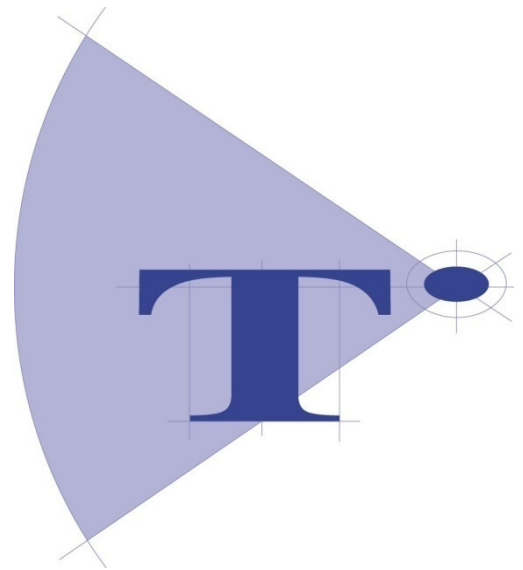




A FLOOD CONSEQUENCE ASSESSMENT FOR RHOSROBIN, WREXHAM

ISSUE 1.0

T/14/1400/FCA

30 SEPTEMBER 2014

Keelan Serjeant

Prepared for:

Liberty Properties

Prepared by:

Tier Environmental Ltd

Chadwick House,
Birchwood Park, Warrington,
WA3 6AE

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EXECUTIVE SUMMARY

This FCA demonstrates that the proposed development would be operated with minimal risk from flooding, would not increase flood risk elsewhere and is compliant with the requirements of TAN15. The development should not therefore be precluded on the grounds of flood risk.

The site is not at risk of flooding from a major source (e.g. fluvial and/or tidal). A number of secondary flooding sources have been identified which may pose a low risk to the site. These are:

- Surface Water (pluvial) Flooding
- Sewer flooding

Provided the buildings are set above the back of the footway of the adjacent carriageway to enable the full capacity of any secondary flood conveyance to be utilised, the risk of flooding from flooding is considered low. The flooding sources will only inundate the site to a relatively low water depth and water velocity, will only last a short period of time, in very extreme cases and will not have an impact on the whole of the proposed development site.

The site has a 'low probability' of fluvial flooding as the site is located within Flood Zone 1 and Zone A with less than a 1 in 1000 annual probability of river flooding in any year (<0.1%).

The proposed development is classified as 'Highly Vulnerable', 'Highly Vulnerable' uses are appropriate within Flood Zone 1 and Zone A after the completion of a satisfactory FCA.

The flood risk at the site will be managed and mitigated by using a number of risk management techniques, and mitigation strategies to manage and reduce the overall flood risk at the site.

The Justification Test will not need to be undertaken as part of this planning application. The development proposals should therefore be considered by the LPA to satisfy the Justification Test as set out in TAN15.

Development of the site will take place with separate systems for foul and surface water drainage. The separate system will extend to the public sewer. Foul water will discharge to the Welsh Water/Dŵr Cymru public foul water public foul sewer located within the vicinity of the site, at a point adjacent the site.

Using the information on the depth and arrangement of the existing sewers it has been assumed that gravity drainage will be possible; however, it would be prudent to undertake further detailed surveys to verify the inverts, depth and arrangement of the existing public sewer.

The SWMS ensures that a sustainable drainage solution can be achieved which reduces the peak discharge rate to manage and reduce the flood risk posed by the surface water runoff from the site. It is understood that the surface water currently drains to the public combined sewers located within the vicinity of the site. Therefore, the surface water will continue to discharge to these combined sewers at a point adjacent the site.



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At this stage it is anticipated that the attenuation storage will be located in: Soakaways, Filter Strips, Infiltration Trenches, Swales, Storage Tanks, Oversized Drainage Networks, Cellular Storage, Surface Storage and Permeable Paving. In order to limit the rate and volume of surface water runoff that is discharged, it will be necessary to include a flow control device. The surface water runoff from the site will be attenuated to the pre-development (greenfield) mean annual peak flow QBAR (rural) rate of 5.21l/s for all events up to and including the 1 in 100 year (+ 30%) rainfall event.

As a consequence of limiting the rate of discharge from the site to the pre-development runoff rate, at times of heavy rainfall the volume of water leaving the site will be significantly less than that draining from it. In order to prevent this water backing up in the system and causing flooding, 2615m³ of attenuation storage will be incorporated into the site layout.

As a consequence of limiting the rate of discharge from the site to the pre-development runoff rate, at times of heavy rainfall the volume of water leaving the site will be significantly less than that draining from it. In order to prevent this water backing up in the system and causing flooding, 70.80m³ of attenuation storage will be incorporated into the site layout.

The size of this attenuation storage has been calculated such that the proposed development has the capacity to accommodate the 100 year rainfall event including a 30% increase in rainfall intensity that is predicted to occur as a result of climate change.

The remainder of the site that is not formally drained, i.e. landscaped areas, will be permeable (grass). The majority of rainwater falling on these areas will soak into the ground. Surface water runoff would be directed to the drainage system through drainage gullies located around the perimeter of the buildings and through contouring of the hardstanding areas.

These methods will reduce peak flows, the volume of runoff, and slow down flows and will provide a suitable SUDS solution for this site. These preliminary considerations are based on the outline development scheme provided and hence the design purposes.

The adoption of a surface water management strategy for the site represents an enhancement from the current conditions as the current surface water runoff from the site is uncontrolled, untreated, unmanaged and unmitigated.

Where SUDS are to be used it must be established that these options are feasible, can be adopted and properly maintained and would not lead to any other environmental problems with a maintenance schedule or the lifetime of the facility and these issues should be considered at the detailed design stage.

At this stage of the planning process it is proposed that a planning condition can be adopted to cover the detailed design of the surface water runoff from the site. It is proposed that the detailed drainage design of the final scheme would be secured by a planning condition attached to any planning permission granted and agreed with the Environment Agency, Welsh Water/Dŵr Cymru and the LPA prior to works commencing.

In adopting these principles it has been demonstrated that a scheme can be developed that does not increase the risk of flooding to adjacent properties and development further downstream.

The flooding sources will be managed on the site by using a number of mitigation strategies to manage and reduce the overall flood risk at the site and will ensure the development will be safe. Measures used:

Minimum Floor Level - There is no minimum finished floor level proposed as a result of fluvial flooding; however, it is recommended that all properties are located above the back of the footway of the adjacent carriageway by 150mm to enable the full capacity of any secondary flood conveyance to be utilised.



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Surface Water Management Strategy - The SWMS ensures that a sustainable drainage solution can be achieved which reduces the peak discharge rate to the pre-development runoff rate to manage and reduce the flood risk posed by the surface water runoff from the site.

Flood Resilience and Resistance - The development of the layout should always consider that the site is potentially at risk from an extreme event and as such the implementation of flood resilience and resistance methods should be assessed.

Designing for Local Drainage System Failure - The landscaped areas will include preferential flow paths that convey water away from buildings. Surface water runoff would be directed to the drainage system through drainage gullies located around the perimeter of the buildings and through contouring of the hardstanding areas.

An exceedance or blockage event of the sewers would not affect the proposed property because finished floor levels will be above surrounding ground levels, ensuring any exceedance flooding would not affect the building. Exceedance flows would be contained within the highways surrounding the buildings.

Access and Egress - The site and surrounding area is located within Flood Zone 1 and Zone A therefore a permanently safe and dry access can be maintained.



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1. INTRODUCTION

1.1. Background

This Flood Consequence Assessment (FCA) has been prepared by Tier Environmental to support a planning application for the proposed development on Land off New Road, Rhosrobin, Wrexham. This FCA includes an assessment of the existing and proposed surface and foul water drainage of the site.

This FCA has been carried out in accordance with guidance contained in Technical Advice Note 15 Development and Flood Risk (TAN15) and associated Development Advice Maps. This FCA identifies and assesses the risks of all forms of flooding to and from the development and demonstrates how these flood risks will be managed so that the development remains safe throughout the lifetime, taking climate change into account.

It is recognised that developments which are designed without regard to flood risk may endanger lives, damage property, cause disruption to the wider community, damage the environment, be difficult to insure and require additional expense on remedial works. The development design should be such that future users will not have difficulty obtaining insurance or mortgage finance, or in selling all or part of the development, as a result of flood risk issues.

1.2. Technical Advice Note 15 (TAN15)

One of the key aims of TAN15 is to ensure that flood risk is taken into account at all stages of the planning process; to avoid inappropriate development in areas at risk of flooding and to direct development away from areas of highest risk.

It advises that where new development is exceptionally necessary in areas of higher risk, this should be safe, without increasing flood risk elsewhere, and where possible, reduce flood risk overall.

A risk based approach is adopted at stages of the planning process, applying a source pathway receptor model to planning and flood risk. To demonstrate this, an FCA is required and should include:

- whether a proposed development is likely to be affected by current or future flooding from all source;
- whether it will increase flood risk elsewhere;
- whether the measures proposed to deal with these effects and risks are appropriate; and
- satisfy the justification test, including the acceptability of consequences.



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1.3. Report Structure

This FCA has the following report structure:

- Section 2 details the sources of information that have been consulted;
- Section 3 describes the location area and the existing and proposed development;
- Section 4 outlines the flood risk to the existing and proposed development;
- Section 5 details the justification test;
- Section 6 describes the existing water networks within the vicinity of the site;
- Section 7 outlines the proposed foul water drainage for the site;
- Section 8 details the proposed surface water drainage for the site and assesses the potential impacts of the proposed development on surface water drainage;
- Section 9 describes the risk management methods used to mitigate all sources of flood risk; and
- Section 10 presents a summary and conclusions.



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2. SOURCES OF INFORMATION

2.1. Discussion with Regulators

Consultation and discussions with the relevant regulators have been undertaken during this FCA including Natural Resources Wales, the Local Planning Authority (LPA), and Sewerage Undertakers.

Natural Resources

The Flood and Water Management Act 2010 gives Natural Resources Wales a strategic overview role for all forms of flooding and coastal erosion. They also have direct responsibility for the prevention, mitigation and remediation of flood damage for main rivers and coastal areas. The Natural Resources Wales is the statutory consultee with regards to flood risk and planning.

Natural Resources Wales Flood Risk Standing Advice and TAN15 have been consulted and reviewed during this FCA. This has confirmed the level of FCA required and that a surface water drainage assessment is to be undertaken. Information regarding the current flood risk at the application site, local flood defences and flood water levels has been obtained from Natural Resources Wales.

Wrexham County Borough Council

Wrexham County Borough Council is the LPA and the Lead Local Flood Authority (LLFA) and has responsibilities for 'local flood risk', which includes surface runoff, groundwater and ordinary watercourses. Planning guidance written by Wrexham County Borough Council regarding flood risk was consulted to assess the mitigation policies in place.

The Wrexham County Council Preliminary Flood Risk Assessment (PFRA) which covers the site has been reviewed.

Welsh Water/Dŵr Cymru

Welsh Water/Dŵr Cymru is responsible for the disposal of waste water and supply of clean for this area. Information with regards to sewer and water main flooding contained within the Wrexham County Council PFRA has been consulted. All Water Companies have a statutory obligation to maintain a register of properties/areas which are at risk of flooding from the public sewerage system, and this is shown on the DG5 Flood Register.

A sewer plan has been received from Welsh Water/Dŵr Cymru (see Appendix B).



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3. LOCATION & DESCRIPTION

3.1. Site Location

The site is located at Land off New Road, Rhosrobin, Wrexham (see Drawing T/14/1400/FCA/1). The National Grid Reference (NGR) of the site is 333292, 352775.

The site comprises an irregular shaped piece of land covering an area of 11 hectares (ha) or 110,000m².

3.2. Existing Development

The site is in a greenfield state with the majority of the site being used as agricultural fields.

3.3. Proposed Development

It is understood that the proposals are for a residential development with up to 400 dwellings, gardens, access and landscaped areas (see Appendix C).

Further details with regard to the proposed development can be found in the accompanying information submitted with the planning application.

3.4. Ground Levels

A topographical survey of the site has recently been undertaken (see Appendix D). The sites falls from south to north with a minimum ground level of 81.90 metres Above Ordnance Datum (mAOD) and a maximum ground level of 98.45mAOD.

3.5. Catchment Hydrology

Located within the site are a number of small drainage channels, at the time of the site visit these were dry. There are no other watercourses evident either on, or within the vicinity of the site (see Drawing T/14/1400/FCA/1).

3.6. Geology

The British Geological Survey (BGS) Map indicates that the bedrock underlying the site consists of the Salop Formation - mudstone, sandstone and conglomerate and the Halesowen Formation - mudstone, siltstone and sandstone. The superficial deposits consist of Till, Devensian - diamicton.

3.7. Groundwater

The Environment Agency has designated the bedrock and superficial deposits as Secondary A Aquifers - permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.



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3.8. Groundwater Source Protection Zones

The site is not located within an Environment Agency Groundwater Source Protection Zone.

3.9. Soil

Information from the National Soil Resource Institute¹ details the site area as being situated on freely draining slightly acid loamy soils. The Flood Studies Report WRAP soil map classification is type 1: i) Well drained permeable sand or loam soils and shallower analogues over highly permeable limestone, chalk, sandstone or related drifts; ii) Earthy peat soils drained by dykes and pumps; and iii) Less permeable loamy over clayey soils on plateaux adjacent to very permeable soils in valleys.

3.10. Permeability/Infiltration Rate

In determining the future surface runoff from the site, the potential of using infiltration devices has been considered. As no site geotechnical information on the permeability and infiltration rate at the site has been acquired at this stage it is not possible to comment definitively upon the suitability of infiltration based systems. However, an overview of the general ground conditions (see Sections 3.6 to 3.9) may be used to gauge if there is potential for their application.

Therefore, it has been concluded that there should be infiltration drainage within the soils and bedrock at the site. SUDS methods such as soakaways, permeable paving, grassed swales may work at the site.

If an infiltration system is proposed, it is recommended that a series of infiltration/soakaway tests are carried out on site to BRE Digest 365 Guidelines to confirm the assumptions made in the calculations. Such work is beyond the scope of this FCA, but should be undertaken to inform the detailed drainage strategy for the site.

¹ National Soil Resources Institute (NSRI) 2013. The Soils Guide. Available: www.landis.org.uk. Cranfield University, UK. Last accessed 29/09/2014.

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4. FLOOD RISK

4.1. Sources of Flooding

All sources of flooding have been considered, these are; Fluvial (river) Flooding, Tidal (coastal) Flooding, Groundwater Flooding, Surface Water (pluvial) Flooding, Sewer Flooding and Flooding from Artificial Drainage Systems/Infrastructure Failure. The key consequences of flooding are death/personal injury, extensive damage to property, properties uninhabitable for long periods, properties cannot be sold, insurance unavailable or too expensive, expense of installing flood resilience measures and business interruptions.

Fluvial (river) Flooding

Located within the site are a number of small drainage channels, at the time of the site visit these were dry. There are no other watercourses evident either on, or within the vicinity of the site (see Drawing T/14/1400/FCA/1). The risk of fluvial flooding is considered to be not significant. Therefore, flooding from this source has not been considered further within this FCA.

Tidal (coastal) Flooding

The site is not located within the vicinity of tidal flooding sources and the risk of tidal flooding is considered to be not significant. Therefore, flooding from this source has not been considered further within this FCA.

Groundwater Flooding

Groundwater flooding is defined as the emergence of groundwater at the ground surface or the rising of groundwater into man-made ground under conditions where the normal range of groundwater levels is exceeded. Groundwater flooding tends to occur sporadically in both location and time. When groundwater flooding does occur, it tends to mostly affect low-lying areas, below surface infrastructure and buildings (for example, tunnels, basements and car parks) underlain by permeable rocks (aquifers).

Site conditions (see Section 3.6 to 3.9) suggest a low probability of groundwater flooding. The Wrexham County Borough Council SFRA confirms that there were no records of past groundwater flooding within Wrexham County Borough Council; this is due to the topography and geology of the area.

No below surface infrastructure and buildings are located or are proposed for the site. The risk from this source will be further mitigated by using a number of risk management measures (see Section 9.0). The risk of flooding from groundwater flooding is considered to be not significant. Therefore, flooding from this source has not been considered further within this FCA.

Surface Water (pluvial) Flooding

The soil condition at the site and within the vicinity of the site (see Section 3.9) and the topography of the site suggest that the site is relatively well drained and surface water flooding would not be expected to accumulate to any significant depths. Surface water flooding tends to occur sporadically in both location and time such surface water would tend to be confined to the streets around the development.

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Drawing T/14/1400/FCA/2 confirms that the majority of the site is not at risk of surface water flooding with a chance of surface water flooding of less than 1 in 1000 years (0.1%). However, a small proportion of the site has a low to high of surface water flooding with a chance of between 1 in 1000 (0.1%) and 1 in 100 (1%) years up to a greater than 1 in 30 (3.3%) years. This may result in water depths of 300mm to 900mm and water velocities of less than 0.25m/s. This is associated with small areas of poor permeability and low spots within the site topography.

Surface water flooding poses a low flood risk to the site; the risk from this source will be mitigated by using a number of risk management measures (see Section 9.0). The risk of flooding from surface water flooding is considered to be of low significance.

Sewer Flooding

Sewer flooding occurs when urban drainage networks become overwhelmed and maximum capacity is reached. This can occur if there is a blockage in the network causing water to back up behind it or if the sheer volume of water draining into the system is too great to be handled. Sewer flooding tends to occur sporadically in both location and time such flood flows would tend to be confined to the streets around the development.

There are existing public sewers within roads adjacent to the site these will inevitably have a limited capacity so in extreme conditions there would be surcharges, which may in turn cause flooding (see Appendix B).

Flood flows could also be generated by burst water mains but these would tend to be of a restricted and much lower volume than weather generated events and so can be discounted for the purposes of this assessment. Given the design parameters normally used for drainage design in recent times and allowing for some deterioration in the performance of the installed systems, which are likely to have been in place for many years, an appropriate flood risk probability from this source could be assumed to have a return period in the order of 1 in 10 to 1 in 30 years. The provision of adequate level difference between the ground floors and adjacent ground level would reduce the annual probability of damage to property from this source to 1 in 100 years or less.

Sewer flooding poses a low flood risk to the site; the risk from this source will be mitigated by using a number of risk management measures (see Section 9.0). The risk of flooding from sewer flooding is considered to be of low significance.

Flooding from Artificial Drainage Systems/Infrastructure Failure

There are no other nearby artificial water bodies, water channels and artificial drainage systems that could be considered a flood risk to the site. The Environment Agency Reservoir flood map shows that the site is not at risk of reservoir flooding (see Drawing T/14/1400/FCA/3). The risk of flooding from reservoir failure is considered to be not significant. Therefore, flooding from these sources has not been considered further within this FCA.

4.2. Natural Resources Wales Flood Zones

A review of the Natural Resources Wales flood map indicates that the site is located within Flood Zone 1 and therefore has a 'low probability' of fluvial flooding as shown in see Drawing T/14/1400/FCA/4, with less than a 1 in 1000 annual probability of river flooding in any year (<0.1%).

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The Flood Zones are the current best information on the extent of the extremes of flooding from rivers or the sea that would occur without the presence of flood defences, because these can be breached, overtopped and may not be in existence for the lifetime of the development.

The Natural Resources Wales Flood Zones and acceptable development types are explained in Table 4.1. Table 4.1, highlighted in green, shows that all development types are generally acceptable in Flood Zone 1.

Table 4.1 - Natural Resources Flood Zones and Appropriate Land Use

Flood Zone	Probability	Explanation	Appropriate Land Use
Zone 1	Low	Less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%)	All development types generally acceptable
Zone 2	Medium	Between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% - 0.1%) in any year	Most development type are generally acceptable
Zone 3a	High	A 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year	Some development types not acceptable
Zone 3b	'Functional Floodplain'	Land where water has to be flow or be stored in times of flood. SFRAs should identify this zone (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1% flood, or at another probability to be agreed between the LPA and the Environment Agency, including water conveyance routes)	Some development types not acceptable

4.3. Natural Resources Wales Flood Zones

The Development Advice Map which accompanies TAN15 confirms that the site has a 'low probability' of fluvial or tidal/coastal flooding (See Table 4.2). Drawing T/14/1400/FCA/5 shows that the site is located within Zone A and is therefore considered to be at little or no risk of fluvial or tidal/coastal flooding.

Table 4.2 describes the composition and use of the TAN15 zones to control and manage development. Applying the Flood Risk Vulnerability Classification in Figure 2 of TAN15, the proposed development is classified as 'Highly Vulnerable'.

In TAN15 (Section 9.0) appropriate uses have been identified for the TAN15 zones. TAN15 states that 'Highly Vulnerable' uses are appropriate within Zone A after the completion of a satisfactory FCA. This is confirmed within Table 4.2.

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Table 4.2 - TAN15 Flood Zones

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

4.4. Historic Flooding

Data from the BGS indicates that the types of deposits located on the site are not of the type normally associated with floodplains. There are no records of anecdotal information of flooding at the site. The British Hydrological Society "Chronology of British Hydrological Event²" has no information on flooding within the vicinity of the site. No other historical records of flooding for the site have been recorded.

Therefore, it has been assumed that the site has not flooded within the recent past (i.e. the last thousand years).

4.5. Existing and Planned Flood Defence Measures

Drawing T/14/1400/FCA/4 shows that the site is not protected by any formal or informal flood defence measures, flood storage areas and is not located within an area benefiting from flood defences.

4.6. Site Specific Flood Risk Assessment

A summary of the sources of flooding and a review of the risk posed by each source at the site is shown in Table 4.3.

² <http://www.dundee.ac.uk/geography/cbhe/>

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Table 4.3 - Risk Posed by Flooding Sources

Sources of Flooding	Potential Flood Risk	Potential Source	Probability/Significance
Fluvial (river) Flooding	No	None Reported	Not significant
Tidal (coastal) Flooding	No	None Reported	Not significant
Groundwater Flooding	No	None Reported	Not significant
Surface Water (pluvial) Flooding	Yes	Poor Permeability/Low Spots	Low
Sewer Flooding	Yes	Local Sewers	Low
Flooding from Artificial Drainage Systems/Infrastructure Failure	No	None Reported	Not significant

The site is not at risk of flooding from a major source (e.g. fluvial and/or tidal). A number of secondary flooding sources have been identified which may pose a low risk to the site. These are:

- Surface Water (pluvial) Flooding
- Sewer flooding

Provided the buildings are set above the back of the footway of the adjacent carriageway to enable the full capacity of any secondary flood conveyance to be utilised, the risk of flooding from flooding is considered low. The flooding sources will only inundate the site to a relatively low water depth and water velocity, will only last a short period of time, in very extreme cases and will not have an impact on the whole of the proposed development site.

As noted in Section 4.2, the site has a 'low probability' of fluvial flooding as the site is located within Flood Zone 1 and Zone A with less than a 1 in 1000 annual probability of river flooding in any year (<0.1%).

The proposed development is classified as 'Highly Vulnerable', 'Highly Vulnerable' uses are appropriate within Flood Zone 1 and Zone A after the completion of a satisfactory FCA.

The flood risk at the site, will be managed and mitigated by using a number of risk management techniques, and mitigation strategies to manage and reduce the overall flood risk at the site (see Section 9.0).

In conclusion, the flood risk to the site can be considered to be limited; the site is situated in Flood Zone 1 and Zone A, with a low annual probability of flooding and from all sources. The site is unlikely to flood except in very extreme conditions.



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5. JUSTIFYING THE LOCATION OF THE DEVELOPMENT

5.1. Justification Test

New development should be directed away from Zone C and towards suitable land in Zone A, otherwise to Zone B, where river or coastal flooding will be less of an issue. The proposed development site complies with the Justification Test which should be applied at all stages of planning.

The Development Advice Map shows that the site is located within Zone A and confirms that the site has a 'low probability' of fluvial or tidal/coastal flooding and is therefore considered to be at little or no risk of fluvial or tidal/coastal flooding (see Drawing T/13/1400/FCA/5).

Therefore, the Justification Test will not need to be undertaken as part of this planning application. The development proposals should therefore be considered by the LPA to satisfy the Justification Test as set out in TAN15.

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6. EXISTING DRAINAGE NETWORKS

6.1. Introduction

This section details the existing water network infrastructure within and adjacent to the site. The existing water network has been identified and assessed using a number of techniques including a review of previous assessments of the site drainage.

It is recognised that developments that are designed without regards to the foul and surface water sewers are likely to result in increased impact on existing off site service provision. In addition, it is possible that substantial services cross the site, which may have associated easements.

6.2. Existing Water Drainage

A public foul sewer is located within the site (see Appendix B). A 150mm diameter public foul sewer is shown entering the southern boundary of the site and running along the southern boundary of the site before turning north and running from south to north along the eastern boundary of the site. This then joins another 600mm diameter public foul sewer and runs to the north through the site as a 225mm diameter public foul sewer (see Appendix B).

Welsh Water/Dŵr Cymru has no duty to keep records of private foul water sewers, and there are no comprehensive records kept elsewhere.

6.3. Existing Surface Water Drainage

There are no public surface water sewers located within the vicinity of the site (see Appendix B).

Welsh Water/Dŵr Cymru has no duty to keep records of private surface water sewers, and there are no comprehensive records kept elsewhere.

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7. PROPOSED FOUL WATER DRAINAGE

7.1. Foul Water Drainage Strategy

Development of the site will take place with separate systems for foul and surface water drainage. The separate system will extend to the public sewer.

Foul water will discharge to the existing Welsh Water/Dŵr Cymru public foul water sewers located within the vicinity of the site at a point adjacent to the site (see Appendix B). Using the information on the depth and arrangement of the existing sewers it has been assumed that gravity drainage will be possible; however, it would be prudent to undertake further detailed surveys to verify the inverts, depth and arrangement of the existing public sewer.

7.2. Conditions

The public sewer network is for domestic sewage purposes. This generally means foul water for domestic purposes and, where suitable surface water or combined sewer is available, surface water from the roofs of buildings together with surface water from paved areas of land appurtenant to those buildings. Land and highway drainage have no right of connection to the public sewer network. No land drainage can be connected/discharged to the public sewer.

At a last resort, highway drainage may be accepted under certain circumstances. If SUDS are not a viable option, there are no watercourses or highway drains available and if capacity is available within the public sewer network, highway drainage discharge to the public sewer network may be permitted. In this event, the developer may be required to enter into a formal agreement with Welsh Water/Dŵr Cymru under Section 115 Water Industry Act 1991 to discharge non-domestic flows into the public sewer network.

Foul water from kitchens and/or food preparation areas of any restaurants and/or canteens etc. must pass through a fat and grease trap of adequate design before any discharge to the public sewer network.

7.3. Application to make connections

The developer will write to Welsh Water/Dŵr Cymru requesting an application form that will be duly completed and returned. No works on the public sewer will be carried out until a letter of consent is received from Northumbrian Water.

7.4. Adoption Agreements

Prospective adoptable sewers and pumping stations will be designed and in constructed in accordance with 'Sewers for Adoption' 6th Edition as supplemented by Welsh Water/Dŵr Cymru requirements, pursuant to an agreement under Section 104 of the Water Industry Act 1991. An application to enter into a Section 104 agreement must be made in writing prior to any works commencing on site.

7.5. Easements

An easement (an area over and to either side of the sewer on which no buildings or other permanent structures are permitted) is required where sewers are laid in land other than highway. The minimum dimension of a sewer easement is 6 metres (3 metres



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either side of the centre line of the sewer), but may be more depending on the size and depth of the sewer. No information has been provided by Welsh Water/Dŵr Cymru on the depth of sewers within the vicinity of the site. Easements are not required where the sewers are in the public highway. If sewers are shown as being present on the site this will be discussed further with Welsh Water/Dŵr Cymru.

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8. SURFACE WATER MANAGEMENT

8.1. Surface Water

It is recognised that consideration of flood issues should not be confined to the floodplain. The alteration of natural surface water flow patterns through developments can lead to problems elsewhere in the catchment, particularly flooding downstream. For example, replacing vegetated areas with roofs, roads and other paved areas can increase both the total and the peak flow of surface water runoff from the development site. Changes of land use on previously developed land can also have significant downstream impacts where the existing drainage system may not have sufficient capacity for the additional drainage.

A surface water management strategy for the site proposals has been developed to manage and reduce the flood risk posed by the surface water runoff from the site. An assessment of the surface water runoff rates has been undertaken, in order to determine the surface water options and attenuation requirements for the site. The assessment considers the impact of the development compared to current conditions. Therefore, the surface water attenuation requirement for the developed site can be determined and reviewed against existing arrangements.

The surface water drainage arrangements for any development site should be such that the volumes and peak flow rates of surface water leaving a developed site are no greater than the rates prior to the proposed development, unless specific off-site arrangements are made and result in the same net effect.

It should be acknowledged that the satisfactory collection, control and discharge of surface water runoff are now a principle planning and design consideration. This is reflected in recently implemented guidance and the soon to be released National Sustainable Drainage Systems (SUDS) Standards.

8.2. Discharge of Surface Water

There are three possible options to discharge the surface water runoff in accordance with requirement H3 of the Building Regulations 2002, this hierarchy is also promoted within TAN15. Rainwater shall discharge to one of the following, listed in order of priority:

1. an adequate soakaway or some other adequate infiltration system; or, where that is not reasonably practicable,
2. a watercourse; or where that is not reasonably practicable,
3. a sewer.

It is necessary to identify the most appropriate method of controlling and discharging surface water. The design should seek to improve the local runoff profile by using systems that can either attenuate runoff and reduce peak flow rates or positively impact on the existing surface water runoff.

Soakaway/Infiltration System

It has been concluded that there should be infiltration drainage within the soils and bedrock at the site (see Section 3.10). SUDS methods such as soakaways, permeable paving, grassed swales may work at the site.

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If an infiltration system is proposed, it is recommended that a series of infiltration/soakaway tests are carried out on site to BRE Digest 365 Guidelines to confirm the assumptions made in the calculations. Such work is beyond the scope of this FCA, but should be undertaken to inform the detailed drainage strategy for the site.

Watercourse

Should infiltration be found to be unsuitable, the next option is discharge to a watercourse. However, there are no watercourses evident either on, or within the vicinity of the site (see Drawing T/14/1403/FCA/1). Therefore, discharge to a watercourse will not be possible.

Sewer

In the event that discharge of surface water via infiltration or discharge to a watercourse is deemed unsuitable, then discharge to the public sewer would have to be investigated further. Where the developer proposes to discharge to a public sewer, prior approval from Dwr Cymru/Welsh Water Developer Services will be required, to ensure that the surface water discharge from the site shall not be detrimental to the existing sewerage system.

8.3. Site Areas

The site is in a greenfield state with the majority of the site being used as agricultural fields. The site comprises an irregular shaped piece of land covering an area of 11.00ha or 110,000m².

It is understood that the existing drainage infrastructure at the site efficiently and effectively manages surface water runoff generated at the site. As there is no history of surface water flooding at the site it is likely that the current drainage system is sufficient for the current site use.

It is understood that the proposals are for a residential development with up to 400 dwellings, gardens, access and landscaped areas (see Appendix C).

Table 8.1 shows that the existing site is constructed from 11.00ha (100%) of permeable surfaces with 0.00ha (0%) of impermeable surfaces located on the site. At this stage a detailed proposed site layout has not been developed. Therefore, a conservative figure for the increase in the impermeable figure has been adopted. Once the proposed site layout is finalised this can be reviewed and amended as required. A figure of 40% for the impermeable areas has been adopted for the proposed site layout. The proposed development will decrease the permeable area to 4.50ha (60%) and increase the impermeable area to 4.50ha (40%) generating higher surface water runoff post-development. If uncontrolled, this could in turn increase the risk of flooding to the site and off-site locations.

Table 8.1 - Site Areas (ha)

Element	Pre-development	Post-development	Difference
Permeable Surfaces	11.00	6.50	- 6.50
Impermeable Surfaces	0.00	4.50	+ 4.50
Total	11.00	11.00	-----

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8.4. Surface Water Runoff from the Existing Site

The current site is not formally drained. The majority of rainfall either infiltrates into the soils substrate or discharges from the site as surface water runoff. In order to quantify any potential increase in surface water runoff, the pre- and post-development runoff rates from the site must be determined (see Table 8.2). Greenfield runoff rates from the existing permeable surfaces have been calculated using the Institute of Hydrology Report 124 method (Ih124)³ using the Masterdrain Drainage software (see Appendix E). QBAR (rural) has been calculated to be 5.21l/s.

Table 8.2 - Existing Site Total Peak Runoff Rates

Return Period (years)	l/s	l/s/ha
1 in 2	5.21	0.47
1 in 30	9.11	0.83
1 in 100	11.35	1.03

8.5. Site Attenuation

The provision of suitable attenuation on site to mitigate the flood risk resulting from the development of the site will be a key factor in the evolution of the site development layout. The provision of large volumes of attenuation, as is likely in this case, can be achieved by a number of methods; however, not all systems can be assessed in direct comparison.

One of the aims of TAN15 is to provide not only flood risk mitigation but also to maximise additional gains such as improvements in runoff quality and provision of amenity and bio-diversity. Systems incorporating these features are often termed SUDS and it is the requirement of TAN15 that these are considered as the primary means of collection, control and disposal for storm water as close to source as possible.

Table 8.3 shows the volume of attenuation required for the proposed development estimated using the Masterdrain Drainage Software for the 2, 30 and 100 year events 6 hour⁴ events, with a 30% allowance for climate change assuming the proposed 40% of impermeable area with the pre-development (greenfield) mean annual peak flow QBAR (rural) rate of 5.21l/s used as the limiting discharge rate (see Appendix F). This can include storing water above ground for events greater than the 1 in 30 year event.

Table 8.3 - Storage Volume

Return Period (years)	Limiting Discharge Rate (l/s)	Volume (m ³)
2 + 30%	5.21	1060
30 + 30%		1991
100 + 30%		2615

³ Institute of Hydrology (1994) Flood estimation for small catchments. Report no 124.

⁴ The 6 hour duration storm is used by designers as this an event which can cause flooding in small catchments.

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This volume may be reduced by implementing a complex control at the outfall which would increase the rate of discharge from the site for events above the 1 in 30 year event. This should be explored at detailed design stage and agreed with the LPA, Welsh Water/Dŵr Cymru and the Environment Agency.

This volume of attenuation storage could be provided by a variety of means these are discussed below.

8.6. SUDS and Water Quality

Current guidance promotes sustainable water management through the use of SUDS. SUDS measures should be used to control the surface water runoff from the proposed development site therefore, managing the flood risk to the site and surrounding areas from surface water runoff.

1. A hierarchy of techniques is identified⁵:
2. Prevention - the use of good site design and housekeeping measures on individual sites to prevent runoff and pollution (e.g. minimise areas of hard standing).
3. Source Control - control of runoff at or very near its source (such as the use of rainwater harvesting, permeable paving, soakaways and/or green roofs).
4. Site Control - management of water from several sub-catchments (including routing water from roofs and car parks to one/several large soakaways for the whole site, swales and/or infiltration trenches).
5. Regional Control - management of runoff from several sites, typically in a detention pond, basins, tanks and/or wetland.

It is generally accepted that the implementation of SUDS as opposed to conventional drainage systems, provides several benefits by:

- reducing peak flows to watercourses or sewers and potentially reducing the risk of flooding downstream;
- reducing the volumes and frequency of water flowing directly to watercourses or sewers from developed sites;
- improving water quality over conventional surface water sewers by removing pollutants from diffuse pollutant sources;
- reducing potable water demand through rainwater harvesting;
- improving amenity through the provision of public open spaces and wildlife habitat; and
- replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.

The most appropriate attenuation system will need to satisfy three main characteristics, firstly, provide the required volume of storage, secondly, minimise the loss of developable land and thirdly, where possible provide local amenity. The application of the

⁵ CIRIA (2004) Report C609, Sustainable Drainage Systems – Hydraulic, Structural and Water Quality advice.

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SUDS Manual⁶ requires that the runoff from sites is not only restricted to meet the pre-development runoff characteristics but also that SUDS systems are utilised to improve the quality of the runoff prior to outfall to watercourses. The SUDS Manual and Natural Resources Wales guidance applies a sustainability hierarchy to the various types of SUDS systems, this is summarised in Table 8.4.

Table 8.4 - Sustainability Hierarchy

Most Sustainable	SUDS Technique	Flood Reduction	Pollution Reduction	Landscape & Wildlife
	Living Roofs	✓	✓	✓
	Basins and ponds	✓	✓	✓
	- Constructed wetlands			
	- Balancing ponds			
	- Detention basins			
	- Retention ponds			
	Filter strips and swales	✓	✓	✓
	Infiltration Devices	✓	✓	✓
Least Sustainable	- soakaways			
	Permeable Surfaces and Filter Drains	✓	✓	
	- Gravelled areas			
	- Solid paving blocks			
	- Permeable paving			
	Tanked systems	✓		
	- over-sized pipes/tanks			
	- cellular storage			

Systems at the top of the hierarchy provide a combination of attenuation, treatment and ecology and are deemed the most sustainable options. There are always specific scenarios where systems are more suitable than others and at this stage it is not possible to guide the development towards a particular strategy.

In addition to the above hierarchy the SUDS Manual (Table 5.6) identifies the number of treatment trains or SUDS devices through which flow should pass from various point sources of runoff (see Table 8.5). This is designed to ensure that the receiving watercourses are not put at risk of pollution by new development.

⁶ CIRIA C697 SUDS Manual, 2007.

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Table 8.5 - Number of Treatment Train Components (assuming effective pre-treatment is in place)

Runoff Catchment Characteristic	Receiving Watercourse Sensitivity		
	Low	Medium	High
Roof only	1	1	1
Residential roads Parking areas Commercial zones	2	2	3
Refuse collection Industrial areas Loading bays Lorry parks Highways	3	3	4

The usual approach is to consider the 'SUDS train' where each of the above options are considered in turn until a suitable solution is found. Thus source control techniques such as soakaways, rainwater harvesting and/or infiltration trenches, if suitable on a site, are considered preferable to permeable conveyance and passive treatment systems such as tanks or ponds. The various options are considered in outline below.

Source Control

(i) Soakaways

Soakaways are buried rings or tanks filled with rubble or stone and allow gradual infiltration of collected runoff from impermeable areas into the surrounding soil. They require relatively permeable strata below a site to allow percolation and the reduction in runoff is achieved by the volume of percolation and the available storage volume. An assessment of their suitability requires the characteristics of the sub-soils or the geology to confirm the infiltration rate or vertical permeability.

It has been concluded that there should be infiltration drainage within the soils and bedrock at the site. Soakaways may work at the site. If an infiltration system is proposed, it is recommended that a series of infiltration/soakaway tests are carried out on site to BRE Digest 365 Guidelines to confirm the assumptions made in the calculations.

(ii) Permeable Paving

The use of permeable paving can often be considered for pedestrian or car parking areas but not for heavy traffic areas such as roadways where the heavy loading could damage the paving infrastructure. It is also possible to provide plot-by-plot systems connecting in to a site wide system. There may be scope to apply these features on a plot-by-plot basis as the layout develops further.

These systems also encourage biological treatment of flow and extraction of oils and heavy metals from the run-off.

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Land take is reduced as storage is located under car parks and access roads. However, maintenance is potentially a long term issue and the possibility of the paving being damaged, dug up and not properly reinstated or not regularly swept could lead to compromising the future capacity of the system.

This system will negate the need for a separate collection system such as kerbs and gullies. It will also assist in reducing the flood profile of the site by significantly attenuating the run-off from the development within the sub base material.

There is no specific amenity provided by the system other than enabling other areas to be utilised for development rather than potentially sterilizing areas with an easement for a sewer or stand-off for a basin.

It has been concluded that there should be infiltration drainage within the soils and bedrock at the site. Permeable paving may work at the site. If an infiltration system is proposed, it is recommended that a series of infiltration/soakaway tests are carried out on site to BRE Digest 365 Guidelines to confirm the assumptions made in the calculations.

(iii) Rainwater Harvesting

The reuse of water from roofed areas to provide grey (non-potable) water for flushing WCs within buildings can reduce storm runoff without the need for treatment or oil separators since the risk of spillage or contamination is low. Such a facility could be practical depending on the available water volumes. Rain water is held in off-line storage tanks at or about roof level from where a gravity feed is used to supplement the standard water supply. This would not include the hard standing areas at ground level such as roads and car parking areas which would require a pumped system to return water to roof level and this is considered impractical. Over the course of a year a grey water system will reduce the volume of water entering the storm water disposal system and could be considered.

Such a system would require one or more tanks at roof level and under optimum conditions these would be kept as near as full as possible to ensure a reliable water supply.

(iv) Green Roofs

A green roof is a multi-layered system that covers the top of a building with soil and vegetation and which can provide a degree of rain storm attenuation and a reduction in site runoff. These can either be extensive roofs which are low maintenance with a 25-125 mm soil layer in which a variety of hardy drought tolerant low plants are grown, or intensive roofs with trees and planters which impose a greater load on the roof structure but are more suitable in certain circumstances. Green roofs can be used to reduce the volume and rate of runoff so that other SUDS techniques in the scheme can be significantly reduced in size.

This is not a practical option and is therefore not considered further.

Site Control - Permeable Conveyance Systems

Permeable conveyance systems can take the form of infiltration trenches, swales or filter strips at road margins where surface runoff from roads, car parking areas and also roof drainage can be directed. Used to collect water directly from linear systems, percolate the flow, attenuate and then discharge the flow to either a traditional system or a secondary SUDS device.

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The use of these systems is more suited to linear applications such as roads as the typical cross section is relatively small and longer runs are required to provide attenuation volume. Land take can be relatively small in comparison to other systems and both types perform well in improving water quality. They are also ideally suited for disposal of water via secondary infiltration.

It is likely that these features could be utilised as the first treatment train and as part of the site collection and conveyance system.

(i) Infiltration Trench

Infiltration trenches are essentially linear soakaways which allows water to infiltrate into the soils as it is transported to a disposal point.

It has been concluded that there should be infiltration drainage within the soils and bedrock at the site. Infiltration trenches may work at the site. If an infiltration system is proposed, it is recommended that a series of infiltration/soakaway tests are carried out on site to BRE Digest 365 Guidelines to confirm the assumptions made in the calculations.

(ii) Swales

Swales are open wide trapezoidal channels across a site which allows water to infiltrate into the soils as it is transported to a disposal point.

It has been concluded that there should be infiltration drainage within the soils and bedrock at the site. Swales may work at the site. If an infiltration system is proposed, it is recommended that a series of infiltration/soakaway tests are carried out on site to BRE Digest 365 Guidelines to confirm the assumptions made in the calculations.

(iii) Filter Strips

Filter strips will be smaller in plan area than a swale although the swale can be landscaped to be incorporated in to the verge of the carriageway, combining two functions.

It has been concluded that there should be infiltration drainage within the soils and bedrock at the site. Filter strips may work at the site. If an infiltration system is proposed, it is recommended that a series of infiltration/soakaway tests are carried out on site to BRE Digest 365 Guidelines to confirm the assumptions made in the calculations.

Passive Treatment Systems

Where ground conditions prevent the use of infiltration, such as on ground that may be impermeable or contaminated, SUDS methods that are designed not to infiltrate can be considered. Passive treatment systems can include a pond, wetland, tank or a basin on the lower parts of a site. These will reduce peak flows, but not the volume of runoff, and slow down flows before disposal to a surface water drainage system. These may provide a suitable SUDS solution for this site and options are therefore considered in outline below.

(i) Ponds and Basins

The nature of these systems is such that the runoff from the development can be treated by biological action and stilling to significantly improve the quality of water discharged from the system.

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Basins also provide large areas of open space that can be developed for recreational uses or as new habitats for wildlife. Both systems do, however, take up significant amounts of developable land and have residual maintenance and liability issues attached to their implementation.

(ii) Storage Tanks

Hard engineered tank storage systems have traditionally been used for attenuation structures for the past decade and are often specified where large volumes of storage are required (>200m³) and available space is an issue. These could be located underneath the roads and paved areas.

These systems have no inherent water treatment properties bar potential sedimentation of the attenuated flow and offer no additional amenity benefits. In some cases the easement to the tank or culvert is such that a significant portion of land area is sterilized from development and certain planting.

There are also significant costs associated with these systems in production, transportation and installation. However, once installed the long term maintenance of the system is relatively low. With a proven record of successful installation, tanks and culverts are regularly adopted by water authorities across the country, albeit with a large associated easement that will sterilise that portion of the site.

(iii) Oversized Drainage Network

A further option on storage and attenuation would be the use of an oversized drainage network designed to act as inline storage, rather than a tank or pond, to provide the required storage volume underground. These could be located underneath the roads and paved areas.

As the diameter of larger pipes readily available is limited the applicability of these types of systems is more suited to <200m³ of attenuation. Above this volume the length of pipe required is excessive and difficult to suitably fit into a normal site layout.

There is no intrinsic amenity provided by the use of this system neither is there any specific level of run-off treatment over and above that of a standard pipe and gully system.

However, due to their traditional nature, the adoption of these types of systems by water authorities is straightforward and does not require any specialist input. The pipes are generally available direct from suppliers with little or no lead in time and the satisfactory long term performance of these systems is well documented.

This option could be used in combination with other SUDS elements to provide the required storage volume.

(iv) Cellular Storage

Large volumes of storage can be provided under grassed and lightly trafficked areas by using proprietary plastic cellular systems. This will maximise the developable area of the site. These could be located underneath the roads and paved areas.

There is no specific mechanism within the system designed to treat flow but extended detention times will allow sedimentation reducing the suspended solids within the discharge.

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There is no creation of amenity by the installation of these types of systems, indeed by maintaining access to the system small areas may need to be reserved.

If the developable footprint is tight then these systems may be advantageous however to ensure adoptability it is recommended that the use of these systems is discussed with the adopting authority as they are not always preferred.

There would be room to install cellular storage under the site to provide the storage volume required. This will require the new drainage network to divert flow from the impermeable buildings and parking areas to this cellular storage facility. This could also be drained via permeable pavement surfaces.

(v) Surface Storage

The use of roads, public areas and even landscaped areas as additional storage is becoming a widely accepted form of attenuation.

Water spilling from drainage systems can be collected via roads and kerbs and channelled to lower lying areas where it would be stored until the capacity in the existing system returns.

These systems have the advantage of requiring little additional infrastructure merely detailing of the proposed roads and grassed areas.

As these systems will only be used in extreme events when the adopted drainage system is exceeded (>1 in 30 years), they provide a very efficient way of catering for these events rather than providing permanent capacity.

There is no inherent water treatment capability in this system or any particular increase in amenity; however the costs associated with this provision are relatively small.

8.7. Proposed Surface Water Management Strategy (SWMS)

The objective of this SWMS is to ensure that a sustainable drainage solution can be achieved which reduces the peak discharge rate to manage and reduce the flood risk posed by the surface water runoff from the site. At this stage it is anticipated that the attenuation storage will be located in: Soakaways, Filter Strips, Infiltration Trenches, Swales, Storage Tanks, Oversized Drainage Networks, Cellular Storage, Surface Storage and Permeable Paving. It is anticipated that the 1 in 30 year (plus climate change) event will be stored below ground and the 1 in 100 year (plus climate change) event will be temporarily stored above ground by the use of roads, public areas and even landscaped areas until the capacity of the drainage system returns.

In order to limit the rate and volume of surface water runoff that is discharged, it will be necessary to include a flow control device. The surface water runoff from the site will be attenuated to the pre-development (greenfield) mean annual peak flow QBAR (rural) rate of 5.21l/s for all events up to and including the 1 in 100 year (+ 30%) rainfall event.

As a consequence of limiting the rate of discharge from the site to the pre-development runoff rate, at times of heavy rainfall the volume of water leaving the site will be significantly less than that draining from it. In order to prevent this water backing up in the system and causing flooding, 2615m³ of attenuation storage will be incorporated into the site layout.

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The size of this attenuation storage has been calculated such that the proposed development has the capacity to accommodate the 100 year rainfall event including a 30% increase in rainfall intensity that is predicted to occur as a result of climate change.

The remainder of the site that is not formally drained, i.e. landscaped areas, will be permeable (grass). The majority of rainwater falling on these areas will soak into the ground. Surface water runoff would be directed to the drainage system through drainage gullies located around the perimeter of the buildings and through contouring of the hardstanding areas.

These methods will reduce peak flows, the volume of runoff, and slow down flows and will provide a suitable SUDS solution for this site. These preliminary considerations are based on the outline development scheme provided and hence the design purposes.

The adoption of a surface water management strategy for the site represents an enhancement from the current conditions as the current surface water runoff from the site is uncontrolled, untreated, unmanaged and unmitigated.

Where SUDS are to be used it must be established that these options are feasible, can be adopted and properly maintained and would not lead to any other environmental problems with a maintenance schedule or the lifetime of the facility and these issues should be considered at the detailed design stage.

At this stage of the planning process it is proposed that a planning condition can be adopted to cover the detailed design of the surface water runoff from the site. It is proposed that the detailed drainage design of the final scheme would be secured by a planning condition attached to any planning permission granted and agreed with the Environment Agency, Welsh Water/Dŵr Cymru and the LPA prior to works commencing.

In adopting these principles it has been demonstrated that a scheme can be developed that does not increase the risk of flooding to adjacent properties and development further downstream.

8.8. Designing for Local Drainage System Failure

It is not economically viable or sustainable to build a drainage system that can accommodate the most extreme events. Consequently, the capacity of the drainage system may be exceeded on rare occasions, with excess water flowing above ground⁷.

Periods of exceedance occur when the rate of surface run-off exceeds the drainage system inlet capacity, when the pipe system becomes overloaded, or when the outfall becomes restricted due to the flood levels in the receiving water.

The attenuation requirements have been designed to accommodate the 100 year storm event plus climate change (+ 30%). To prevent flooding of the proposed properties if the design event is exceeded the surface flows generated will be managed.

The design of the site layout provides an opportunity to manage this exceedance flow and ensure that indiscriminate flooding of property does not occur.

There will not be an extensive sewerage network on the proposed development site and therefore any potential exceedance flooding would be from the public sewers located within the vicinity of the site. An exceedance or blockage event of the sewers would not

⁷ CIRIA (2006) Designing for exceedance in urban drainage – good practice.



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Engineer: Keelan
Serjeant

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affect the proposed property because finished floor levels will be above surrounding ground levels, ensuring any exceedance flooding would not affect the building. Exceedance flows would be contained within the highways surrounding the buildings.

In particular the landscaped areas will include preferential flow paths that convey water away from buildings. Surface water runoff would be directed to the drainage system through drainage gullies located around the perimeter of the buildings and through contouring of the hardstanding areas.

Therefore, managing and mitigating the flood risk from surface water runoff to the proposed properties from surface water runoff generated by the site development and to offsite locations as well the risk from surface water runoff generated offsite.

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9. RISK MANAGEMENT

9.1. Introduction

The flood risk at this location is considered suitable for 'highly vulnerable' developments within TAN15. In this flood zone, developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area through the layout, form of the development and the use of flood mitigation measures including SUDS techniques.

The flooding sources have been mitigated on the site by using a number of techniques, and mitigation strategies to manage and reduce the overall flood risk at the site. This will ensure the development will be safe and there is:

- Minimal risk to life;
- Minimal disruption to people living and working in the area;
- Minimal potential damage to property;
- Minimal impact of the proposed development on flood risk generally; and
- Minimal disruption to natural heritage.

9.2. Minimum Floor Level

There is no minimum finished floor level proposed as a result of flooding. However, it is recommended that all buildings are located above the back of footway of the adjacent carriageway by 150mm to enable the full capacity of any secondary flood conveyance to be utilised.

9.3. Proposed Surface Water Management Strategy (SWMS)

The surface water runoff produced by the site during a rainfall event is restricted which reduces the peak discharge rate to manage and reduce the flood risk posed by the surface water runoff from the site (see Section 8.0).

9.4. Flood Resilience and Resistance

The development of the layout should always consider that the site is potentially at risk from an extreme event and as such the implementation of flood resilience and resistance methods should be assessed.

Relatively simple measures such as raising utility entry points, using first floor or ceiling down electrical circuits and sloping landscaping away from properties can be easily and economically incorporated into the development of the site.

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9.5. Designing for Local Drainage System Failure

The landscaped areas will include preferential flow paths that convey water away from buildings. Surface water runoff would be directed to the drainage system through drainage gullies located around the perimeter of the buildings and through contouring of the hardstanding areas.

There will not be an extensive sewerage network on the proposed development site and therefore any potential exceedance flooding would be from the public sewers located within the vicinity of the site. An exceedance or blockage event of the sewers would not affect the proposed property because finished floor levels will be above surrounding ground levels, ensuring any exceedance flooding would not affect the building. Exceedance flows would be contained within the highways surrounding the buildings.

9.6. Access and Egress

The site and surrounding area is located within Flood Zone 1 and Zone A therefore a permanently safe and dry access can be maintained.

9.7. Flooding Consequences

The mitigation measures detailed above show that the flood risk can be effectively managed and therefore the consequences of flooding are acceptable.

In conclusion, the flood risk to the site can be considered to be limited; the site is situated in Flood Zone 1, with a low annual probability of flooding and from all sources. The site is unlikely to flood except in very extreme conditions.

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10. SUMMARY AND CONCLUSIONS

10.1. Introduction

This report presents an FCA in accordance with TAN15 for the proposed development on Land off New Road, Rhosrobin, Wrexham and includes an assessment of the existing and proposed surface and foul water drainage of the site.

This FCA identifies and assesses the risks of all forms of flooding to and from the development and demonstrates how these flood risks will be managed so that the development remains safe throughout the lifetime, taking climate change into account.

10.2. Flood Risk

The site is not at risk of flooding from a major source (e.g. fluvial and/or tidal). A number of secondary flooding sources have been identified which may pose a low risk to the site. These are:

- Surface Water (pluvial) Flooding
- Sewer flooding

Provided the buildings are set above the back of the footway of the adjacent carriageway to enable the full capacity of any secondary flood conveyance to be utilised, the risk of flooding from flooding is considered low. The flooding sources will only inundate the site to a relatively low water depth and water velocity, will only last a short period of time, in very extreme cases and will not have an impact on the whole of the proposed development site.

The site has a 'low probability' of fluvial flooding as the site is located within Flood Zone 1 and Zone A with less than a 1 in 1000 annual probability of river flooding in any year (<0.1%).

The proposed development is classified as 'Highly Vulnerable', 'Highly Vulnerable' uses are appropriate within Flood Zone 1 and Zone A after the completion of a satisfactory FCA.

The flood risk at the site will be managed and mitigated by using a number of risk management techniques, and mitigation strategies to manage and reduce the overall flood risk at the site.

In conclusion, the flood risk to the site can be considered to be limited; the site is situated in Flood Zone 1 and Zone A, with a low annual probability of flooding and from all sources. The site is unlikely to flood except in very extreme conditions.

10.3. Justification Test

The Justification Test will not need to be undertaken as part of this planning application. The development proposals should therefore be considered by the LPA to satisfy the Justification Test as set out in TAN15.

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10.4. Foul Water Drainage Strategy

Development of the site will take place with separate systems for foul and surface water drainage. The separate system will extend to the public sewer.

Foul water will discharge to the Welsh Water/Dŵr Cymru public foul water public foul sewer located within the vicinity of the site, at a point adjacent the site.

Using the information on the depth and arrangement of the existing sewers it has been assumed that gravity drainage will be possible; however, it would be prudent to undertake further detailed surveys to verify the inverts, depth and arrangement of the existing public sewer.

10.5. Surface Water Management Strategy (SWMS)

The SWMS ensures that a sustainable drainage solution can be achieved which reduces the peak discharge rate to manage and reduce the flood risk posed by the surface water runoff from the site. It is understood that the surface water currently drains to the public combined sewers located within the vicinity of the site. Therefore, the surface water will continue to discharge to these combined sewers at a point adjacent the site.

At this stage it is anticipated that the attenuation storage will be located in: Soakaways, Filter Strips, Infiltration Trenches, Swales, Storage Tanks, Oversized Drainage Networks, Cellular Storage, Surface Storage and Permeable Paving. In order to limit the rate and volume of surface water runoff that is discharged, it will be necessary to include a flow control device. The surface water runoff from the site will be attenuated to the pre-development (greenfield) mean annual peak flow QBAR (rural) rate of 5.21l/s for all events up to and including the 1 in 100 year (+ 30%) rainfall event.

As a consequence of limiting the rate of discharge from the site to the pre-development runoff rate, at times of heavy rainfall the volume of water leaving the site will be significantly less than that draining from it. In order to prevent this water backing up in the system and causing flooding, 2615m³ of attenuation storage will be incorporated into the site layout.

As a consequence of limiting the rate of discharge from the site to the pre-development runoff rate, at times of heavy rainfall the volume of water leaving the site will be significantly less than that draining from it. In order to prevent this water backing up in the system and causing flooding, 70.80m³ of attenuation storage will be incorporated into the site layout.

The size of this attenuation storage has been calculated such that the proposed development has the capacity to accommodate the 100 year rainfall event including a 30% increase in rainfall intensity that is predicted to occur as a result of climate change.

The remainder of the site that is not formally drained, i.e. landscaped areas, will be permeable (grass). The majority of rainwater falling on these areas will soak into the ground. Surface water runoff would be directed to the drainage system through drainage gullies located around the perimeter of the buildings and through contouring of the hardstanding areas.

These methods will reduce peak flows, the volume of runoff, and slow down flows and will provide a suitable SUDS solution for this site. These preliminary considerations are based on the outline development scheme provided and hence the design purposes.

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The adoption of a surface water management strategy for the site represents an enhancement from the current conditions as the current surface water runoff from the site is uncontrolled, untreated, unmanaged and unmitigated.

Where SUDS are to be used it must be established that these options are feasible, can be adopted and properly maintained and would not lead to any other environmental problems with a maintenance schedule or the lifetime of the facility and these issues should be considered at the detailed design stage.

At this stage of the planning process it is proposed that a planning condition can be adopted to cover the detailed design of the surface water runoff from the site. It is proposed that the detailed drainage design of the final scheme would be secured by a planning condition attached to any planning permission granted and agreed with the Environment Agency, Welsh Water/Dŵr Cymru and the LPA prior to works commencing.

In adopting these principles it has been demonstrated that a scheme can be developed that does not increase the risk of flooding to adjacent properties and development further downstream.

10.6. Risk Management

The flooding sources will be managed on the site by using a number of mitigation strategies to manage and reduce the overall flood risk at the site and will ensure the development will be safe. Measures used:

Minimum Floor Level - There is no minimum finished floor level proposed as a result of fluvial flooding; however, it is recommended that all properties are located above the back of the footway of the adjacent carriageway by 150mm to enable the full capacity of any secondary flood conveyance to be utilised.

Surface Water Management Strategy - The SWMS ensures that a sustainable drainage solution can be achieved which reduces the peak discharge rate to the pre-development runoff rate to manage and reduce the flood risk posed by the surface water runoff from the site.

Flood Resilience and Resistance - The development of the layout should always consider that the site is potentially at risk from an extreme event and as such the implementation of flood resilience and resistance methods should be assessed.

Designing for Local Drainage System Failure - The landscaped areas will include preferential flow paths that convey water away from buildings. Surface water runoff would be directed to the drainage system through drainage gullies located around the perimeter of the buildings and through contouring of the hardstanding areas.

An exceedance or blockage event of the sewers would not affect the proposed property because finished floor levels will be above surrounding ground levels, ensuring any exceedance flooding would not affect the building. Exceedance flows would be contained within the highways surrounding the buildings.

Access and Egress - The site and surrounding area is located within Flood Zone 1 and Zone A therefore a permanently safe and dry access can be maintained.

**A FLOOD CONSEQUENCE
ASSESSMENT FOR RHOSROBIN,
WREXHAM**

Date: 30/09/2014

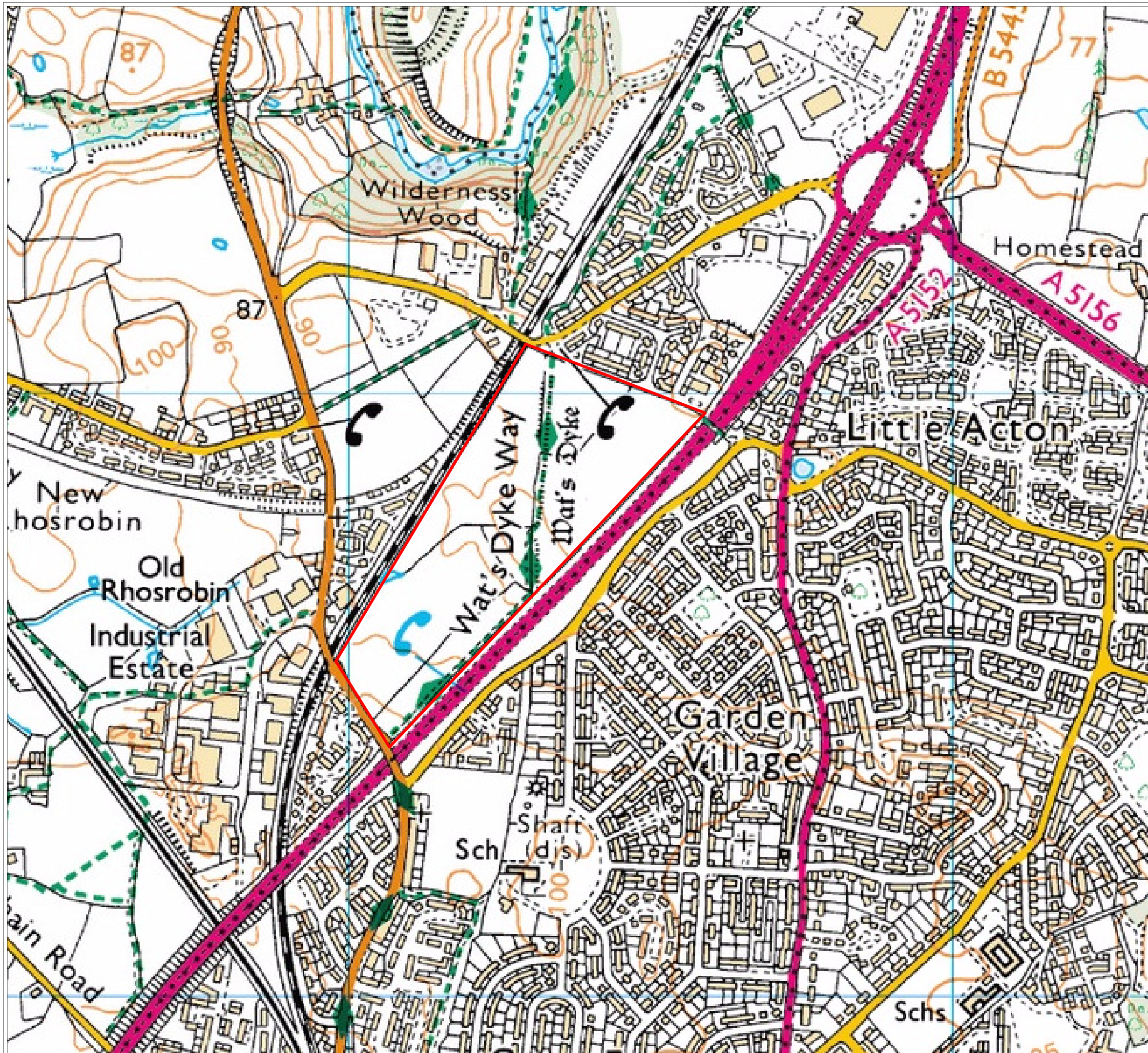
10.7. Conclusion

Table 10.1 summarises the probability and consequence of flooding for the site with and without mitigation measures. This FCA demonstrates that the site can be operated with minimal risk from flooding and will not increase flood risk elsewhere. The site should not therefore be precluded on the grounds of flood risk.

Table 10.1 - Probability and Consequences of all Sources of Flooding

Sources of Flooding	Potential Source	Probability	Consequence & Impact Without Mitigation	Consequence & Impact With Mitigation
Fluvial Flooding	No	Not Significant	Negligible	Negligible
Tidal Flooding	No	Not Significant	Negligible	Negligible
Groundwater Flooding	No	Not Significant	Negligible	Negligible
Surface Water Flooding	Poor Permeability/Low Spots	Low	Low	Negligible
Sewer Flooding	Local Sewers	Low	Low	Negligible
Flooding from Artificial Drainage Systems/Infrastructure Failure	No	Not Significant	Negligible	Negligible

APPENDIX A - FIGURES AND DRAWINGS



KEY

 Site Boundary



PROJECT

Land off New Road, Rhosrobin, Wrexham

CLIENT

Liberty Properties

TITLE

Site Location

PROJECT REF

T/14/1400

DRAWING NO

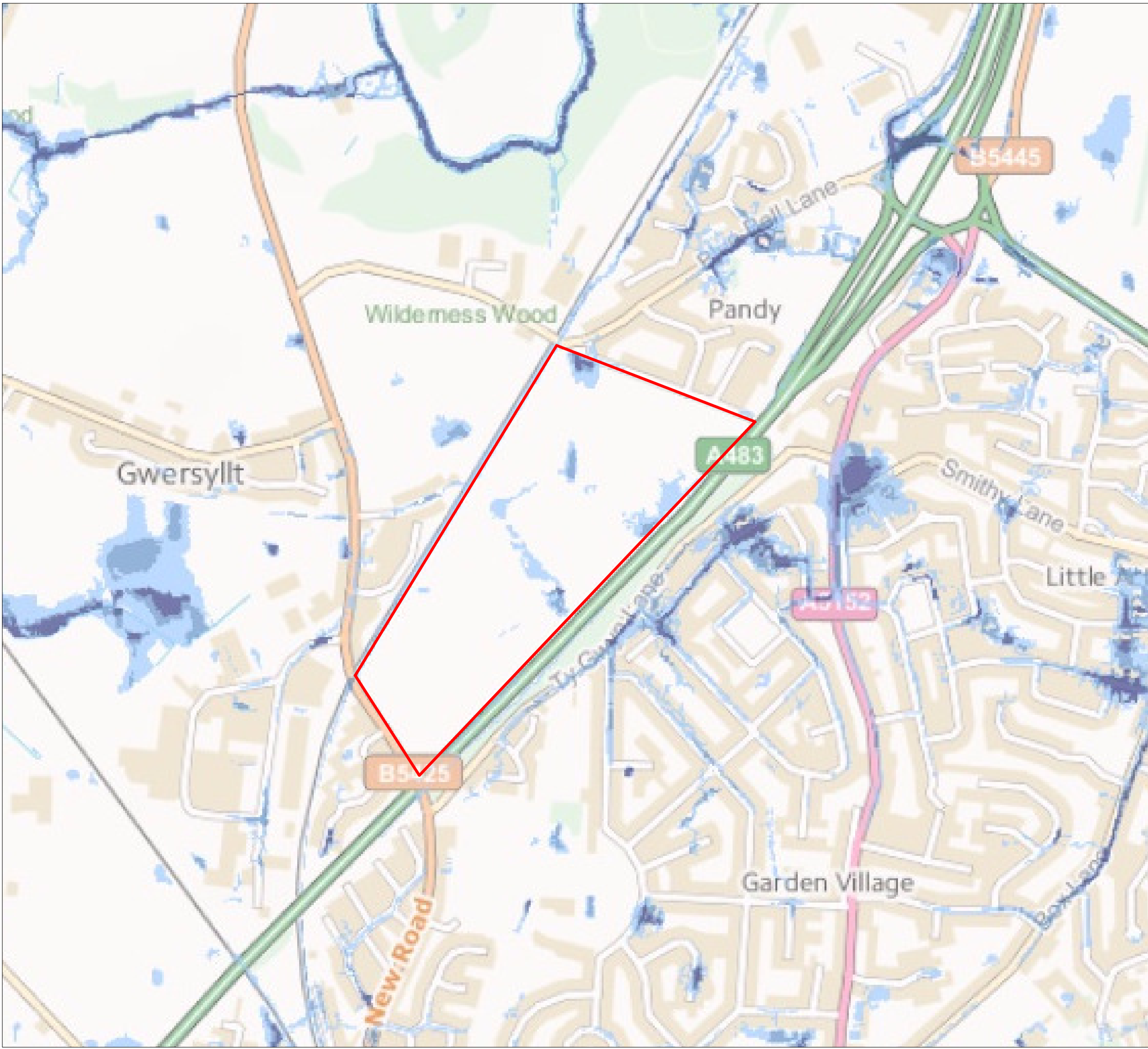
T/14/1400/FRA/1

SCALE

NTS@A3

DATE

September 2014

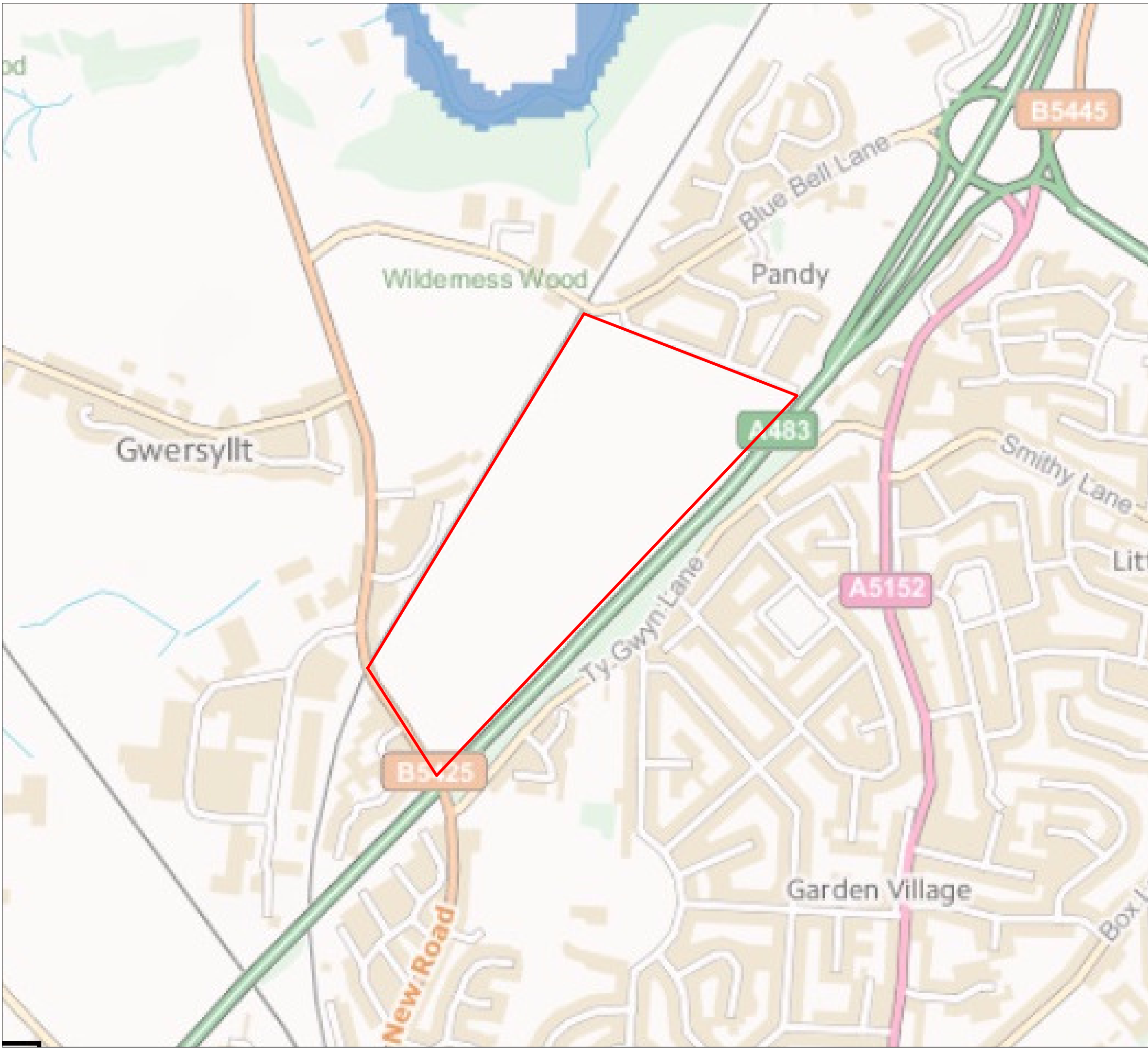


KEY

- Site Boundary
- Very Low
- Low
- Medium
- High



PROJECT	
Land off New Road, Rhosrobin, Wrexham	
CLIENT	
Liberty Properties	
TITLE	
Environment Agency Surface Water Flood Map	
PROJECT REF	
T/14/1400	
DRAWING NO	
T/14/1400/FRA/2	
SCALE	
NTS@A3	
DATE	
September 2014	

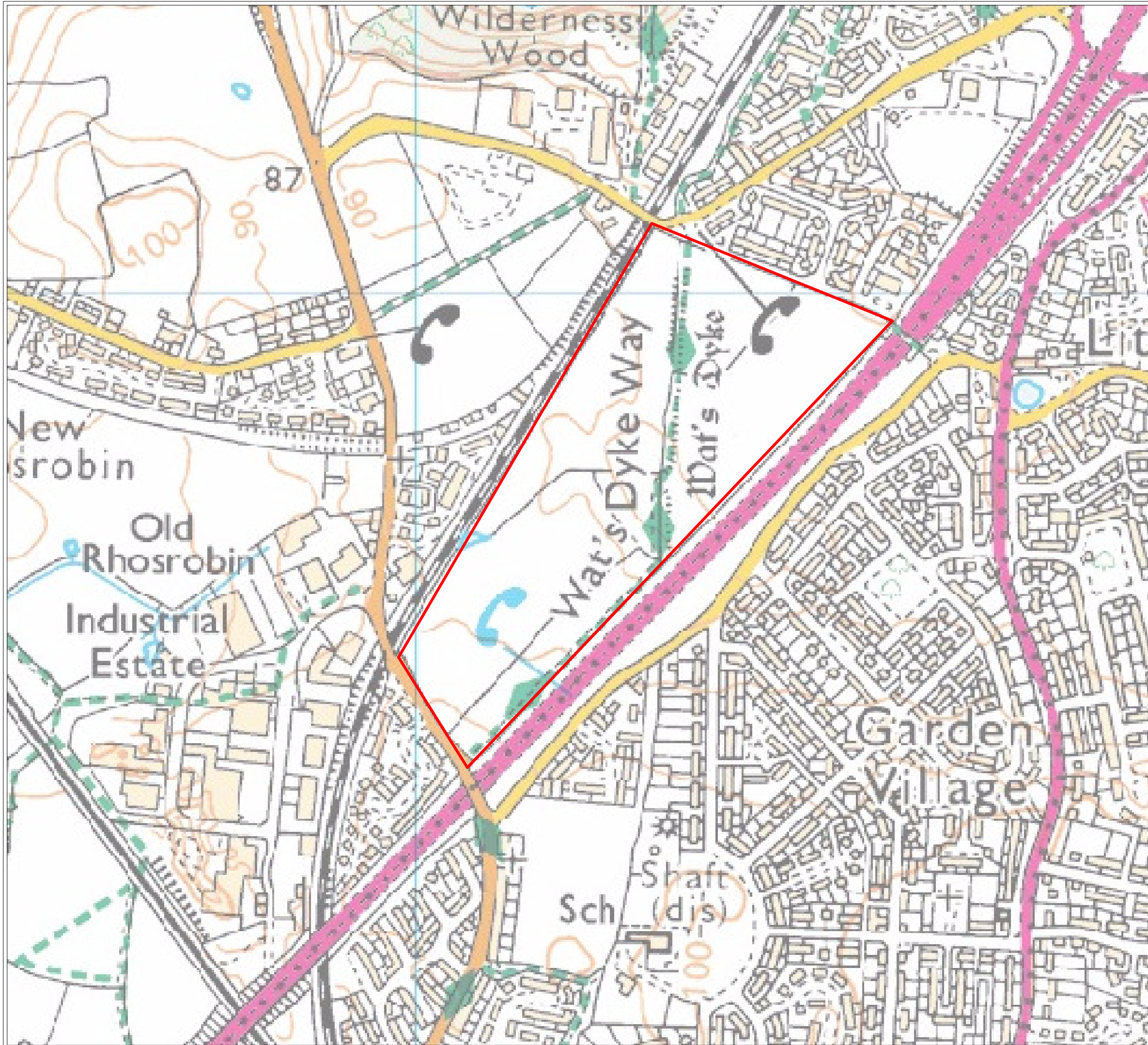


KEY

-  Site Boundary
-  Reservoir Flood Outline



PROJECT	
Land off New Road, Rhosrobin, Wrexham	
CLIENT	
Liberty Properties	
TITLE	
Environment Agency Reservoir Flood Map	
PROJECT REF	
T/14/1400	
DRAWING NO	
T/14/1400/FRA/3	
SCALE	
NTS@A3	
DATE	
September 2014	

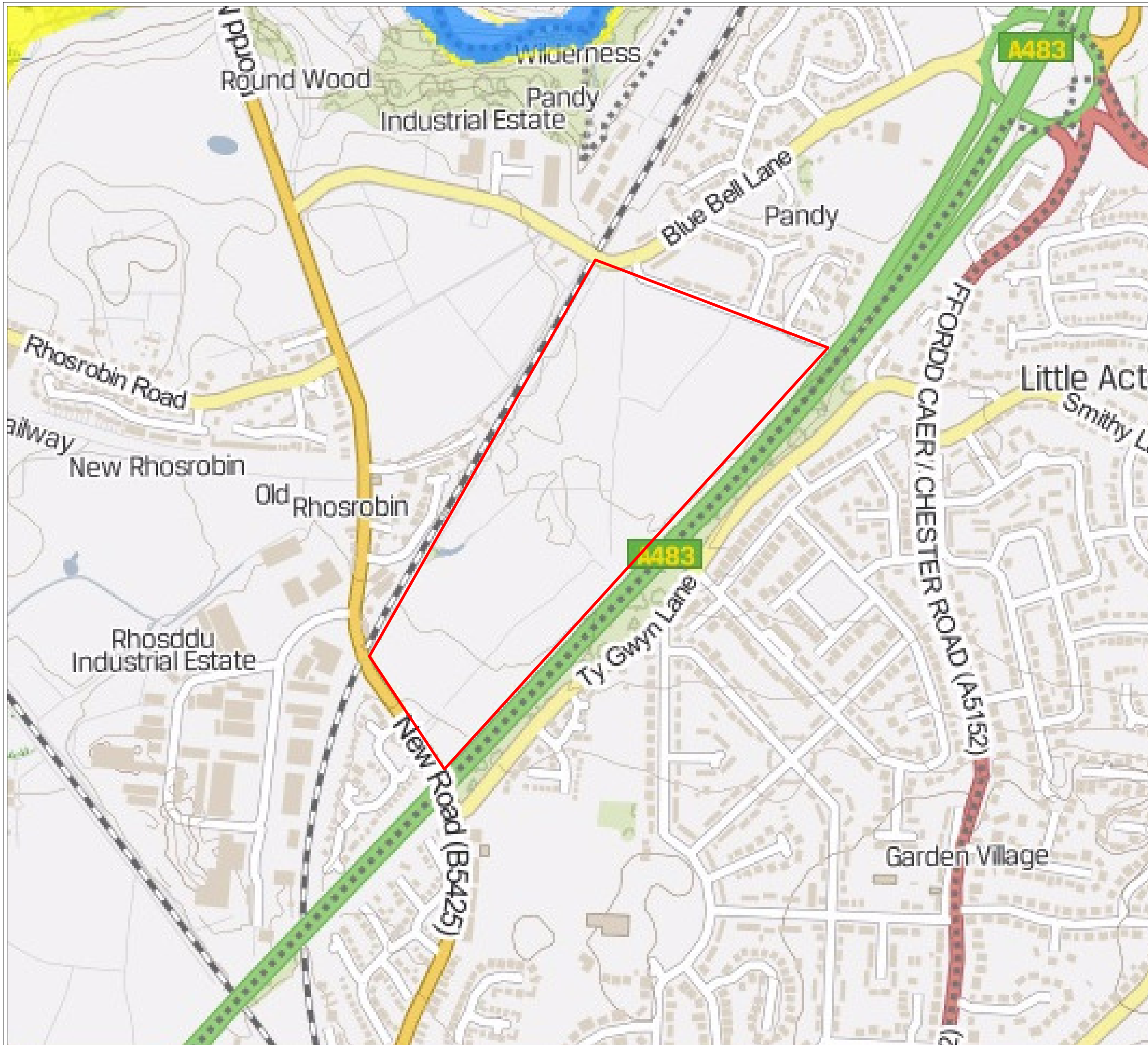


KEY

-  Site Boundary
-  Flood Zone 3
-  Flood Zone 2
-  Flood Zone 1



PROJECT	Land off New Road, Rhosrobin, Wrexham
CLIENT	Liberty Properties
TITLE	Environment Agency Flood Zones
PROJECT REF	T/14/1400
DRAWING NO	T/14/1400/FRA/4
SCALE	NTS@A3
DATE	September 2014



KEY

-  Site Boundary
-  Zone C1: Served by significant infrastructure, including flood defences.
-  Zone C2: Without significant flood defence infrastructure.
-  Zone B: Areas known to have been flooded in the past.
-  Zone A: Considered to be at little or no risk of fluvial or tidal/coastal flooding.



PROJECT	
Land off New Road, Rhosrobin, Wrexham	
CLIENT	
Liberty Properties	
TITLE	
Development Advice Map	
PROJECT REF	T/14/1400
DRAWING NO	T/14/1400/FRA/5
SCALE	NTS@A3
DATE	September 2014

APPENDIX B - WELSH WATER/DŴR CYMRU SEWER PLAN

12 September 2012

Jordans (Account)
21 St Thomas Street
Bristol
BS1 6SS

Drainage and Water Enquiry

Responses as required by the Home Information Pack Regulations

The information contained within this report refers to the existing property at:	LAND TO THE EAST OF NEW RO RHOSROBIN WREXHAM
Search report produced by:	Dŵr Cymru Welsh Water Pentwyn Road Nelson Treharris Mid Glamorgan CF46 6LY Tel 01443 331155 www.dwrcymru.com www.dwrcymrusearches.com enquiries@dwrcymru.com Water supply - Call 0800 052 0130 Sewerage services - Call 0800 085 3968
Our reference:	387743
Your reference:	M30796 SG

The following records were referenced in compiling this search report

Customer Account System
Asset Information System
Water Quality Database

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

Q	1	Interpretation of Drainage and Water Enquiry
Response		<i>Appendix 1 contains definitions of terms and expressions identified within this report.</i>
Informative		Not Applicable.
Q	2	Enquiries and Responses
Response		<i>1. The records were searched by Jonathan Evans who has no nor not likely to have, any personal or business relationship with any person involved in the sale of the property. 2. This search report was prepared by Jonathan Evans who have no nor not likely to have any personal or business relationship with any person involved in the sale of the property.</i>
Informative		For the Residential Drainage & Water Search Complaint Procedure please see Appendix 6.
Q	3	Where relevant, please include a copy of an extract from the public sewer map.
Response		<i>A copy of an extract from the public sewer map is included in which the location of the property is identified.</i>
Informative		Public Sewers are defined as those for which the Company holds statutory responsibility under the Water Industry Act 1991. The company is not responsible for rivers, watercourses, ponds, culverts or highway drains. If any of these are shown on the copy extract they are shown for information only. Sewers indicated on the extract of the public sewer map as being subject to an agreement under section 104 of the Water Industry Act 1991 are not an 'as constructed' record. It is recommended that these details are checked with the developer, if any. Assets other than public sewers may be shown on the copy extract, for information only. The presence of a public sewer located within the boundary of the property may restrict further development within it. The sewerage undertaker has a statutory right of access to carry out work on its assets, subject to notice. This may result in employees of the sewerage undertaker or its contractors needing to enter the property to carry out works.
Q	4	Does foul water from the property drain to a public sewer?
Response		<i>This enquiry appears to relate to a plot of land or a recently built property. It is recommended that drainage proposals are checked with the developer.</i>
Informative		Water companies are not responsible for any private drains and sewers that connect the property to the public sewerage system, and do not hold details of these. The property owner will normally have sole responsibility for private drains serving the property and may have shared responsibility, with other users, if the property is served by a private sewer which also serves other properties. These may pass through land outside of the control of the seller and the buyer may wish to investigate whether separate rights or easements are needed for their inspection, repair or renewal. If foul water does not drain to the public sewerage system the property may have private facilities in the form of a cesspit, septic tank or other type of treatment plant.

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

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

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

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

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

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

Informative

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

Q 22

Is the property at risk of receiving low water pressure or flow?

Response

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

Informative

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

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

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

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

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

Allowable exclusions:

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

Abnormal demand:

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

Planned maintenance:

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

One-off incidents:

This exclusion covers a number of causes of low pressure; mains bursts; failures of company equipment (such as PRVs or booster pumps); firefighting; and action by a third party. However, if problems of this type affect a property frequently, they cannot be classed as one-off events and further investigation will be required before they can be excluded.

Low pressure incidents of short duration:

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

The buyer should also make enquiries with the seller.

Q	23	Please include details of a water quality analysis made by the water undertaker for the water supply zone in respect of the most recent calendar year.
Response		<i>The analysis records confirmed that tests failed to meet the standards of the 2000 Regulations or the 2001 Regulations in relation to another substance or substances, and these details are included in the attached report.</i>
Informative		Drinking water quality in England and Wales is regulated by the Government through the Drinking Water Inspectorate (DWI). Drinking Water Supplies are of a very high standard and the legal requirements are set out in the Water Supply (Water Quality) Regulations 2001 (Wales). Last year Dwr Cymru Welsh Water carried out over 100,000 water quality tests of which 99.9% showed that the drinking water produced by Welsh Water met the required standards. Each Water Quality Zone covers a population of up to 100,000, sampling address are generated on a random basis. Distribution sampling is conducted to assess the quality of drinking water throughout Dwr Cymru Welsh Water's distribution network and not as an indicator of the condition of an individual property. Therefore Dwr Cymru Welsh Water will not disclose the sampled address. If you have specific concerns regarding an individual property relating to water quality (e.g. Lead) then we would suggest you instruct your surveyor accordingly. Some standards relate to the appearance of the water rather than to health. Where a standard has been set for health reasons, this is normally based on a lifetime exposure and there is a wide margin of safety. It should also be noted that most failures are of short duration and are satisfactory on resample. All exceedences of the regulatory standard are reported to the Drinking Water Inspectorate along with details of any remedial work undertaken.
Q	24	Please include details of any departures authorised by the Secretary of State under Part 6 of the 2000 Regulations from the provisions of Part 3 of those Regulations; or authorised by the National Assembly for Wales under Part 6 of the 2001 Regulations from the provisions of Part 3 of those Regulations.
Response		<i>There are no such authorised departures for the water supply zone</i>
Informative		Authorised departures are not permitted if the extent of the departure from the standard is likely to constitute a potential danger to human health. Please contact your water undertaker if you require further information.
Q	25	Please state the distance from the property to the nearest boundary of the nearest sewage treatment works
Response		<i>The nearest sewage treatment works is 3.4km to the NNE of the property. The name of the nearest sewage treatment works is Gresford.</i>
Informative		The nearest sewage treatment works will not always be the sewage treatment works serving the catchment within which the property is situated. The Sewerage undertaker's records were inspected to determine the nearest sewage treatment works. It should be noted therefore that there may be a private sewage treatment works closer than the one detailed above that have not been identified.



Title: 387743

Date: 11/09/2012

Scale: 1:2500

Dee Valley Water plc
Packsaddle
Wrexham Road
Rhosyllten
Wrexham LL14 4EH
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Based upon the Ordnance Survey map by Dee Valley Water plc by permission of Ordnance Survey and on behalf of the Controller of Her Majesty's Stationery Office

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

DO NOT SCALE FROM THIS PRINT



LEGEND/Representative of most common features)

- [illegible]

Abstract:

The Census Bureau provides the information in its public data, although such information is available only on a quarterly basis. It is important that I discuss the data and information available to me, so you can see how the information is collected and the extent of any limitations in the data. The Census Bureau's data are the result of a complex process of gathering data from the various sources of information, and the data are subject to a number of limitations. The data are subject to a number of limitations, and the data are subject to a number of limitations. The data are subject to a number of limitations, and the data are subject to a number of limitations.

EXACT LOCATIONS OF ALL APPARATUS
TO BE DETERMINED ON SITE

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Map Ref:	333141,352638
Map scale:	1:2,500
Printed by:	JG
Printed on:	11/9/12



Name of Water Supply Zone - Legacy zone
Schedule 1 Parameters

Parameter	Units	PCV	Number of Samples	Number of Samples > PCV	% > PCV	Number of Samples above Auth top	% > Auth	Min	Mean	Max
COLOUR	mg/l Pt/Co	20	36	0	0	-	-	0.4	1.2	3.9
TURBIDITY	N.T.U.	4	36	0	0	-	-	<0.09	0.14	0.68
ODOUR (QUANTITATIVE)	DIL NO.	0	37	0	0	-	-	0	0	0
TASTE (QUANTITATIVE)	DIL NO.	0	37	0	0	-	-	0	0	0
SODIUM	mg Na/l	200	8	0	0	-	-	8.3	10.61	16.6
NITRATE	mg NO3/l	50	8	0	0	-	-	1.33	2.82	4.43
NITRITE IN ZONES	mg NO2/l	0.5	8	0	0	-	-	<0.006	<0.008	<0.010
NO3 NO2 CALCULATION	1	1	8	0	0	-	-	0.03	0.06	0.09
ALUMINIUM	ug Al/l	200	36	0	0	-	-	<3.4	39.7	42.9
IRON	ug Fe/l	200	36	1	2.78	-	-	4	26	257
MANGANESE	ug Mn/l	50	36	0	0	-	-	1	7	22
COPPER	ug Cu/l	2	8	0	0	-	-	<0.002	0.011	0.033
ARSENIC	ug As/l	10	8	0	0	-	-	0.2	0.2	0.4
CADMIUM	ug Cd/l	5	8	0	0	-	-	<0.04	0.04	0.08
CHROMIUM	ug Cr/l	50	8	0	0	-	-	<0.2	0.3	0.3
NICKEL	ug Ni/l	20	8	0	0	-	-	<0.2	0.7	3.4
LEAD	ug Pb/l	25	8	0	0	-	-	<0.3	2.5	33
ANTIMONY	ug Sb/l	5	8	0	0	-	-	0	0.1	0.1
SELENIUM	ug Se/l	10	8	0	0	-	-	<0.3	0.4	0.6
P.A.H(TOTAL)	ug/l	0.1	8	0	0	-	-	0	0	0
E.COU	CFU/100ml	0	85	0	0	-	-	N/A	N/A	N/A
ENTEROCOCCI	CFU/200ml	0	8	0	0	-	-	N/A	N/A	N/A
BENZO [a] PYRENE	ug/l	0.01	8	0	0	-	-	<0.0020	<0.0020	<0.0020
TOTAL TRIHALOMETHANES	ug/l	100	9	0	0	-	-	8.72	25.32	42.2
BROMATE	ug BrO3/l	10	8	0	0	-	-	<0.5	<0.5	<0.5

Indicator Parameters

Parameter	Units	Specification	Number of samples	Number of samples > specification	% > specification	Min	Mean	Max
HYDROGEN ION	pH value	9.5	36	1	2.78	6.42	7.26	7.86
AMMONIUM	mg NH4/l	0.5	36	0	0	<0.000	0.005	0.01
TOTAL COLIFORMS	CFU/100ml	0	85	0	0	N/A	N/A	N/A
COLONY COUNTS(22C)	CFU/1ml	50	36	0	0	0	9	178
FREE CHLORINE	mg/l	10	85	0	0	0.02	0.15	0.4
TOTAL CHLORINE	mg/l	10	85	0	0	0.02	0.22	0.45
COLONY COUNTS(37C)	CFU/1ml	10	36	0	0	0	0	3

Explanation of Exceedences in Legacy Zone

An Iron regulatory sample taken from a customer's property demonstrated a level above PCV. An investigation was undertaken and all resamples were satisfactory. The regulatory limit is based on aesthetic quality and is specific to the property no discoloured contacts were received from the area during the time of the failure.

One Hydrogen Ion (pH) failure occurred this has no impact on water quality.

Legacy Zone

Number of sample: 72

Number of sample failures: 2

- An Iron regulatory sample taken from a customer's property demonstrated a level above Prescribed Concentration Value. An investigation was undertaken and all resamples were satisfactory. The regulatory limit is based on aesthetic quality and is specific to the property no discoloured contacts were received from the area during the time of the failure.
- One Hydrogen Ion (pH) failure occurred; this has no impact on water quality.

For further information relating the Water Quality failure identified within the CON29DW report please contact:

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

Telephone: Wrexham (01978) 846946

Email: contact@deevalleygroup.com

Appendix 1 - General Interpretation

1. In this Schedule-

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

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

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

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

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

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

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

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

"disposal main" means (subject to section 219(2) of the 1991 Act) any outfall pipe or other pipe which—

(a) is a pipe for the conveyance of effluent to or from any sewage disposal works, whether of a sewerage undertaker or of any other person; and

(b) is not a public sewer;

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

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

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

"lateral drain" means—

(a) that part of a drain which runs from the curtilage of a building (or buildings or yards within the same curtilage) to the sewer with which the drain communicates or is to communicate; or

(b) (if different and the context so requires) the part of a drain identified in a declaration of vesting made under section 102 of the 1991 Act or in an agreement made under section 104 of that Act(e);

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

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

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

(b) until the date that private sewer or lateral drain is vested in the sewerage undertaker;

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

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

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

(a) by virtue of a scheme under Schedule 2 to the Water Act 1989(i);

(b) by virtue of a scheme under Schedule 2 to the 1991 Act(j);

(c) under section 179 of the 1991 Act(k); or

(d) otherwise;

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

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

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

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

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

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

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

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

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

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

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

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

Note:

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

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

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

Definitions

'Company' means Dwr Cymru Cyf who produces the Report.
'Order' means any request completed by the Customer requesting the Report.
'Report' means the drainage and/or water report prepared by The Company in respect of the Property.
'Property' means the address or location supplied by the Customer in the Order.
'Customer' means the person, company, firm or other legal body placing the Order, either on their own behalf as Client, or, as an agent for a Client.
'Client' means the person, company or body who is the intended recipient of the Report with an actual or potential interest in the Property.
'Purchaser' means the actual or potential purchaser of an interest in the Property including the mortgage lender.

Agreement

1. The Company agrees to supply the Report to the Customer and to allow it to be provided to the Client and the Purchaser subject, in each case, to these terms. The scope and limitations of the Report are described in paragraph 2 of these terms. Where the Customer is acting as an agent for the Client then the Customer shall be responsible for bringing these terms to the attention of the Client.
- 1.1 The Customer, the Client and Purchaser agree that the placing of an Order for a Report and the subsequent provision of a copy of the Report to the Purchaser indicates their acceptance of these terms.

The Report

2. Whilst The Company will use reasonable care and skill in producing the Report, it is provided to the Customer, the Client and Purchaser on the basis that they acknowledge and agree to the following:-
 - 2.1 The information contained in the Report can change on a regular basis so The Company cannot be responsible to the Customer, the Client and Purchaser for any change in the information contained in the Report after the date on which the Report was first produced and sent to the Customer.
 - 2.2 The Report does not give details about the actual state or condition of the Property nor should it be used or taken to indicate or exclude actual suitability or unsuitability of the Property for any particular purpose, or relied upon for determining suitability or value, or used as a substitute for any physical investigation or inspection. Further advice and information from appropriate experts and professionals should always be obtained.
 - 2.3 The information contained in the Report is based upon the accuracy of the address and plan supplied to the Company.
 - 2.4 The Report provides information as to the location & connection of existing services and other information in relation to drainage and water enquiries and should not be relied on for any other purpose. The Report may contain opinions or general advice to the Customer, the Client and Purchaser which The Company cannot ensure that any such opinion or general advice is accurate, complete or valid and accepts no liability therefore.
 - 2.5 The position and depth of apparatus shown on any maps attached to the Report are approximate, and are furnished as a general guide only, and no warranty as to its correctness is given or implied. The exact positions and depths should be obtained by excavation trial holes and the maps must not be relied on in the event of excavation or other works made in the vicinity of The Company's apparatus.

Liability

3. The Company shall not be liable to the Customer, the Client and Purchaser for any failure defect or non-performance of its obligations arising from any failure of or defect in any machine, processing system or transmission link or anything beyond The Company's reasonable control or the acts or omissions of any party for whom The Company are not responsible.
- 3.1 Where a report is requested for an address falling within a geographical area where two different Companies separately provide Water and Sewerage Services, then it shall be deemed that liability for the information given by either Company will remain with that Company in respect of the accuracy of the information supplied. A Company supplying information which has been provided to it by another Company for the purposes outlined in this agreement will therefore not be liable in any way for the accuracy of that information and will supply that information as agent for the Company from which the information was obtained.
- 3.2 The Report is produced for use in relation to individual domestic property transactions and cannot be used for commercial developments of domestic properties or commercial properties for intended occupation by third parties.
- 3.3 The Company shall accept liability for death or personal injury arising from its negligence but in any other case, the Company's liability for negligence shall be limited to £5000.000. Such liability will be met by the Company or its insurers and the Company has and will maintain an appropriate contract of insurance.

Copyright and Confidentiality

4. The Customer, the Client and Purchaser acknowledge that the Report is confidential and is intended for the personal use of the Client and Purchaser. The copyright and any other intellectual property rights in the Report shall remain the property of The Company. No intellectual or other property rights are transferred or licensed to the Customer, the Client or the Purchaser except to the extent expressly provided.
 - 4.1 The Customer or Client is entitled to make copies of the Report but may only copy the Ordnance Survey mapping or data contained in the, or attached to the Report, if they have an appropriate licence from the originating source of that mapping or data.
 - 4.2 The Customer, the Client and Purchaser agree (in respect of both the original and any copies made) to respect and not to alter any trademark, copyright notice or other property marking which appears on the Report.
 - 4.3 The maps contained in the Report are protected by Crown Copyright and must not be used for any purpose outside the context of the Report.
 - 4.4 The Customer, the Client and Purchaser agree on a joint and several basis to indemnify The Company against any losses, costs, claims and damage suffered by The Company as a result of any breach by either of them of the terms of paragraphs 4.1 to 4.4 inclusive.

Payment

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

General

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

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

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

5 – Additional Information

Appendix 6 – Residential Drainage & Water Search Complaint Procedure

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

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

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

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

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

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

APPENDIX C - PROPOSED SITE LAYOUT



KEY:

-  Footpath
-  Linking Roundabout
-  Collector Road
-  Estate Roads
-  Internal Roads
-  Swale/Attenuation Pond
-  Green Corridor / Open Space
-  Development Area (11.21ha)
-  Site Boundary (15.79ha)
-  Existing / Proposed Trees



NEW ROAD - RHOSROBIN, WREXHAM
PRELIMINARY DEVELOPMENT FRAMEWORK

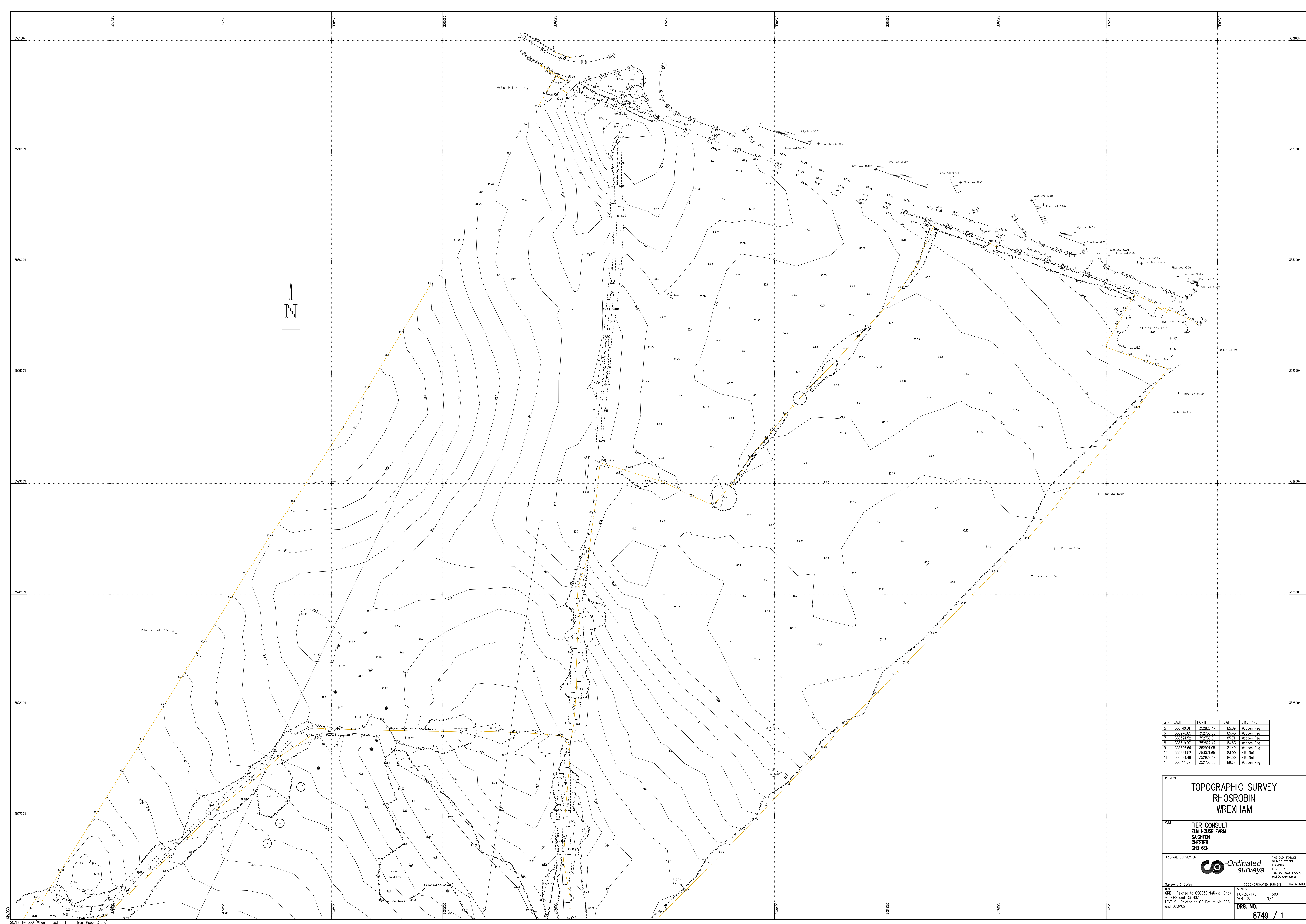
C3429 - P01 Rev C

Cassidy+Ashton

C+A

ARCHITECTURE	BUILDING SURVEYING	TOWN PLANNING
PLANNING OFFICE	1000 SOUTH STREET, WREXHAM, CH1 2JY	1000 SOUTH STREET, WREXHAM, CH1 2JY
TEL: 01928 555555	TEL: 01928 555555	TEL: 01928 555555
WWW.CASSIDYASHTON.CO.UK	WWW.CASSIDYASHTON.CO.UK	WWW.CASSIDYASHTON.CO.UK

APPENDIX D - TOPOGRAPHICAL SURVEY



STN	EAST	NORTH	HEIGHT	STN. TYPE
5	333140.01	352822.47	85.89	Wooden Peg
6	333278.85	352753.08	85.43	Wooden Peg
7	333324.52	352736.61	85.71	Wooden Peg
8	333319.87	352827.42	84.63	Wooden Peg
9	333338.88	352991.05	84.49	Wooden Peg
10	333334.52	353071.65	83.00	Hill Nail
11	333384.49	352978.47	84.50	Hill Nail
15	333114.62	352736.20	86.64	Wooden Peg

PROJECT

TOPOGRAPHIC SURVEY
RHOSROBIN
WREXHAM

CLIENT

TIER CONSULT
ELM HOUSE FARM
SAUGHTON
CHESTER
CH5 6EN

ORIGINAL SURVEY BY :

 **Ordinated surveys**

NOTES

GRID- Related to OSGB36(National Grid)
via GPS and OSN02
LEVELS- Related to OS Datum via GPS
and OSBM02

THE OLD STABLES
GARDEN STREET
LANCUDNO
LL20 1UH
TEL: 01483 870277
mailto:info@ordinatedsurveys.com

Surveyor : G. Davies

© CO-ORDINATED SURVEYS March 2014

SCALES

HORIZONTAL 1: 500
VERTICAL N/A

DRG. NO.

8749 / 1



STN	EAST	NORTH	HEIGHT	STN. TYPE
1	332865.45	352511.99	86.78	HIU Nail
2	333052.81	352449.86	99.24	Road Nail
3	333207.27	352581.61	88.91	Wooden Peg
4	333159.08	352700.25	86.68	Wooden Peg
6	333276.85	352753.08	85.43	Wooden Peg
7	333324.52	352736.61	85.71	Wooden Peg
15	333114.62	352756.20	86.64	Wooden Peg
22	333077.45	352409.79	100.63	HIU Nail

PROJECT

TOPOGRAPHIC SURVEY
RHOSROBIN
WREXHAM

CLIENT

TIER CONSULT
ELM HOUSE FARM
SAUGHTON
CHESTER
CH3 6EN

ORIGINAL SURVEY BY :

Ordinated surveys

THE OLD STABLES
GARAGE STREET
LANARCON
LL20 1UH
TEL: 01483 870277
mailto:info@ordinatedsurveys.com

NOTES

GRID- Related to OSGB36(National Grid)
via GPS and OSN02
LEVELS- Related to OS Datum via GPS
and OSM02

SCALES

HORIZONTAL 1: 500
VERTICAL N/A

DRG. NO.

8749 / 2

APPENDIX E - EXISTING GREENFIELD RUNOFF RATES



KRS Environmental Limited.

www.krsenvironmental.com

29a Green Abbey, Hade Edge
Holmfirth
Huddersfield HD9 2SH
Tel: 01484 684565 Mob: 07857 264 376
email: keelan@krsenvironmental.com

Job No.		
Sheet no. 1		
Date 29/09/14		
By	Checked	Reviewed

MasterDrain
HY 8.66

Project **Land off New Road, Rhosrobin, Wrexham**
Title **Existing Surface Water Runoff**

Hydrological Data:-

FSR Hydrology:-

Location =	Grid reference = SJ3449
M5-60 (mm) = 18	r = 0.32
Soil runoff = 0.15	SAAR (mm/yr) = 800
WRAP = 1	Area = England & Wales
Hydrological area = 9	Hydrological zone = 3

Soil classification for WRAP type 1

- i) Well drained permeable sandy or loam soils and shallower analogues over highly permeable limestone, chalk, sandstone or related drifts;
- ii) Earthy peat soils drained by dykes and pumps;
- iii) Less permeable loamy over clayey soils on plateaux adjacent to very permeable soils in valleys.

Design data:-

Area = 0.11 Km² - 11.0 Ha - 110000 m² % Urbanisation = 0.00%

Calculation method:-

Runoff is calculated from:-

$$Q_{BAR(urban)} = Q_{BAR(rural)} (1 + URBAN)^{2NC} [1 + URBAN \{ (21/CIND) - 0.3 \}]$$

where:-

NC varies with the value of SAAR:-

for 500 < SAAR < 1100 mm then NC = 0.92 - 0.00024 SAAR

for 1100 < SAAR < 3000 mm then NC = 0.74 - 0.000082 SAAR

CIND = 102.4 SOIL + 0.28 (CWI - 125) CWI = Catchment Wetness Index

CIND = 4.440 (see note below) CWI = 86.000 NC = 0.728

For areas less than 50Ha, a modified calculation which multiplies the 50Ha runoff value by the ratio of the site area to 50Ha is used

Reducing factor used for these calculations is 0.220

$$Q_{BAR(rural)} = 5.208 \text{ (1/s)}$$

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

Calculated data:-

Mean Annual Peak Flow $Q_{BAR(urban)} = 5.21 \text{ l/s}$

Values for $Q_{BAR(urban)}$

1 year	2 year	5 year	30 year	100 year	200 year	Units
0.004	0.005	0.006	0.009	0.011	0.013	cumecs
4.43	5.21	6.35	9.11	11.35	13.02	l/s
0.40	0.47	0.58	0.83	1.03	1.18	l/s/Ha
0.850	1.000	1.220	1.750	2.180	2.500	GC(T)

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

For WRAP type 1 soils, CIND can become negative for lower values of SAAR. In this case the CIND value is multiplied by -1 to return a positive value (CIND is very small at this point).

APPENDIX F - STORAGE VOLUMES



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KRS Environmental Limited.

www.krsenvironmental.com

29a Green Abbey, Hade Edge
Holmfirth
Huddersfield HD9 2SH
Tel:01484 684565 Mob: 07857 264 376
email: keelan@krsenvironmental.com

Job No.		
Sheet no. 1		
Date 29/09/14		
By	Checked	Reviewed

Project Land off New Road, Rhosrobin, Wrexham

Title 1 in 2 Year (+cc) Storage Volume

Data:-

Hydrology:-

Grid reference = SJ3449

M5-60 (mm) = 18

WRAP/Soil = 1 / 0.15

Return period = 2

Climate change factor = 30%

Pipeline storage = 0.0 m³

Offline storage = 0.0 m³

Location =

r = 0.32

SAAR (mm/yr) = 800

Mean intensity = 5.8mm/hr for a 6 hour storm

Available MH storage = 0.0 m³

Percentage runoff = 73.0% calculated from:-

Percentage runoff = (0.829*PIMP)+(25*SOIL)+(0.078*UCWI)-20.7

where

PIMP = ImpervArea*100/(ImpervArea+PervArea) = 100.0

UCWI = Calculated value for Wetness Index = 86.0

Imperv. area = 45000 m²

Total area = 45000 m²

Total runoff = 1143.5 m³

Storage (m³) = 1059.5 m³ (Sum of all balance quantities)

Total rainfall depth = 34.8 mm

Pervious area = 0 m²

Equiv area = 32850 m² (Tot. area x % runoff).

Discharge rate = 5.210 l/s

Calculations :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
0.060	20.0	1.2	2.287	1.125	1.162	1.162
0.120	20.0	1.2	2.287	1.125	1.162	2.323
0.180	21.0	1.2	2.401	1.125	1.276	3.599
0.240	21.0	1.2	2.401	1.125	1.276	4.875
0.300	22.0	1.3	2.516	1.125	1.390	6.266
0.360	23.0	1.3	2.630	1.125	1.505	7.770
0.420	24.0	1.4	2.744	1.125	1.619	9.389
0.480	26.0	1.5	2.973	1.125	1.848	11.237
0.540	27.0	1.6	3.087	1.125	1.962	13.199
0.600	29.0	1.7	3.316	1.125	2.191	15.390
0.660	31.0	1.8	3.545	1.125	2.419	17.809
0.720	32.0	1.9	3.659	1.125	2.534	20.343
0.780	33.0	1.9	3.774	1.125	2.648	22.991
0.840	34.0	2.0	3.888	1.125	2.763	25.754
0.900	36.0	2.1	4.117	1.125	2.991	28.745
0.960	38.0	2.2	4.345	1.125	3.220	31.965
1.020	39.0	2.3	4.460	1.125	3.334	35.299
1.080	40.0	2.3	4.574	1.125	3.449	38.748
1.140	42.0	2.4	4.803	1.125	3.677	42.425
1.200	45.0	2.6	5.146	1.125	4.020	46.445
1.260	49.0	2.8	5.603	1.125	4.478	50.923
1.320	53.0	3.1	6.061	1.125	4.935	55.858
1.380	57.0	3.3	6.518	1.125	5.393	61.251
1.440	62.0	3.6	7.090	1.125	5.964	67.215
1.500	66.0	3.8	7.547	1.125	6.422	73.637
1.560	71.0	4.1	8.119	1.125	6.993	80.630
1.620	77.0	4.5	8.805	1.125	7.680	88.310
1.680	84.0	4.9	9.605	1.125	8.480	96.790
1.740	91.0	5.3	10.406	1.125	9.280	106.070
1.800	98.0	5.7	11.206	1.125	10.081	116.151
1.860	105.0	6.1	12.007	1.125	10.881	127.032
1.920	114.0	6.6	13.036	1.125	11.910	138.943
1.980	125.0	7.3	14.294	1.125	13.168	152.111
2.040	135.0	7.8	15.437	1.125	14.312	166.423
2.100	143.0	8.3	16.352	1.125	15.227	181.649
2.160	154.0	8.9	17.610	1.125	16.484	198.134
2.220	164.0	9.5	18.753	1.125	17.628	215.762
2.280	173.0	10.0	19.782	1.125	18.657	234.419
2.340	183.0	10.6	20.926	1.125	19.801	254.219



KRS Environmental Limited.

www.krsenvironmental.com

29a Green Abbey, Hade Edge
Holmfirth
Huddersfield HD9 2SH
Tel:01484 684565 Mob: 07857 264 376
email: keelan@krsenvironmental.com

Job No.		
Sheet no. 2		
Date 29/09/14		
By	Checked	Reviewed

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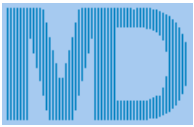
Project **Land off New Road, Rhosrobin, Wrexham**

Title **1 in 2 Year (+cc) Storage Volume**

Calculations (cont.) :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
2.460	204.0	11.8	23.327	1.125	22.202	297.479
2.520	212.0	12.3	24.242	1.125	23.117	320.596
2.580	219.0	12.7	25.042	1.125	23.917	344.513
2.640	226.0	13.1	25.843	1.125	24.718	369.231
2.700	233.0	13.5	26.643	1.125	25.518	394.749
2.760	239.0	13.9	27.329	1.125	26.204	420.953
2.820	244.0	14.2	27.901	1.125	26.776	447.729
2.880	248.0	14.4	28.359	1.125	27.233	474.962
2.940	249.0	14.4	28.473	1.125	27.348	502.309
3.000	250.0	14.5	28.587	1.125	27.462	529.771
3.060	250.0	14.5	28.587	1.125	27.462	557.233
3.120	249.0	14.4	28.473	1.125	27.348	584.581
3.180	248.0	14.4	28.359	1.125	27.233	611.814
3.240	244.0	14.2	27.901	1.125	26.776	638.590
3.300	239.0	13.9	27.329	1.125	26.204	664.794
3.360	233.0	13.5	26.643	1.125	25.518	690.312
3.420	226.0	13.1	25.843	1.125	24.718	715.030
3.480	219.0	12.7	25.042	1.125	23.917	738.947
3.540	212.0	12.3	24.242	1.125	23.117	762.063
3.600	204.0	11.8	23.327	1.125	22.202	784.265
3.660	194.0	11.3	22.184	1.125	21.058	805.323
3.720	183.0	10.6	20.926	1.125	19.801	825.124
3.780	173.0	10.0	19.782	1.125	18.657	843.781
3.840	164.0	9.5	18.753	1.125	17.628	861.409
3.900	154.0	8.9	17.610	1.125	16.484	877.893
3.960	143.0	8.3	16.352	1.125	15.227	893.120
4.020	135.0	7.8	15.437	1.125	14.312	907.432
4.080	125.0	7.3	14.294	1.125	13.168	920.600
4.140	114.0	6.6	13.036	1.125	11.910	932.510
4.200	105.0	6.1	12.007	1.125	10.881	943.392
4.260	98.0	5.7	11.206	1.125	10.081	953.473
4.320	91.0	5.3	10.406	1.125	9.280	962.753
4.380	84.0	4.9	9.605	1.125	8.480	971.233
4.440	77.0	4.5	8.805	1.125	7.680	978.912
4.500	71.0	4.1	8.119	1.125	6.993	985.906
4.560	66.0	3.8	7.547	1.125	6.422	992.328
4.620	62.0	3.6	7.090	1.125	5.964	998.292
4.680	57.0	3.3	6.518	1.125	5.393	1003.684
4.740	53.0	3.1	6.061	1.125	4.935	1008.620
4.800	49.0	2.8	5.603	1.125	4.478	1013.097
4.860	45.0	2.6	5.146	1.125	4.020	1017.118
4.920	42.0	2.4	4.803	1.125	3.677	1020.795
4.980	40.0	2.3	4.574	1.125	3.449	1024.243
5.040	39.0	2.3	4.460	1.125	3.334	1027.578
5.100	38.0	2.2	4.345	1.125	3.220	1030.797
5.160	36.0	2.1	4.117	1.125	2.991	1033.789
5.220	34.0	2.0	3.888	1.125	2.763	1036.551
5.280	33.0	1.9	3.774	1.125	2.648	1039.199
5.340	32.0	1.9	3.659	1.125	2.534	1041.733
5.400	31.0	1.8	3.545	1.125	2.419	1044.153
5.460	29.0	1.7	3.316	1.125	2.191	1046.343
5.520	27.0	1.6	3.087	1.125	1.962	1048.305
5.580	26.0	1.5	2.973	1.125	1.848	1050.153
5.640	24.0	1.4	2.744	1.125	1.619	1051.772
5.700	23.0	1.3	2.630	1.125	1.505	1053.277
5.760	22.0	1.3	2.516	1.125	1.390	1054.667
5.820	21.0	1.2	2.401	1.125	1.276	1055.943
5.880	21.0	1.2	2.401	1.125	1.276	1057.219
5.940	20.0	1.2	2.287	1.125	1.162	1058.381
6.000	20.0	1.2	2.287	1.125	1.162	1059.542

Storage volume (m³) = 1059.5 m³ (Sum of all balance quantities)



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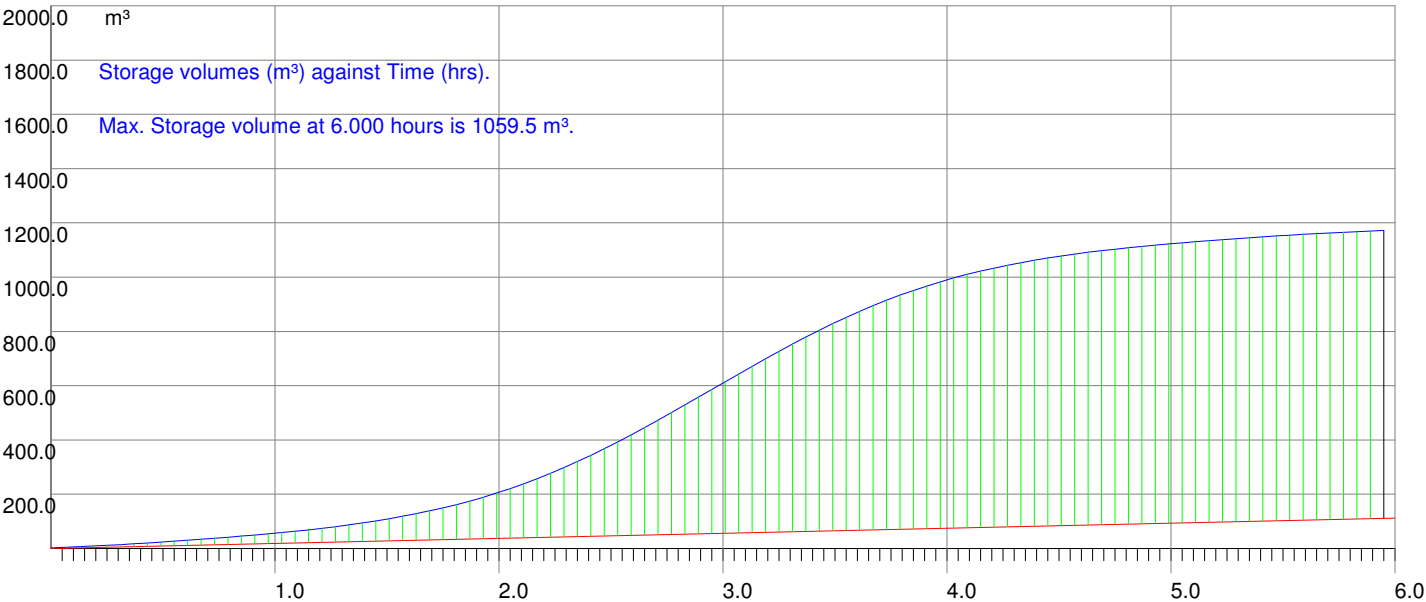
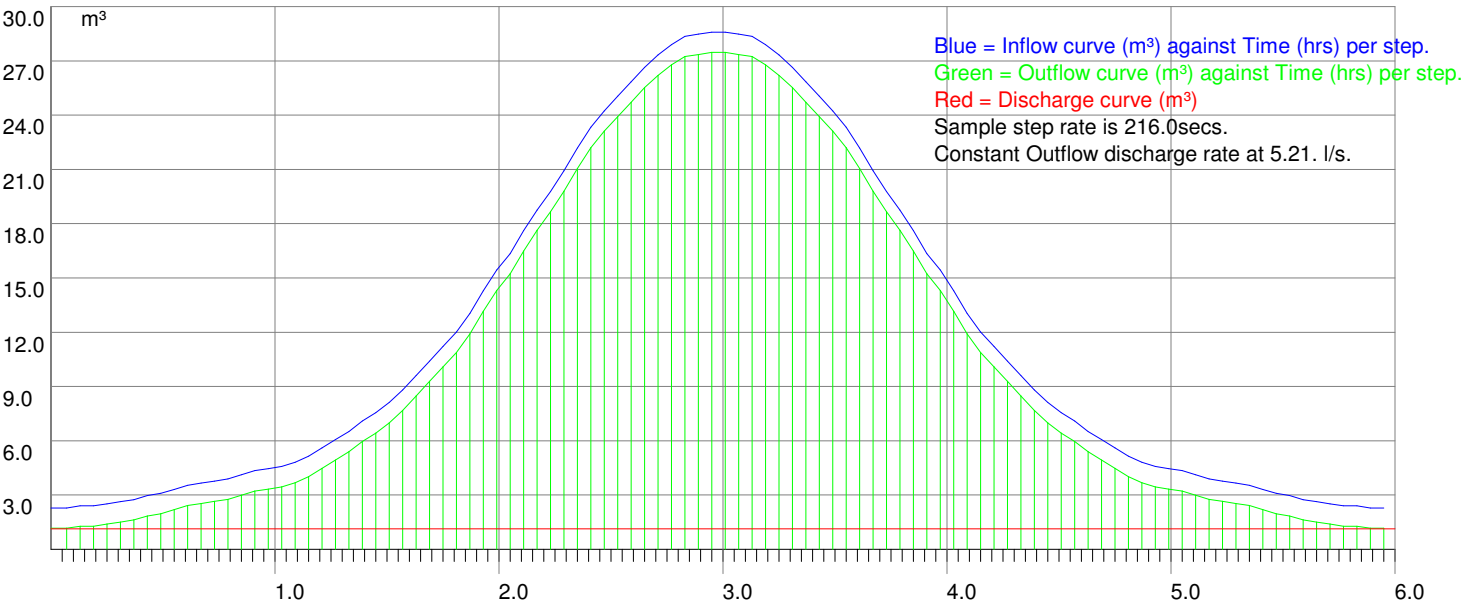
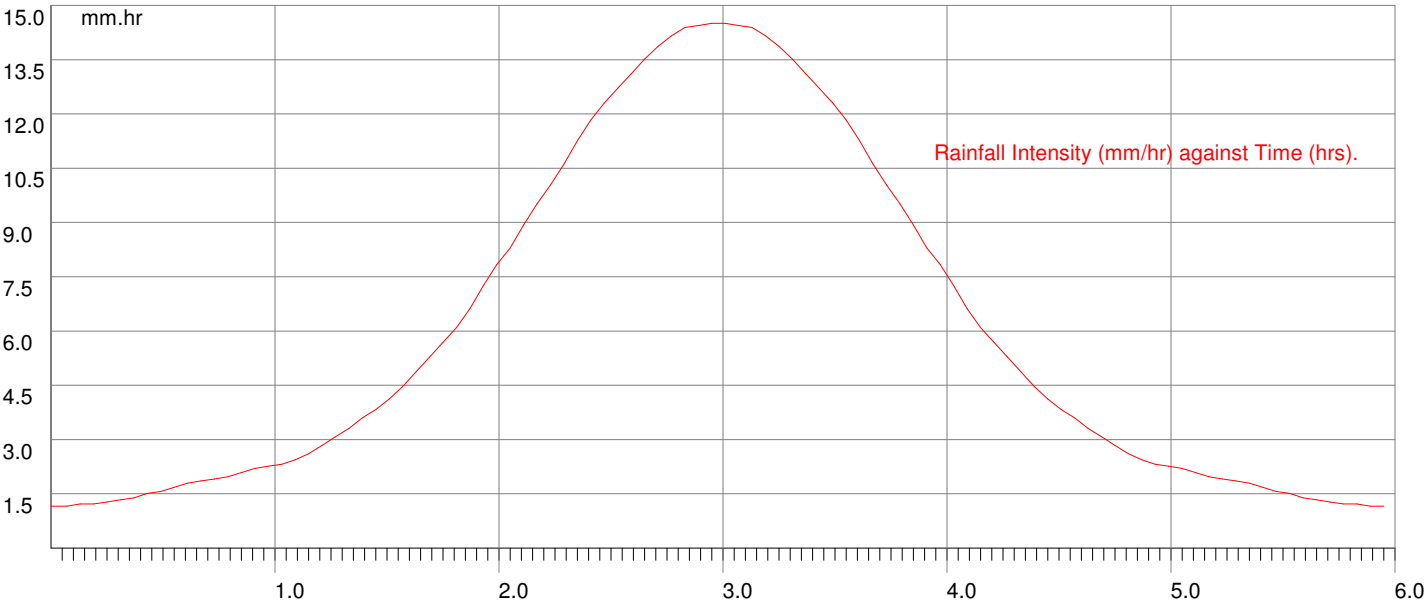
www.krsenvironmental.com

29a Green Abbey, Hade Edge
Holmfirth
Huddersfield HD9 2SH
Tel: 01484 684565 Mob: 07857 264 376
email: keelan@krsenvironmental.com

Job No.		
Sheet no. 3		
Date 29/09/14		
By	Checked	Reviewed

Project **Land off New Road, Rhosrobin, Wrexham**

Title **1 in 2 Year (+cc) Storage Volume**





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Holmfirth
Huddersfield HD9 2SH
Tel: 01484 684565 Mob: 07857 264 376
email: keelan@krsenvironmental.com

Job No.		
Sheet no. 4		
Date 29/09/14		
By	Checked	Reviewed

Project **Land off New Road, Rhosrobin, Wrexham**

Title **1 in 2 Year (+cc) Storage Volume**

Explanatory notes for Peak Flow Storage

- 1) This system uses the rainfall intensity/ duration curve calculated using either the Wallingford or FEH method as selected.
- 2) The balance is calculated from the inflow minus the outflow.
- 3) The storage volume is the maximum value of the balance curve.
- 4) This method was described by Davis (1963) - see Butler & Davies, 2nd edition, p294
- 5) References to 'storm duration' relate only to the hydrograph method (qv).
- 6) There are always 600 steps in the calculation process, thus a 'run' time of 10 hours will be sampled every minute,

Explanatory notes for Hydrograph Storage

- 1) The user has the choice of Summer or Winter curves
- 2) The mean intensity varies with the duration of the storm curve
- 3) There are always 120 steps in the calculation process, irrespective of storm duration.
- 4) The balance is calculated from the inflow minus the outflow.
- 5) The storage volume is the sum of the balance values for each step.
- 6) Varying durations should be tried to find the maximum storage value - this can be narrowed down very closely.

*Modelling using the flow characteristics of the restrictor is available using Vortex Control modelling function. Please be aware that this function needs the full design data file to function.

Why do the two methods give different results?

The rainfall characteristics for each method are very different.

The Peak flow (using the Intensity/Duration/Frequency curve) does not model the actual rainfall. This curve is joined points which represent the mean intensity of a storm at a given duration i.e. a value of 19.5 mm/hr for a 60 minute storm indicates that over the sixty minute period, the mean intensity was 19.5 mm/hr. The calculation method samples the IDF curve for a given location and frequency (Return Period) and calculates the storage for that rate and duration less the outflow volume. The maximum value is displayed as the 'worst case' storage.

The hydrograph method uses a standard curve for either Winter or Summer storms. Traditionally these are symmetrical about the central peak. UK rainfall does not fit into this convenient curve, so the calculations are dealing with a stylised set of data. The mean intensity for the storm is calculated from the IDF curve and applied to the curve data, calculating the storage for that step less the outflow volume. The final storage volume is the sum of the storage for all the steps.

It can be seen that these two methods are very different, and the user may have the choice of which result to use. This is not an exact science, though is often treated as such by those that do not understand the principles of the calculations.



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KRS Environmental Limited.

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29a Green Abbey, Hade Edge
Holmfirth
Huddersfield HD9 2SH
Tel: 01484 684565 Mob: 07857 264 376
email: keelan@krsenvironmental.com

Job No.		
Sheet no. 1		
Date 29/09/14		
By	Checked	Reviewed

Project **Land off New Road, Rhosrobin, Wrexham**

Title **1 in 30 Year (+cc) Storage Volume**

Data:-

Hydrology:-

Grid reference = SJ3449

M5-60 (mm) = 18

WRAP/Soil = 1 / 0.15

Return period = 30

Climate change factor = 30%

Pipeline storage = 0.0 m³

Offline storage = 0.0 m³

Location =

r = 0.32

SAAR (mm/yr) = 800

Mean intensity = 10.4mm/hr for a 6 hour storm

Available MH storage = 0.0 m³

Percentage runoff = 73.0% calculated from:-

Percentage runoff = (0.829*PIMP) + (25*SOIL) + (0.078*UCWI) - 20.7

where

PIMP = ImpervArea*100/(ImpervArea+PervArea) = 100.0

UCWI = Calculated value for Wetness Index = 86.0

Imperv. area = 45000 m²

Total area = 45000 m²

Total runoff = 2052.1 m³

Storage (m³) = 1990.8 m³ (Sum of all balance quantities)

Total rainfall depth = 62.5 mm

Pervious area = 0 m²

Equiv area = 32850 m² (Tot. area x % runoff).

Discharge rate = 5.210 l/s

Calculations :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
0.060	20.0	2.1	4.104	1.125	2.979	2.979
0.120	20.0	2.1	4.104	1.125	2.979	5.958
0.180	21.0	2.2	4.309	1.125	3.184	9.142
0.240	21.0	2.2	4.309	1.125	3.184	12.325
0.300	22.0	2.3	4.515	1.125	3.389	15.715
0.360	23.0	2.4	4.720	1.125	3.594	19.309
0.420	24.0	2.5	4.925	1.125	3.800	23.109
0.480	26.0	2.7	5.335	1.125	4.210	27.319
0.540	27.0	2.8	5.541	1.125	4.415	31.734
0.600	29.0	3.0	5.951	1.125	4.826	36.560
0.660	31.0	3.2	6.361	1.125	5.236	41.796
0.720	32.0	3.3	6.567	1.125	5.441	47.237
0.780	33.0	3.4	6.772	1.125	5.646	52.883
0.840	34.0	3.5	6.977	1.125	5.852	58.735
0.900	36.0	3.7	7.387	1.125	6.262	64.997
0.960	38.0	4.0	7.798	1.125	6.672	71.670
1.020	39.0	4.1	8.003	1.125	6.878	78.547
1.080	40.0	4.2	8.208	1.125	7.083	85.630
1.140	42.0	4.4	8.619	1.125	7.493	93.123
1.200	45.0	4.7	9.234	1.125	8.109	101.232
1.260	49.0	5.1	10.055	1.125	8.930	110.162
1.320	53.0	5.5	10.876	1.125	9.751	119.913
1.380	57.0	5.9	11.697	1.125	10.571	130.484
1.440	62.0	6.5	12.723	1.125	11.597	142.082
1.500	66.0	6.9	13.544	1.125	12.418	154.500
1.560	71.0	7.4	14.570	1.125	13.444	167.944
1.620	77.0	8.0	15.801	1.125	14.676	182.620
1.680	84.0	8.7	17.237	1.125	16.112	198.732
1.740	91.0	9.5	18.674	1.125	17.548	216.280
1.800	98.0	10.2	20.110	1.125	18.985	235.265
1.860	105.0	10.9	21.547	1.125	20.421	255.686
1.920	114.0	11.9	23.394	1.125	22.268	277.954
1.980	125.0	13.0	25.651	1.125	24.525	302.480
2.040	135.0	14.1	27.703	1.125	26.578	329.057
2.100	143.0	14.9	29.345	1.125	28.219	357.277
2.160	154.0	16.0	31.602	1.125	30.476	387.753
2.220	164.0	17.1	33.654	1.125	32.529	420.282
2.280	173.0	18.0	35.501	1.125	34.375	454.657
2.340	183.0	19.1	37.553	1.125	36.427	491.084



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Holmfirth
Huddersfield HD9 2SH
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Project **Land off New Road, Rhosrobin, Wrexham**

Title **1 in 30 Year (+cc) Storage Volume**

Calculations (cont.) :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
2.460	204.0	21.2	41.862	1.125	40.737	570.506
2.520	212.0	22.1	43.504	1.125	42.378	612.884
2.580	219.0	22.8	44.940	1.125	43.815	656.699
2.640	226.0	23.5	46.377	1.125	45.251	701.951
2.700	233.0	24.3	47.813	1.125	46.688	748.638
2.760	239.0	24.9	49.044	1.125	47.919	796.557
2.820	244.0	25.4	50.070	1.125	48.945	845.502
2.880	248.0	25.8	50.891	1.125	49.766	895.268
2.940	249.0	25.9	51.096	1.125	49.971	945.239
3.000	250.0	26.0	51.302	1.125	50.176	995.416
3.060	250.0	26.0	51.302	1.125	50.176	1045.592
3.120	249.0	25.9	51.096	1.125	49.971	1095.563
3.180	248.0	25.8	50.891	1.125	49.766	1145.329
3.240	244.0	25.4	50.070	1.125	48.945	1194.274
3.300	239.0	24.9	49.044	1.125	47.919	1242.193
3.360	233.0	24.3	47.813	1.125	46.688	1288.881
3.420	226.0	23.5	46.377	1.125	45.251	1334.132
3.480	219.0	22.8	44.940	1.125	43.815	1377.947
3.540	212.0	22.1	43.504	1.125	42.378	1420.325
3.600	204.0	21.2	41.862	1.125	40.737	1461.062
3.660	194.0	20.2	39.810	1.125	38.685	1499.747
3.720	183.0	19.1	37.553	1.125	36.427	1536.174
3.780	173.0	18.0	35.501	1.125	34.375	1570.550
3.840	164.0	17.1	33.654	1.125	32.529	1603.078
3.900	154.0	16.0	31.602	1.125	30.476	1633.555
3.960	143.0	14.9	29.345	1.125	28.219	1661.774
4.020	135.0	14.1	27.703	1.125	26.578	1688.351
4.080	125.0	13.0	25.651	1.125	24.525	1712.877
4.140	114.0	11.9	23.394	1.125	22.268	1735.145
4.200	105.0	10.9	21.547	1.125	20.421	1755.566
4.260	98.0	10.2	20.110	1.125	18.985	1774.551
4.320	91.0	9.5	18.674	1.125	17.548	1792.100
4.380	84.0	8.7	17.237	1.125	16.112	1808.212
4.440	77.0	8.0	15.801	1.125	14.676	1822.887
4.500	71.0	7.4	14.570	1.125	13.444	1836.331
4.560	66.0	6.9	13.544	1.125	12.418	1848.750
4.620	62.0	6.5	12.723	1.125	11.597	1860.347
4.680	57.0	5.9	11.697	1.125	10.571	1870.919
4.740	53.0	5.5	10.876	1.125	9.751	1880.669
4.800	49.0	5.1	10.055	1.125	8.930	1889.599
4.860	45.0	4.7	9.234	1.125	8.109	1897.708
4.920	42.0	4.4	8.619	1.125	7.493	1905.201
4.980	40.0	4.2	8.208	1.125	7.083	1912.284
5.040	39.0	4.1	8.003	1.125	6.878	1919.162
5.100	38.0	4.0	7.798	1.125	6.672	1925.834
5.160	36.0	3.7	7.387	1.125	6.262	1932.096
5.220	34.0	3.5	6.977	1.125	5.852	1937.948
5.280	33.0	3.4	6.772	1.125	5.646	1943.594
5.340	32.0	3.3	6.567	1.125	5.441	1949.036
5.400	31.0	3.2	6.361	1.125	5.236	1954.272
5.460	29.0	3.0	5.951	1.125	4.826	1959.098
5.520	27.0	2.8	5.541	1.125	4.415	1963.513
5.580	26.0	2.7	5.335	1.125	4.210	1967.723
5.640	24.0	2.5	4.925	1.125	3.800	1971.522
5.700	23.0	2.4	4.720	1.125	3.594	1975.117
5.760	22.0	2.3	4.515	1.125	3.389	1978.506
5.820	21.0	2.2	4.309	1.125	3.184	1981.690
5.880	21.0	2.2	4.309	1.125	3.184	1984.874
5.940	20.0	2.1	4.104	1.125	2.979	1987.852
6.000	20.0	2.1	4.104	1.125	2.979	1990.831

Storage volume (m³) = 1990.8 m³ (Sum of all balance quantities)



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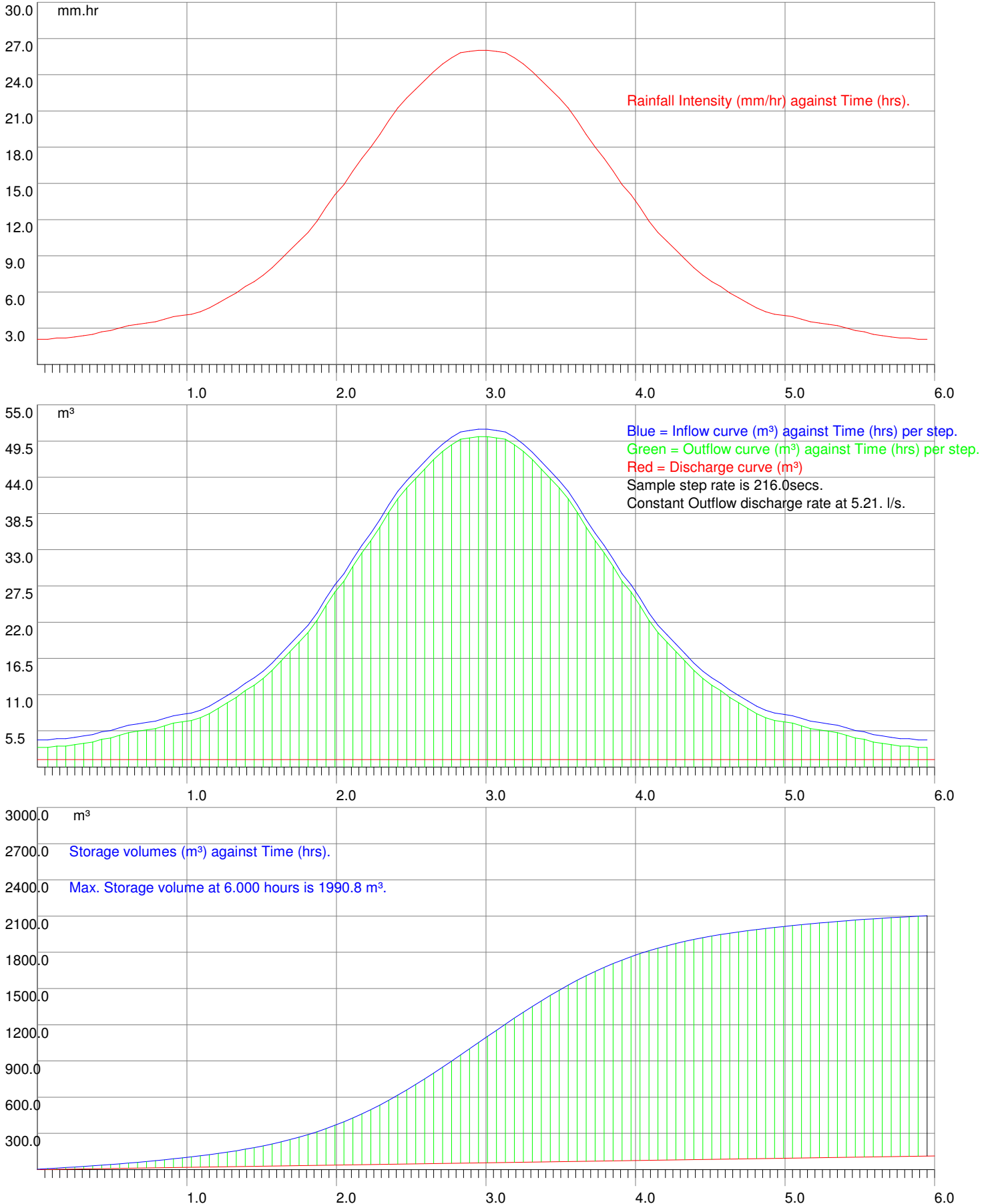
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29a Green Abbey, Hade Edge
Holmfirth
Huddersfield HD9 2SH
Tel:01484 684565 Mob: 07857 264 376
email: keelan@krsenvironmental.com

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Project **Land off New Road, Rhosrobin, Wrexham**

Title **1 in 30 Year (+cc) Storage Volume**





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Holmfirth
Huddersfield HD9 2SH
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Title **1 in 30 Year (+cc) Storage Volume**

Explanatory notes for Peak Flow Storage

- 1) This system uses the rainfall intensity/ duration curve calculated using either the Wallingford or FEH method as selected.
- 2) The balance is calculated from the inflow minus the outflow.
- 3) The storage volume is the maximum value of the balance curve.
- 4) This method was described by Davis (1963) - see Butler & Davies, 2nd edition, p294
- 5) References to 'storm duration' relate only to the hydrograph method (qv).
- 6) There are always 600 steps in the calculation process, thus a 'run' time of 10 hours will be sampled every minute,

Explanatory notes for Hydrograph Storage

- 1) The user has the choice of Summer or Winter curves
- 2) The mean intensity varies with the duration of the storm curve
- 3) There are always 120 steps in the calculation process, irrespective of storm duration.
- 4) The balance is calculated from the inflow minus the outflow.
- 5) The storage volume is the sum of the balance values for each step.
- 6) Varying durations should be tried to find the maximum storage value - this can be narrowed down very closely.

*Modelling using the flow characteristics of the restrictor is available using Vortex Control modelling function. Please be aware that this function needs the full design data file to function.

Why do the two methods give different results?

The rainfall characteristics for each method are very different.

The Peak flow (using the Intensity/Duration/Frequency curve) does not model the actual rainfall. This curve is joined points which represent the mean intensity of a storm at a given duration i.e. a value of 19.5 mm/hr for a 60 minute storm indicates that over the sixty minute period, the mean intensity was 19.5 mm/hr. The calculation method samples the IDF curve for a given location and frequency (Return Period) and calculates the storage for that rate and duration less the outflow volume. The maximum value is displayed as the 'worst case' storage.

The hydrograph method uses a standard curve for either Winter or Summer storms. Traditionally these are symmetrical about the central peak. UK rainfall does not fit into this convenient curve, so the calculations are dealing with a stylised set of data. The mean intensity for the storm is calculated from the IDF curve and applied to the curve data, calculating the storage for that step less the outflow volume. The final storage volume is the sum of the storage for all the steps.

It can be seen that these two methods are very different, and the user may have the choice of which result to use. This is not an exact science, though is often treated as such by those that do not understand the principles of the calculations.



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Project Land off New Road, Rhosrobin, Wrexham

Title 1 in 100 Year (+cc) Storage Volume

Data:-

Hydrology:-

Grid reference = SJ3449

M5-60 (mm) = 18

WRAP/Soil = 1 / 0.15

Return period = 100

Climate change factor = 30%

Pipeline storage = 0.0 m³

Offline storage = 0.0 m³

Location =

r = 0.32

SAAR (mm/yr) = 800

Mean intensity = 13.5mm/hr for a 6 hour storm

Available MH storage = 0.0 m³

Percentage runoff = 73.0% calculated from:-

Percentage runoff = (0.829*PIMP)+(25*SOIL)+(0.078*UCWI)-20.7

where

PIMP = ImpervArea*100/(ImpervArea+PervArea) = 100.0

UCWI = Calculated value for Wetness Index = 86.0

Imperv. area = 45000 m²

Total area = 45000 m²

Total runoff = 2661.3 m³

Storage (m³) = 2615.3 m³ (Sum of all balance quantities)

Total rainfall depth = 81.0 mm

Pervious area = 0 m²

Equiv area = 32850 m² (Tot. area x % runoff).

Discharge rate = 5.210 l/s

Calculations :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
0.060	20.0	2.7	5.323	1.125	4.197	4.197
0.120	20.0	2.7	5.323	1.125	4.197	8.395
0.180	21.0	2.8	5.589	1.125	4.463	12.858
0.240	21.0	2.8	5.589	1.125	4.463	17.321
0.300	22.0	3.0	5.855	1.125	4.730	22.051
0.360	23.0	3.1	6.121	1.125	4.996	27.047
0.420	24.0	3.2	6.387	1.125	5.262	32.309
0.480	26.0	3.5	6.919	1.125	5.794	38.103
0.540	27.0	3.6	7.186	1.125	6.060	44.163
0.600	29.0	3.9	7.718	1.125	6.592	50.755
0.660	31.0	4.2	8.250	1.125	7.125	57.880
0.720	32.0	4.3	8.516	1.125	7.391	65.271
0.780	33.0	4.5	8.782	1.125	7.657	72.928
0.840	34.0	4.6	9.049	1.125	7.923	80.851
0.900	36.0	4.9	9.581	1.125	8.455	89.307
0.960	38.0	5.1	10.113	1.125	8.988	98.294
1.020	39.0	5.3	10.379	1.125	9.254	107.548
1.080	40.0	5.4	10.645	1.125	9.520	117.068
1.140	42.0	5.7	11.178	1.125	10.052	127.120
1.200	45.0	6.1	11.976	1.125	10.851	137.971
1.260	49.0	6.6	13.041	1.125	11.915	149.886
1.320	53.0	7.2	14.105	1.125	12.980	162.866
1.380	57.0	7.7	15.170	1.125	14.044	176.910
1.440	62.0	8.4	16.500	1.125	15.375	192.285
1.500	66.0	8.9	17.565	1.125	16.439	208.724
1.560	71.0	9.6	18.895	1.125	17.770	226.494
1.620	77.0	10.4	20.492	1.125	19.367	245.861
1.680	84.0	11.3	22.355	1.125	21.230	267.091
1.740	91.0	12.3	24.218	1.125	23.093	290.184
1.800	98.0	13.2	26.081	1.125	24.956	315.140
1.860	105.0	14.2	27.944	1.125	26.819	341.958
1.920	114.0	15.4	30.339	1.125	29.214	371.172
1.980	125.0	16.9	33.267	1.125	32.141	403.313
2.040	135.0	18.2	35.928	1.125	34.803	438.116
2.100	143.0	19.3	38.057	1.125	36.932	475.047
2.160	154.0	20.8	40.984	1.125	39.859	514.907
2.220	164.0	22.1	43.646	1.125	42.520	557.427
2.280	173.0	23.4	46.041	1.125	44.916	602.343
2.340	183.0	24.7	48.702	1.125	47.577	649.920



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29a Green Abbey, Hade Edge
Holmfirth
Huddersfield HD9 2SH
Tel:01484 684565 Mob: 07857 264 376
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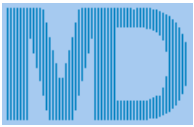
Project **Land off New Road, Rhosrobin, Wrexham**

Title **1 in 100 Year (+cc) Storage Volume**

Calculations (cont.) :-

Time (hrs)	%Mean intens	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)	Cumulative (m3)
2.460	204.0	27.5	54.291	1.125	53.166	753.590
2.520	212.0	28.6	56.420	1.125	55.295	808.885
2.580	219.0	29.6	58.283	1.125	57.158	866.042
2.640	226.0	30.5	60.146	1.125	59.021	925.063
2.700	233.0	31.5	62.009	1.125	60.884	985.947
2.760	239.0	32.3	63.606	1.125	62.480	1048.427
2.820	244.0	32.9	64.936	1.125	63.811	1112.238
2.880	248.0	33.5	66.001	1.125	64.876	1177.114
2.940	249.0	33.6	66.267	1.125	65.142	1242.255
3.000	250.0	33.8	66.533	1.125	65.408	1307.663
3.060	250.0	33.8	66.533	1.125	65.408	1373.071
3.120	249.0	33.6	66.267	1.125	65.142	1438.213
3.180	248.0	33.5	66.001	1.125	64.876	1503.089
3.240	244.0	32.9	64.936	1.125	63.811	1566.900
3.300	239.0	32.3	63.606	1.125	62.480	1629.380
3.360	233.0	31.5	62.009	1.125	60.884	1690.264
3.420	226.0	30.5	60.146	1.125	59.021	1749.284
3.480	219.0	29.6	58.283	1.125	57.158	1806.442
3.540	212.0	28.6	56.420	1.125	55.295	1861.737
3.600	204.0	27.5	54.291	1.125	53.166	1914.903
3.660	194.0	26.2	51.630	1.125	50.504	1965.407
3.720	183.0	24.7	48.702	1.125	47.577	2012.984
3.780	173.0	23.4	46.041	1.125	44.916	2057.900
3.840	164.0	22.1	43.646	1.125	42.520	2100.420
3.900	154.0	20.8	40.984	1.125	39.859	2140.279
3.960	143.0	19.3	38.057	1.125	36.932	2177.211
4.020	135.0	18.2	35.928	1.125	34.803	2212.013
4.080	125.0	16.9	33.267	1.125	32.141	2244.155
4.140	114.0	15.4	30.339	1.125	29.214	2273.369
4.200	105.0	14.2	27.944	1.125	26.819	2300.187
4.260	98.0	13.2	26.081	1.125	24.956	2325.143
4.320	91.0	12.3	24.218	1.125	23.093	2348.236
4.380	84.0	11.3	22.355	1.125	21.230	2369.465
4.440	77.0	10.4	20.492	1.125	19.367	2388.832
4.500	71.0	9.6	18.895	1.125	17.770	2406.602
4.560	66.0	8.9	17.565	1.125	16.439	2423.042
4.620	62.0	8.4	16.500	1.125	15.375	2438.417
4.680	57.0	7.7	15.170	1.125	14.044	2452.461
4.740	53.0	7.2	14.105	1.125	12.980	2465.441
4.800	49.0	6.6	13.041	1.125	11.915	2477.356
4.860	45.0	6.1	11.976	1.125	10.851	2488.206
4.920	42.0	5.7	11.178	1.125	10.052	2498.259
4.980	40.0	5.4	10.645	1.125	9.520	2507.779
5.040	39.0	5.3	10.379	1.125	9.254	2517.032
5.100	38.0	5.1	10.113	1.125	8.988	2526.020
5.160	36.0	4.9	9.581	1.125	8.455	2534.476
5.220	34.0	4.6	9.049	1.125	7.923	2542.399
5.280	33.0	4.5	8.782	1.125	7.657	2550.056
5.340	32.0	4.3	8.516	1.125	7.391	2557.447
5.400	31.0	4.2	8.250	1.125	7.125	2564.571
5.460	29.0	3.9	7.718	1.125	6.592	2571.164
5.520	27.0	3.6	7.186	1.125	6.060	2577.224
5.580	26.0	3.5	6.919	1.125	5.794	2583.018
5.640	24.0	3.2	6.387	1.125	5.262	2588.280
5.700	23.0	3.1	6.121	1.125	4.996	2593.276
5.760	22.0	3.0	5.855	1.125	4.730	2598.005
5.820	21.0	2.8	5.589	1.125	4.463	2602.469
5.880	21.0	2.8	5.589	1.125	4.463	2606.932
5.940	20.0	2.7	5.323	1.125	4.197	2611.129
6.000	20.0	2.7	5.323	1.125	4.197	2615.326

Storage volume (m³) = 2615.3 m³ (Sum of all balance quantities)



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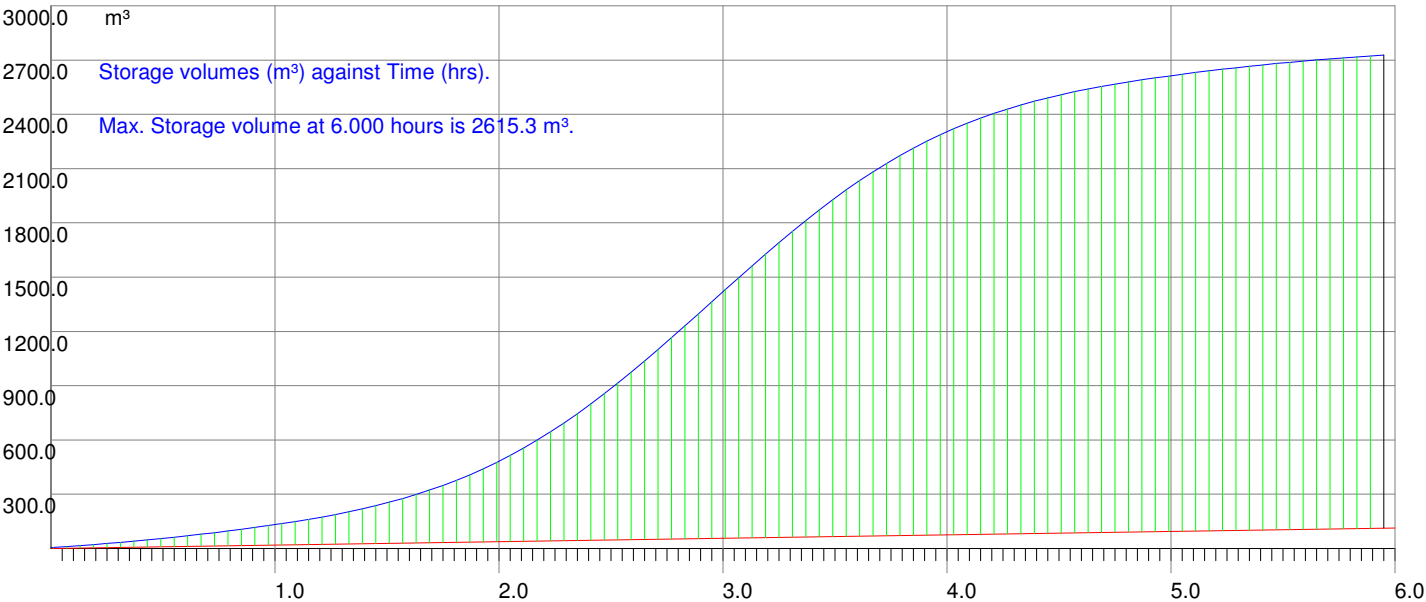
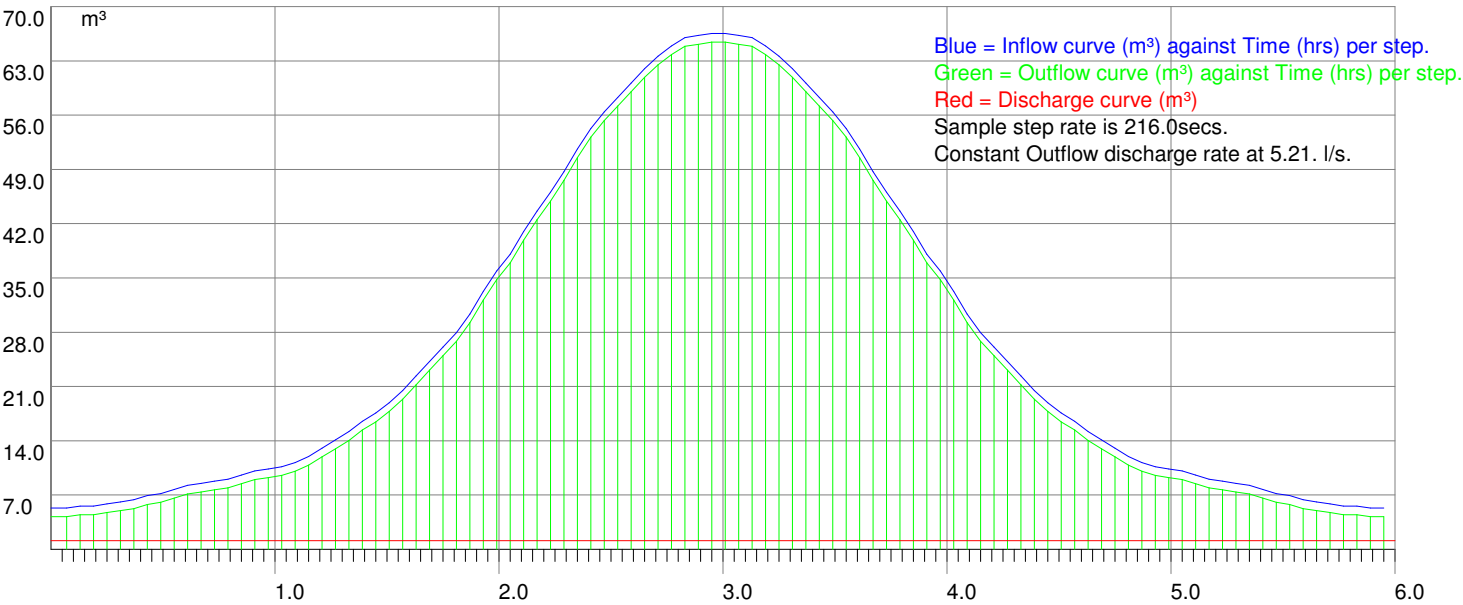
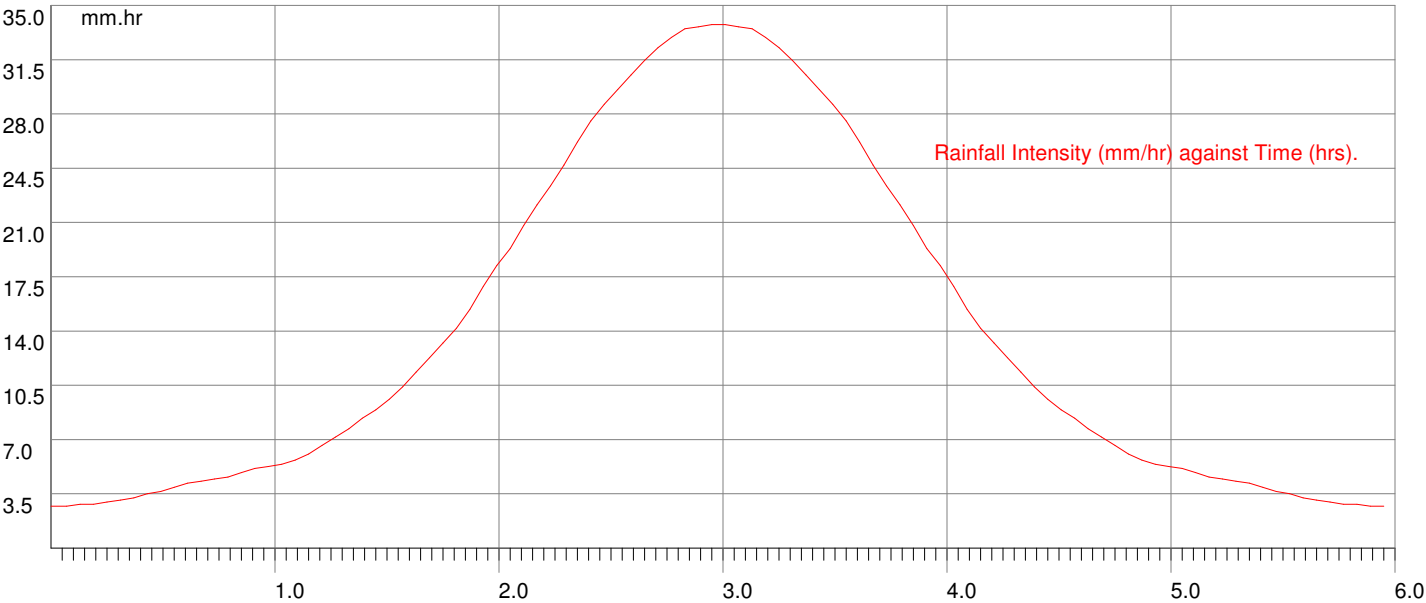
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Holmfirth
Huddersfield HD9 2SH
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29a Green Abbey, Hade Edge
Holmfirth
Huddersfield HD9 2SH
Tel:01484 684565 Mob: 07857 264 376
email: keelan@krsenvironmental.com

Job No.		
Sheet no. 4		
Date 29/09/14		
By	Checked	Reviewed

Project **Land off New Road, Rhosrobin, Wrexham**

Title **1 in 100 Year (+cc) Storage Volume**

Maximum storage volumes for varying duration storms.

Storm length (hrs)	Max. Vol (m ³)	Max. Vol time	Mean intens (mm/hr)	Step time. (mins)	Peak found
0.25	3633.86	100.00	1.59	60.0	Peak found
0.5	3501.34	----	1.16	90.0	
225	3221.99	----	0.85	135.0	
300	2912.36	----	0.68	180.0	
375	2597.57	----	0.58	225.0	
450	2290.90	----	0.50	270.0	
525	1994.56	----	0.45	315.0	
600	1708.42	----	0.40	360.0	
675	1439.93	----	0.37	405.0	
750	1189.92	----	0.34	450.0	
825	959.06	----	0.32	495.0	
900	746.69	----	0.30	540.0	
975	551.59	----	0.28	585.0	
1050	377.60	----	0.27	630.0	
1125	228.82	----	0.25	675.0	
1200	108.75	----	0.24	720.0	
1275	22.20	----	0.23	765.0	
1350	0.00	----	0.22	810.0	
1425	0.00	----	0.21	855.0	
1500	0.00	----	0.21	900.0	
1575	0.00	----	0.20	945.0	
1650	0.00	----	0.19	990.0	
1725	0.00	----	0.19	1035.0	
1800	0.00	----	0.18	1080.0	
1875	0.00	----	0.18	1125.0	
1950	0.00	----	0.17	1170.0	
2025	0.00	----	0.17	1215.0	
2100	0.00	----	0.16	1260.0	
100	3633.86	----	1.59	60.0	
150	3501.34	----	1.16	90.0	
225	3221.99	----	0.85	135.0	
300	2912.36	----	0.68	180.0	
375	2597.57	----	0.58	225.0	
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1050	377.60	----	0.27	630.0	
1125	228.82	----	0.25	675.0	
1200	108.75	----	0.24	720.0	
1275	22.20	----	0.23	765.0	



MasterDrain
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29a Green Abbey, Hade Edge
Holmfirth
Huddersfield HD9 2SH
Tel: 01484 684565 Mob: 07857 264 376
email: keelan@krsenvironmental.com

Job No.		
Sheet no. 5		
Date 29/09/14		
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Project **Land off New Road, Rhosrobin, Wrexham**

Title **1 in 100 Year (+cc) Storage Volume**

Explanatory notes for Peak Flow Storage

- 1) This system uses the rainfall intensity/ duration curve calculated using either the Wallingford or FEH method as selected.
- 2) The balance is calculated from the inflow minus the outflow.
- 3) The storage volume is the maximum value of the balance curve.
- 4) This method was described by Davis (1963) - see Butler & Davies, 2nd edition, p294
- 5) References to 'storm duration' relate only to the hydrograph method (qv).
- 6) There are always 600 steps in the calculation process, thus a 'run' time of 10 hours will be sampled every minute,

Explanatory notes for Hydrograph Storage

- 1) The user has the choice of Summer or Winter curves
- 2) The mean intensity varies with the duration of the storm curve
- 3) There are always 120 steps in the calculation process, irrespective of storm duration.
- 4) The balance is calculated from the inflow minus the outflow.
- 5) The storage volume is the sum of the balance values for each step.
- 6) Varying durations should be tried to find the maximum storage value - this can be narrowed down very closely.

*Modelling using the flow characteristics of the restrictor is available using Vortex Control modelling function. Please be aware that this function needs the full design data file to function.

Why do the two methods give different results?

The rainfall characteristics for each method are very different.

The Peak flow (using the Intensity/Duration/Frequency curve) does not model the actual rainfall. This curve is joined points which represent the mean intensity of a storm at a given duration i.e. a value of 19.5 mm/hr for a 60 minute storm indicates that over the sixty minute period, the mean intensity was 19.5 mm/hr. The calculation method samples the IDF curve for a given location and frequency (Return Period) and calculates the storage for that rate and duration less the outflow volume. The maximum value is displayed as the 'worst case' storage.

The hydrograph method uses a standard curve for either Winter or Summer storms. Traditionally these are symmetrical about the central peak. UK rainfall does not fit into this convenient curve, so the calculations are dealing with a stylised set of data. The mean intensity for the storm is calculated from the IDF curve and applied to the curve data, calculating the storage for that step less the outflow volume. The final storage volume is the sum of the storage for all the steps.

It can be seen that these two methods are very different, and the user may have the choice of which result to use. This is not an exact science, though is often treated as such by those that do not understand the principles of the calculations.