected to increase. Without mitigation, this could lead to an increase in flood risk to areas downstream of the site.

Climate Change

- 4.5.5 It is also necessary to take account of climate change for the lifetime of the development when assessing future flood risk. New climate change guidance was published by the Environment Agency in February 2016⁶. The guidance provides predictions of anticipated change to peak rainfall intensity. In assessing surface water runoff from the proposed development, the climate change predictions for peak rainfall intensity for the lifetime of the development need to be taken into account.
- 4.5.6 Wrexham County Borough Council (the Lead Local Flood Authority) state that an increased intensity of 30% is acceptable (see Appendix 3).
- 4.5.7 It is considered, therefore, that the risk of surface water flooding could increase as a result of the proposed development and that mitigation measures are required.

4.6 Flood Management Plan

Surface Water Management

- 4.6.1 To mitigate the potential increase in flood risk to areas downstream of the site, surface water runoff from the proposed development which exceeds the restricted discharge rates will be retained and attenuated within the site areas for all storm events up to and including the 1 in 100 year event, including a 30% allowance for climate change recommended by Wrexham County Borough Council in correspondence (see Appendix 3). To help to achieve this, Sustainable Drainage Systems (SuDS) will be incorporated into the development to provide attenuation. Further details are included in the Drainage Strategy (see Section 5).
- 4.6.2 Any incoming overland flow from higher land to the west of the site will be retained in open space within the site area for the majority of storm events. Were the capacity of this area to be exceeded during extreme storm events, any exceedance flows will progress through the site north-eastwards to the B5101 as indicated on Figure 2 without diversion to other off-site areas previously unaffected.

- 4.6.3 The risk of flooding to areas downstream of the site will not, therefore, increase as a result of the proposed development.

Residual Risk

- 4.6.4 There is always a possibility of a storm event that exceeds the design standards of the proposed flood risk management measures for new developments. Potential risks include exceedance of the on-site surface water attenuation facilities during storm events.
- 4.6.5 On-site attenuation will be provided for storm events up to and including the 1 in 100 year storm event, including an appropriate allowance for climate change. For storm events with an annual probability of occurrence greater than this the on-site attenuation may be exceeded. It is considered that the probability of the attenuation facilities being exceeded is extremely low (eg freeboard included within detention basins for safety reasons will provide additional temporary storage during extreme storm events). Furthermore, all SuDS features will be located within shared spaces and open ground away from properties. Were the attenuation capacity of these features to be exceeded, exceedance flows could be managed by landscaping and features such as kerbing or speed humps to prevent properties and off-site areas from being affected.

⁶ GOV.UK (February 2016). *Guidance – Flood Risk Assessments: Climate Change Allowances*. Available from: <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>

5 DRAINAGE STRATEGY

Surface Water Runoff Attenuation

- 5.1.1 Surface water runoff from the development will be controlled on site to ensure that there is no increase in the risk of flooding to areas downstream of the site, and to the development itself. To help to achieve this, Sustainable Drainage Systems (SuDS) will be incorporated into the development to provide attenuation.
- 5.1.2 An indicative Surface Water Management Plan is shown on Drawing No ST16882-007 '*Indicative Surface Water Management Plan*'.
- 5.1.3 The Building Regulations (2010) Part H stipulate a hierarchy for the disposal of surface water, which should be followed as part of any surface water drainage design. This hierarchy is as follows:
- i. an adequate soakaway or some other adequate infiltration system; or, where that is not practicable,
 - ii. a watercourse; or, where that is not practicable,
 - iii. a sewer.
- 5.1.4 Due to the historical land use at the former steelworks site and the large sub-surface volumes of Made Ground (including waste iron and steel slags), it is not considered feasible to use infiltration drainage within the area of the site. Surface water inundation of the sub-surface materials would risk unacceptable ground settlement and risk the mobilisation of any contaminants, which may be present.
- 5.1.5 It is proposed, therefore, to discharge surface water runoff from the site to the culverted watercourse located to the north of the site via the existing drainage network in Phoenix Drive, which was designed and constructed to serve future developments at the site.
- 5.1.6 Discharge from the sewer network to the culverted watercourse will be restricted to a rate of 769 l/s for all storm events up to the 1 in 100 year storm event (including an allowance for climate change), as agreed with Welsh Water in 2016 as part of a previous planning application and S106 Agreement.
- 5.1.7 This discharge rate is based on the rate at the outfall from the site for the 1 in 100 year storm event determined, from modelling undertaken by URS Infrastructure and Environment Ltd in 2015 (see Appendix 4). This models the sewer network within the

highways in the site area and includes runoff from the roads and incoming flows from the heritage site and enterprise centre located outside of the site boundary.

5.1.8 The model assigns nominal impermeable areas to six of the seven existing 'stub' connections into the main sewer within Phoenix Drive in order to calculate the flows entering the sewer network. These modelled flow rates are shown on Drawing No. P 47067923/43 Rev G 'Site Wide Drainage Proposals'

5.1.9 For the proposed surface water drainage strategy the site will be divided into seven subcatchments each discharging via an existing stub connection. The agreed discharge rate for each outfall and contributing impermeable areas within the associated subcatchment, based on the proposed site layout, is shown in Table 3 below.

5.1.10 The outfall from Catchment C does not have an agreed discharge rate and the proposed rate of 10 l/s for the 1 in 100 year storm event is based on the rate proposed for the "Ty Cerrig" catchment in the 2015 model. This area, located to the west of the site, will no longer be developed as part of the planning application and there will be no discharge into the Phoenix Drive drainage network.

Table 3: Restricted Discharge Rates and Contributing Areas				
Catchment	Contributing Impermeable Area		Discharge Rate (1 in 30 year)	Discharge Rate (1 in 100 year)
	Buildings/Infrastructure ¹	Access Roads		
A	1.35 ha	0.30 ha	101.1 l/s	125 l/s
B	0.89 ha	0.55 ha	32.8 l/s	39 l/s
C ²	0.71 ha	0.27 ha	6.8 l/s	10 l/s
D	0.37 ha	-	18.7 l/s	22 l/s
E	0.39 ha	-	14.8 l/s	17 l/s
F	0.36 ha	-	62.4 l/s	72 l/s
Additional flows (off site areas and access roads)			484 l/s	484 l/s
Total	4.07 ha	1.12 ha	720.6 l/s	769 l/s
1. Impermeable area based on density of 35% for residential areas, 60% for district centre and 95% for retail and leisure 2. Discharge rate for outfall C not specified on Drawing No. P 47067923/43 Rev G. Proposed rate based on rate of nearby land of Ty Cerrig.				

5.1.11 It is proposed that flows in excess of the restricted discharge rate will be attenuated within each subcatchment or adjacent areas of public open space for all storm events up to and including the 1 in 100 year event (including an allowance for climate change). The required attenuation for each subcatchment was calculated using Causeway software. Calculations are contained in Appendix 5 and summarised in Table 4 below.

Table 4: Summary of Flood Consequences to the Site					
Catchment	Restricted Discharge Rate		Impermeable Area	Estimated Attenuation	
	1 in 30 year	1 in 100 year		1 in 30 year	1 in 100 year (+ 30% climate change)
A	101.1 l/s	125 l/s	1.65 ha	193	398
B	32.8 l/s	39 l/s	1.44 ha	285	569
C	6.8 l/s	10 l/s	0.98 ha	317	552
D	18.7 l/s	22 l/s	0.37 ha	49	102
E	14.8 l/s	17 l/s	0.39 ha	60	125
F	62.4 l/s	72 l/s	0.36 ha	20	47
Attenuation calculations exclude infiltration to provide a 'worst case' estimate					

5.1.12 An indicative surface water drainage strategy is shown on Drawing No. ST16882-007 '*Indicative Surface Water Management Plan*'. The management plan shows potential locations of larger attenuation features such as swales and detention basins within areas of open space, however, the internal layout within land parcels is unconfirmed and specific SuDS features feasible for use within each area are not specified at this stage.

5.1.13 A variety of SuDS techniques are discussed within The SUDS Manual⁷ (CIRIA 753) and many of these could, as outlined in Table 5, potentially be suitable for use of the site.

⁷ CIRIA (2015) *The SuDS Manual* (C753)

Table 5. Sustainable Drainage System (SuDS) Options and Suitability			
Type	Device	Description	Suitability
Source Control	Green roof	Green roofs are systems which cover a building's roof with vegetation. They are laid over a drainage layer, with other layers providing protection, waterproofing and insulation.	Green roofs are not generally suitable for private dwellings within large scale development sites, however, may be suitable for non-residential buildings.
	Infiltration devices	Infiltration devices temporarily store runoff from a development and allow it to percolate into the ground.	Due to the brownfield nature of the development and presence of Made Ground at the former steelworks site, the ground conditions are unsuitable for infiltration drainage.
	Pervious surfaces	Pervious surfaces allow rainwater to infiltrate through the surface into an underlying storage layer, where water is stored before infiltration to the ground, reuse, or release to surface water or sewers.	Permeable paving would be suitable for roadways and parking areas within this site. This would allow surface water to be filtered through the paving before being collected underground and connected to attenuation areas.
	Bioretention systems	Shallow landscaped depressions (eg tree pits, rain gardens) generally used for intercepting, managing and treating runoff from frequent rainfall events.	Suitable for use in shared open space. Runoff would be filtered through soils and vegetation and collected in an underdrain system and discharged to attenuation areas.
	Rainwater harvesting	Rainwater harvesting reduces the amount of runoff from a site by re-using the water for non-potable uses.	Rainwater harvesting may potentially be suitable for use within the development.
Permeable Conveyance	Filter strips	These are wide, gently sloping areas of grass or other dense vegetation that treat runoff from adjacent impermeable areas.	Filter strips may potentially be suitable for use within the development.
	Swales	Swales are broad, shallow channels covered by grass or other suitable vegetation. They are designed to convey and/or store runoff and can infiltrate the water into the ground (if ground conditions allow).	Swales may potentially be suitable for use within land parcels as conveyance and storage. Site ground conditions do not facilitate ground infiltration.
Passive treatment/ end of pipe treatment	Infiltration basins	Infiltration basins are depressions in the surface that are designed to store runoff and infiltrate the water to the ground. They may also be landscaped to provide aesthetic and amenity value.	Due to the brownfield nature of areas of the development and presence of Made Ground, the ground conditions are unsuitable for infiltration drainage.

Table 5. Sustainable Drainage System (SuDS) Options and Suitability			
Type	Device	Description	Suitability
	Detention basins	Detention basins are depressions which are designed to store runoff prior to discharge to a watercourse or sewer. They may also be landscaped to provide aesthetic and amenity value.	Detention basins are considered to be suitable within areas of open space at the site.
	Wet ponds	Wet ponds are basins that have a permanent pool of water for water quality treatment. They provide temporary storage for additional storm runoff above the permanent water level. Wet ponds may provide amenity and wildlife benefits.	Wet ponds may potentially be suitable for use within areas of open space at the site.
	Constructed wetlands	Constructed wetlands are ponds with shallow areas and wetland vegetation to improve pollutant removal and enhance wildlife habitat.	Constructed wetlands may potentially be suitable for use on the site.
	Underground attenuation	Underground attenuation can be used where other forms of SuDS are not appropriate for the site. Underground attenuation stores water for volumes above the allowable discharge rate and releases the water at the restricted discharge rate.	Underground attenuation would be suitable for use on the site and could be used in conjunction with permeable paving. Unlined underground attenuation stores are not considered appropriate.

Surface Water Quality

5.1.14 In accordance with ‘good practice design’ in the SuDS Manual, the quality of surface water runoff will be managed within the proposed development to treat and remove pollutants to protect receiving waters downstream of the site. Treatment will be provided within SuDS features individually or as part of a chain of features forming a treatment ‘train’.

5.1.15 SuDS features provide treatment by ‘velocity control’ (sediment deposition and filtration by the control of velocities within SuDS components) and ‘retention time’ (removal of contaminants through settling, adsorption and other treatment over the time that the water is in contact with the ‘treatment media’ within the SuDS components).

- 5.1.16 SuDS features proposed in the Indicative Surface Water Management Plan which could be incorporated into the drainage strategy for the site include swales, bioretention systems, permeable paving and detention basins.
- 5.1.17 Dividing the proposed development into subcatchments, each with its own drainage network, will allow runoff to be treated closer to the source rather than being conveyed downstream to a single site control feature and will allow more stages of treatment to be incorporated upstream of the discharge point.

6 CONCLUSIONS

- 6.1.1 This report gives details of the Flood Consequence Assessment, which has been carried out in accordance with TAN15. The majority of the site area is located within Zone A, described in TAN15 as an area '*considered to be at little or no risk of fluvial or tidal/coastal flooding*' on the Welsh Government's Development Advice Map. A small section adjacent to the eastern boundary is shown to be located within Zone B described in TAN15 as '*areas known to have been flooded in the past evidenced by sedimentary deposits*'.
- 6.1.2 The proposed development comprises a mixed use of residential and commercial properties and a primary school, along with areas of public open space. In Figure 2 of TAN15, residential developments and public buildings are categorised as 'Highly vulnerable' developments. Commercial and retail developments are categorised as 'Less vulnerable' developments. As the proposed development will be located within Zone A and Zone B the Justification Test, which aims to direct new developments away from land within Zone C, is considered to be passed.
- 6.1.3 Based on the source-pathway-receptor approach, the risk of flooding from fluvial, tidal, groundwater and artificial sources has been discounted as there is considered to be no pathway from the identified sources onto the site.
- 6.1.4 The existing sewer network within the Phoenix Drive access road has been designed as part of earlier works to serve the proposed development at the site and is considered to be suitably-sized to accommodate all flows., The risk of flooding from this source is considered to be Low.
- 6.1.5 Surface water flood risk mapping shows that the majority of the site is at a Very Low or Low risk of surface water flooding. Based on the topography, there are minimal pathways for runoff from higher ground to the west of the site to enter the site area. It is proposed that any overland flows from this area are retained within open ground within the site boundary and are not diverted to off-site areas previously unaffected by surface water runoff.
- 6.1.6 A Flood Management Plan will be implemented to ensure that the risk of flooding to areas downstream of the site is not increased as a result of the development. Surface water runoff will be managed in a sustainable manner. Ground conditions are not appropriate to infiltration due to the unacceptable risk of ground settlement and the potential mobilisation of contaminants. Surface water runoff, therefore, will be

discharged to the culverted watercourse via the existing surface water sewer network at a restricted rate of 742 l/s, as agreed with Welsh Water as part of a previous planning application.

- 6.1.7 The surface water management rationale is based on dividing the site area into six subcatchments each discharging to the wider surface water sewer network at a restricted rate via a flow control device. On-site attenuation will be provided within each subcatchment by Sustainable Drainage Systems (SuDS) features to accommodate flows in exceedance of the discharge rate in extreme storm events up to and including the 1 in 100 year storm event, including an appropriate allowance for climate change. Surface water runoff will be regulated by a system of flow control.
- 6.1.8 On the basis of the findings of this report it is concluded that the flooding consequences to and from the site are negligible and the Justification Test is passed. The site is, therefore, considered suitable for the type of development proposed.