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Report No. 2978/R/01

THE BUNGALOW, GAMFORD LANE Flood Consequence Assessment and Conceptual Surface Water Management Plan

Carried out for:

Land Planning

The Wyvern, Church Street, Malpas, Cheshire, SY14 8NU

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2978/1/001- Indicative Surface Water management Plan

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Appendix 3 Natural Resource Wales Flood Risk Mapping

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THE BUNGALOW, GAMFORD LANE

Flood Consequence Assessment and Indicative Surface Water Management Plan

1. INTRODUCTION

- 1.1 LAPLAN Ltd (the Client) has instructed TerraConsult Ltd to prepare this Flood Consequence Assessment and indicative Surface Water Management Plan (FCA and SWMP) for “The Bungalow” at land off Gamford Lane, Wrexham, (the Site, see LAPLAN Ltd Drawing– GAM-002, attached to this report as Drawing 1) to support the planning application for proposed operations associated with residential development of the site. The proposed development of the site constitutes a revised landform that may increase potential flood risk and impacts to associated drainage infrastructure through increasing of the sites impermeability. This report has therefore been developed, to assess the potential flood risk mitigation required and provide conceptual analysis of a site Surface Water Management Plan.

2. PROJECT DESCRIPTION

- 2.1 The project is to accommodate the development of , residential property at the site and will require the installation of associated drainage to service the area. This will consist of providing land for total of 47 houses, associated local roads and open space areas that serves to conserve and improve social, commercial or environmental interests with the locality of Rosset, which resides in Wrexham County Council.

The site requires a site specific FCA due to the following reasons:

- *Residential development is considered highly vulnerable development category;*
- *There is potential material flood risk (based on evidence such as a recorded history of flooding, or improved flood risk information); and;*
- *There is potential that the development could exacerbate flooding elsewhere and constitutes a development with total area in excess of 1.0 hectare.*

- 2.2 Due to the above, the site therefore requires a site-specific FCA and associated review of drainage strategy, to appropriately identify the level of flood risk to property, future users of the site and identify any effect to offsite receptors.
- 2.3 The detail on existing drainage if any and proposed areas of amendment to surface water management strategies.

3. ASSESSMENT OBJECTIVES

- 3.1 The objectives of the FCA component of this report are to ensure that the site's proposed development does not adversely impact, or increase flooding, or present risk to life and livelihood by virtue of its delivery. This will be done with reference to currently established and defined flood risk areas and provide recommendation around potential mitigation measures, if required. In accordance with TAN 15, the key objectives of any flood risk assessment should be to provide further appreciation of:

- *The consequences of flooding on the development;*
- *The consequences (i.e. the overall impacts) of the development on flood risk elsewhere within the catchment, for a range of potential flooding scenarios up to that flood having a probability of 0.1%;*
- *To establish whether appropriate mitigation measures can be incorporated within the design of the development, to ensure that development minimises*

risk to life, damage to property and disruption to people living and working on the site or elsewhere in the floodplain.

- 3.2 The indicative SWMP component of this report aims to provide surety that the proposed surface water management and drainage strategy, safely and appropriately, conveys all water flows derived from the site, to appropriate discharge or attenuation locations. This will further establish the mitigation requirements for any potential future sources of flooding, on or off the site, and ensure that sustainable and safe site operation can be delivered.
- 3.3 The SWMP assessment has been developed using the HR Wallingford surface water assessment website (uksuds.co.uk) and the computer programme WinDes, the industry standard drainage design suite by Microdrainage. It takes into consideration applicable Sustainable Drainage Systems or SuDS design criteria as recommended by the Department of Environment, Food and Rural Affairs (DEFRA). This conceptual design has also taken into account surrounding surface water bodies, hydrogeological impacts and localised infrastructure / environmental constraints.
- 3.4 This analysis and design is indicative of the currently proposed final land use and form. Construction phase SWMP recommendations have been included to accommodate necessary site disturbance and drainage activities; although it is recommended that the final SWMP controls as defined within any detailed design reports are constructed as a priority, with consideration to potential systems impact and operational maintenance requirements wherever reasonable and practicable. This will ensure that waters may be diverted and drained from active construction operations to the appropriate drainage and attenuation system.

4. LEGISLATION AND GUIDANCE

- 4.1 This FCA and SWMP has been developed in reference to the following documents and legislative guidelines:
- CIRIA 753 The SUDS Manual (2007);
 - DEFRA “Flood Risk Assessment Guidance for New Developments” (2006);
 - DEFRA “Surface Water Management Plan Technical Guidance” (2010);
 - Environment Agency River Dee Catchment Flood Management Plan (2010);
 - Wrexham County Borough Council Local Flood Risk management Strategy (2008);
 - Wrexham County Borough Council Draft Flood Risk Management Plan 2016 – 2021 (2016);
 - Wrexham County Borough Council – Management of Surface Water Generated From new Development (2016);
 - BS 8533 2011 Assessing & Managing Flood Risk in Development Code of Practice (2011);
 - • Planning Policy Wales (Ed 5, November 2012) Planning Policy Wales - Technical Advice Note (TAN) 15;
 - Flood Risk Regulations (2009); and;
 - Flood and Water Management Act (2010).

5. PREVIOUS STUDIES

- 5.1 TerraConsult have not been provided with previous reports or studies conducted for the site, with regards to the proposed development..

6. SITE LOCATION AND BACKGROUND

- 6.1 The site is located adjacent to the hamlet of Darland, which resides between the towns of Rossett (situated approximately 1.17 km to the south-west) and Lavister (situated approximately 0.7 km to the north-west). The city of Wrexham is located approximately 8.50 km to the south-west of the site. The site resides in the Wrexham County Borough Council.
- 6.2 The A483 is the main distributor lies approximately 1.2 km to the west of the site and runs in north south orientation between Wrexham and Chester. Wrexham – Chester Road (B5445) is the main local road which diverts onto Darland Lane for access to the site. The site is located at the junction of Darland and Gamford Lane, with main access to the site being off Gamford Lane. A tributary of the River Dee catchment, Pulford Brook, lies approximately 900 m to the north-east of the site at its closest reach. These will be focused on in terms of access under any applicable flooding conditions.
- 6.3 Review of aerial photos indicates that the surrounding area is semi-rural, with low density housing estates located to the west of the site and arable, agricultural land to the east. There is a wooded pond located approximately 130 m to the north of the site opposite Darland Lane. There is a water treatment facility, located approximately 500 m to the north of the site, which is indicated as being linked to Pulford Brook as the main discharge location.
- 6.4 The area of the site proposed for development with 47 residential houses, public open space and associated roadways is approximately 2.35 ha or 23490 m², as defined by its proposed development boundary. The site is currently undeveloped and is used as a grazing paddock for livestock. A small treeline is currently situated across the southern aspect of the site, on an east west orientation and the site abuts a triangular wooded section at the south-eastern boundary. The western boundary is formed by Gamford Lane and a number of farm houses, which will not be affected as part of the development. A number of buildings also form the north-eastern boundary of the site.
- 6.5 The indicative areas to be considered as part of this FCA and conceptual SWMP are presented in Figure 1 below.



Figure 1 – Site Location and Access Map (Base map source: Google Earth)

- 6.6 A preliminary site investigation was conducted by TerraConsult to identify potential drainage and flooding issues and existing drainage infrastructure on site. The photographic record of this site investigation has been provided as Appendix 1 to this report.

7. EXISTING SITE DRAINAGE / WATERCOURSES

- 7.1 Based on evidence from the site investigation, there is no major ditch or drain network servicing the site, although a number of service manholes were identified in the north-west section of the site, adjacent to the existing field access. There are road gullies evident along Gamford Lane however, the current “as-built” drainage infrastructure plans have not been provided at this stage to investigate potential points for connection. The main watercourse within vicinity of the site is the aforementioned Pulford Brook.

8. SITE TOPOGRAPHY

- 8.1 The site is generally flat in nature, with surface elevations ranging from 13 to 14 m AOD across the site from north to south and similarly in an east to west orientation. There is a minor depression noted adjacent to the northern access point, which sits at approximately 12 m AOD. Land located approximately 100 m to the east of the site is shown to rise to approximately 15 m AOD, before

dropping away towards Pulford Brook. The surrounding water shed area continues to slope away to the north east, at a shallow grade of approximately 1.5 – 2.0 %. Pulford Brook is indicated as existing at approximately 8m AOD at its closest reach. The site is well grassed and uniform in its cover.

- 8.2 The proposed development topography will allow rainwater to shed evenly over the development, and drain to appropriately sized and designed, surface water conveyance network. This network will outfall to further sustainable drainage system controls, and be further directed to a final discharge location at a nominal design rate.

9. SITE HYDROGEOLOGY

- 9.1 The BGS website geology 1: 50,000 mapping indicates that the site overlies superficial material of River Terrace Deposits, consisting of undifferentiated sands and gravels, formed from the deposition of detrital river material along river channels in the Quaternary period. This is situated above bedrock material of the Salop Formation, which generally consists of mudstones, sandstones and conglomerates.
- 9.2 The BGS website also provides information on a number of historic boreholes that have been bored in the vicinity of the site to various depths. Borehole SJ35NE154 located on the north western boundary of the site indicates that the local soil type generally consists of clayey peat and silty clay, to depths of 1.2 – 4.8 m BGL. Borehole SJ35NE37 located adjacent to the south-eastern boundary indicates that the locality of the site is generally underlain by slightly sandy clay material, describing it as upper boulder clay material, extending from very shallow depths to approximately 18.00 m total depth BGL. The surrounding boreholes do not indicate any strike of water at shallow depths, however a number of boreholes have been installed for the commercial abstraction of irrigation water at Darland Farm and Gamfrod House, from depths of approximately 9.00 – 10.00 m BGL. A copy of the full exploratory borehole records are presented in Appendix 2 to this report.
- 9.3 According to the Natural Resources Wales website, both the superficial stratum and bedrock are designated as Secondary A Aquifers, however the bedrock aquifer is considered to border on an area designated as a Principal Aquifer. Additionally, the site is located within the Zone 3 – Total Catchment Source Protection Zone (SPZ), which is where the Source Catchment Protection Zone is defined as the whole aquifer recharge area. Indicative representation of these site designations have been provided in Figures 2 - 4 below.
- 9.4 There is no available information on the presence of surface or groundwater abstractions on the Natural Resources Wales website.

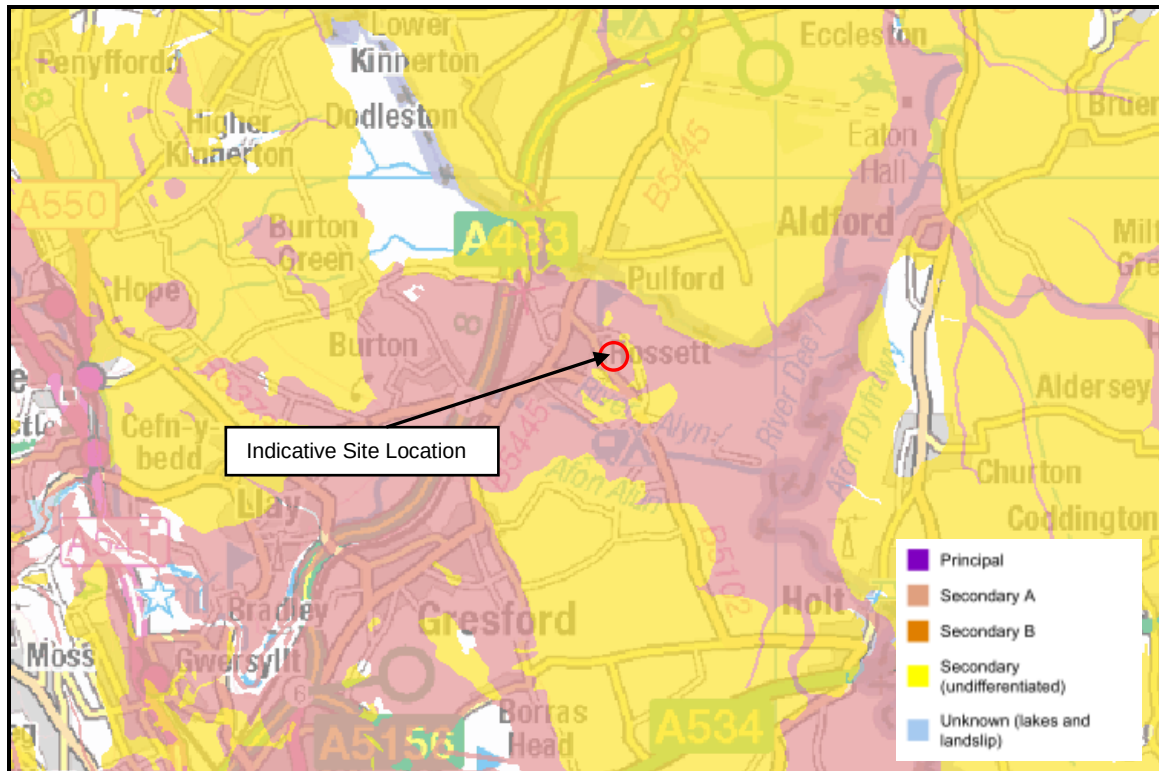


Figure 2 – Environment Agency BGS Aquifer Maps – Superficial Deposits Designation

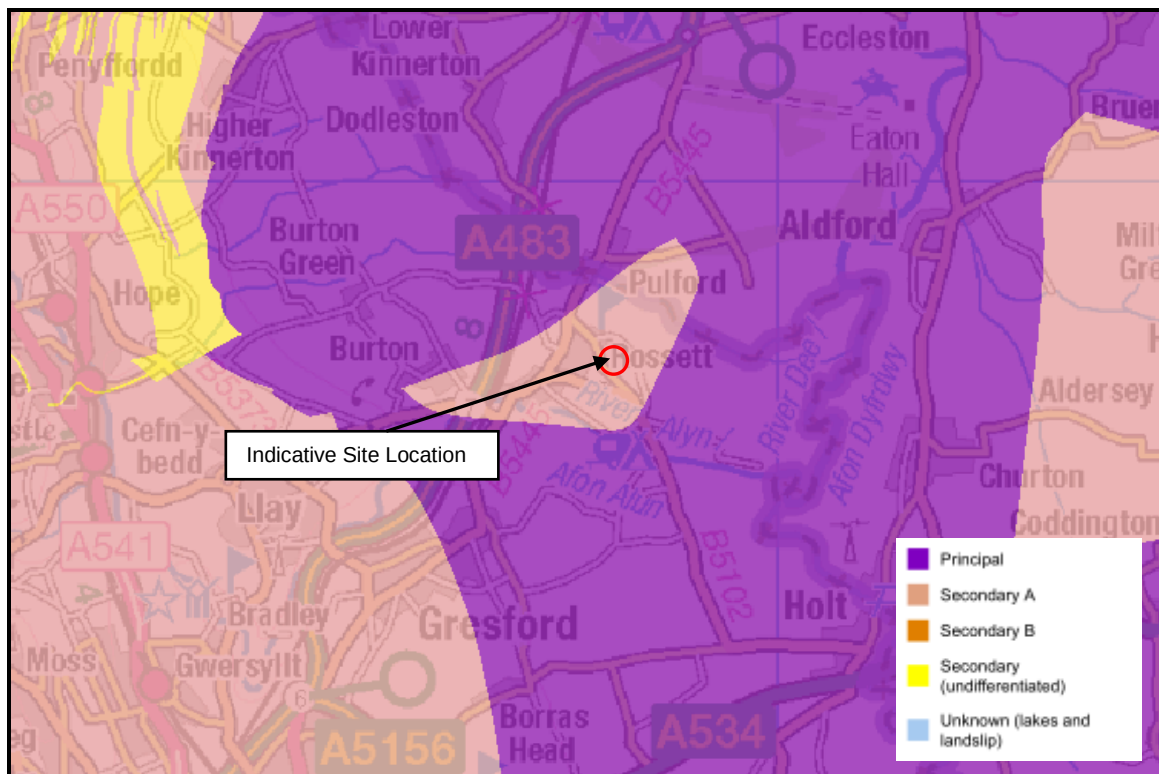


Figure 3 – Environment Agency BGS Aquifer Maps – Superficial Deposits Designation

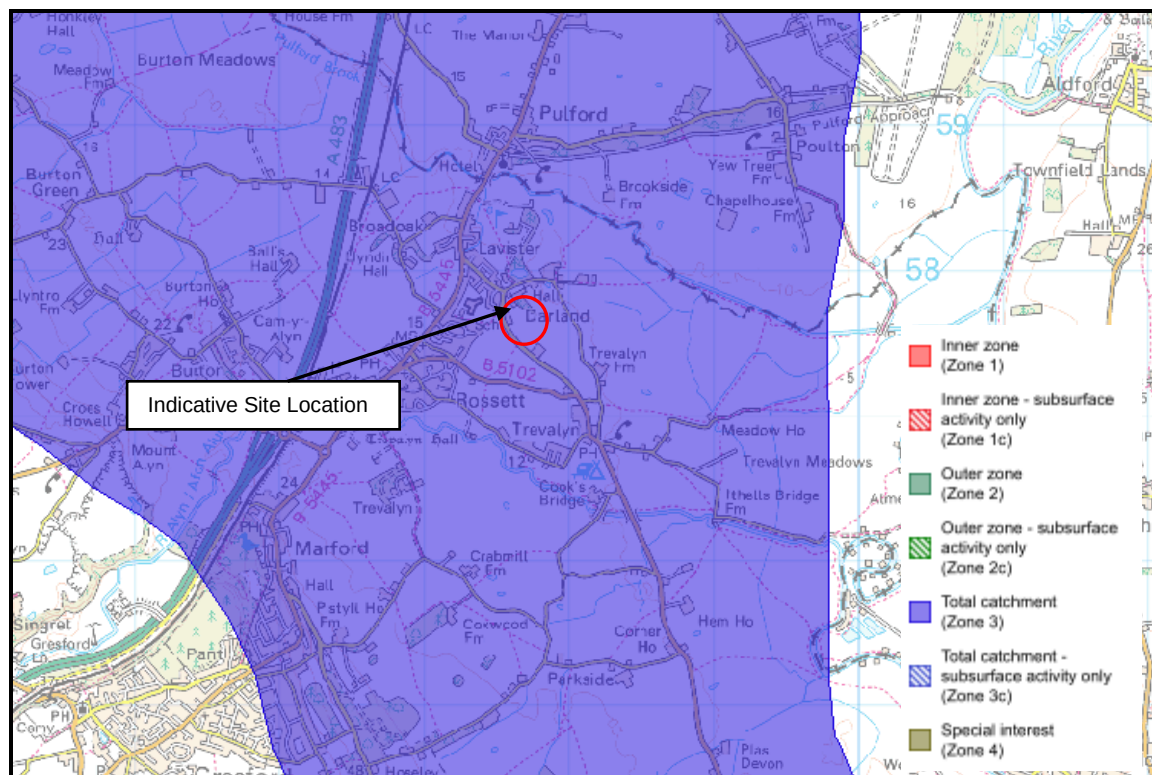


Figure 4 – Environment Agency Groundwater Protection Zones

10. SITE HYDROLOGY AND RAINFALL

- 10.1 The site is located in Lower Dee (Chester Weir to Ceiriog) operational catchment, which is a tributary to the larger downstream catchment of the River Dee. Hydromorphological designation for the area categorises the catchment as not artificial or heavily modified, with moderate ecological and good chemical characteristics. The effective watershed of the catchment is defined as contributing runoff to the local drainage ditch networks to the north of the site, which in turn provide flows of surface runoff waters to Pulford Brook.
- 10.2 Hydrologically, the common soil type is classified as Type 4, which has an applicable Standard Potential Runoff (SPR) value as defined within the Flood Studies Report (FSR) of 0.47 (47%), with soil hydrological properties categorised as being consistent with a clayey loam, with high potential for runoff and low total permeability. It is proposed that the site impermeability factors for areas contributing runoff to surface water drainage, will be defined by their applicable end-use. They will also be reflective of total areas indicated within the site development layout and will be assessed in accordance with prescribed land use impermeability factors, indicated in Table 1.

Table 1 - Land Use Impermeability Factors (adapted from CIRIA 753 Table 26.14)

<i>Land Use Surface type</i>		<i>Impermeability Factor</i>
Roofs	Industrial	1
	Residential	0.9
Highways	Motorways	0.9
	Highways	0.8
	Distributor Roads	0.7
	Residential streets	0.6
	Pavements	0.6
Car Parks/ Hardstanding	Industrial / commercial	0.8
	Driveways (residential)	0.5
Open areas	Gardens	0.1
	Parks	0.2
	Grassed Areas	0.1

- 10.3 The volumetric runoff coefficient for surface waters arising from the site, will be calculated on the basis of using the existing soil type of clayey loam overlain with cultivated, short grass. The hydrological classification for the region, under the Institute of Hydrology Report 124, is Region 9.
- 10.4 It is anticipated that although the acceptance potential for the capping material will remain low, the antecedent moisture content on the surface of the restored landfill area will also be low due to selection of freely draining soils that will support vegetation and grass growth.
- 10.5 The standard Average Annual Rainfall (SAAR) for the area around the site, as defined within the Flood Studies Report (NERC, 1975), is 693 mm, with higher rainfall depths experienced in the winter months. The average monthly rainfall patterns as recorded through the UK Meteorological Office, are presented below in Table 2 below and indicate an average annual rainfall depth of 595 mm. For the purposes of this investigation the higher, conservative limit will be used for any surface water management design requirements.

Table 2 - Average Monthly Rainfall – Rossett, Wrexham

	<i>Jan</i>	<i>Feb</i>	<i>Mar</i>	<i>Apr</i>	<i>May</i>	<i>Jun</i>	<i>Jul</i>	<i>Aug</i>	<i>Sep</i>	<i>Oct</i>	<i>Nov</i>	<i>Dec</i>
Rainfall (mm)	46.3	40.3	37.3	39.4	48.7	48.5	48.4	45.6	50.3	70.7	56.6	63.1
Days /month	17	15	15	15	13	12	12	13	14	18	18	16

11. CURRENT DRAINAGE STRATEGY

- 11.1 The site is indicated as being generally well drained, however the noted small depression area in the north of the site, adjacent to the existing access, may be susceptible to pluvial flooding due to run-on water flows and inadequate road drainage. The degree of potential infiltration on a broad scale is considered to be low due to the dominant clayey loam soil scape formations, evident on review of the site geology; however there may be limited potential in various locations which will require verification through further intrusive site investigation.

- 11.2 Therefore, due to the potential for contributing pollution to the Secondary A Aquifers below the site and locally mapped soil types, the use of infiltration for surface water management controls has been initially precluded and will not be investigated further within this report. Hydrogeologically, there is limited potential for potential groundwater intrusion, or base-flows affecting surface water controls and hydrology.

12. SITE ENVIRONMENTAL CONSTRAINTS AND CONDITIONS

- 12.1 There are no Areas of Outstanding Natural Beauty (Wales) (AONB), Sites of Special Scientific Interest (Wales) (SSSIs), Special Biosphere Reserves (SBR) or Special Areas of Conservation (SAC) within or adjacent to the site.
- 12.2 Given the catchment's ecological and chemical health categorisation being moderate to good, mitigatory requirements for the site will look to ensure that there is no additional impact to the downstream condition of the catchment, due to surface water flows from the proposed development.

13. FLOOD CONSEQUENCE ASSESSMENT METHODOLOGY

- 13.1 This FCA will utilise existing qualitative and quantitative flood risk information from the Natural Resources Wales (NRW) and Wrexham Borough County Council. Potential risk will be evaluated in accordance with the applicable hazards and associated flood consequence for the sites locations and surrounding areas.
- 13.2 Site vulnerability will be assessed in accordance with the Technical Advisory Note 15 (TAN 15) guidance, so as to ensure there is minimal risk from flooding to the proposed development, the site will not increase flooding potential elsewhere and any mitigation requirements are accurately identified.
- 13.3 The site is situated in primarily situated in Flood Zone and the proposed development area as defined by the site boundary is approximately 2.349 ha. Proposals on sites of 1.0ha or more, situated within Flood Zone A are required to submit an FCA in accordance with TAN 15. Therefore a further justification test is required to ensure that the development is appropriately sited.
- 13.4 The FCA should therefore seek to address the following:
- The potential for the development to be affected by flooding either from the development itself or from external sources;
 - The potential for the development to increase the flood risk elsewhere;
 - The consequences of flooding on the development;
 - The consequences (i.e. the overall impacts) of the development on flood risk elsewhere within the catchment for a range of potential flooding scenarios up to that flood having a probability of 0.1%;
 - Identification the extent of any mitigation measures required to remediate potential for flood risk and how they can be successfully managed; and;
 - That the site can be developed safely.
- 13.5 The key steps associated with the development of this FCA and SWMP will include the following process:
- Identify the sources of floodwater (if any);
 - Define how floodwater enters and flows across the site;

- Assess how high floodwaters will reach; and;
- Define the extent of modifications required (such as raising levels) to prevent impact to the development and surrounding areas.

14. FLOOD CONSEQUENCE ASSESSMENT CRITERIA

14.1 Flood risk mapping is produced and published by the NRW for the different potential forms and cause of localised flooding. The Flood Map definitions (Flood Risk from Rivers and Seas for Planning) are:

- Flood Zone A, identified by no shading, indicates the area where flooding from rivers and the sea is very unlikely, i.e. land with a less than 0.1% (1 in 1,000) chance of flooding occurring each year. This land is considered to be at little or no risk of fluvial/coastal flooding;
- Flood Zone B, is defined as areas known to have been flooded in the past evidenced by sedimentary deposits. The levels of the proposed development are required to be checked off against the outline for 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;
- Flood Zone C, identified by light blue shading, identifies the additional extent of an extreme flood from rivers or the sea. These outlying areas are likely to be affected by a major flood, with up to a 0.1% (1 in 1,000) chance of occurring each year; and;
- Flood Zone C1 and C2, shown as Dark Blue, identifies the areas that could be affected by flooding, either from rivers or the sea by a flood that has a 0.5% (1 in 200) or greater chance of happening each year; or from a river by a flood that has a 1% (1 in 100) or greater chance of happening each year. C1 is indicative of areas which are served by significant flood protection infrastructure and C2 is indicative of areas in functional floodplain which have no flood defence infrastructure.

15. POTENTIAL FLOOD RISKS

15.1 In accordance with relevant legislature, guidance and BS8533-2011, a variety of flood risks have been assessed in relation to the proposed development of the site. These are:

- River-system (Fluvial) flooding;
- Surface Water (Pluvial) Flooding;
- Groundwater flooding; and;
- Reservoir or Canal Breach Flooding.

15.2 Due to the distance from coastal areas or locations of tidal influence and the lack of information pertaining to the presence of existing surface or foul water sewers being located in the site, potential flood risk from these two sources has not been further assessed.

16. FLUVIAL FLOOD RISK

16.1 Fluvial flood risk is defined as that risk arising from rivers and watercourses. The NRW Flood Map for planning (rivers and sea), provided below as Figure 5 confirms that the site is currently located within Flood Zone A, and has minimal or negligible risk of flooding from rivers or sea (risk of flooding less than 0.001 % in any year). An area indicated as being located in Flood Zone B is located

approximately 280 m to the north-east of the site along Darland Lane. However given the topographical nature in this location, it is not expected to present a hazard to development

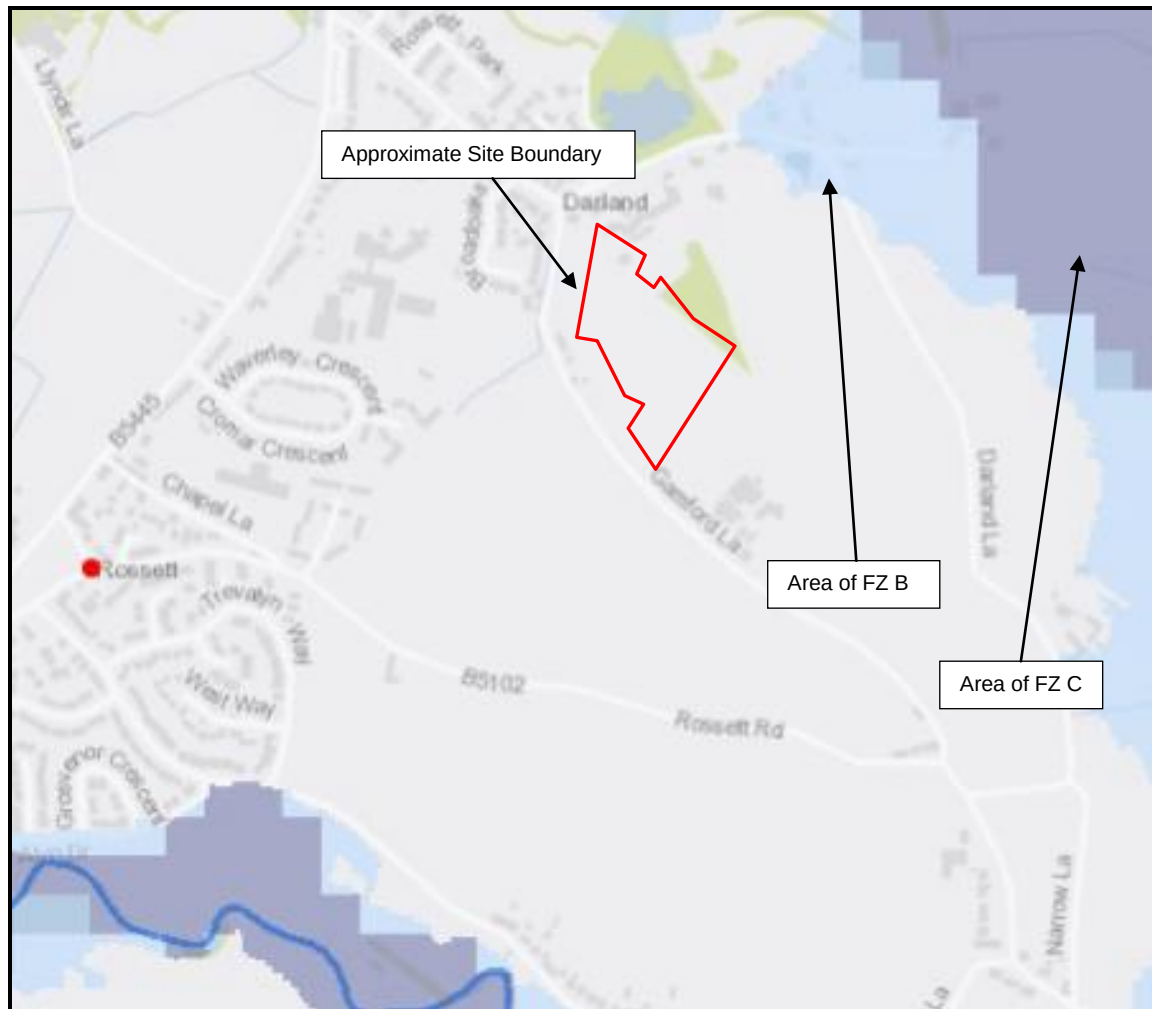


Figure 5 – NRW - Flood Risk from Rivers and Seas (for Planning) (Source: Natural Resources Wales, 2016)

17. PLUVIAL FLOOD RISK

- 17.1 Pluvial flood risk is defined as the risk arising from surface waters, generated by rainfall and is generally harder to model and define, as it may be subject to localised rainfall patterns and altered topography. Current NRW surface water flood mapping for the area, indicates that the majority of the site is considered to be at low risk of surface water flooding, although there are areas on and surrounding the site potentially susceptible to surface water flooding. The risk for these areas ranges from low (a chance of flooding of between 1 in 1000 (0.1%) and 1 in 100 (1%) in any year) to medium (area has a chance of flooding of greater than 1 in 100 (1%) in any year). This can be seen in Figure 6 Below.
- 17.2 The main area is located adjacent to the northern boundary and access of the site and is considered to be representative of the minor surface depression evident in this location. This however does not accurately represent the finalised topography, or site elevations for the development, which will be elevated to mitigate the potential impact of this flood risk. Any displacement or elevation of those areas potentially at risk from surface water flooding, will be addressed through mitigation measures including the development of a strategic surface water management and attenuation strategy. The overall risk category associated with surface water flooding for the site has been assessed as low.

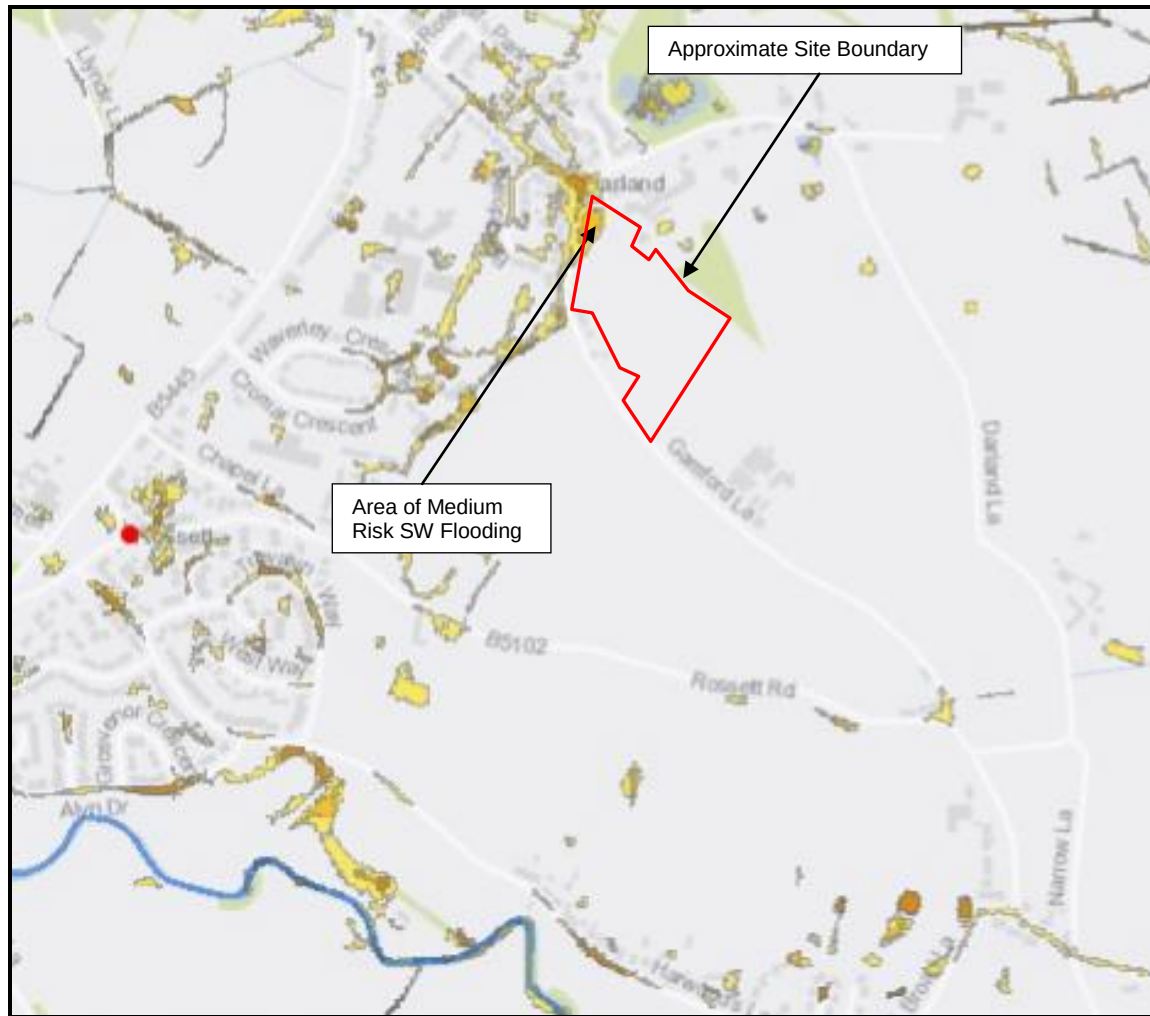


Figure 6 -- NRW Flood Risk from Surface Waters (Source: Natural Resources Wales, 2016)

- 17.3 There is some wider surface water flooding identified as affecting the road network in Darland, presumably due to the former lack of detailed flood risk assessments being required for housing developments. However, it is also noted that the areas of flooding are primarily restricted to the road network, which is due to the larger concentration of impermeable areas in a naturally low topographical area. Potential impact from this external source of flood waters impacting the site will be addressed through development of a strategic surface water management and attenuation strategy.
- 17.4 Based on existing topographical information from Ordnance Survey maps, the identified areas affected by potential for surface water flooding are shown to reside at about 12 m AOD. This level is consistent with other areas adjacent to the site which are similarly indicated as being affected by surface flooding.
- 17.5 As the proposed site development plan is to raise levels and improve overall site drainage through formalisation of road kerbing and on-site attenuation and source control, the potential flood risk associated with surface water overland flows from the surrounding external catchment area impacting the site, may be considered as negligible and has therefore has not been further assessed as part of this report.

18. RESERVOIR OR CANAL BREACH FLOOD RISK

- 18.1 Reservoir breach has been assessed due to the location of minor reservoirs farm dams being located to the north of the site. Review and investigation of NRW flood mapping for these reservoirs indicates

that they do not pose risk of breach flooding. This is supported by the fact they appear to be excavated depressions as against walled or dammed catchment reservoirs, that may be susceptible to failure in extreme weather events due to unregulated construction practises.

19. GROUNDWATER FLOOD RISK

- 19.1 There is limited potential for clear water (unconfined aquifer) groundwater flooding, in the north-west location of the site. As the proposed site restoration plan is to elevate the existing landform through infilling and stabilisation from the existing topographical elevation, the potential flood risk associated with groundwater water flooding in this particular location, may be considered as negligible and unlikely to impact the site.

20. IMPACTS OF CLIMATE CHANGE

- 20.1 So as to accurately represent the future risk associated with climate change impacts, which may compound flood risk on the site and surrounding areas, an additional allowance of 40% has been provided in estimation of peak rainfall events and surface water flows generated from site. This is in accordance with TAN 15, which states that the upper-end climate change allowance for projects requiring drainage systems up to the 2070 should make provision for 40% additional allowance in peak rainfall intensity. A conservative additional allowance of 40% has therefore been provided for peak rainfall estimation on the site, for estimation of surface water drainage required.

21. CONNECTIONS BETWEEN FLOOD RISKS

- 21.1 There is potential connection between the infilling and development of the site leading to potential displacement of surface waters into surrounding areas. Mitigatory control measures will therefore require incorporation into the surface water management for water being drained from the site, including the assessment of attenuation and discharge requirements.
- 21.2 A full set of flood risk plans as exported from the Natural Resources website have been provided as Appendix 3 to this report.

22. SUMMARY OF FLOOD RISKS

- 22.1 A summary of the applicable flood risks and areas of further investigation and potential control required has been provided in Table 3.

Table 3 – Existing Flood Risk Summary

Type of Flood	Assessed Risk	Control Measures
Fluvial	Flood Zone A <0.1% annual probability	None required
Surface Water (Pluvial)	Minor areas of site considered to be at medium risk of surface water flooding along the northern section of roadway and field access. This is considered to be due to historic topographical conditions being used in surface water analysis. Low to medium flood risk areas adjacent to the northern boundary of the site	On site mitigation measures to provide sustainable drainage systems and attenuation features on Site. This will be done so as to minimise potential for impact to local surface water drainage systems, road network and surrounding land-use.
Overland Flow	Minor intrusion of surface water flooding from surrounding road network identified as potentially affecting the site	On site mitigation measures to ensure that site development levels are elevated above the indicative surface water flooding level of 12 m AOD. This will be done so as to minimise potential for impact to local surface water drainage systems, road network and surrounding land-use.
Groundwater	Very Low - Negligible	None required
Reservoir	Outside of maximum extent	None required

23. VULNERABILITY OF PEOPLE

- 23.1 Given that the proposed development is for residential housing, it carries a classification of being Highly Vulnerable within TANB 15 guidance. Based on the previously defined flood risk summary, the potential hazard or vulnerability of people due to flood risk can be considered very low to negligible as the site is predominantly located in Flood Zone A, however the development must be justified to ensure that potential risk of surface water flooding can be managed effectively and not increase potential for flooding on the proposed or existing developments. This will be provided in the indicative SWMP.

24. VULNERABILITY OF PROPERTY

- 24.1 The development proposal accommodated the development of any 47 residential properties within the site boundary, and is bordered by numerous existing residential properties. The site therefore requires a classification for assessment as highly vulnerable and requires further confirmation that the surface waters generated from the site, can be satisfactorily managed to prevent any potential impact upon proposed or existing property.

25. VULNERABILITY OF ENVIRONMENT

- 25.1 Based on the development proposal for the site, potential impacts due to environmental vulnerability due to flooding should be considered. Applicable conditions associated with quality monitoring for release of attenuated flood waters arising from the proposed development site may require further assessment, however treatment and storage volumes for mitigating the potential release of contaminants such as hydrocarbons, suspended solid material and biological agents will be provided for within the indicative SWMP.

26. SUMMARY OF HAZARDS

26.1 Based on the flood extent information available, potential hazards associated with flooding of and from the site are primarily defined as those due to localised flooding from surface water displacement, or contribution to overland flows. Potential hazards are therefore summarised as:

- Insufficient capacity within local drainage network to accommodate potential surface water flows from the development site.

27. ASSESSMENT OF FLOODING

27.1 In accordance with the Wrexham Local Flood Risk Management Strategy, Rotherham SFRA – Level 1 and TAN 15, a justification test approach should be taken to ensure that the development site chosen offers the lowest possible flood risk, based on the qualitative assessment of potential flood risk. The Planning Authority should only approve development where it can be demonstrated that the proposal doesn't increase the overall risk of flooding in the area and is adequately protected from flooding itself. This has been provided below, assuming the development vulnerability classification for residential development as being 'Highly Vulnerable'.

Table 3 –Justification Test Application Test for Proposed Development Site (in Accordance with TAN 15)

<i>Development Classification</i>	<i>Flood Zones</i>		
	<i>Zone A</i>	<i>Zone B</i>	<i>Zone C (1 and 2)</i>
<i>Highly vulnerable</i>	Appropriate	Justification Required	Justification Required
<i>Less vulnerable</i>	Appropriate	Appropriate	Justification Required
<i>Water-compatible</i>	Appropriate	Appropriate	Appropriate

27.2 Based on the fact the majority of the site is indicated as residing in Flood Zone A, no further detailed flood risk assessment is necessary under the Justification Test, although strategies for managing the potential localised surface water flooding issues require further definition so as to ensure development of the site will not adversely impact external receptors or increase flood risk elsewhere.

27.3 The site location is deemed as appropriate and flood risk to people, property or the environment is considered to be low to negligible given the proposed development type, provided that surface water management techniques are identified and appropriately designed to ensure potential localised flooding issues are obviated.

28. RESIDUAL FLOOD RISK

28.1 As previously indicated, there is a potential for residual flood risk associated with the displacement of surface water flows from the site to surrounding drainage networks and infrastructure, primarily those located along Gamford Lane. This will be further addressed through the development of an indicative surface water drainage assessment and sustainable drainage system design to attenuate and release surface water flows generated on site to an acceptable level.

28.2 This drainage assessment and sustainable drainage system design will further provide mitigation to address the potential environmental implications associated with release of surface waters generated during the filling and restoration of the proposed development site.

29. MITIGATION OPTIONS

29.1 The existing site already includes many measures that prevent and reduce potential of flood risk and pollution to surface water receptors. In addition to design measures, there are a series of management and monitoring procedures in place to mitigate impacts on surface water quality. A summary of the mitigation measures that would operate at the site is as follows:

- Appropriately designed and engineered sustainable surface water drainage system to mitigate displacement of surface water flooding areas;
- Proposed finished floor levels of the development will be engineered to provide positive drainage and prevent surface water flooding on site. The accumulation of standing water would therefore not occur and thus not pose a risk to the development;
- Regular inspection of incorporated SuDS drainage schemes as required under a Section 106 agreement to ensure functionality and efficient operation;
- Early seeding and planting of public open space areas to reduce runoff potential and increase time of concentration to receiving drainage networks; and;
- Installation of appropriately sized oil and petrol interceptor prior to any constructed attenuation of volumetric control feature.

30. SWMP DESIGN CRITERIA

- 30.1 TAN15 and the Wrexham Borough County Council 'Management of Surface Water Generated from New Developments' guidance recommends that surface water generated by the proposed development should, as far as is practicable, be managed in a sustainable manner to mimic the site pre-development flow conditions (i.e. the Greenfield flow rate). Surface water drainage design should therefore seek to ensure that volumes and peak flow rates of surface water leaving the development, are no greater than those prior to development, reducing surface water run-off where possible and taking climate change into account.
- 30.2 On this basis, the indicative SWMP design criteria for this development are to be set as follows:
- There would be no on-site flooding from drainage up to the 1 in 100 year (+ 40% Climate Change) rainfall event, with all flows being restricted to the corresponding rural greenfield discharge rate for up to and including the Q100 + 40% CC peak flow event (i.e. cumulative maximum discharge from site no greater than the Q100 Greenfield Runoff Rate); and;
 - Discharge to existing off-site surface water drains is restricted to the applicable return periods for Greenfield rural runoff volume and flow rate so as not to adversely impact downstream receivers through increased flows.
- 30.3 Technical guidance provided within CIRIA 753 indicates that a surface water collection system should be sized to provide sufficient capacity during a storm event, and prior to discharge of runoff from the site, the water should be controlled by use of attenuation to improve first flush quality characteristics from the roadways and hardstanding drainage areas. Detailed design of surface water control measures should therefore look to provide short term treatment capacity, with no discharge from site for rainfall events up to and including 5 mm.
- 30.4 Site Greenfield runoff rates have been calculated using the IH124 method for a site of 50 ha size and linearly interpolated for the applicable development area (2.35 ha). Table 5 below provides maximum allowable discharge rates as calculated for the Site. Full details of calculation as provided by Microdrainage can be found in Appendix 4 to this document.

Table 4 – Maximum Permissible Greenfield Discharge Rates and Volumes

	IH124 Area	Site Discharge Rate (l/s)	Site Discharge Vol (m3)
Runoff Area Assessed (ha)	50	2.35	2.35
Q bar (l/s)	238.60	11.21	252
Q1 (l/s)	209.90	9.87	207
Q30 (l/s)	420.60	19.77	478
Q100 (l/s)	520.10	24.44	650

31. SWMP DESIGN CONCEPT

- 31.1 The initial concept for management of the surface water generated from areas on the site is through the design and construction of roadway pipe drainage network. Drainage from this network would then be attenuated in a pond or cellular storage structure for rainfall events up to and including the 1 in 100 year + 40% climate change rainfall event.
- 31.2 Due to the potential for alterations to the proposed layout, two concepts for the attenuation and drainage of surface waters generated on site have been investigated. These are:
- Option 1 - The use of a central control basin for attenuation of surface water flows located within the western portion of allocated public open space, which will then discharge to the existing sewerage network within Gamford Lane; and;
 - Option 2 - The use of a cellular storage structure within the primary access located at the north of the site, which will then discharge to the existing sewerage network within Gamford Lane.
- 31.3 It is proposed that the main attenuation feature will be fitted with an exceedance flow / overflow discharge point in the form of a 0.150 mm diameter pipe, lain at a gradient no shallower than 1:150.
- 31.4 It is also proposed that to appropriately accommodate the construction process on the proposed development site, the final surface water management controls are constructed as a priority, thereby allowing a temporary maintenance regime of internally drained waters being pumped out at the nominal design discharge rates for the site. It is recommended that this design discharge rate from landfill cells, during the infilling operation does not exceed that of the Qbar for the total development area. Therefore discharge from site area during construction should not exceed 11.21 L/s or 4.77 L/s/ha.

32. SURFACE WATER DESIGN ASSUMPTIONS AND INPUTS

- 32.1 The SWMP drainage network has been developed using the computer programme WinDes, the industry standard drainage design suite by Microdrainage, and takes into consideration SuDS design criteria as recommended by the DEFRA. This conceptual design has also taken into account surrounding surface water bodies, hydrogeological impacts and localised infrastructure / environmental constraints.
- 32.2 The design calculations undertaken for this SWMP have been performed based on assumption of the following conditions:
- Site impermeability has been calculated under the finished land use conditions as defined in Table 1 of this report and descriptive layout in Drawing 1;
 - The use of infiltration techniques for surface water drainage has been precluded due to the existing hydrogeological constraints and soil types; and;

- There is no existing discharge consent applicable to the site, therefore maximum permissible discharge rates and volumes may be based upon calculated Greenfield discharge rates. Maximum discharge rate has been calculated using the on IH124 Rural Runoff methods. Details of Greenfield discharge rate calculation have been provided in Appendix 4 to this report.

- 32.3 The SWMP design has been developed on the basis it is to accommodate the final development landform for the site and the proposed topographical conditions are appropriate and have been approved. Design levels for attenuation controls have been derived from the indicative levels provided by Google Earth. The levels are **not** indicative of finished floor levels, although may be used to inform the finished floor level requirements of future detailed drainage design and mitigatory earthwork requirements
- 32.4 The proposed site development layout indicates that the final landform shall shed water positively towards drainage. A summary of contributing surface water drainage areas has been provided in Table 6 below.
- 32.5 Analysis for strategy design was conducted for return periods of 1, 30 and 100 year storms with climate change allowed for by an increase in runoff volumes of 40%, in accordance with Welsh National Planning Policy Guidance.
- 32.6 Rainfall input was generated using the Flood Studies Report (FSR) function within the Source Control Module of Microdrainage. Main catchment parameters for input as part of this design criteria are as follows:
- M5-60 (mm) = 17.00 mm
 - R-Factor = 0.3
 - Global Time of Entry (Time of Concentration for lead pipe in a Network Branch) = 5 minutes
 - Percentage of Site Impermeability = User Defined
 - Volumetric Run-off Coefficient – 0.84 (Summer) and 0.75 (Winter).

Table 5 – Contributing Surface Water Drainage Areas

Total Site = 23490 m ²		Impermeability %	SW Drainage Areas - Corrected (m ²)	SW Drainage Areas - Corrected (ha)
Remainder (Backyards, hedges, tree lines)	9597	50	4798.5	0.47985
POS1 - East	872	10	87.2	0.00872
POS2 - South-east	1905	10	190.5	0.01905
POS3 - West	1698	10	169.8	0.01698
Hardstanding - Roof	3531.00	100	3531	0.3531
Hardstanding - Paved	2453.00	100	2453	0.2453
Hardstanding - Patio	742.00	100	742	0.0742
Road - Roadside Path	2692	100	2692	0.2692
Totals	23490	60	14664	1.4664

- 32.7 Cover levels utilised within the analysis for the Site were determined from the LAPLAN Site Layout drawing, provided as Drawing 1 for this report.

32.8 The conceptual design inputs for the two attenuation options area as follows:

32.9 Option 1 – Attenuation Basin

- Cover level: 13.00 m AOD
- Invert level – 12.00m AOD
- Min. Cover Level – 1.00 m
- Base Length – 21.50 m
- Base Width – 30.00 m
- Top Length – 45.00 m
- Top Width – 15.00 m
- Internal embankment slopes – 1:4
- Cellular Storage Depth = 1.20 m
- Exceedance Overflow invert level – 12.70 m AOD
- Exceedance Overflow pipe diameter – 0.150 m
- Exceedance Overflow pipe grade– 1 : 100

32.10 Option 2 – Cellular Storage

- Cover level: 13.00 m AOD
- Invert level – 11.00m AOD
- Min. Cover Level – 0.80 m
- Length – 30.00 m
- Width – 30.00 m
- Cellular Storage Depth = 1.20 m
- Exceedance Overflow invert level – 12.00 m AOD
- Exceedance Overflow pipe diameter – 0.150 m
- Exceedance Overflow pipe grade– 1 : 100

33. SITE SURFACE WATER MANAGEMENT CONSTRAINTS

33.1 The main constraint evident on site (applicable to the implementation of a successful surface water management strategy), is due to the fact there is currently no identifiable surface water ditches which may be discharged to, and the use of infiltration, across the site has been initially precluded based on the local geology type. Therefore, surface waters generated may need to be discharged to the local sewerage network, in which instance it may require further restriction. Potential connection point and

discharge surface water network will also need to be designed to an adoptable standard, and will be subject to statutory maintenance requirements as defined with S106 and S38 agreements.

34. MICRODRAINAGE ANALYSIS OUTPUTS

34.1 Analysis for strategy design was conducted for return periods of 1, 30 and 100 year storms with climate change allowance of 40% on all return periods, in accordance with Technical Advisory Note 15 Guidance. Full details of the analysis outputs for the two options assessed have been provided as Appendix 4 to this report.

35. SURFACE WATER MANAGEMENT DESIGN SUMMARY

35.1 A summary of the proposed surface water management controls structures and performance is shown in Table 7 and 8 – Summary of Surface Water Management Results.

35.2 It is proposed to intercept flows from the development by a roadway network of gullies discharging to a surface water sewer. Surface water attenuation will be provided either by the construction of a centralised surface water attenuation basin located in the western portion of the site or a cellular storage installation located in the north of the site. All surface water flows for the events up to and including the 1 in 30 year critical rainfall event will be restricted to the Qbar Greenfield runoff discharge rate, with events in exceedance of this up to and including the 1 in 100 year + 40 climate change being restricted to the cumulative Q100 Greenfield runoff discharge rate.

Table 6 – Surface Water Management Results- Option 1: Attenuation Basin

	Max. Water Depth (m)	Max. Discharge Hydro-brake (l/s)	Max. Discharge Overflow (l/s)	Improvement on Greenfield Discharge Rate (l/s)	Max. Volume (m ³)	Discharge Volume (m ³)
Q1	0.177	10.6	0.00	-0.73	157.4	246.4
Q30	0.432	11.1	0.00	8.67	406.8	555.2
Q100	0.582	11.1	0.00	13.34	568.4	723.3
Q100 + 40%	0.805	11.1	5.9	8.44	827.2	1085.0

Table 7 – Surface Water Management Results- Option 2: Cellular Storage

	Max. Water Depth (m)	Max. Discharge Hydro-brake (l/s)	Max. Discharge Overflow (l/s)	Improvement on Greenfield Discharge Rate (l/s)	Max. Volume (m ³)	Discharge Volume (m ³)
Q1	0.185	10.3	0.00	-0.43	157.9	246.3
Q30	0.476	11.1	0.00	8.67	407.1	555.1
Q100	0.666	11.1	0.00	13.34	569.0	723.2
Q100 + 40%	1.018	11.1	0.2	13.14	870.3	1140.9

36. MICRODRAINAGE ANALYSIS OUTPUTS AND DESIGN RATIONALE

36.1 The indicative layout for the surface water drainage network, surface water ponds and drainage section profiles are attached to this report as Drawing 2 - 2978/1/001.

36.2 The results of the Microdrainage analyses are presented in Appendix 4 however from the summary of results provided in Table 7 and 8, it can be seen that the proposed indicative designs can effectively reduce the discharge rate from the proposed development, to the receiving environment below that of the allowable Greenfield discharge rate. Therefore either of these designs may be considered appropriate.

- 36.3 No flooding was observed for the critical simulation storm (as defined by maximum level) event in either of the indicative options assessed for all events up to and including the 1 in 100 year + 40% climate change allowance event.
- 36.4 A hydro-brake flow restriction control system has been utilized as the main control outlet for both the options and has successfully limited all simulation flows to that of the Greenfield Qbar discharge rate. Full details of these controls can be found in Appendix 4.

37. TREATMENT STAGES REQUIRED TO IMPROVE WATER QUALITY

- 37.1 The CIRIA SuDS Manual (C753) specifies the number of treatment train components required in order to provide an appropriate level of treatment, to minimise risk to the environment and receiving surface waters. To prevent damage to the SuDS features and to potential downstream surface water discharge locations, erosion and sediment control for both the construction and operation phases should be incorporated within the design may include:
- Source control – permeable pavements at driveways;
 - Sedimentation units/ Silt traps and oil separators;
 - Geotextiles for filtration and treatment (if cellular storage units selected); and;
 - Sediment retention sumps in gully installations.

38. OPERATION AND MAINTENANCE REQUIREMENTS

- 38.1 The surface water management system shall be inspected regularly (minimum 12 months between inspections) and after periods of heavy rain, the inspection being carried out and results being recorded by a suitability qualified/experienced person. In particular the following shall be recorded:
- The condition of any discharge points to the main attenuation / storage control;
 - Any siltation of the within surface water drainage; and;
 - Any siltation of the basin or control structures.
- 38.2 Any repairs or maintenance required to the system shall be undertaken as soon as is reasonably practical.
- 38.3 Any repairs or maintenance required to the system shall be undertaken as soon as is reasonably practical.

39. FCA AND SWMP CONCLUSIONS

- 39.1 It is concluded that surface water generated from the assessable site area can be successfully directed to, and contained in, the proposed attenuation structure to appropriate Greenfield runoff discharge rates. This will further mitigate potential for on- site and off-site surface water flooding affecting vulnerable receptors such as households.
- 39.2 The site is not considered to be at risk of flooding from sources such as fluvial waters, reservoir failure or tidal surge. Based on the available information, it is considered that the probability of the site flooding from surface water is generally low, but there are isolated locations of medium risk areas within the proposed development, in its existing condition and existing topographical conditions. The proposed development will not increase flood risk to the site or to surrounding properties providing that the suggested mitigation measures of raising finished floor levels above 12.00 m AOD and the provision of appropriately designed surface water drainage controls are implemented.

-
- 39.3 The available ground investigation data indicates that the site is underlain by clayey loamy sand, which will preclude the use of shallow infiltration methods as a means of surface water disposal. The site lies within a SPZ and therefore deep bore soakaways will not be appropriate for this development, precluding the use of infiltration as a means of surface water disposal.
- 39.4 The indicative system designed can attenuate surface water run-off for all rainfall events up to the 1 in 100 year + 40% Climate Change to the corresponding rural Greenfield Discharge Rate (Q_{bar}). The figures for rural Greenfield Discharge Rate have been calculated using the Institute of Hydrology Report 124.
- 39.5 Further storage potential and volumetric reduction pollutant concentrations in the surface water discharge, may be implemented by the further use of permeable paving, roof area runoff source control and road-side drainage swales.
- 39.6 If infiltration is to be further explored as a means of discharging surface waters from the site, further intrusive site investigation to assess for soakaway potential will be required.

DRAWINGS

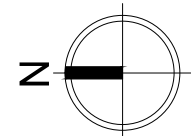
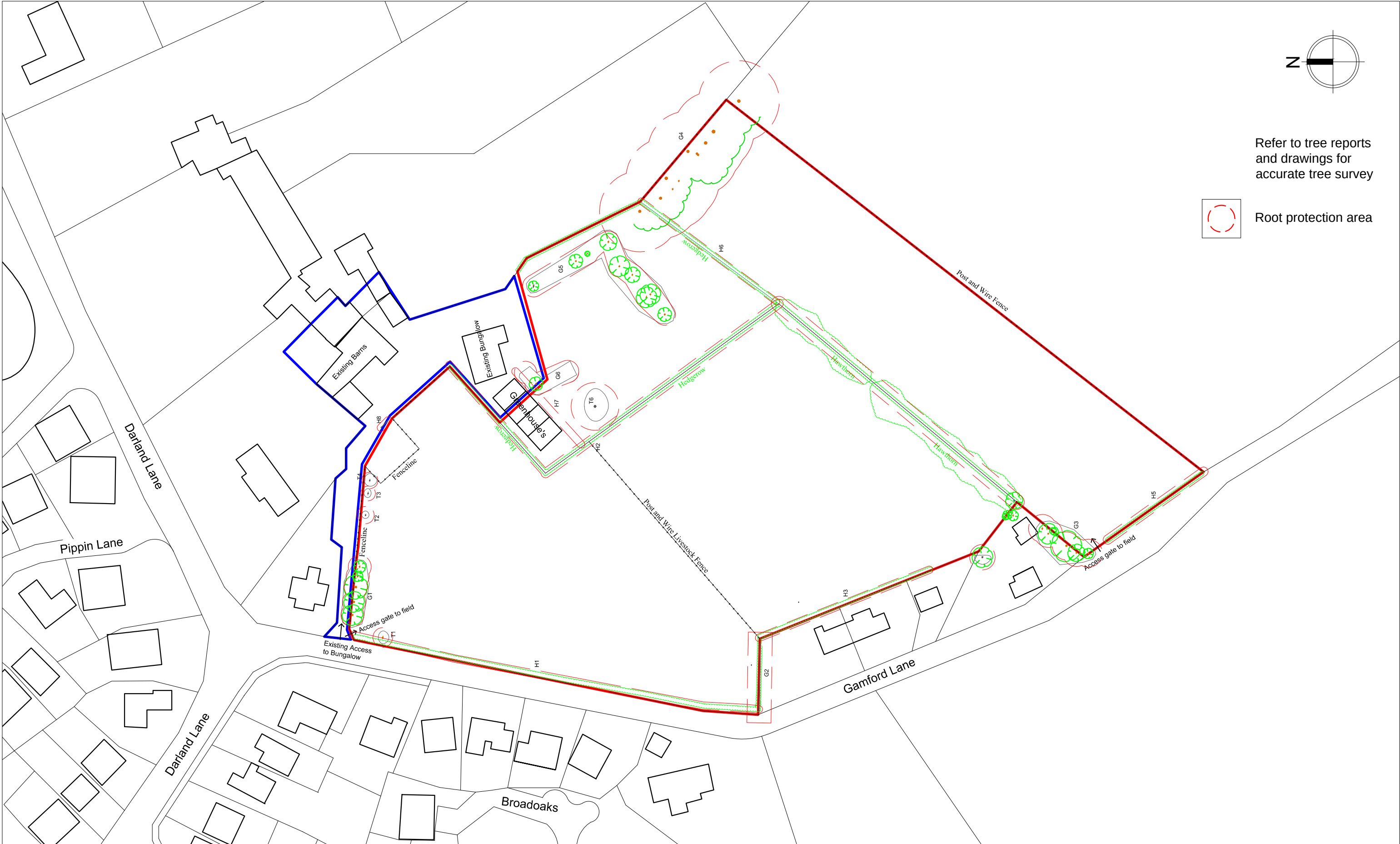
LAPLAN Drawing

LAPLAN GAM-002 – Existing Site Layout Plan

LAPLAN GAM-003 – Proposed Site Layout Plan

TERRACONSULT DRAWINGS

2978/1/001- Indicative Surface Water management Plan



Refer to tree reports
and drawings for
accurate tree survey



Root protection area

Land Planning

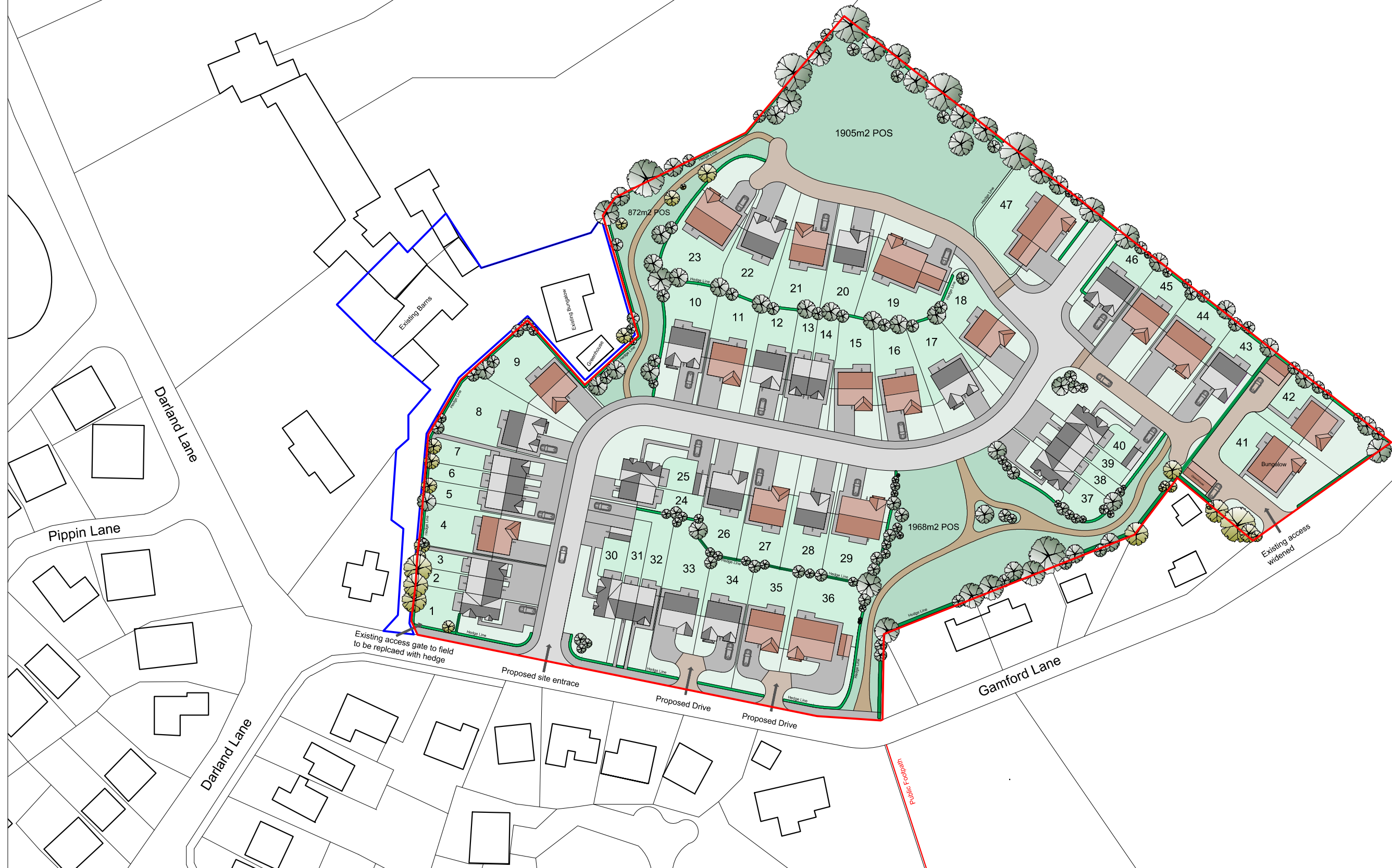
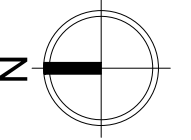
The Wyvern, Church Street, Malpas, Cheshire, SY14 8NU
Tel : 01948 861 484
www.laplan.co.uk

The Bungalow, Darland Lodge, Gamford Lane, Rossett,
Wrexham, LL12 0BA

Existing Site Layout Plan

Dwg no.	GAM - 002
Rev.	
Scale	1:1000 @ A3
Date	22/07/16
Drawn	tom@laplan

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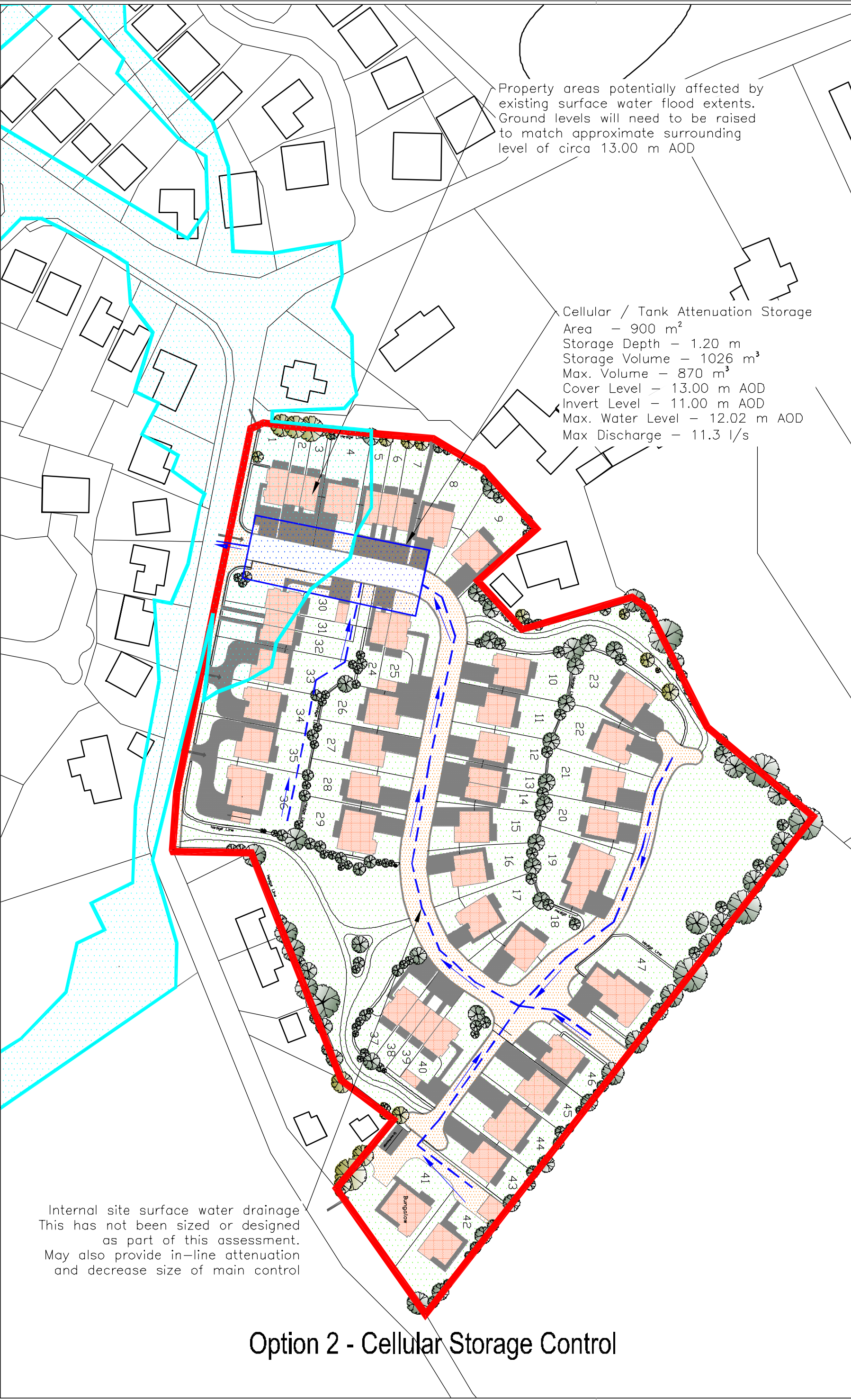
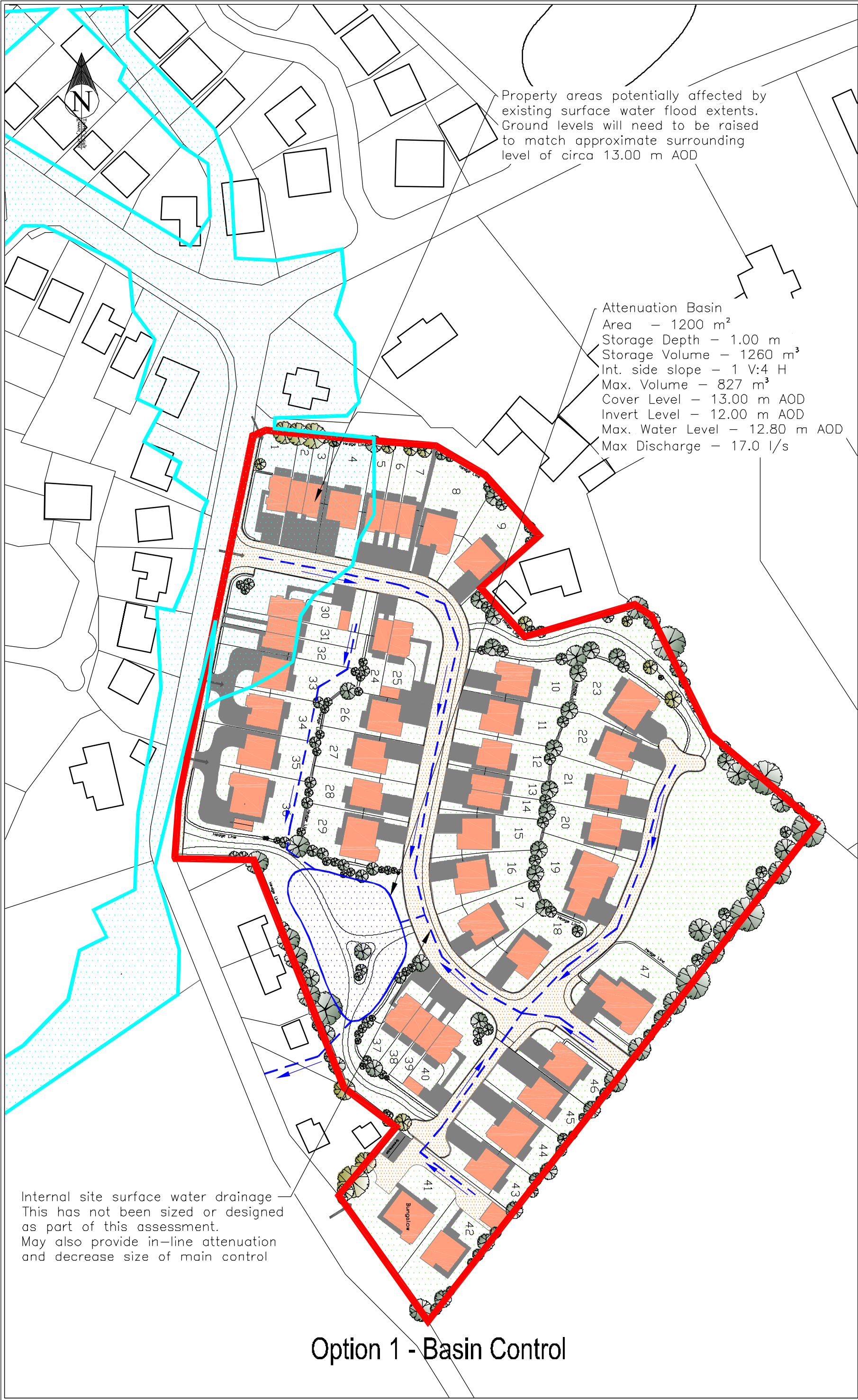
The Bungalow, Darland Lodge, Gamford Lane, Rossett,
Wrexham, LL12 0BA

Proposed Site Layout Plan

Dwg no.
Rev.
Scale
Date
Drawn

GAM - 003
0
1:1000 @ A3
22/07/16
tom@laplan

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- Notes
- Indicative Boundary
 - SW Drains
 - Patios and Driveway Area
 - Roof Area
 - Roadway Area
 - Permeable / Open Space
 - Medium Risk SW Flooding Extents
 - SW Direction of Flow

- Do not scale from drawing. Not issued for construction
- Location and exact alignment of drainage and water strategy requirements requires confirmation from Architect and Design Engineer.
- Surface water sewer and drainage locations are indicative only and not to be used for construction
- Assumed site levels have been utilised for development of indicative SWMP design. Levels may be subject to change based on development finishing and layout amendments.
- Flooding extents have been based on figure provided to client from Natural Resource Wales Flood Officer on 05/08/2016 (Reference: P/2016/0712)
- Site impermeability based on SOIL type 4 – Clayey loam with low permeability and high runoff potential
- Assumed all impermeable drainage areas directed to the cetral surface water drainage network. Gully locations for road drainage have not been indicated.
- SWMP to be reviewed with TerraConsult Report 297B/1/R01
- Site discharge limits have been obtained from Microdrainage calculation, which are provided as Appendix 4 to TerraConsult Report 297B/1/R01.
- Exceedance pathways are indicative only and will require confirmation from Architect and Design Engineer.



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Site
**The Bungalow,
Gamford land**

Title
**Indicative Surface Water
Management Plan**

Scale		1:1,000	@ A2
Drawing No.		2978/1/001	
Rev	Date	Description	
File	29781001-Indicative SWMP.dwg		
Date	09/16	Engineer	JAG
Drawn	JAG	Checked	DRAFT

Appendix 1

Photographic Record of Site Visit



Photo 1 – Site looking north from fence line which bifurcates the site. Note overhead powerline.



Photo 2 – Service manhole covers at the main northern access gate, adjacent to junction of Gamford and Darland Lane



Photo 3 – Existing site access gate looking south along Gamford Lane. Note road gully on left hand side of road



Photo 4 – Service manhole covers at the main northern access gate on Gamfrod Lane



Photo 5 – Southern site boundary, looking north. Note site is uniform in cover and generally flat.

Appendix 2

Existing BGS borehole scans



[Report an issue with this borehole](#)

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MAU Sand and Gravel Borehole Log Form

LOG:

23/09/2016 10:47



**British
Geological Survey**

NATURAL ENVIRONMENT RESEARCH COUNCIL

BGS ID: 154065 : BGS Reference: SJ35NE36

British National Grid (27700) : 337650,358250

[Report an issue with this borehole](#)

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36

IGS 1536 (1159) 2000 1/76

Institute of Geological Sciences

Sheet 1 of 1

Borehole Reg No: **SJ35NE 36**
 Temp borehole No: **SJ 35 NE 11**
 Nat Grid Ref: **37655825**
 Locality:
 Surface level: m O.D.(ft O.D.)
 Drilled by: **STRATA SURVEYS LTD**
 Drill type: **SHELL**
 Hole diameter: **8"**
 Depth(s) bailed:
 Date started:
 Date finished:
 Recorded by: **A.R. CLAYTON**

Classification of ground	Thickness m	Nature
OVER BURDEN	1.0	ALLUVIUM
MINERAL	1.1	TERRACE GRAVELS
WASTE	15.9+	UPPER TILL

Remarks

Explanation
 ▽ Groundwater depth first encountered
 a ▽ Morning water level
 p ▽ Evening water level

==== Casing depth
 — Borehole depth
 W Water sample

U, sample; solid ornament shows fraction recovered
 • Spot disturbed sample
 } Bulk sample
 S.P.T. Standard Penetration Test

Geological Classification	Description of Strata	Depth to Base m	Thickness m	Sampling	Sample Nos	Water level	Drilling and Casing progress
ALLUVIUM	SOIL AND ROOTLETS, CLAYEY BELOW 0.6m.	1.0	1.0				
TERRACE GRAVELS	GRAVEL; MAINLY COARSE WITH SOME COBBLES, SUBROUNDED, DOMINANTLY QUARTZITE/SANDSTONE WITH SOME LIMESTONE AND IGNEOUS TYPES. SAND; COARSE WITH MEDIUM, CONSTITUENTS AS GRAVEL. BROWN.	2.1	1.1		CL 286		
UPPER TILL	CLAY, REDDISH BROWN, FIRM, SILTY THROUGHOUT, RARE +4mm MATERIAL, MAINLY QUARTZITE AND SANDSTONE, SOME COAL. NO CHANGE TO BASE	18.0	15.9 +				
	BOREHOLE COMPLETED AT				18m		



**British
Geological Survey**

NATURAL ENVIRONMENT RESEARCH COUNCIL

BGS ID: 154191 : BGS Reference: SJ35NE162

British National Grid (27700) : 338110,357930

[Report an issue with this borehole](#)

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15B-4.TIF

British Geological Survey

WELSH NATIONAL WATER DEVELOPMENT AUTHORITY

DEE AND CLWYD RIVER DIVISION

DETAILED HYDROGEOLOGICAL RECORD SHEET: INDIVIDUAL SITE RECORD

SJ35/15B
.....

NAME The Darland, Rosset.

N.G.R.

3811 5793 /

EXACT SITE KNOWN

YES/NO

LOCATION SKETCH

YES/NO

HEIGHT A.O.D.

.....9.74. METRES

ESTIMATED FROM

MAP/SURVEY

REFERENCE POINT

NONE/DETAILS/SKETCH

LOG

YES/NO

LOCATION OF LOG

HERE/L.G.S.

SUMMARY OF LOG

Spring-fed well 10-15' deep, brick-lined, 4" with artesian overflow
See enclosed site visit sheet.

WATER QUALITY

INFORMATION

YES/NO

8.11.79.

WATER LEVEL INFORMATION

ABSTRACTION

YES/NO/OCCASIONALLY/NOT KNOWN/STAND-BY

LICENCE NO.

LICENSED ABSTRACTION

/HOUR 9.09m³ /DAY 3.3ML /YEAR

67/9/68C

PUMPING TEST

YES/NO

DATE

LOCATION OF DATA

WATER LEVELS RECORDED

NONE/ISOLATED READINGS/MONTHLY/AUTOGRAPHIC

LOCATION OF RECORDS

ACCESS



**British
Geological Survey**

NATURAL ENVIRONMENT RESEARCH COUNCIL

BGS ID: 154183 : BGS Reference: SJ35NE154

British National Grid (27700) : 337530,357650

[Report an issue with this borehole](#)

<<

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>>

SJ35NE 154

Holst Soil Engineering Limited									
PARKSIDE LANE									
LEEDS LS1158X.									
Contract No. <u>SI0990/F2671</u>					Borehole No. <u>1</u>				
Location <u>Wrexham</u>					Ground Level <u> </u>				
Client <u>Denbigh County Architect</u>					Date <u>5.3.73</u> 3753 5765				
BOREHOLE LOG									
STRATA	Legend	Depth below Ground Level	Thickness of Strata	Type of Sample	c kN / sq. m	φ deg.	m.c %	γ kg / cu m.	N
TOPSOIL		0.30	0.30						
Soft brown silty sandy organic CLAY		0.60	0.30						
Very soft dark brown/black organic CLAY		1.20	0.60						
Very soft dark brown clayey PEAT		1.50	0.30						
Very soft brown and black silty organic CLAY		2.40	0.90						
Stiff dark red/brown silty slightly stony CLAY		4.80	2.40						
Water Struck at <u>Overnight Seepage</u> Maximum Observed Water Level <u>3.00m</u>									
Undisturbed Sample ☐					c = Cohesion				
Disturbed Sample ☐					φ = Angle of Internal Friction				
Water Sample ☐					m.c = Moisture Content				
Penetration Test ☐					γ = Bulk Density				
					N = Standard Penetration Value				
Water levels are subject to seasonal or tidal variation and should not be taken as constant									



**British
Geological Survey**

NATURAL ENVIRONMENT RESEARCH COUNCIL

BGS ID: 154068 : BGS Reference: SJ35NE39

British National Grid (27700) : 338520,357910

[Report an issue with this borehole](#)

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British Geological Survey

British Geological Survey

British Geological Survey

39

IGS 1586 (1159) 2/00 1/76

Institute of Geological Sciences

Sheet 1 of 2

Borehole Reg No: **SJ35NE 39**

Temp borehole No: **SJ35NE 17**

Nat Grid Ref: **3852 5791**

Locality: **E of Darland N. Romelt**

Surface level: m O.D. (ft O.D.)

Drilled by: **Strata Surveys Ltd**

Drill type: **200mm**

Hole diameter: **Shell.**

Depth(s) bailed:

Date started: _____

Date finished: **10 - 06 - 77**

Recorded by: **AR Clayton**

Remarks

Explanation

▽ Groundwater depth
first encountered

a▽ Morning water level

p▽ Evening water level

== Casing depth

— Borehole depth

w Water sample

U, sample; solid ornament
shows fraction recovered

• Spot disturbed sample

— Bulk sample

S.P.T. Standard Penetration Test

Geological Classification	Description of Strata	Depth to Base m	Thickness m	Sampling	Sample Nos	Water level	Drilling and Casing progress
Alluvium	Top soil	0.3	0.3				
	Silty clay, dark grey, bioturbated in upper 0.7m. Slightly sandy, rare fine and coarse subrounded pebbles, mainly quartzite (some igneous). Clay generally structureless.	3.9	3.6				
Alluvial Gravel	Gravel [G40/550/F10] Gravel: fine to coarse with some cobbles. Subrounded mainly quartzite, sandstone, quartz and igneous, some limestone. Sand: medium, constituents as for gravel.	4.9	1.0		CL 287		
	Gravel - as above, but no cobbles.	6.2	1.3		CL 288		
							Continued over: -

Appendix 3

Natural Resource Wales Flood Risk Mapping

Map Title

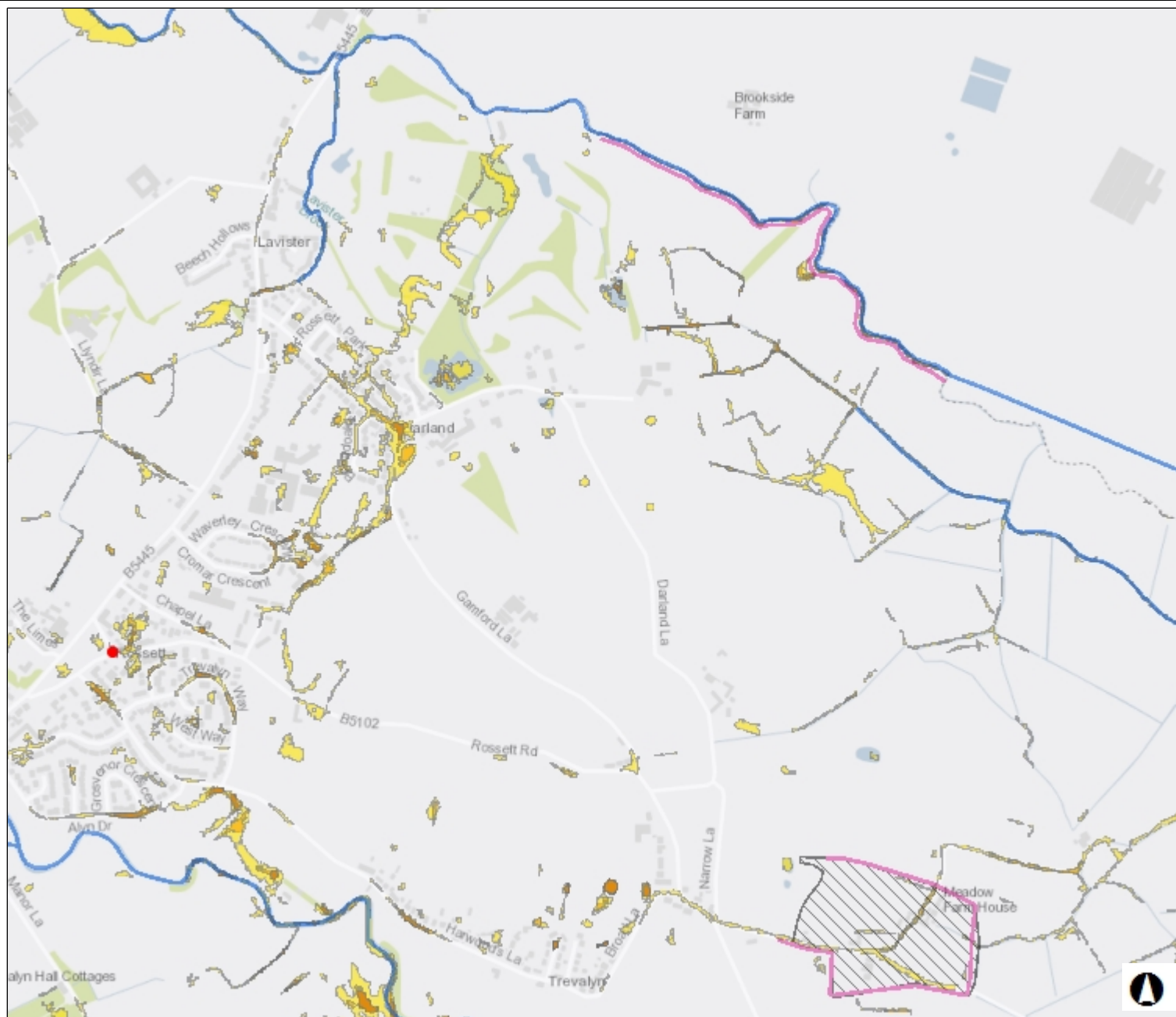
Map Perygl Llifogydd / Flood Risk Map

Allwedd / Legend

-  Main rivers
-  Flood defences
-  Areas benefitting from flood defences
-  Risk of flooding from surface water - High
-  Risk of flooding from surface water - Medium
-  Risk of flooding from surface water - Low

Graddfa / Scale 1: 12,434

Dyddiad / Date
23/09/2016



0.4 0 0.20 0.4 Miles

British_National_Grid

Ceir rhestr lawn o delerau ac amondau yn <https://naturalresources.wales/rhybuddsafonol> neu drwy gysylltu ag ymholiadau@cyfoethnaturiolcymru.gov.uk.. © Hawlfraint y Goron a hawliau cronfa ddata 2015 Arolwg Ordnans 100019741. A full list of terms and conditions is available from the <https://naturalresources.wales/StandardNotice> or by contacting enquires@naturalresourceswales.gov.uk © Crown copyright and database rights 2015 Ordnance Survey 100019741.

Map Title

Map Perygl Llifogydd / Flood Risk Map

Allwedd / Legend

— Main rivers

— Flood defences

 Areas benefitting from flood defences

Risk of Flooding from Rivers and the Sea

■ High

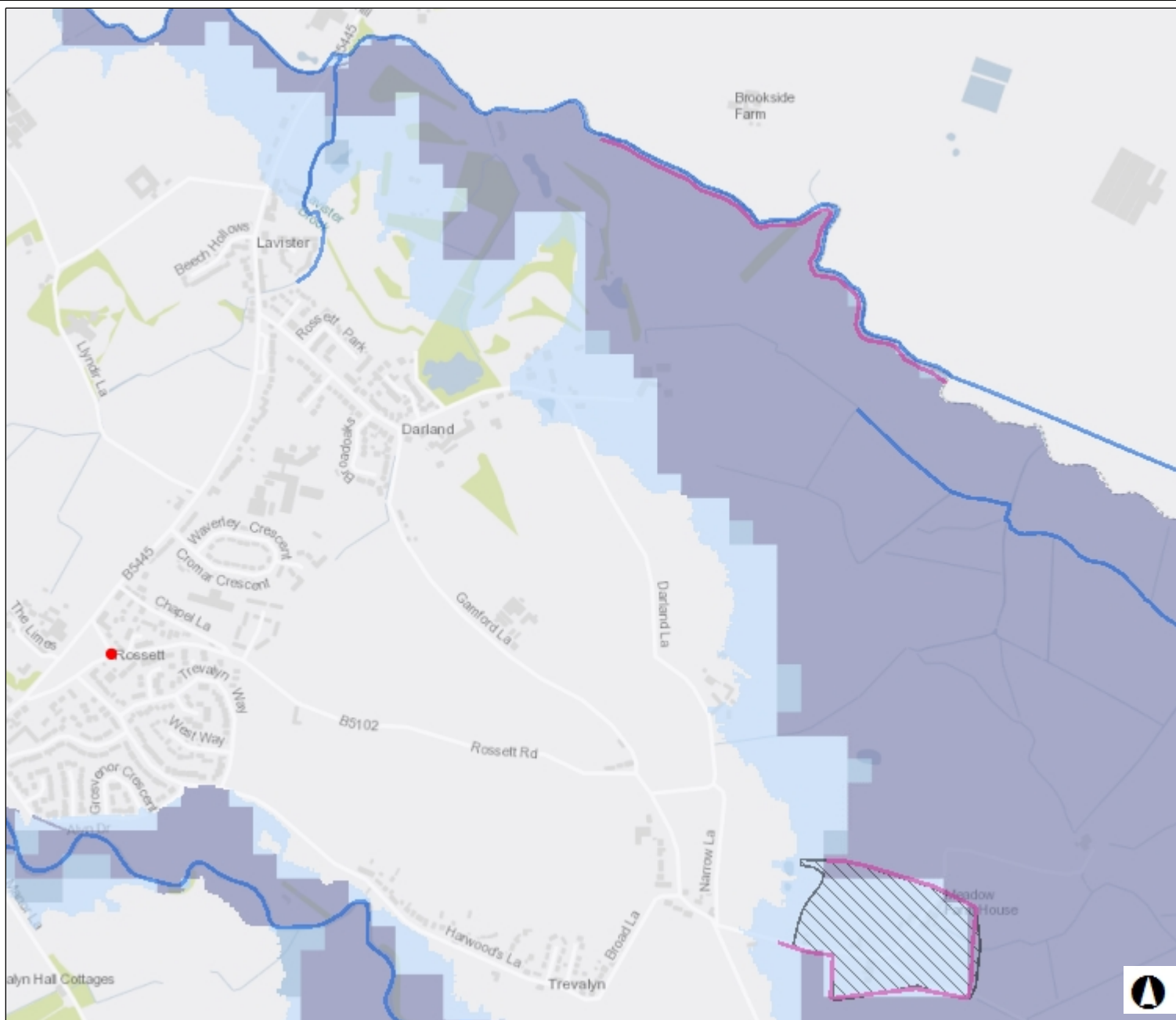
■ Medium

■ Low

■ Very Low

Graddfa / Scale 1: 12,434

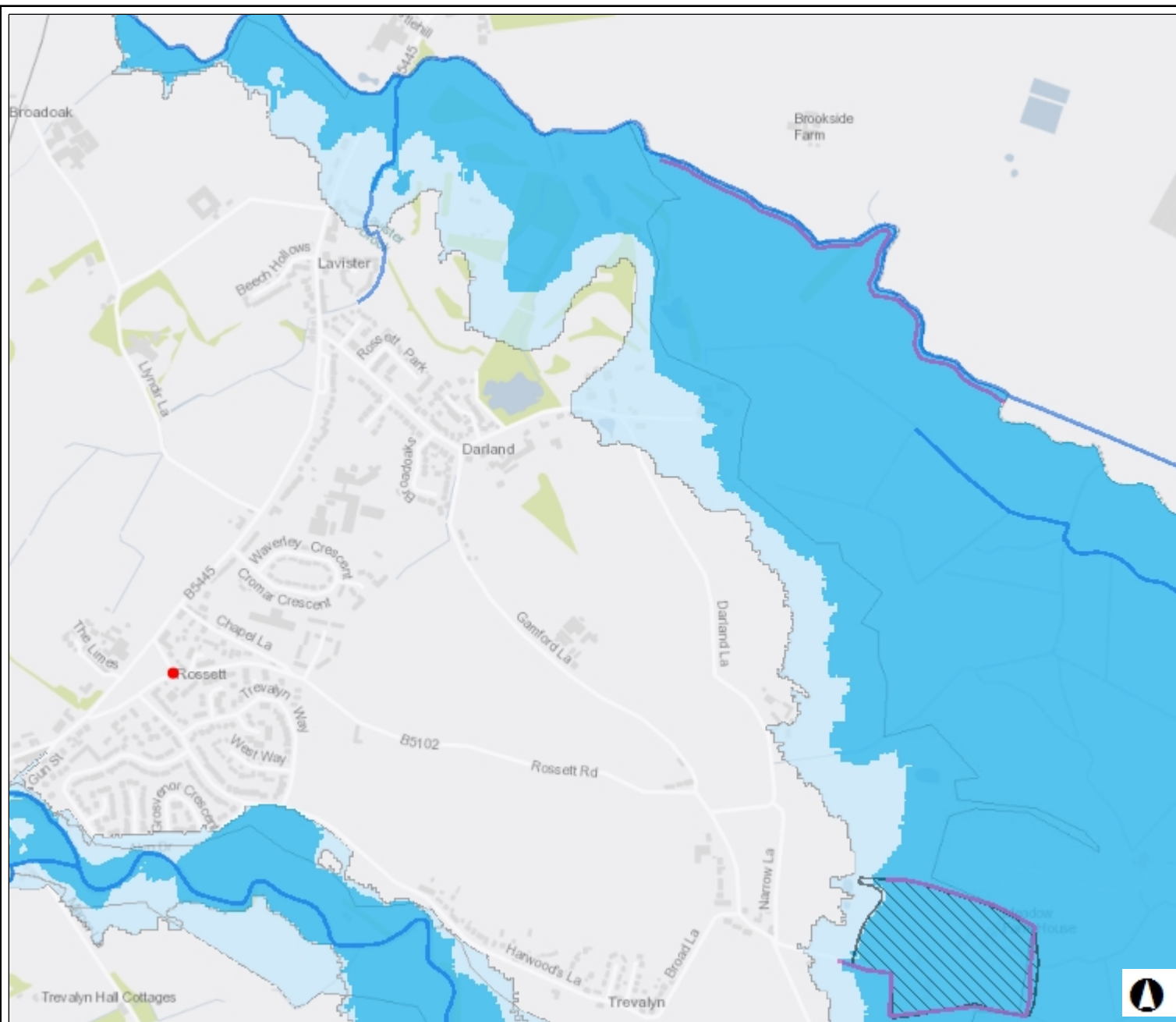
Dyddiad / Date
23/09/2016



0.4 0 0.20 0.4 Miles

British_National_Grid

Ceir rhestr lawn o delerau ac amondau yn <https://naturalresources.wales/rhybuddsafonol> neu drwy gysylltu ag ymholiada@cymru.gov.uk.. © Hawlfraint y Goron a hawliau cronfa ddata 2015 Arolwg Ordnans 100019741. A full list of terms and conditions is available from the <https://naturalresources.wales/StandardNotice> or by contacting enquires@naturalresourceswales.gov.uk © Crown copyright and database rights 2015 Ordnance Survey 100019741.



Cyfoeth Naturiol Cymru
Natural Resources Wales

Map Title

Map Perygl Llifogydd / Flood Risk Map

Allwedd / Legend

- Main rivers
- Flood defences
- ▨ Areas benefitting from flood defences

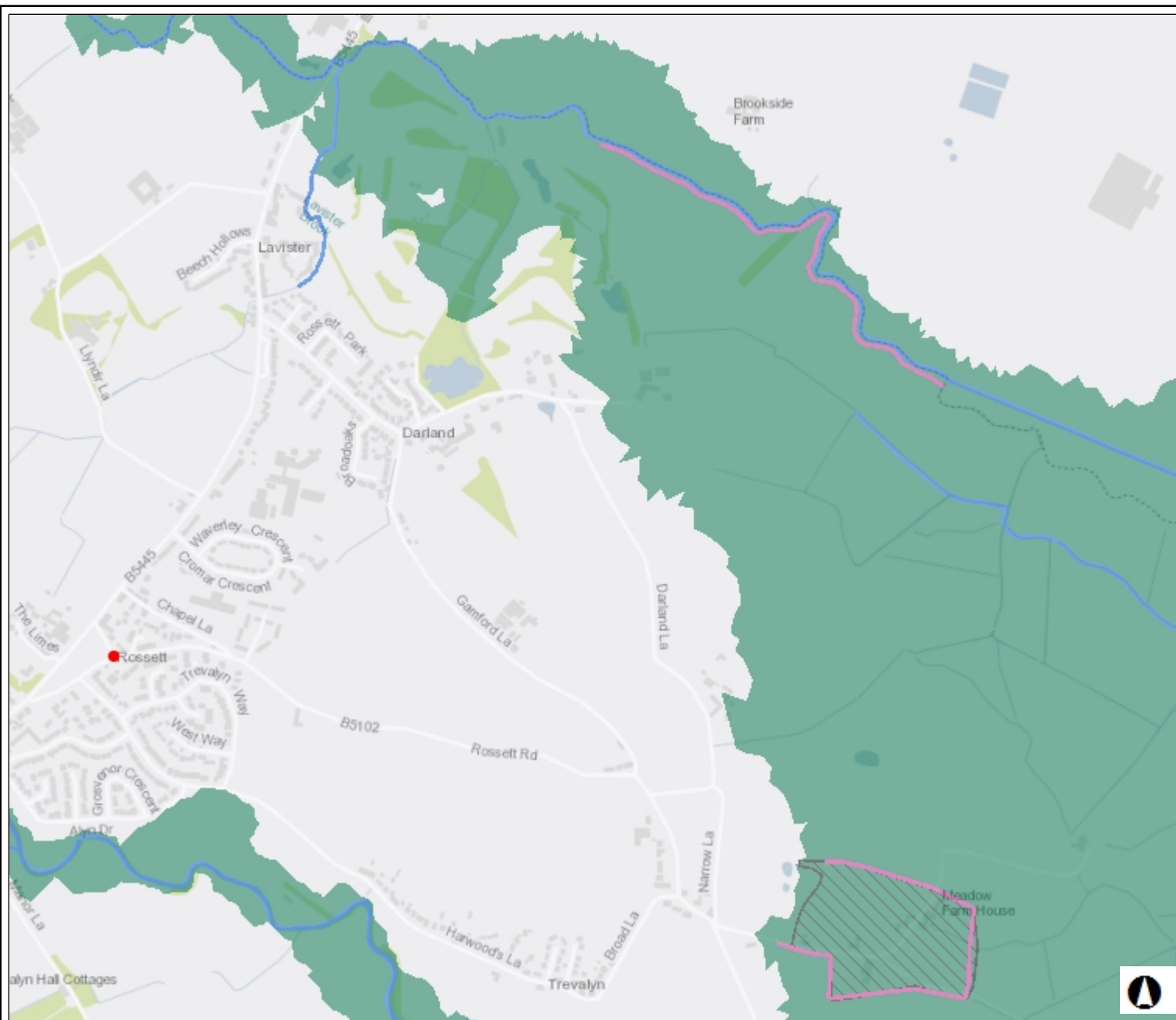
Graddfa / Scale 1: 12,434

Dyddiad / Date
23/09/2016

0.4 0 0.20 0.4 Miles

British_National_Grid

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Cyfoeth Naturiol Cymru
Natural Resources Wales

Map Title

Map Perygl Llifogydd / Flood Risk Map

Allwedd / Legend

- Main rivers
- Flood defences
- ▨ Areas benefitting from flood defences
- Risk of flooding from reservoirs

Graddfa / Scale 1: 12,434

Dyddiad / Date
23/09/2016

0.4 0 0.20 0.4 Miles

British_National_Grid

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Appendix 4

Microdrainage SW Calculations

TerraConsult Ltd		Page 1												
Bold Business Centre Sutton St Helens WA9 4TX	2978 - The Bungalow Gamford Lane Qbar Calcs													
Date 16/09/2016 File 2016_09_04-2978-Concept...	Designed by JAG Checked by													
Micro Drainage														
Source Control 2015.1														
<u>IH 124 Mean Annual Flood</u> Input <table><tr><td>Return Period (years)</td><td>100</td><td>Soil</td><td>0.470</td></tr><tr><td>Area (ha)</td><td>50.000</td><td>Urban</td><td>0.000</td></tr><tr><td>SAAR (mm)</td><td>693</td><td>Region Number</td><td>Region 9</td></tr></table> Results l/s QBAR Rural 238.6 QBAR Urban 238.6 Q100 years 520.1 Q1 year 209.9 Q2 years 221.6 Q5 years 288.7 Q10 years 338.8 Q20 years 389.1 Q25 years 406.5 Q30 years 420.6 Q50 years 461.9 Q100 years 520.1 Q200 years 589.3 Q250 years 613.1 Q1000 years 761.0 Area Ratio = 2.35 / 50 = 0.047 Therefore, Qbar = 238.60 l/s x 0.047 = 11.21 l/s Q1 = 9.87 l/s Q30 = 19.77 l/s Q100 = 24.44 l/s			Return Period (years)	100	Soil	0.470	Area (ha)	50.000	Urban	0.000	SAAR (mm)	693	Region Number	Region 9
Return Period (years)	100	Soil	0.470											
Area (ha)	50.000	Urban	0.000											
SAAR (mm)	693	Region Number	Region 9											
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TerraConsult Ltd		Page 1
Bold Business Centre Sutton St Helens WA9 4TX	2978 - The Bungalow Gamford Lane Greenfield Discharge Volumes	
Date 20/09/2016 File	Designed by JAG Checked by	
Micro Drainage Source Control 2015.1		

Greenfield Runoff Volume

FSR Data

Return Period (years)	100
Storm Duration (mins)	360
Region	England and Wales
M5-60 (mm)	17.000
Ratio R	0.300
Areal Reduction Factor	1.00
Area (ha)	2.350
SAAR (mm)	693
CWI	103.740
Urban	0.000
SPR	47.000

Results

Percentage Runoff (%)	45.46
Greenfield Runoff Volume (m ³)	650.027

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Bold Business Centre Sutton St Helens WA9 4TX				2978 - The Bungalow Gamford Lane, Rossett Option 1 - Basin 1 Yr			
Date 16/09/2019 File 2016_09_016-2978-CONCEP...				Designed by JAG Checked by			
Micro Drainage				Source Control 2015.1			
<u>Summary of Results for 1 year Return Period</u>							
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	12.082	0.082	3.9	0.0	3.9	71.0	O K
30 min Summer	12.105	0.105	5.9	0.0	5.9	91.1	O K
60 min Summer	12.127	0.127	7.8	0.0	7.8	110.9	O K
120 min Summer	12.144	0.144	9.0	0.0	9.0	126.4	O K
180 min Summer	12.152	0.152	9.6	0.0	9.6	134.4	O K
240 min Summer	12.158	0.158	9.9	0.0	9.9	139.6	O K
360 min Summer	12.164	0.164	10.3	0.0	10.3	144.9	O K
480 min Summer	12.165	0.165	10.3	0.0	10.3	145.7	O K
600 min Summer	12.164	0.164	10.3	0.0	10.3	144.9	O K
720 min Summer	12.162	0.162	10.1	0.0	10.1	143.1	O K
960 min Summer	12.157	0.157	9.8	0.0	9.8	138.3	O K
1440 min Summer	12.146	0.146	9.1	0.0	9.1	128.1	O K
2160 min Summer	12.131	0.131	8.1	0.0	8.1	115.4	O K
2880 min Summer	12.121	0.121	7.3	0.0	7.3	105.7	O K
4320 min Summer	12.106	0.106	6.0	0.0	6.0	92.5	O K
5760 min Summer	12.097	0.097	5.2	0.0	5.2	84.0	O K
7200 min Summer	12.089	0.089	4.6	0.0	4.6	77.6	O K
8640 min Summer	12.084	0.084	4.1	0.0	4.1	72.7	O K
10080 min Summer	12.080	0.080	3.8	0.0	3.8	68.9	O K
15 min Winter	12.091	0.091	4.7	0.0	4.7	79.4	O K
30 min Winter	12.117	0.117	7.0	0.0	7.0	101.9	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)		
15 min Summer	26.802	0.0	62.9	0.0	25		
30 min Summer	17.695	0.0	85.9	0.0	38		
60 min Summer	11.376	0.0	119.0	0.0	64		
120 min Summer	7.194	0.0	151.9	0.0	108		
180 min Summer	5.480	0.0	174.3	0.0	138		
240 min Summer	4.513	0.0	191.9	0.0	170		
360 min Summer	3.430	0.0	219.4	0.0	240		
480 min Summer	2.804	0.0	239.5	0.0	306		
600 min Summer	2.399	0.0	256.3	0.0	374		
720 min Summer	2.112	0.0	270.8	0.0	440		
960 min Summer	1.727	0.0	295.4	0.0	568		
1440 min Summer	1.301	0.0	333.2	0.0	818		
2160 min Summer	0.982	0.0	383.8	0.0	1188		
2880 min Summer	0.803	0.0	418.1	0.0	1556		
4320 min Summer	0.605	0.0	469.8	0.0	2288		
5760 min Summer	0.495	0.0	519.3	0.0	3000		
7200 min Summer	0.424	0.0	555.4	0.0	3744		
8640 min Summer	0.374	0.0	586.4	0.0	4424		
10080 min Summer	0.336	0.0	612.5	0.0	5152		
15 min Winter	26.802	0.0	71.5	0.0	25		
30 min Winter	17.695	0.0	97.3	0.0	38		
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Bold Business Centre Sutton St Helens WA9 4TX	2978 - The Bungalow Gamford Lane, Rossett Option 1 - Basin 1 Yr	
Date 16/09/2019 File 2016_09_016-2978-CONCEP...	Designed by JAG Checked by	
Micro Drainage Source Control 2015.1		

Summary of Results for 1 year Return Period							
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
60 min Winter	12.141	0.141	8.8	0.0	8.8	124.2	O K
120 min Winter	12.161	0.161	10.1	0.0	10.1	141.9	O K
180 min Winter	12.169	0.169	10.5	0.0	10.5	149.8	O K
240 min Winter	12.174	0.174	10.5	0.0	10.5	154.4	O K
360 min Winter	12.177	0.177	10.6	0.0	10.6	157.4	O K
480 min Winter	12.175	0.175	10.5	0.0	10.5	155.1	O K
600 min Winter	12.171	0.171	10.5	0.0	10.5	151.1	O K
720 min Winter	12.166	0.166	10.4	0.0	10.4	146.6	O K
960 min Winter	12.156	0.156	9.8	0.0	9.8	137.8	O K
1440 min Winter	12.139	0.139	8.7	0.0	8.7	122.4	O K
2160 min Winter	12.121	0.121	7.3	0.0	7.3	106.1	O K
2880 min Winter	12.109	0.109	6.3	0.0	6.3	95.2	O K
4320 min Winter	12.094	0.094	5.0	0.0	5.0	81.4	O K
5760 min Winter	12.084	0.084	4.1	0.0	4.1	72.9	O K
7200 min Winter	12.077	0.077	3.6	0.0	3.6	66.8	O K
8640 min Winter	12.072	0.072	3.2	0.0	3.2	62.3	O K
10080 min Winter	12.068	0.068	2.9	0.0	2.9	58.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
60 min Winter	11.376	0.0	133.9	0.0	64
120 min Winter	7.194	0.0	170.8	0.0	116
180 min Winter	5.480	0.0	195.9	0.0	144
240 min Winter	4.513	0.0	215.6	0.0	184
360 min Winter	3.430	0.0	246.4	0.0	258
480 min Winter	2.804	0.0	269.0	0.0	330
600 min Winter	2.399	0.0	287.8	0.0	400
720 min Winter	2.112	0.0	304.1	0.0	466
960 min Winter	1.727	0.0	331.7	0.0	598
1440 min Winter	1.301	0.0	374.2	0.0	852
2160 min Winter	0.982	0.0	430.3	0.0	1216
2880 min Winter	0.803	0.0	468.8	0.0	1588
4320 min Winter	0.605	0.0	527.3	0.0	2300
5760 min Winter	0.495	0.0	581.9	0.0	3056
7200 min Winter	0.424	0.0	622.5	0.0	3752
8640 min Winter	0.374	0.0	657.5	0.0	4496
10080 min Winter	0.336	0.0	687.3	0.0	5168

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Bold Business Centre Sutton St Helens WA9 4TX	2978 - The Bungalow Gamford Lane, Rossett Option 1 - Basin 1 Yr	
Date 16/09/2019 File 2016_09_016-2978-CONCEP...	Designed by JAG Checked by	
Micro Drainage Source Control 2015.1		

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.000	Shortest Storm (mins)	15
Ratio R	0.359	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 1.464

Time (mins)	Area	Time (mins)	Area	Time (mins)	Area
From: To:	(ha)	From: To:	(ha)	From: To:	(ha)
0 4	0.488	4 8	0.488	8 12	0.488

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Bold Business Centre Sutton St Helens WA9 4TX	2978 - The Bungalow Gamford Lane, Rossett Option 1 - Basin 1 Yr	
Date 16/09/2019 File 2016_09_016-2978-CONCEP...	Designed by JAG Checked by	
Micro Drainage Source Control 2015.1		

Model Details

Storage is Online Cover Level (m) 13.000

Tank or Pond Structure

Invert Level (m) 12.000

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	850.0	0.700	1164.0	1.400	0.0	2.100	0.0
0.100	891.8	0.800	1212.9	1.500	0.0	2.200	0.0
0.200	934.7	0.900	1262.8	1.600	0.0	2.300	0.0
0.300	978.5	1.000	1313.7	1.700	0.0	2.400	0.0
0.400	1023.4	1.100	0.0	1.800	0.0	2.500	0.0
0.500	1069.3	1.200	0.0	1.900	0.0		
0.600	1116.1	1.300	0.0	2.000	0.0		

Hydro-Brake Optimum® Outflow Control

Unit Reference MD-SHE-0153-1120-1000-1120

Design Head (m) 1.000

Design Flow (l/s) 11.2

Flush-Flo™ Calculated

Objective Minimise upstream storage

Diameter (mm) 153

Invert Level (m) 12.000

Minimum Outlet Pipe Diameter (mm) 225

Suggested Manhole Diameter (mm) 1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	11.1
Flush-Flo™	0.309	11.1
Kick-Flo®	0.684	9.3
Mean Flow over Head Range	-	9.5

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.5	1.200	12.1	3.000	18.7	7.000	28.0
0.200	10.8	1.400	13.0	3.500	20.1	7.500	29.0
0.300	11.1	1.600	13.8	4.000	21.4	8.000	29.9
0.400	11.0	1.800	14.6	4.500	22.7	8.500	30.8
0.500	10.7	2.000	15.4	5.000	23.8	9.000	31.7
0.600	10.2	2.200	16.1	5.500	25.0	9.500	32.5
0.800	10.0	2.400	16.8	6.000	26.0		
1.000	11.1	2.600	17.4	6.500	27.1		

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Bold Business Centre Sutton St Helens WA9 4TX	2978 - The Bungalow Gamford Lane, Rossett Option 1 - Basin 1 Yr	
Date 16/09/2019	Designed by JAG	
File 2016_09_016-2978-CONCEP...	Checked by	
Micro Drainage		Source Control 2015.1
<u>Pipe Overflow Control</u> Diameter (m) 0.150 Entry Loss Coefficient 0.500 Slope (1:X) 100.0 Coefficient of Contraction 0.600 Length (m) 30.000 Upstream Invert Level (m) 12.700 Manning's n 0.010		
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Bold Business Centre Sutton St Helens WA9 4TX				2978 - The Bungalow Gamford Lane, Rossett Option 1 - Basin 30 Yr			
Date 16/09/2019 File 2016_09_016-2978-Concep...				Designed by JAG Checked by			
Micro Drainage				Source Control 2015.1			
<u>Summary of Results for 30 year Return Period</u>							
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	12.193	0.193	10.7	0.0	10.7	171.7	O K
30 min Summer	12.249	0.249	11.0	0.0	11.0	224.3	O K
60 min Summer	12.303	0.303	11.1	0.0	11.1	277.2	O K
120 min Summer	12.351	0.351	11.1	0.0	11.1	324.3	O K
180 min Summer	12.371	0.371	11.1	0.0	11.1	344.3	O K
240 min Summer	12.378	0.378	11.1	0.0	11.1	352.2	O K
360 min Summer	12.383	0.383	11.1	0.0	11.1	357.1	O K
480 min Summer	12.384	0.384	11.1	0.0	11.1	357.3	O K
600 min Summer	12.381	0.381	11.1	0.0	11.1	354.4	O K
720 min Summer	12.376	0.376	11.1	0.0	11.1	349.3	O K
960 min Summer	12.362	0.362	11.1	0.0	11.1	335.3	O K
1440 min Summer	12.328	0.328	11.1	0.0	11.1	302.0	O K
2160 min Summer	12.279	0.279	11.1	0.0	11.1	253.5	O K
2880 min Summer	12.237	0.237	11.0	0.0	11.0	213.2	O K
4320 min Summer	12.179	0.179	10.6	0.0	10.6	159.1	O K
5760 min Summer	12.152	0.152	9.5	0.0	9.5	133.9	O K
7200 min Summer	12.135	0.135	8.4	0.0	8.4	118.7	O K
8640 min Summer	12.123	0.123	7.5	0.0	7.5	108.0	O K
10080 min Summer	12.115	0.115	6.8	0.0	6.8	100.5	O K
15 min Winter	12.215	0.215	10.9	0.0	10.9	192.8	O K
30 min Winter	12.278	0.278	11.1	0.0	11.1	252.5	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)		
15 min Summer	65.562	0.0	167.5	0.0	25		
30 min Summer	43.485	0.0	225.4	0.0	39		
60 min Summer	27.653	0.0	297.1	0.0	68		
120 min Summer	17.097	0.0	368.6	0.0	124		
180 min Summer	12.773	0.0	413.6	0.0	182		
240 min Summer	10.341	0.0	446.8	0.0	232		
360 min Summer	7.633	0.0	495.1	0.0	290		
480 min Summer	6.154	0.0	532.5	0.0	354		
600 min Summer	5.204	0.0	563.0	0.0	420		
720 min Summer	4.536	0.0	588.9	0.0	490		
960 min Summer	3.649	0.0	631.6	0.0	626		
1440 min Summer	2.683	0.0	695.7	0.0	892		
2160 min Summer	1.969	0.0	774.1	0.0	1276		
2880 min Summer	1.580	0.0	827.6	0.0	1640		
4320 min Summer	1.158	0.0	906.0	0.0	2332		
5760 min Summer	0.928	0.0	975.0	0.0	3008		
7200 min Summer	0.781	0.0	1025.1	0.0	3744		
8640 min Summer	0.678	0.0	1067.0	0.0	4424		
10080 min Summer	0.602	0.0	1101.5	0.0	5152		
15 min Winter	65.562	0.0	188.8	0.0	25		
30 min Winter	43.485	0.0	253.6	0.0	39		
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Bold Business Centre Sutton St Helens WA9 4TX	2978 - The Bungalow Gamford Lane, Rossett Option 1 - Basin 30 Yr						
Date 16/09/2019 File 2016_09_016-2978-Concep...	Designed by JAG Checked by						
Micro Drainage Source Control 2015.1							
<u>Summary of Results for 30 year Return Period</u>							
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
60 min Winter	12.339	0.339	11.1	0.0	11.1	312.9	O K
120 min Winter	12.394	0.394	11.1	0.0	11.1	368.0	O K
180 min Winter	12.418	0.418	11.1	0.0	11.1	392.8	O K
240 min Winter	12.429	0.429	11.1	0.0	11.1	404.0	O K
360 min Winter	12.432	0.432	11.1	0.0	11.1	406.8	O K
480 min Winter	12.429	0.429	11.1	0.0	11.1	403.9	O K
600 min Winter	12.423	0.423	11.1	0.0	11.1	397.8	O K
720 min Winter	12.414	0.414	11.1	0.0	11.1	388.5	O K
960 min Winter	12.391	0.391	11.1	0.0	11.1	364.9	O K
1440 min Winter	12.338	0.338	11.1	0.0	11.1	311.2	O K
2160 min Winter	12.262	0.262	11.1	0.0	11.1	237.1	O K
2880 min Winter	12.204	0.204	10.8	0.0	10.8	181.8	O K
4320 min Winter	12.149	0.149	9.3	0.0	9.3	131.3	O K
5760 min Winter	12.126	0.126	7.7	0.0	7.7	110.6	O K
7200 min Winter	12.113	0.113	6.6	0.0	6.6	98.4	O K
8640 min Winter	12.103	0.103	5.8	0.0	5.8	89.8	O K
10080 min Winter	12.096	0.096	5.1	0.0	5.1	83.3	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)		
60 min Winter	27.653	0.0	333.4	0.0	66		
120 min Winter	17.097	0.0	413.4	0.0	124		
180 min Winter	12.773	0.0	463.9	0.0	180		
240 min Winter	10.341	0.0	501.1	0.0	236		
360 min Winter	7.633	0.0	555.2	0.0	338		
480 min Winter	6.154	0.0	597.0	0.0	382		
600 min Winter	5.204	0.0	631.1	0.0	458		
720 min Winter	4.536	0.0	660.2	0.0	534		
960 min Winter	3.649	0.0	708.1	0.0	682		
1440 min Winter	2.683	0.0	780.0	0.0	962		
2160 min Winter	1.969	0.0	867.5	0.0	1344		
2880 min Winter	1.580	0.0	927.6	0.0	1680		
4320 min Winter	1.158	0.0	1016.0	0.0	2336		
5760 min Winter	0.928	0.0	1092.3	0.0	3048		
7200 min Winter	0.781	0.0	1148.6	0.0	3752		
8640 min Winter	0.678	0.0	1195.8	0.0	4456		
10080 min Winter	0.602	0.0	1235.2	0.0	5240		
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Bold Business Centre Sutton St Helens WA9 4TX	2978 - The Bungalow Gamford Lane, Rossett Option 1 - Basin 30 Yr	
Date 16/09/2019 File 2016_09_016-2978-Concep...	Designed by JAG Checked by	
Micro Drainage Source Control 2015.1		

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.000	Shortest Storm (mins)	15
Ratio R	0.359	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 1.464

Time (mins)	Area	Time (mins)	Area	Time (mins)	Area
From: To:	(ha)	From: To:	(ha)	From: To:	(ha)
0 4	0.488	4 8	0.488	8 12	0.488

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Bold Business Centre Sutton St Helens WA9 4TX	2978 - The Bungalow Gamford Lane, Rossett Option 1 - Basin 30 Yr																																																																																																																																																																											
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Micro Drainage		Source Control 2015.1																																																																																																																																																																										
<u>Model Details</u> Storage is Online Cover Level (m) 13.000 <u>Tank or Pond Structure</u> Invert Level (m) 12.000 <table><tr><th>Depth (m)</th><th>Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th></tr><tr><td>0.000</td><td>850.0</td><td>0.700</td><td>1164.0</td><td>1.400</td><td>0.0</td><td>2.100</td><td>0.0</td></tr><tr><td>0.100</td><td>891.8</td><td>0.800</td><td>1212.9</td><td>1.500</td><td>0.0</td><td>2.200</td><td>0.0</td></tr><tr><td>0.200</td><td>934.7</td><td>0.900</td><td>1262.8</td><td>1.600</td><td>0.0</td><td>2.300</td><td>0.0</td></tr><tr><td>0.300</td><td>978.5</td><td>1.000</td><td>1313.7</td><td>1.700</td><td>0.0</td><td>2.400</td><td>0.0</td></tr><tr><td>0.400</td><td>1023.4</td><td>1.100</td><td>0.0</td><td>1.800</td><td>0.0</td><td>2.500</td><td>0.0</td></tr><tr><td>0.500</td><td>1069.3</td><td>1.200</td><td>0.0</td><td>1.900</td><td>0.0</td><td></td><td></td></tr><tr><td>0.600</td><td>1116.1</td><td>1.300</td><td>0.0</td><td>2.000</td><td>0.0</td><td></td><td></td></tr></table> <u>Hydro-Brake Optimum® Outflow Control</u> <table><tr><td>Unit Reference</td><td>MD-SHE-0153-1120-1000-1120</td></tr><tr><td>Design Head (m)</td><td>1.000</td></tr><tr><td>Design Flow (l/s)</td><td>11.2</td></tr><tr><td>Flush-Flo™</td><td>Calculated</td></tr><tr><td>Objective</td><td>Minimise upstream storage</td></tr><tr><td>Diameter (mm)</td><td>153</td></tr><tr><td>Invert Level (m)</td><td>12.000</td></tr><tr><td>Minimum Outlet Pipe Diameter (mm)</td><td>225</td></tr><tr><td>Suggested Manhole Diameter (mm)</td><td>1200</td></tr></table> <table><tr><th>Control Points</th><th>Head (m)</th><th>Flow (l/s)</th></tr><tr><td>Design Point (Calculated)</td><td>1.000</td><td>11.1</td></tr><tr><td>Flush-Flo™</td><td>0.309</td><td>11.1</td></tr><tr><td>Kick-Flo®</td><td>0.684</td><td>9.3</td></tr><tr><td>Mean Flow over Head Range</td><td>-</td><td>9.5</td></tr></table> The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated <table><tr><th>Depth (m)</th><th>Flow (l/s)</th><th>Depth (m)</th><th>Flow (l/s)</th><th>Depth (m)</th><th>Flow (l/s)</th><th>Depth (m)</th><th>Flow (l/s)</th></tr><tr><td>0.100</td><td>5.5</td><td>1.200</td><td>12.1</td><td>3.000</td><td>18.7</td><td>7.000</td><td>28.0</td></tr><tr><td>0.200</td><td>10.8</td><td>1.400</td><td>13.0</td><td>3.500</td><td>20.1</td><td>7.500</td><td>29.0</td></tr><tr><td>0.300</td><td>11.1</td><td>1.600</td><td>13.8</td><td>4.000</td><td>21.4</td><td>8.000</td><td>29.9</td></tr><tr><td>0.400</td><td>11.0</td><td>1.800</td><td>14.6</td><td>4.500</td><td>22.7</td><td>8.500</td><td>30.8</td></tr><tr><td>0.500</td><td>10.7</td><td>2.000</td><td>15.4</td><td>5.000</td><td>23.8</td><td>9.000</td><td>31.7</td></tr><tr><td>0.600</td><td>10.2</td><td>2.200</td><td>16.1</td><td>5.500</td><td>25.0</td><td>9.500</td><td>32.5</td></tr><tr><td>0.800</td><td>10.0</td><td>2.400</td><td>16.8</td><td>6.000</td><td>26.0</td><td></td><td></td></tr><tr><td>1.000</td><td>11.1</td><td>2.600</td><td>17.4</td><td>6.500</td><td>27.1</td><td></td><td></td></tr></table>				Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	0.000	850.0	0.700	1164.0	1.400	0.0	2.100	0.0	0.100	891.8	0.800	1212.9	1.500	0.0	2.200	0.0	0.200	934.7	0.900	1262.8	1.600	0.0	2.300	0.0	0.300	978.5	1.000	1313.7	1.700	0.0	2.400	0.0	0.400	1023.4	1.100	0.0	1.800	0.0	2.500	0.0	0.500	1069.3	1.200	0.0	1.900	0.0			0.600	1116.1	1.300	0.0	2.000	0.0			Unit Reference	MD-SHE-0153-1120-1000-1120	Design Head (m)	1.000	Design Flow (l/s)	11.2	Flush-Flo™	Calculated	Objective	Minimise upstream storage	Diameter (mm)	153	Invert Level (m)	12.000	Minimum Outlet Pipe Diameter (mm)	225	Suggested Manhole Diameter (mm)	1200	Control Points	Head (m)	Flow (l/s)	Design Point (Calculated)	1.000	11.1	Flush-Flo™	0.309	11.1	Kick-Flo®	0.684	9.3	Mean Flow over Head Range	-	9.5	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	0.100	5.5	1.200	12.1	3.000	18.7	7.000	28.0	0.200	10.8	1.400	13.0	3.500	20.1	7.500	29.0	0.300	11.1	1.600	13.8	4.000	21.4	8.000	29.9	0.400	11.0	1.800	14.6	4.500	22.7	8.500	30.8	0.500	10.7	2.000	15.4	5.000	23.8	9.000	31.7	0.600	10.2	2.200	16.1	5.500	25.0	9.500	32.5	0.800	10.0	2.400	16.8	6.000	26.0			1.000	11.1	2.600	17.4	6.500	27.1		
Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)																																																																																																																																																																					
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Bold Business Centre Sutton St Helens WA9 4TX	2978 - The Bungalow Gamford Lane, Rossett Option 1 - Basin 30 Yr	
Date 16/09/2019	Designed by JAG	
File 2016_09_016-2978-Concep...	Checked by	
Micro Drainage		Source Control 2015.1
<u>Pipe Overflow Control</u> Diameter (m) 0.150 Entry Loss Coefficient 0.500 Slope (1:X) 100.0 Coefficient of Contraction 0.600 Length (m) 30.000 Upstream Invert Level (m) 12.700 Manning's n 0.010		
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Bold Business Centre Sutton St Helens WA9 4TX		2978 - The Bungalow Gamford Lane, Rossett Option 1 - Basin 100 Yr					
Date 16/09/2019 File 2016_09_016-2978-Concep...		Designed by JAG Checked by					
Micro Drainage		Source Control 2015.1					
Summary of Results for 100 year Return Period							
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	12.247	0.247	11.0	0.0	11.0	222.8	O K
30 min Summer	12.322	0.322	11.1	0.0	11.1	295.4	O K
60 min Summer	12.396	0.396	11.1	0.0	11.1	370.1	O K
120 min Summer	12.463	0.463	11.1	0.0	11.1	439.4	O K
180 min Summer	12.493	0.493	11.1	0.0	11.1	471.4	O K
240 min Summer	12.507	0.507	11.1	0.0	11.1	486.6	O K
360 min Summer	12.513	0.513	11.1	0.0	11.1	492.2	O K
480 min Summer	12.512	0.512	11.1	0.0	11.1	491.1	O K
600 min Summer	12.508	0.508	11.1	0.0	11.1	486.8	O K
720 min Summer	12.502	0.502	11.1	0.0	11.1	480.6	O K
960 min Summer	12.486	0.486	11.1	0.0	11.1	464.1	O K
1440 min Summer	12.448	0.448	11.1	0.0	11.1	424.1	O K
2160 min Summer	12.388	0.388	11.1	0.0	11.1	362.4	O K
2880 min Summer	12.333	0.333	11.1	0.0	11.1	306.9	O K
4320 min Summer	12.247	0.247	11.0	0.0	11.0	222.5	O K
5760 min Summer	12.191	0.191	10.7	0.0	10.7	169.9	O K
7200 min Summer	12.161	0.161	10.1	0.0	10.1	142.2	O K
8640 min Summer	12.144	0.144	9.0	0.0	9.0	126.7	O K
10080 min Summer	12.132	0.132	8.2	0.0	8.2	116.0	O K
15 min Winter	12.276	0.276	11.1	0.0	11.1	250.3	O K
30 min Winter	12.359	0.359	11.1	0.0	11.1	332.5	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)		
15 min Summer	84.641	0.0	219.2	0.0	26		
30 min Summer	56.695	0.0	296.7	0.0	40		
60 min Summer	36.294	0.0	391.6	0.0	68		
120 min Summer	22.488	0.0	486.4	0.0	126		
180 min Summer	16.773	0.0	544.7	0.0	184		
240 min Summer	13.540	0.0	586.6	0.0	242		
360 min Summer	9.927	0.0	645.4	0.0	342		
480 min Summer	7.969	0.0	691.0	0.0	398		
600 min Summer	6.715	0.0	727.8	0.0	458		
720 min Summer	5.836	0.0	758.9	0.0	522		
960 min Summer	4.672	0.0	809.9	0.0	658		
1440 min Summer	3.409	0.0	885.1	0.0	928		
2160 min Summer	2.483	0.0	976.8	0.0	1324		
2880 min Summer	1.980	0.0	1038.0	0.0	1704		
4320 min Summer	1.437	0.0	1126.4	0.0	2388		
5760 min Summer	1.143	0.0	1202.1	0.0	3064		
7200 min Summer	0.957	0.0	1256.9	0.0	3752		
8640 min Summer	0.827	0.0	1302.1	0.0	4488		
10080 min Summer	0.730	0.0	1339.1	0.0	5152		
15 min Winter	84.641	0.0	246.6	0.0	25		
30 min Winter	56.695	0.0	333.3	0.0	40		
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Summary of Results for 100 year Return Period <table><tr><th>Storm Event</th><th>Max Level (m)</th><th>Max Depth (m)</th><th>Max Control (l/s)</th><th>Max Overflow (l/s)</th><th>Max E Outflow (l/s)</th><th>Max Volume (m³)</th><th>Status</th></tr><tr><td>60 min Winter</td><td>12.442</td><td>0.442</td><td>11.1</td><td>0.0</td><td>11.1</td><td>417.3</td><td>O K</td></tr><tr><td>120 min Winter</td><td>12.517</td><td>0.517</td><td>11.1</td><td>0.0</td><td>11.1</td><td>497.5</td><td>O K</td></tr><tr><td>180 min Winter</td><td>12.553</td><td>0.553</td><td>11.1</td><td>0.0</td><td>11.1</td><td>536.2</td><td>O K</td></tr><tr><td>240 min Winter</td><td>12.571</td><td>0.571</td><td>11.1</td><td>0.0</td><td>11.1</td><td>556.3</td><td>O K</td></tr><tr><td>360 min Winter</td><td>12.582</td><td>0.582</td><td>11.1</td><td>0.0</td><td>11.1</td><td>568.4</td><td>O K</td></tr><tr><td>480 min Winter</td><td>12.580</td><td>0.580</td><td>11.1</td><td>0.0</td><td>11.1</td><td>566.0</td><td>O K</td></tr><tr><td>600 min Winter</td><td>12.571</td><td>0.571</td><td>11.1</td><td>0.0</td><td>11.1</td><td>556.1</td><td>O K</td></tr><tr><td>720 min Winter</td><td>12.563</td><td>0.563</td><td>11.1</td><td>0.0</td><td>11.1</td><td>546.8</td><td>O K</td></tr><tr><td>960 min Winter</td><td>12.540</td><td>0.540</td><td>11.1</td><td>0.0</td><td>11.1</td><td>521.8</td><td>O K</td></tr><tr><td>1440 min Winter</td><td>12.482</td><td>0.482</td><td>11.1</td><td>0.0</td><td>11.1</td><td>459.7</td><td>O K</td></tr><tr><td>2160 min Winter</td><td>12.390</td><td>0.390</td><td>11.1</td><td>0.0</td><td>11.1</td><td>364.0</td><td>O K</td></tr><tr><td>2880 min Winter</td><td>12.307</td><td>0.307</td><td>11.1</td><td>0.0</td><td>11.1</td><td>281.1</td><td>O K</td></tr><tr><td>4320 min Winter</td><td>12.193</td><td>0.193</td><td>10.7</td><td>0.0</td><td>10.7</td><td>172.1</td><td>O K</td></tr><tr><td>5760 min Winter</td><td>12.150</td><td>0.150</td><td>9.4</td><td>0.0</td><td>9.4</td><td>132.4</td><td>O K</td></tr><tr><td>7200 min Winter</td><td>12.130</td><td>0.130</td><td>8.0</td><td>0.0</td><td>8.0</td><td>114.3</td><td>O K</td></tr><tr><td>8640 min Winter</td><td>12.118</td><td>0.118</td><td>7.0</td><td>0.0</td><td>7.0</td><td>102.8</td><td>O K</td></tr><tr><td>10080 min Winter</td><td>12.108</td><td>0.108</td><td>6.2</td><td>0.0</td><td>6.2</td><td>94.7</td><td>O K</td></tr></table> <table><tr><th>Storm Event</th><th>Rain (mm/hr)</th><th>Flooded Volume (m³)</th><th>Discharge Volume (m³)</th><th>Overflow Volume (m³)</th><th>Time-Peak (mins)</th></tr><tr><td>60 min Winter</td><td>36.294</td><td>0.0</td><td>439.2</td><td>0.0</td><td>68</td></tr><tr><td>120 min Winter</td><td>22.488</td><td>0.0</td><td>545.4</td><td>0.0</td><td>124</td></tr><tr><td>180 min Winter</td><td>16.773</td><td>0.0</td><td>610.7</td><td>0.0</td><td>182</td></tr><tr><td>240 min Winter</td><td>13.540</td><td>0.0</td><td>657.5</td><td>0.0</td><td>238</td></tr><tr><td>360 min Winter</td><td>9.927</td><td>0.0</td><td>723.3</td><td>0.0</td><td>350</td></tr><tr><td>480 min Winter</td><td>7.969</td><td>0.0</td><td>774.3</td><td>0.0</td><td>456</td></tr><tr><td>600 min Winter</td><td>6.715</td><td>0.0</td><td>815.6</td><td>0.0</td><td>500</td></tr><tr><td>720 min Winter</td><td>5.836</td><td>0.0</td><td>850.4</td><td>0.0</td><td>566</td></tr><tr><td>960 min Winter</td><td>4.672</td><td>0.0</td><td>907.4</td><td>0.0</td><td>718</td></tr><tr><td>1440 min Winter</td><td>3.409</td><td>0.0</td><td>991.7</td><td>0.0</td><td>1012</td></tr><tr><td>2160 min Winter</td><td>2.483</td><td>0.0</td><td>1094.4</td><td>0.0</td><td>1416</td></tr><tr><td>2880 min Winter</td><td>1.980</td><td>0.0</td><td>1163.3</td><td>0.0</td><td>1792</td></tr><tr><td>4320 min Winter</td><td>1.437</td><td>0.0</td><td>1262.9</td><td>0.0</td><td>2428</td></tr><tr><td>5760 min Winter</td><td>1.143</td><td>0.0</td><td>1346.7</td><td>0.0</td><td>3056</td></tr><tr><td>7200 min Winter</td><td>0.957</td><td>0.0</td><td>1408.2</td><td>0.0</td><td>3752</td></tr><tr><td>8640 min Winter</td><td>0.827</td><td>0.0</td><td>1459.1</td><td>0.0</td><td>4488</td></tr><tr><td>10080 min Winter</td><td>0.730</td><td>0.0</td><td>1501.3</td><td>0.0</td><td>5240</td></tr></table>			Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status	60 min Winter	12.442	0.442	11.1	0.0	11.1	417.3	O K	120 min Winter	12.517	0.517	11.1	0.0	11.1	497.5	O K	180 min Winter	12.553	0.553	11.1	0.0	11.1	536.2	O K	240 min Winter	12.571	0.571	11.1	0.0	11.1	556.3	O K	360 min Winter	12.582	0.582	11.1	0.0	11.1	568.4	O K	480 min Winter	12.580	0.580	11.1	0.0	11.1	566.0	O K	600 min Winter	12.571	0.571	11.1	0.0	11.1	556.1	O K	720 min Winter	12.563	0.563	11.1	0.0	11.1	546.8	O K	960 min Winter	12.540	0.540	11.1	0.0	11.1	521.8	O K	1440 min Winter	12.482	0.482	11.1	0.0	11.1	459.7	O K	2160 min Winter	12.390	0.390	11.1	0.0	11.1	364.0	O K	2880 min Winter	12.307	0.307	11.1	0.0	11.1	281.1	O K	4320 min Winter	12.193	0.193	10.7	0.0	10.7	172.1	O K	5760 min Winter	12.150	0.150	9.4	0.0	9.4	132.4	O K	7200 min Winter	12.130	0.130	8.0	0.0	8.0	114.3	O K	8640 min Winter	12.118	0.118	7.0	0.0	7.0	102.8	O K	10080 min Winter	12.108	0.108	6.2	0.0	6.2	94.7	O K	Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)	60 min Winter	36.294	0.0	439.2	0.0	68	120 min Winter	22.488	0.0	545.4	0.0	124	180 min Winter	16.773	0.0	610.7	0.0	182	240 min Winter	13.540	0.0	657.5	0.0	238	360 min Winter	9.927	0.0	723.3	0.0	350	480 min Winter	7.969	0.0	774.3	0.0	456	600 min Winter	6.715	0.0	815.6	0.0	500	720 min Winter	5.836	0.0	850.4	0.0	566	960 min Winter	4.672	0.0	907.4	0.0	718	1440 min Winter	3.409	0.0	991.7	0.0	1012	2160 min Winter	2.483	0.0	1094.4	0.0	1416	2880 min Winter	1.980	0.0	1163.3	0.0	1792	4320 min 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Bold Business Centre Sutton St Helens WA9 4TX	2978 - The Bungalow Gamford Lane, Rossett Option 1 - Basin 100 Yr	
Date 16/09/2019 File 2016_09_016-2978-Concep...	Designed by JAG Checked by	
Micro Drainage Source Control 2015.1		

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.000	Shortest Storm (mins)	15
Ratio R	0.359	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 1.464

Time (mins)	Area	Time (mins)	Area	Time (mins)	Area
From: To:	(ha)	From: To:	(ha)	From: To:	(ha)
0 4	0.488	4 8	0.488	8 12	0.488

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Micro Drainage Source Control 2015.1		

Model Details

Storage is Online Cover Level (m) 13.000

Tank or Pond Structure

Invert Level (m) 12.000

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	850.0	0.700	1164.0	1.400	0.0	2.100	0.0
0.100	891.8	0.800	1212.9	1.500	0.0	2.200	0.0
0.200	934.7	0.900	1262.8	1.600	0.0	2.300	0.0
0.300	978.5	1.000	1313.7	1.700	0.0	2.400	0.0
0.400	1023.4	1.100	0.0	1.800	0.0	2.500	0.0
0.500	1069.3	1.200	0.0	1.900	0.0		
0.600	1116.1	1.300	0.0	2.000	0.0		

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0153-1120-1000-1120
Design Head (m)	1.000
Design Flow (l/s)	11.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	153
Invert Level (m)	12.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	11.1
Flush-Flo™	0.309	11.1
Kick-Flo®	0.684	9.3
Mean Flow over Head Range	-	9.5

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.5	1.200	12.1	3.000	18.7	7.000	28.0
0.200	10.8	1.400	13.0	3.500	20.1	7.500	29.0
0.300	11.1	1.600	13.8	4.000	21.4	8.000	29.9
0.400	11.0	1.800	14.6	4.500	22.7	8.500	30.8
0.500	10.7	2.000	15.4	5.000	23.8	9.000	31.7
0.600	10.2	2.200	16.1	5.500	25.0	9.500	32.5
0.800	10.0	2.400	16.8	6.000	26.0		
1.000	11.1	2.600	17.4	6.500	27.1		

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Date 16/09/2019	Designed by JAG	
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Micro Drainage		Source Control 2015.1
<u>Pipe Overflow Control</u> Diameter (m) 0.150 Entry Loss Coefficient 0.500 Slope (1:X) 100.0 Coefficient of Contraction 0.600 Length (m) 30.000 Upstream Invert Level (m) 12.700 Manning's n 0.010		
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Date 16/09/2019 File 2016_09_016-2978-Concep...			Designed by JAG Checked by				
Micro Drainage			Source Control 2015.1				
<u>Summary of Results for 100 year Return Period (+40%)</u>							
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	12.341	0.341	11.1	0.0	11.1	314.6	O K
30 min Summer	12.443	0.443	11.1	0.0	11.1	418.7	O K
60 min Summer	12.545	0.545	11.1	0.0	11.1	527.7	O K
120 min Summer	12.641	0.641	11.1	0.0	11.1	634.4	O K
180 min Summer	12.690	0.690	11.1	0.0	11.1	690.3	O K
240 min Summer	12.717	0.717	11.1	0.2	11.1	722.2	Flood Risk
360 min Summer	12.739	0.739	11.1	0.9	11.1	747.6	Flood Risk
480 min Summer	12.743	0.743	11.1	1.1	11.1	752.8	Flood Risk
600 min Summer	12.740	0.740	11.1	1.0	11.1	749.4	Flood Risk
720 min Summer	12.736	0.736	11.1	0.8	11.1	744.7	Flood Risk
960 min Summer	12.725	0.725	11.1	0.4	11.1	731.0	Flood Risk
1440 min Summer	12.691	0.691	11.1	0.0	11.1	691.3	O K
2160 min Summer	12.625	0.625	11.1	0.0	11.1	616.6	O K
2880 min Summer	12.562	0.562	11.1	0.0	11.1	545.7	O K
4320 min Summer	12.445	0.445	11.1	0.0	11.1	421.0	O K
5760 min Summer	12.347	0.347	11.1	0.0	11.1	320.8	O K
7200 min Summer	12.273	0.273	11.1	0.0	11.1	247.5	O K
8640 min Summer	12.220	0.220	10.9	0.0	10.9	196.8	O K
10080 min Summer	12.184	0.184	10.6	0.0	10.6	163.2	O K
15 min Winter	12.380	0.380	11.1	0.0	11.1	353.4	O K
30 min Winter	12.493	0.493	11.1	0.0	11.1	470.8	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)		
15 min Summer	118.498	0.0	310.5	0.0	26		
30 min Summer	79.373	0.0	418.5	0.0	40		
60 min Summer	50.812	0.0	550.3	0.0	70		
120 min Summer	31.483	0.0	682.8	0.0	128		
180 min Summer	23.483	0.0	764.2	0.0	188		
240 min Summer	18.956	0.0	822.6	0.4	246		
360 min Summer	13.897	0.0	904.6	4.2	362		
480 min Summer	11.157	0.0	968.1	8.3	480		
600 min Summer	9.402	0.0	1019.4	10.1	548		
720 min Summer	8.170	0.0	1062.5	9.5	610		
960 min Summer	6.541	0.0	1132.7	4.4	748		
1440 min Summer	4.773	0.0	1234.6	0.0	1022		
2160 min Summer	3.476	0.0	1368.6	0.0	1412		
2880 min Summer	2.772	0.0	1454.9	0.0	1796		
4320 min Summer	2.011	0.0	1580.3	0.0	2556		
5760 min Summer	1.600	0.0	1684.0	0.0	3280		
7200 min Summer	1.339	0.0	1760.9	0.0	3960		
8640 min Summer	1.157	0.0	1824.8	0.0	4592		
10080 min Summer	1.023	0.0	1877.6	0.0	5248		
15 min Winter	118.498	0.0	348.8	0.0	26		
30 min Winter	79.373	0.0	469.3	0.0	40		
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Bold Business Centre Sutton St Helens WA9 4TX			2978 - The Bungalow Gamford Lane, Rossett Option 1 - Basin 100+40% CC Yr				
Date 16/09/2019 File 2016_09_016-2978-Concep...			Designed by JAG Checked by				
Micro Drainage			Source Control 2015.1				
<u>Summary of Results for 100 year Return Period (+40%)</u>							
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
60 min Winter	12.606	0.606	11.1	0.0	11.1	594.3	O K
120 min Winter	12.713	0.713	11.1	0.1	11.1	717.7	Flood Risk
180 min Winter	12.765	0.765	11.1	2.3	12.1	778.5	Flood Risk
240 min Winter	12.790	0.790	11.1	4.7	14.6	808.3	Flood Risk
360 min Winter	12.805	0.805	11.1	5.9	15.9	826.7	Flood Risk
480 min Winter	12.805	0.805	11.1	5.9	15.9	827.2	Flood Risk
600 min Winter	12.803	0.803	11.1	5.8	15.8	824.6	Flood Risk
720 min Winter	12.801	0.801	11.1	5.6	15.5	821.6	Flood Risk
960 min Winter	12.791	0.791	11.1	4.8	14.7	809.4	Flood Risk
1440 min Winter	12.761	0.761	11.1	2.1	11.8	773.4	Flood Risk
2160 min Winter	12.686	0.686	11.1	0.0	11.1	685.8	O K
2880 min Winter	12.583	0.583	11.1	0.0	11.1	569.3	O K
4320 min Winter	12.403	0.403	11.1	0.0	11.1	377.3	O K
5760 min Winter	12.267	0.267	11.1	0.0	11.1	242.4	O K
7200 min Winter	12.186	0.186	10.6	0.0	10.6	165.4	O K
8640 min Winter	12.155	0.155	9.7	0.0	9.7	136.8	O K
10080 min Winter	12.139	0.139	8.7	0.0	8.7	122.2	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)		
60 min Winter	50.812	0.0	616.8	0.0	68		
120 min Winter	31.483	0.0	765.1	0.1	126		
180 min Winter	23.483	0.0	856.3	9.4	182		
240 min Winter	18.956	0.0	921.8	25.4	238		
360 min Winter	13.897	0.0	1013.8	50.0	348		
480 min Winter	11.157	0.0	1085.0	66.4	448		
600 min Winter	9.402	0.0	1142.5	75.3	482		
720 min Winter	8.170	0.0	1190.8	78.3	560		
960 min Winter	6.541	0.0	1269.2	70.6	720		
1440 min Winter	4.773	0.0	1379.9	31.5	1056		
2160 min Winter	3.476	0.0	1533.0	0.0	1560		
2880 min Winter	2.772	0.0	1629.9	0.0	1960		
4320 min Winter	2.011	0.0	1771.3	0.0	2688		
5760 min Winter	1.600	0.0	1886.5	0.0	3344		
7200 min Winter	1.339	0.0	1972.8	0.0	3904		
8640 min Winter	1.157	0.0	2044.6	0.0	4504		
10080 min Winter	1.023	0.0	2104.6	0.0	5240		
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Bold Business Centre Sutton St Helens WA9 4TX	2978 - The Bungalow Gamford Lane, Rossett Option 1 - Basin 100+40% CC Yr	
Date 16/09/2019 File 2016_09_016-2978-Concep...	Designed by JAG Checked by	
Micro Drainage Source Control 2015.1		

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.000	Shortest Storm (mins)	15
Ratio R	0.359	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 1.464

Time (mins)	Area	Time (mins)	Area	Time (mins)	Area
From: To:	(ha)	From: To:	(ha)	From: To:	(ha)
0 4	0.488	4 8	0.488	8 12	0.488

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Bold Business Centre Sutton St Helens WA9 4TX	2978 - The Bungalow Gamford Lane, Rossett Option 1 - Basin 100+40% CC Yr																																																																																																																																																									
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Micro Drainage		Source Control 2015.1																																																																																																																																																								
<u>Model Details</u> Storage is Online Cover Level (m) 13.000 <u>Tank or Pond Structure</u> Invert Level (m) 12.000 <table><tr><th>Depth (m)</th><th>Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th></tr><tr><td>0.000</td><td>850.0</td><td>0.700</td><td>1164.0</td><td>1.400</td><td>0.0</td><td>2.100</td><td>0.0</td></tr><tr><td>0.100</td><td>891.8</td><td>0.800</td><td>1212.9</td><td>1.500</td><td>0.0</td><td>2.200</td><td>0.0</td></tr><tr><td>0.200</td><td>934.7</td><td>0.900</td><td>1262.8</td><td>1.600</td><td>0.0</td><td>2.300</td><td>0.0</td></tr><tr><td>0.300</td><td>978.5</td><td>1.000</td><td>1313.7</td><td>1.700</td><td>0.0</td><td>2.400</td><td>0.0</td></tr><tr><td>0.400</td><td>1023.4</td><td>1.100</td><td>0.0</td><td>1.800</td><td>0.0</td><td>2.500</td><td>0.0</td></tr><tr><td>0.500</td><td>1069.3</td><td>1.200</td><td>0.0</td><td>1.900</td><td>0.0</td><td></td><td></td></tr><tr><td>0.600</td><td>1116.1</td><td>1.300</td><td>0.0</td><td>2.000</td><td>0.0</td><td></td><td></td></tr></table> <u>Hydro-Brake Optimum® Outflow Control</u> Unit Reference MD-SHE-0153-1120-1000-1120 Design Head (m) 1.000 Design Flow (l/s) 11.2 Flush-Flo™ Calculated Objective Minimise upstream storage Diameter (mm) 153 Invert Level (m) 12.000 Minimum Outlet Pipe Diameter (mm) 225 Suggested Manhole Diameter (mm) 1200 <table><tr><th>Control Points</th><th>Head (m)</th><th>Flow (l/s)</th></tr><tr><td>Design Point (Calculated)</td><td>1.000</td><td>11.1</td></tr><tr><td>Flush-Flo™</td><td>0.309</td><td>11.1</td></tr><tr><td>Kick-Flo®</td><td>0.684</td><td>9.3</td></tr><tr><td>Mean Flow over Head Range</td><td>-</td><td>9.5</td></tr></table> The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated <table><tr><th>Depth (m)</th><th>Flow (l/s)</th><th>Depth (m)</th><th>Flow (l/s)</th><th>Depth (m)</th><th>Flow (l/s)</th><th>Depth (m)</th><th>Flow (l/s)</th></tr><tr><td>0.100</td><td>5.5</td><td>1.200</td><td>12.1</td><td>3.000</td><td>18.7</td><td>7.000</td><td>28.0</td></tr><tr><td>0.200</td><td>10.8</td><td>1.400</td><td>13.0</td><td>3.500</td><td>20.1</td><td>7.500</td><td>29.0</td></tr><tr><td>0.300</td><td>11.1</td><td>1.600</td><td>13.8</td><td>4.000</td><td>21.4</td><td>8.000</td><td>29.9</td></tr><tr><td>0.400</td><td>11.0</td><td>1.800</td><td>14.6</td><td>4.500</td><td>22.7</td><td>8.500</td><td>30.8</td></tr><tr><td>0.500</td><td>10.7</td><td>2.000</td><td>15.4</td><td>5.000</td><td>23.8</td><td>9.000</td><td>31.7</td></tr><tr><td>0.600</td><td>10.2</td><td>2.200</td><td>16.1</td><td>5.500</td><td>25.0</td><td>9.500</td><td>32.5</td></tr><tr><td>0.800</td><td>10.0</td><td>2.400</td><td>16.8</td><td>6.000</td><td>26.0</td><td></td><td></td></tr><tr><td>1.000</td><td>11.1</td><td>2.600</td><td>17.4</td><td>6.500</td><td>27.1</td><td></td><td></td></tr></table>				Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	0.000	850.0	0.700	1164.0	1.400	0.0	2.100	0.0	0.100	891.8	0.800	1212.9	1.500	0.0	2.200	0.0	0.200	934.7	0.900	1262.8	1.600	0.0	2.300	0.0	0.300	978.5	1.000	1313.7	1.700	0.0	2.400	0.0	0.400	1023.4	1.100	0.0	1.800	0.0	2.500	0.0	0.500	1069.3	1.200	0.0	1.900	0.0			0.600	1116.1	1.300	0.0	2.000	0.0			Control Points	Head (m)	Flow (l/s)	Design Point (Calculated)	1.000	11.1	Flush-Flo™	0.309	11.1	Kick-Flo®	0.684	9.3	Mean Flow over Head Range	-	9.5	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	0.100	5.5	1.200	12.1	3.000	18.7	7.000	28.0	0.200	10.8	1.400	13.0	3.500	20.1	7.500	29.0	0.300	11.1	1.600	13.8	4.000	21.4	8.000	29.9	0.400	11.0	1.800	14.6	4.500	22.7	8.500	30.8	0.500	10.7	2.000	15.4	5.000	23.8	9.000	31.7	0.600	10.2	2.200	16.1	5.500	25.0	9.500	32.5	0.800	10.0	2.400	16.8	6.000	26.0			1.000	11.1	2.600	17.4	6.500	27.1		
Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)																																																																																																																																																			
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0.400	1023.4	1.100	0.0	1.800	0.0	2.500	0.0																																																																																																																																																			
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Bold Business Centre Sutton St Helens WA9 4TX	2978 - The Bungalow Gamford Lane, Rossett Option 1 - Basin 100+40% CC Yr	
Date 16/09/2019	Designed by JAG	
File 2016_09_016-2978-Concep...	Checked by	
Micro Drainage		Source Control 2015.1
<u>Pipe Overflow Control</u> Diameter (m) 0.150 Entry Loss Coefficient 0.500 Slope (1:X) 100.0 Coefficient of Contraction 0.600 Length (m) 30.000 Upstream Invert Level (m) 12.700 Manning's n 0.010		
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Bold Business Centre Sutton St Helens WA9 4TX				2978 - The Bungalow Gamford Lane, Rossett Option 2 - Cellular 1 Yr				
Date 16/09/2016 File 2016_09_016-2978-Concep...				Designed by JAG Checked by				
Micro Drainage				Source Control 2015.1				
<u>Summary of Results for 1 year Return Period</u> Half Drain Time : 179 minutes.								
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	11.083	0.083	0.0	4.0	0.0	4.0	71.0	O K
30 min Summer	11.107	0.107	0.0	6.0	0.0	6.0	91.1	O K
60 min Summer	11.130	0.130	0.0	7.8	0.0	7.8	110.8	O K
120 min Summer	11.148	0.148	0.0	9.0	0.0	9.0	126.3	O K
180 min Summer	11.157	0.157	0.0	9.6	0.0	9.6	134.3	O K
240 min Summer	11.163	0.163	0.0	10.0	0.0	10.0	139.4	O K
360 min Summer	11.169	0.169	0.0	10.1	0.0	10.1	144.9	O K
480 min Summer	11.170	0.170	0.0	10.1	0.0	10.1	145.7	O K
600 min Summer	11.169	0.169	0.0	10.1	0.0	10.1	144.8	O K
720 min Summer	11.167	0.167	0.0	10.1	0.0	10.1	142.9	O K
960 min Summer	11.161	0.161	0.0	9.8	0.0	9.8	138.1	O K
1440 min Summer	11.149	0.149	0.0	9.1	0.0	9.1	127.7	O K
2160 min Summer	11.134	0.134	0.0	8.1	0.0	8.1	114.9	O K
2880 min Summer	11.123	0.123	0.0	7.3	0.0	7.3	105.2	O K
4320 min Summer	11.108	0.108	0.0	6.1	0.0	6.1	92.0	O K
5760 min Summer	11.098	0.098	0.0	5.2	0.0	5.2	83.5	O K
7200 min Summer	11.090	0.090	0.0	4.6	0.0	4.6	77.2	O K
8640 min Summer	11.085	0.085	0.0	4.1	0.0	4.1	72.4	O K
10080 min Summer	11.080	0.080	0.0	3.8	0.0	3.8	68.7	O K
15 min Winter	11.093	0.093	0.0	4.8	0.0	4.8	79.4	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)			
15 min Summer	26.802	0.0	62.8	0.0	25			
30 min Summer	17.695	0.0	85.8	0.0	38			
60 min Summer	11.376	0.0	118.9	0.0	64			
120 min Summer	7.194	0.0	151.8	0.0	108			
180 min Summer	5.480	0.0	174.2	0.0	138			
240 min Summer	4.513	0.0	191.8	0.0	170			
360 min Summer	3.430	0.0	219.3	0.0	240			
480 min Summer	2.804	0.0	239.4	0.0	308			
600 min Summer	2.399	0.0	256.2	0.0	374			
720 min Summer	2.112	0.0	270.8	0.0	440			
960 min Summer	1.727	0.0	295.3	0.0	568			
1440 min Summer	1.301	0.0	333.1	0.0	818			
2160 min Summer	0.982	0.0	383.8	0.0	1188			
2880 min Summer	0.803	0.0	418.0	0.0	1556			
4320 min Summer	0.605	0.0	469.7	0.0	2260			
5760 min Summer	0.495	0.0	519.2	0.0	3000			
7200 min Summer	0.424	0.0	555.4	0.0	3744			
8640 min Summer	0.374	0.0	586.4	0.0	4424			
10080 min Summer	0.336	0.0	612.5	0.0	5152			
15 min Winter	26.802	0.0	71.4	0.0	25			
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Sutton
St Helens WA9 4TX

Date 16/09/2016
File 2016_09_016-2978-Concep...

Micro Drainage

2978 - The Bungalow
Gamford Lane, Rossett
Option 2 - Cellular 1 Yr

Designed by JAG
Checked by

Source Control 2015.1

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Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	11.119	0.119	0.0	7.0	0.0	7.0	101.8	O K
60 min Winter	11.145	0.145	0.0	8.9	0.0	8.9	124.2	O K
120 min Winter	11.166	0.166	0.0	10.1	0.0	10.1	141.8	O K
180 min Winter	11.175	0.175	0.0	10.2	0.0	10.2	150.0	O K
240 min Winter	11.181	0.181	0.0	10.3	0.0	10.3	154.8	O K
360 min Winter	11.185	0.185	0.0	10.3	0.0	10.3	157.9	O K
480 min Winter	11.182	0.182	0.0	10.3	0.0	10.3	155.6	O K
600 min Winter	11.177	0.177	0.0	10.2	0.0	10.2	151.5	O K
720 min Winter	11.172	0.172	0.0	10.2	0.0	10.2	146.7	O K
960 min Winter	11.161	0.161	0.0	9.8	0.0	9.8	137.4	O K
1440 min Winter	11.143	0.143	0.0	8.7	0.0	8.7	121.9	O K
2160 min Winter	11.123	0.123	0.0	7.3	0.0	7.3	105.5	O K
2880 min Winter	11.111	0.111	0.0	6.3	0.0	6.3	94.6	O K
4320 min Winter	11.095	0.095	0.0	5.0	0.0	5.0	80.9	O K
5760 min Winter	11.085	0.085	0.0	4.1	0.0	4.1	72.5	O K
7200 min Winter	11.078	0.078	0.0	3.6	0.0	3.6	66.6	O K
8640 min Winter	11.073	0.073	0.0	3.2	0.0	3.2	62.1	O K
10080 min Winter	11.069	0.069	0.0	2.9	0.0	2.9	58.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
30 min Winter	17.695	0.0	97.2	0.0	38
60 min Winter	11.376	0.0	133.9	0.0	64
120 min Winter	7.194	0.0	170.7	0.0	116
180 min Winter	5.480	0.0	195.8	0.0	146
240 min Winter	4.513	0.0	215.5	0.0	184
360 min Winter	3.430	0.0	246.3	0.0	260
480 min Winter	2.804	0.0	268.9	0.0	332
600 min Winter	2.399	0.0	287.8	0.0	402
720 min Winter	2.112	0.0	304.1	0.0	470
960 min Winter	1.727	0.0	331.6	0.0	598
1440 min Winter	1.301	0.0	374.2	0.0	852
2160 min Winter	0.982	0.0	430.3	0.0	1216
2880 min Winter	0.803	0.0	468.8	0.0	1588
4320 min Winter	0.605	0.0	527.2	0.0	2300
5760 min Winter	0.495	0.0	581.9	0.0	3056
7200 min Winter	0.424	0.0	622.5	0.0	3752
8640 min Winter	0.374	0.0	657.4	0.0	4496
10080 min Winter	0.336	0.0	687.2	0.0	5200

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Micro Drainage Source Control 2015.1		

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.000	Shortest Storm (mins)	15
Ratio R	0.359	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 1.464

Time (mins)	Area	Time (mins)	Area	Time (mins)	Area
From: To:	(ha)	From: To:	(ha)	From: To:	(ha)
0 4	0.488	4 8	0.488	8 12	0.488

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Micro Drainage		Source Control 2015.1

Model Details

Storage is Online Cover Level (m) 13.000

Cellular Storage Structure

Invert Level (m) 11.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	900.0	900.0	1.300	0.0	1050.0
0.100	900.0	912.0	1.400	0.0	1050.0
0.200	900.0	924.0	1.500	0.0	1050.0
0.300	900.0	936.0	1.600	0.0	1050.0
0.400	900.0	948.0	1.700	0.0	1050.0
0.500	900.0	960.0	1.800	0.0	1050.0
0.600	900.0	972.0	1.900	0.0	1050.0
0.700	900.0	984.0	2.000	0.0	1050.0
0.800	900.0	996.0	2.100	0.0	1050.0
0.900	900.0	1008.0	2.200	0.0	1050.0
1.000	900.0	1020.0	2.300	0.0	1050.0
1.100	900.0	1032.0	2.400	0.0	1050.0
1.200	900.0	1044.0	2.500	0.0	1050.0

Hydro-Brake Optimum® Outflow Control

Unit Reference MD-SHE-0150-1120-1200-1120
Design Head (m) 1.200
Design Flow (l/s) 11.2
Flush-Flo™ Calculated
Objective Minimise upstream storage
Diameter (mm) 150
Invert Level (m) 11.000
Minimum Outlet Pipe Diameter (mm) 225
Suggested Manhole Diameter (mm) 1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	11.1
Flush-Flo™	0.357	11.1
Kick-Flo®	0.780	9.1
Mean Flow over Head Range	-	9.6

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.4	0.300	11.0	0.500	10.9	0.800	9.2
0.200	10.5	0.400	11.0	0.600	10.6	1.000	10.2

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Date 16/09/2016 File 2016_09_016-2978-Concep...				Designed by JAG Checked by				
Micro Drainage				Source Control 2015.1				
<u>Summary of Results for 30 year Return Period</u> Half Drain Time : 319 minutes.								
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	11.201	0.201	0.0	10.5	0.0	10.5	171.8	O K
30 min Summer	11.263	0.263	0.0	10.9	0.0	10.9	224.4	O K
60 min Summer	11.324	0.324	0.0	11.1	0.0	11.1	277.3	O K
120 min Summer	11.379	0.379	0.0	11.1	0.0	11.1	324.5	O K
180 min Summer	11.403	0.403	0.0	11.1	0.0	11.1	344.4	O K
240 min Summer	11.412	0.412	0.0	11.1	0.0	11.1	352.3	O K
360 min Summer	11.418	0.418	0.0	11.1	0.0	11.1	357.3	O K
480 min Summer	11.418	0.418	0.0	11.1	0.0	11.1	357.6	O K
600 min Summer	11.415	0.415	0.0	11.1	0.0	11.1	354.7	O K
720 min Summer	11.409	0.409	0.0	11.1	0.0	11.1	349.6	O K
960 min Summer	11.393	0.393	0.0	11.1	0.0	11.1	335.8	O K
1440 min Summer	11.354	0.354	0.0	11.1	0.0	11.1	303.0	O K
2160 min Summer	11.298	0.298	0.0	11.0	0.0	11.0	255.1	O K
2880 min Summer	11.252	0.252	0.0	10.8	0.0	10.8	215.3	O K
4320 min Summer	11.188	0.188	0.0	10.4	0.0	10.4	160.9	O K
5760 min Summer	11.156	0.156	0.0	9.5	0.0	9.5	133.4	O K
7200 min Summer	11.138	0.138	0.0	8.4	0.0	8.4	118.1	O K
8640 min Summer	11.126	0.126	0.0	7.5	0.0	7.5	107.3	O K
10080 min Summer	11.117	0.117	0.0	6.8	0.0	6.8	99.7	O K
15 min Winter	11.226	0.226	0.0	10.7	0.0	10.7	192.9	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)			
15 min Summer	65.562	0.0	167.5	0.0	25			
30 min Summer	43.485	0.0	225.3	0.0	39			
60 min Summer	27.653	0.0	297.0	0.0	68			
120 min Summer	17.097	0.0	368.5	0.0	124			
180 min Summer	12.773	0.0	413.5	0.0	182			
240 min Summer	10.341	0.0	446.7	0.0	232			
360 min Summer	7.633	0.0	495.0	0.0	290			
480 min Summer	6.154	0.0	532.4	0.0	354			
600 min Summer	5.204	0.0	562.9	0.0	420			
720 min Summer	4.536	0.0	588.8	0.0	490			
960 min Summer	3.649	0.0	631.5	0.0	626			
1440 min Summer	2.683	0.0	695.6	0.0	894			
2160 min Summer	1.969	0.0	774.0	0.0	1276			
2880 min Summer	1.580	0.0	827.6	0.0	1644			
4320 min Summer	1.158	0.0	905.9	0.0	2336			
5760 min Summer	0.928	0.0	974.9	0.0	3008			
7200 min Summer	0.781	0.0	1025.1	0.0	3744			
8640 min Summer	0.678	0.0	1067.0	0.0	4416			
10080 min Summer	0.602	0.0	1101.5	0.0	5152			
15 min Winter	65.562	0.0	188.7	0.0	25			
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Date 16/09/2016 File 2016_09_016-2978-Concep...			Designed by JAG Checked by					
Micro Drainage			Source Control 2015.1					
Summary of Results for 30 year Return Period								
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	11.296	0.296	0.0	11.0	0.0	11.0	252.7	O K
60 min Winter	11.366	0.366	0.0	11.1	0.0	11.1	313.0	O K
120 min Winter	11.431	0.431	0.0	11.1	0.0	11.1	368.1	O K
180 min Winter	11.460	0.460	0.0	11.1	0.0	11.1	392.9	O K
240 min Winter	11.473	0.473	0.0	11.1	0.0	11.1	404.2	O K
360 min Winter	11.476	0.476	0.0	11.1	0.0	11.1	407.1	O K
480 min Winter	11.473	0.473	0.0	11.1	0.0	11.1	404.3	O K
600 min Winter	11.466	0.466	0.0	11.1	0.0	11.1	398.2	O K
720 min Winter	11.455	0.455	0.0	11.1	0.0	11.1	389.0	O K
960 min Winter	11.428	0.428	0.0	11.1	0.0	11.1	365.8	O K
1440 min Winter	11.366	0.366	0.0	11.1	0.0	11.1	312.8	O K
2160 min Winter	11.281	0.281	0.0	11.0	0.0	11.0	240.0	O K
2880 min Winter	11.217	0.217	0.0	10.6	0.0	10.6	185.1	O K
4320 min Winter	11.153	0.153	0.0	9.3	0.0	9.3	130.7	O K
5760 min Winter	11.129	0.129	0.0	7.7	0.0	7.7	109.9	O K
7200 min Winter	11.114	0.114	0.0	6.6	0.0	6.6	97.6	O K
8640 min Winter	11.104	0.104	0.0	5.8	0.0	5.8	89.1	O K
10080 min Winter	11.097	0.097	0.0	5.1	0.0	5.1	82.7	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)			
30 min Winter	43.485	0.0	253.5	0.0	39			
60 min Winter	27.653	0.0	333.3	0.0	66			
120 min Winter	17.097	0.0	413.4	0.0	124			
180 min Winter	12.773	0.0	463.8	0.0	180			
240 min Winter	10.341	0.0	501.0	0.0	236			
360 min Winter	7.633	0.0	555.1	0.0	338			
480 min Winter	6.154	0.0	596.9	0.0	380			
600 min Winter	5.204	0.0	631.1	0.0	458			
720 min Winter	4.536	0.0	660.1	0.0	534			
960 min Winter	3.649	0.0	708.0	0.0	682			
1440 min Winter	2.683	0.0	779.9	0.0	962			
2160 min Winter	1.969	0.0	867.4	0.0	1344			
2880 min Winter	1.580	0.0	927.5	0.0	1700			
4320 min Winter	1.158	0.0	1015.9	0.0	2336			
5760 min Winter	0.928	0.0	1092.3	0.0	3048			
7200 min Winter	0.781	0.0	1148.6	0.0	3752			
8640 min Winter	0.678	0.0	1195.7	0.0	4488			
10080 min Winter	0.602	0.0	1235.1	0.0	5160			
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Micro Drainage		Source Control 2015.1

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.000	Shortest Storm (mins)	15
Ratio R	0.359	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 1.464

Time (mins)	Area	Time (mins)	Area	Time (mins)	Area
From: To:	(ha)	From: To:	(ha)	From: To:	(ha)
0 4	0.488	4 8	0.488	8 12	0.488

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Micro Drainage		Source Control 2015.1

Model Details

Storage is Online Cover Level (m) 13.000

Cellular Storage Structure

Invert Level (m) 11.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	900.0	900.0	1.300	0.0	1050.0
0.100	900.0	912.0	1.400	0.0	1050.0
0.200	900.0	924.0	1.500	0.0	1050.0
0.300	900.0	936.0	1.600	0.0	1050.0
0.400	900.0	948.0	1.700	0.0	1050.0
0.500	900.0	960.0	1.800	0.0	1050.0
0.600	900.0	972.0	1.900	0.0	1050.0
0.700	900.0	984.0	2.000	0.0	1050.0
0.800	900.0	996.0	2.100	0.0	1050.0
0.900	900.0	1008.0	2.200	0.0	1050.0
1.000	900.0	1020.0	2.300	0.0	1050.0
1.100	900.0	1032.0	2.400	0.0	1050.0
1.200	900.0	1044.0	2.500	0.0	1050.0

Hydro-Brake Optimum® Outflow Control

Unit Reference MD-SHE-0150-1120-1200-1120
Design Head (m) 1.200
Design Flow (l/s) 11.2
Flush-Flo™ Calculated
Objective Minimise upstream storage
Diameter (mm) 150
Invert Level (m) 11.000
Minimum Outlet Pipe Diameter (mm) 225
Suggested Manhole Diameter (mm) 1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	11.1
Flush-Flo™	0.357	11.1
Kick-Flo®	0.780	9.1
Mean Flow over Head Range	-	9.6

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.4	0.300	11.0	0.500	10.9	0.800	9.2
0.200	10.5	0.400	11.0	0.600	10.6	1.000	10.2

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2978 - The Bungalow Gamford Lane, Rossett Option 2 - Cellular 30 Yr



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Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
1.200	11.1	2.400	15.5	5.000	22.0	8.000	27.5
1.400	12.0	2.600	16.1	5.500	23.0	8.500	28.3
1.600	12.8	3.000	17.2	6.000	24.0	9.000	29.1
1.800	13.5	3.500	18.5	6.500	24.9	9.500	29.9
2.000	14.2	4.000	19.7	7.000	25.8		
2.200	14.8	4.500	20.9	7.500	26.7		

Diameter (m)	0.150	Entry Loss Coefficient	0.500
Slope (1:X)	100.0	Coefficient of Contraction	0.600
Length (m)	30.000	Upstream Invert Level (m)	12.000
Manning's n	0.010		

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Micro Drainage

2978 - The Bungalow
Gamford Lane, Rossett
Option 2 - Cellular 100 Yr

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Source Control 2015.1

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Summary of Results for 100 year Return Period

Half Drain Time : 440 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	11.261	0.261	0.0	10.9	0.0	10.9	222.9	O K
30 min Summer	11.346	0.346	0.0	11.1	0.0	11.1	295.5	O K
60 min Summer	11.433	0.433	0.0	11.1	0.0	11.1	370.2	O K
120 min Summer	11.514	0.514	0.0	11.1	0.0	11.1	439.4	O K
180 min Summer	11.551	0.551	0.0	11.1	0.0	11.1	471.4	O K
240 min Summer	11.569	0.569	0.0	11.1	0.0	11.1	486.7	O K
360 min Summer	11.576	0.576	0.0	11.1	0.0	11.1	492.3	O K
480 min Summer	11.575	0.575	0.0	11.1	0.0	11.1	491.3	O K
600 min Summer	11.570	0.570	0.0	11.1	0.0	11.1	487.1	O K
720 min Summer	11.562	0.562	0.0	11.1	0.0	11.1	480.9	O K
960 min Summer	11.543	0.543	0.0	11.1	0.0	11.1	464.5	O K
1440 min Summer	11.497	0.497	0.0	11.1	0.0	11.1	424.6	O K
2160 min Summer	11.425	0.425	0.0	11.1	0.0	11.1	363.4	O K
2880 min Summer	11.361	0.361	0.0	11.1	0.0	11.1	308.6	O K
4320 min Summer	11.263	0.263	0.0	10.9	0.0	10.9	225.2	O K
5760 min Summer	11.201	0.201	0.0	10.5	0.0	10.5	172.2	O K
7200 min Summer	11.166	0.166	0.0	10.1	0.0	10.1	141.6	O K
8640 min Summer	11.148	0.148	0.0	9.0	0.0	9.0	126.1	O K
10080 min Summer	11.135	0.135	0.0	8.2	0.0	8.2	115.3	O K
15 min Winter	11.293	0.293	0.0	11.0	0.0	11.0	250.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	84.641	0.0	219.1	0.0	26
30 min Summer	56.695	0.0	296.6	0.0	40
60 min Summer	36.294	0.0	391.5	0.0	68
120 min Summer	22.488	0.0	486.4	0.0	126
180 min Summer	16.773	0.0	544.7	0.0	184
240 min Summer	13.540	0.0	586.5	0.0	242
360 min Summer	9.927	0.0	645.3	0.0	342
480 min Summer	7.969	0.0	690.9	0.0	398
600 min Summer	6.715	0.0	727.7	0.0	460
720 min Summer	5.836	0.0	758.9	0.0	522
960 min Summer	4.672	0.0	809.8	0.0	658
1440 min Summer	3.409	0.0	885.0	0.0	928
2160 min Summer	2.483	0.0	976.7	0.0	1324
2880 min Summer	1.980	0.0	1038.0	0.0	1704
4320 min Summer	1.437	0.0	1126.3	0.0	2420
5760 min Summer	1.143	0.0	1202.1	0.0	3072
7200 min Summer	0.957	0.0	1256.8	0.0	3752
8640 min Summer	0.827	0.0	1302.1	0.0	4488
10080 min Summer	0.730	0.0	1339.0	0.0	5152
15 min Winter	84.641	0.0	246.5	0.0	25

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Micro Drainage			Source Control 2015.1					
Summary of Results for 100 year Return Period								
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	11.389	0.389	0.0	11.1	0.0	11.1	332.5	O K
60 min Winter	11.488	0.488	0.0	11.1	0.0	11.1	417.4	O K
120 min Winter	11.582	0.582	0.0	11.1	0.0	11.1	497.6	O K
180 min Winter	11.627	0.627	0.0	11.1	0.0	11.1	536.4	O K
240 min Winter	11.651	0.651	0.0	11.1	0.0	11.1	556.6	O K
360 min Winter	11.666	0.666	0.0	11.1	0.0	11.1	569.0	O K
480 min Winter	11.663	0.663	0.0	11.1	0.0	11.1	566.9	O K
600 min Winter	11.651	0.651	0.0	11.1	0.0	11.1	556.9	O K
720 min Winter	11.640	0.640	0.0	11.1	0.0	11.1	547.6	O K
960 min Winter	11.611	0.611	0.0	11.1	0.0	11.1	522.6	O K
1440 min Winter	11.539	0.539	0.0	11.1	0.0	11.1	460.7	O K
2160 min Winter	11.428	0.428	0.0	11.1	0.0	11.1	365.8	O K
2880 min Winter	11.333	0.333	0.0	11.1	0.0	11.1	284.5	O K
4320 min Winter	11.206	0.206	0.0	10.5	0.0	10.5	176.2	O K
5760 min Winter	11.154	0.154	0.0	9.4	0.0	9.4	131.9	O K
7200 min Winter	11.133	0.133	0.0	8.0	0.0	8.0	113.6	O K
8640 min Winter	11.119	0.119	0.0	7.0	0.0	7.0	101.9	O K
10080 min Winter	11.110	0.110	0.0	6.2	0.0	6.2	93.9	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)			
30 min Winter	56.695	0.0	333.2	0.0	40			
60 min Winter	36.294	0.0	439.2	0.0	68			
120 min Winter	22.488	0.0	545.3	0.0	124			
180 min Winter	16.773	0.0	610.6	0.0	182			
240 min Winter	13.540	0.0	657.4	0.0	238			
360 min Winter	9.927	0.0	723.2	0.0	350			
480 min Winter	7.969	0.0	774.2	0.0	456			
600 min Winter	6.715	0.0	815.5	0.0	502			
720 min Winter	5.836	0.0	850.3	0.0	568			
960 min Winter	4.672	0.0	907.3	0.0	720			
1440 min Winter	3.409	0.0	991.5	0.0	1012			
2160 min Winter	2.483	0.0	1094.4	0.0	1416			
2880 min Winter	1.980	0.0	1163.2	0.0	1792			
4320 min Winter	1.437	0.0	1262.8	0.0	2464			
5760 min Winter	1.143	0.0	1346.7	0.0	3064			
7200 min Winter	0.957	0.0	1408.1	0.0	3752			
8640 min Winter	0.827	0.0	1459.1	0.0	4496			
10080 min Winter	0.730	0.0	1501.2	0.0	5160			
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Micro Drainage		Source Control 2015.1

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.000	Shortest Storm (mins)	15
Ratio R	0.359	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 1.464

Time (mins)	Area	Time (mins)	Area	Time (mins)	Area
From:	To:	From:	To:	From:	To:
0	4	0.488	4	8	0.488
				8	12
					0.488

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Bold Business Centre Sutton St Helens WA9 4TX	2978 - The Bungalow Gamford Lane, Rossett Option 2 - Cellular 100 Yr	
Date 16/09/2016 File 2016_09_016-2978-Concep...	Designed by JAG Checked by	
Micro Drainage Source Control 2015.1		

Model Details

Storage is Online Cover Level (m) 13.000

Cellular Storage Structure

Invert Level (m) 11.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	900.0	900.0	1.300	0.0	1050.0
0.100	900.0	912.0	1.400	0.0	1050.0
0.200	900.0	924.0	1.500	0.0	1050.0
0.300	900.0	936.0	1.600	0.0	1050.0
0.400	900.0	948.0	1.700	0.0	1050.0
0.500	900.0	960.0	1.800	0.0	1050.0
0.600	900.0	972.0	1.900	0.0	1050.0
0.700	900.0	984.0	2.000	0.0	1050.0
0.800	900.0	996.0	2.100	0.0	1050.0
0.900	900.0	1008.0	2.200	0.0	1050.0
1.000	900.0	1020.0	2.300	0.0	1050.0
1.100	900.0	1032.0	2.400	0.0	1050.0
1.200	900.0	1044.0	2.500	0.0	1050.0

Hydro-Brake Optimum® Outflow Control

Unit Reference MD-SHE-0150-1120-1200-1120
Design Head (m) 1.200
Design Flow (l/s) 11.2
Flush-Flo™ Calculated
Objective Minimise upstream storage
Diameter (mm) 150
Invert Level (m) 11.000
Minimum Outlet Pipe Diameter (mm) 225
Suggested Manhole Diameter (mm) 1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	11.1
Flush-Flo™	0.357	11.1
Kick-Flo®	0.780	9.1
Mean Flow over Head Range	-	9.6

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.4	0.300	11.0	0.500	10.9	0.800	9.2
0.200	10.5	0.400	11.0	0.600	10.6	1.000	10.2

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Bold Business Centre Sutton St Helens WA9 4TX			2978 - The Bungalow Gamford Lane, Rossett Option 2 - Cellular 100Yr+40%					
Date 16/09/2016 File 2016_09_016-2978-Concep...			Designed by JAG Checked by					
Micro Drainage			Source Control 2015.1					
<u>Summary of Results for 100 year Return Period (+40%)</u> Half Drain Time : 671 minutes.								
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	11.368	0.368	0.0	11.1	0.0	11.1	314.7	O K
30 min Summer	11.490	0.490	0.0	11.1	0.0	11.1	418.7	O K
60 min Summer	11.617	0.617	0.0	11.1	0.0	11.1	527.8	O K
120 min Summer	11.743	0.743	0.0	11.1	0.0	11.1	634.9	O K
180 min Summer	11.809	0.809	0.0	11.1	0.0	11.1	691.3	O K
240 min Summer	11.846	0.846	0.0	11.1	0.0	11.1	723.4	O K
360 min Summer	11.879	0.879	0.0	11.1	0.0	11.1	751.1	O K
480 min Summer	11.889	0.889	0.0	11.1	0.0	11.1	759.9	O K
600 min Summer	11.885	0.885	0.0	11.1	0.0	11.1	757.1	O K
720 min Summer	11.878	0.878	0.0	11.1	0.0	11.1	750.7	O K
960 min Summer	11.859	0.859	0.0	11.1	0.0	11.1	734.7	O K
1440 min Summer	11.812	0.812	0.0	11.1	0.0	11.1	694.4	O K
2160 min Summer	11.724	0.724	0.0	11.1	0.0	11.1	619.4	O K
2880 min Summer	11.640	0.640	0.0	11.1	0.0	11.1	547.4	O K
4320 min Summer	11.495	0.495	0.0	11.1	0.0	11.1	422.8	O K
5760 min Summer	11.379	0.379	0.0	11.1	0.0	11.1	323.8	O K
7200 min Summer	11.294	0.294	0.0	11.0	0.0	11.0	251.6	O K
8640 min Summer	11.235	0.235	0.0	10.7	0.0	10.7	200.8	O K
10080 min Summer	11.194	0.194	0.0	10.4	0.0	10.4	166.2	O K
15 min Winter	11.413	0.413	0.0	11.1	0.0	11.1	353.4	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)			
15 min Summer	118.498	0.0	310.4	0.0	26			
30 min Summer	79.373	0.0	418.4	0.0	40			
60 min Summer	50.812	0.0	550.2	0.0	70			
120 min Summer	31.483	0.0	682.7	0.0	128			
180 min Summer	23.483	0.0	764.1	0.0	188			
240 min Summer	18.956	0.0	822.5	0.0	246			
360 min Summer	13.897	0.0	904.4	0.0	364			
480 min Summer	11.157	0.0	967.8	0.0	482			
600 min Summer	9.402	0.0	1019.0	0.0	586			
720 min Summer	8.170	0.0	1062.2	0.0	632			
960 min Summer	6.541	0.0	1132.3	0.0	760			
1440 min Summer	4.773	0.0	1234.0	0.0	1024			
2160 min Summer	3.476	0.0	1368.5	0.0	1412			
2880 min Summer	2.772	0.0	1454.9	0.0	1800			
4320 min Summer	2.011	0.0	1580.2	0.0	2556			
5760 min Summer	1.600	0.0	1684.0	0.0	3280			
7200 min Summer	1.339	0.0	1760.9	0.0	3960			
8640 min Summer	1.157	0.0	1824.7	0.0	4592			
10080 min Summer	1.023	0.0	1877.5	0.0	5256			
15 min Winter	118.498	0.0	348.7	0.0	26			
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2978 - The Bungalow
Gamford Lane, Rossett
Option 2 - Cellular 100Yr+40%

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Micro Drainage

Source Control 2015.1

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Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	11.551	0.551	0.0	11.1	0.0	11.1	470.9	O K
60 min Winter	11.695	0.695	0.0	11.1	0.0	11.1	594.5	O K
120 min Winter	11.840	0.840	0.0	11.1	0.0	11.1	718.3	O K
180 min Winter	11.915	0.915	0.0	11.1	0.0	11.1	782.3	O K
240 min Winter	11.959	0.959	0.0	11.1	0.0	11.1	819.7	O K
360 min Winter	12.000	1.000	0.0	11.1	0.0	11.1	854.9	O K
480 min Winter	12.016	1.016	0.0	11.1	0.2	11.1	869.0	O K
600 min Winter	12.018	1.018	0.0	11.1	0.2	11.1	870.3	O K
720 min Winter	12.011	1.011	0.0	11.1	0.1	11.1	864.2	O K
960 min Winter	11.983	0.983	0.0	11.1	0.0	11.1	840.0	O K
1440 min Winter	11.923	0.923	0.0	11.1	0.0	11.1	788.9	O K
2160 min Winter	11.809	0.809	0.0	11.1	0.0	11.1	691.4	O K
2880 min Winter	11.670	0.670	0.0	11.1	0.0	11.1	572.7	O K
4320 min Winter	11.446	0.446	0.0	11.1	0.0	11.1	380.9	O K
5760 min Winter	11.291	0.291	0.0	11.0	0.0	11.0	248.7	O K
7200 min Winter	11.200	0.200	0.0	10.5	0.0	10.5	171.2	O K
8640 min Winter	11.159	0.159	0.0	9.7	0.0	9.7	136.4	O K
10080 min Winter	11.142	0.142	0.0	8.7	0.0	8.7	121.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
30 min Winter	79.373	0.0	469.2	0.0	40
60 min Winter	50.812	0.0	616.7	0.0	68
120 min Winter	31.483	0.0	765.0	0.0	126
180 min Winter	23.483	0.0	856.0	0.0	184
240 min Winter	18.956	0.0	921.3	0.0	242
360 min Winter	13.897	0.0	1012.9	0.0	356
480 min Winter	11.157	0.0	1083.7	0.4	468
600 min Winter	9.402	0.0	1140.9	0.7	578
720 min Winter	8.170	0.0	1188.8	0.3	684
960 min Winter	6.541	0.0	1266.6	0.0	796
1440 min Winter	4.773	0.0	1376.8	0.0	1094
2160 min Winter	3.476	0.0	1532.9	0.0	1564
2880 min Winter	2.772	0.0	1629.8	0.0	1964
4320 min Winter	2.011	0.0	1771.3	0.0	2688
5760 min Winter	1.600	0.0	1886.4	0.0	3352
7200 min Winter	1.339	0.0	1972.7	0.0	3968
8640 min Winter	1.157	0.0	2044.5	0.0	4504
10080 min Winter	1.023	0.0	2104.5	0.0	5240

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Micro Drainage Source Control 2015.1		

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.000	Shortest Storm (mins)	15
Ratio R	0.359	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 1.464

Time (mins)	Area	Time (mins)	Area	Time (mins)	Area
From:	To:	From:	To:	From:	To:
0	4 0.488	4	8 0.488	8	12 0.488

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Date 16/09/2016 File 2016_09_016-2978-Concep...	Designed by JAG Checked by	
Micro Drainage Source Control 2015.1		

Model Details

Storage is Online Cover Level (m) 13.000

Cellular Storage Structure

Invert Level (m) 11.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	900.0	900.0	1.300	0.0	1050.0
0.100	900.0	912.0	1.400	0.0	1050.0
0.200	900.0	924.0	1.500	0.0	1050.0
0.300	900.0	936.0	1.600	0.0	1050.0
0.400	900.0	948.0	1.700	0.0	1050.0
0.500	900.0	960.0	1.800	0.0	1050.0
0.600	900.0	972.0	1.900	0.0	1050.0
0.700	900.0	984.0	2.000	0.0	1050.0
0.800	900.0	996.0	2.100	0.0	1050.0
0.900	900.0	1008.0	2.200	0.0	1050.0
1.000	900.0	1020.0	2.300	0.0	1050.0
1.100	900.0	1032.0	2.400	0.0	1050.0
1.200	900.0	1044.0	2.500	0.0	1050.0

Hydro-Brake Optimum® Outflow Control

Unit Reference MD-SHE-0150-1120-1200-1120
Design Head (m) 1.200
Design Flow (l/s) 11.2
Flush-Flo™ Calculated
Objective Minimise upstream storage
Diameter (mm) 150
Invert Level (m) 11.000
Minimum Outlet Pipe Diameter (mm) 225
Suggested Manhole Diameter (mm) 1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	11.1
Flush-Flo™	0.357	11.1
Kick-Flo®	0.780	9.1
Mean Flow over Head Range	-	9.6

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.4	0.300	11.0	0.500	10.9	0.800	9.2
0.200	10.5	0.400	11.0	0.600	10.6	1.000	10.2

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