LAND AT THE VALLEY
RADFORD SEMELE

FLOOD RISK ASSESSMENT
INC SURFACE & FOUL WATER
DRAINAGE STRATEGY

ON BEHALF OF
PROTECH DEVELOPMENTS LTD

Document Status

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RMO

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APPENDICIES

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1 INTRODUCTION

1.1 RMO Consultants Limited (RMO) is appointed by Protech Developments Ltd to complete a Flood Risk Assessment in support of a proposed residential development on land off The Valley, Radford Semele, incorporating a Surface water and Foul Drainage Strategy.

1.2 The objective of the study is to demonstrate that the development proposals are acceptable from a flooding risk and drainage viewpoint. The proposals have therefore been developed having regard to NPPF, CIRIA, regional and local guidance.

1.3 This report summarises the findings of the study and specifically addresses the following issues in the context of the current legislative regime:

- Flooding risk
- Water management
- Surface water drainage
- Foul water drainage

1.4 Plans showing the site are contained in the Appendix.

2 BACKGROUND INFORMATION

Location & Details

2.1 The proposed development lies to the south east of Radford Semele. The southern and western boundaries of the site are bounded by existing residential properties. Undeveloped land bounds the site to the north and east.

2.2 The land is currently undeveloped and is not thought to have been historically subject to build development. The site location and boundary is shown indicatively on Figure 2a, below.

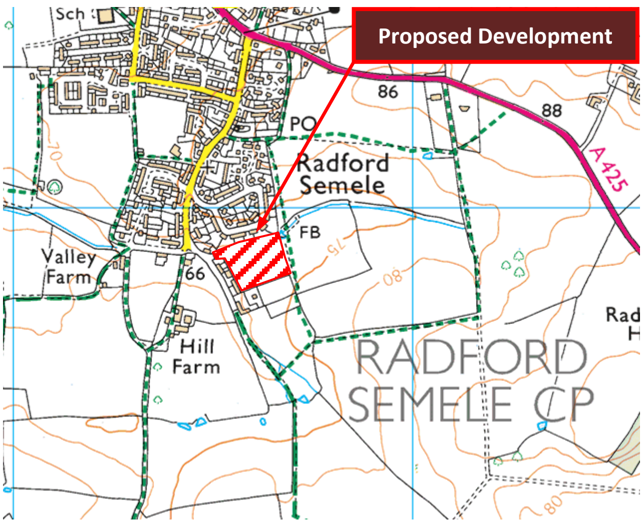


Figure 2a: Site location.

Development Criteria

2.3 It is proposed to develop up to 40 residential dwellings within the site.

Sources of Information

2.4 The following additional information has been available while completing the study:

- Mastermap Data - Ordnance Survey
- Published Geology - British Geological Survey
- LiDAR Survey Data - Emapsite
- Level 1 Strategic Flood Risk Assessment - Warwickshire County Council 2008 & 2013

Site Survey

2.5 Topography across the site is characterised by shallow gradients falling in both west and south westerly directions towards an unnamed ordinary watercourse which runs along the sites western boundary and flows in a north east to south west direction. LiDAR survey data identifies levels falling from circa 74.5mAOD on the eastern boundary down to a low point of 66.50mAOD on the south western boundary.

Ground Conditions

2.6 Published geology identifies the presence of a Mercia Mudstone formation. This is shown in Figure 2b below:

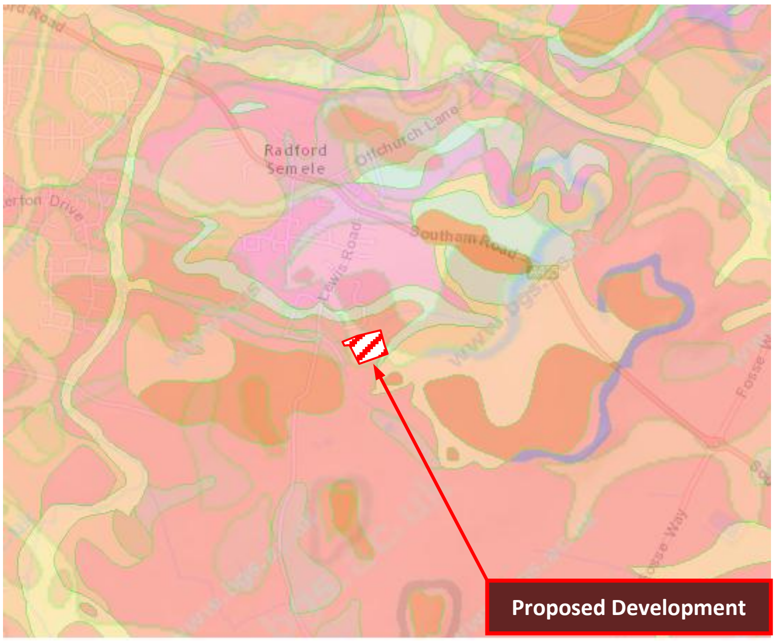


Figure 2b: BGS Published Geology

Mercia Mudstone Formation

Watercourse Systems & Drainage

2.7 The dominant watercourse in the area is the Whitnash Brook which lies approximately 750m west of the site.

2.8 Within the site boundary, an ordinary watercourse tributary of the Whitnash Brook is identified. Travelling generally in an westerly direction, the watercourse originates some 400m east of the site.

2.9 Hereafter, the watercourse passes through a series of open channels interspersed with culverted sections underneath field accesses up until it enters a pond near the north eastern corner of the site. From this point the watercourse flows through the site within an open channel before being culverted underneath The Valley and continuing west towards the Whitnash Brook.

2.10 Reference to the Flood Estimation Handbook CD dataset V3 confirms the land to lie within the catchment of an ordinary watercourse tributary of the Whitnash Brook passing through the site. Having an URBEXT2000 value of 0.0144 the catchment can be described as *"slightly urbanised"*. The FEH catchment is shown in Figure 2c, below.

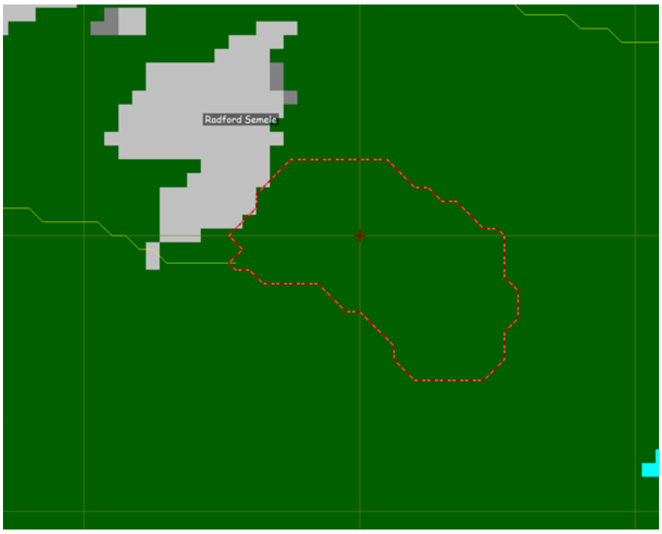


Figure 2c: FEH reported catchment.

FEH Catchment

3 FLOODING RISK

National Planning Policy Context

3.1 The National Planning Policy Framework (NPPF) was introduced in March 2012, with the aim at rationalising and simplifying planning guidance. The Policy is supported by a Technical Guide, which provides advice in relation to Flood Risk and Drainage matters at Paragraphs 2 to 9. This element of the Technical Guide largely follows the principles set out in the earlier adopted planning guidance on flood risk and drainage, being PPS25.

3.2 Allocation and planning of development must be considered against a risk based search sequence, as provided by the NPPF guidance. In terms of fluvial flooding, the guidance categorises flood zones in three principal levels of risk, as follows:

Flood Zone	Annual Probability of Flooding
Zone 1: Low probability	< 0.1 %
Zone 2: Medium probability	0.1 – 1.0 %
Zone 3a / 3b: High probability	> 1.0 %

Figure 3a: NPPF Flood Risk Parameters

3.3 The Guidance states that Planning Authorities should *"apply a sequential, risk-based approach to the location of development to avoid where possible flood risk to people and property and manage any residual risk, taking account of the impacts of climate change."*

3.4 According to the NPPF guidance, residential development at the proposed site being designated as a "More Vulnerable" classification, should lie outside the envelope of the predicted 1 in 100 year (1%) flood, with preference given to sites lying outside the 1 in 1,000 (0.1%) year event and within Flood Zone 1.

3.5 Sites with the potential to flood during a 1 in 100 (1%) year flood event (Flood Zone 3a) are not normally considered appropriate for proposed residential development unless on application of the "Sequential Test", the site is demonstrated to be the most appropriate for development and satisfactory flood mitigation can be provided. Additionally, proposed residential developments within Flood Zone 3a are required to pass the "Exception Test", the test being that:

- The development is to provide wider sustainability benefits
- The development will be safe, not increase flood risk and where possible reduce flood risk

Regional & Local Policy

3.6 **Regional Flood Risk Assessment:** In accordance with NPPF guidance, the West Midlands Regional Assembly produced their Regional Flood Risk Appraisal (RFRA) in October 2007. This document reviews flood risk and associated strategy across the wider West Midlands region.

3.7 As with many RFRA's, this document outlines the broad understanding of flooding risk across areas of potential higher growth.

3.8 **Strategic Flood Risk Assessment:** To support local planning policy, NPPF guidance recommends that local planning authorities produce a Strategic Flood Risk Assessment (SFRA). The SFRA should be used to help define the Local Development Framework and associated policies; considering potential development zones in the context of the sequential test defined in the guidance.

3.9 Warwickshire County Council commissioned a Level 1 SFRA to look into flood risk across a number of development areas in 2008. The document outlines the results of a review of available flood risk related policy and data across the region and sets out recommendations and guidance in terms of flood risk and drainage policy that generally underpins national guidance. This document was last updated in July 2013.

3.10 **Development Flood Risk Assessment:** At a local, site by site, level the NPPF guidance and supporting documents advocate the preparation of a Flood Risk Assessment (FRA). NPPF requires that developments covering an area of greater than one hectare prepare an FRA in accordance with the guidance. The FRA is required to be proportionate to the risk and appropriate to the scale, nature and location of the development.

3.11 This document forms a Flood Risk Assessment (FRA), to accord with current guidance and addresses national, regional and local policy requirements in demonstrating that the proposed development lies within the acceptable flood risk parameters.

Flood Mechanisms

3.12 Having completed a site hydrological desk study and walk over inspection, the possible flooding mechanisms at the site are identified as follows:

Mechanisms	Potential?	Comment
Fluvial (Annex C: C4)	Y	The site is bisected by an ordinary watercourse forming a tributary of the Whitnash brook. Whilst the Environment Agency's flood mapping indicates the whole of the site to be within Flood Zone 1, the SFRA has identified a possible area of either side of this ordinary watercourse which has the potential to flood.
Coastal & tidal (Annex C: C5)	N	No tidal watercourses are close to the site
Overland flow (Annex C: C6)	Y	The proposed development land near a potential low point for the surrounding area with much of the surrounding ground to the east in agricultural use.
Ground water (Annex C: C7)	Y	Geology underlying the site is of a possibly impermeable nature. While not considered a high risk mechanism, ground water flooding needs to be considered.
Sewers (Annex C: C8)	N	Searches with Severn Trent Water have identified a number of sewers near to the site. From initial enquiries, the surrounding network is not known to suffer from drainage related flooding problems.
Reservoirs, Canals etc (Annex C: C9)	N	Whilst the Grand Union Canal is situated 1km to the north of the site, it is not considered to be within an influencing distance of the proposed development.

Figure 3b: Flooding mechanisms

3.13 Where potential risks are identified in Figure 3b, above, more detailed assessments have been completed and are outlined below. Further background is also outlined below.

Fluvial Flooding: C4

3.14 The Environment Agency's (EA) National Generalised Modelling (NGM) Flood Zones Plan indicates predicted flood envelopes of Main Rivers across the UK. In many circumstances, the NGM is based on basic catchment characteristic data and modelling techniques. Where appropriate, more accurate Section 105 / SFRM models are produced using more robust analysis techniques.

3.15 The Flood Zone mapping shows the 1 in 100 year (1%AEP) and 1 in 1000 year (0.1%AEP) event storms based on this modelling approach.

3.16 The mapping shows that the site lies well within Flood Zone 1; being an area of Low Probability of flooding and outside both the 1 in 100 (1% AEP) and 1 in 1,000 (0.1% AEP) year flood events.

3.17 The EA Flood Zone plan reprinted as Figure 3c below.

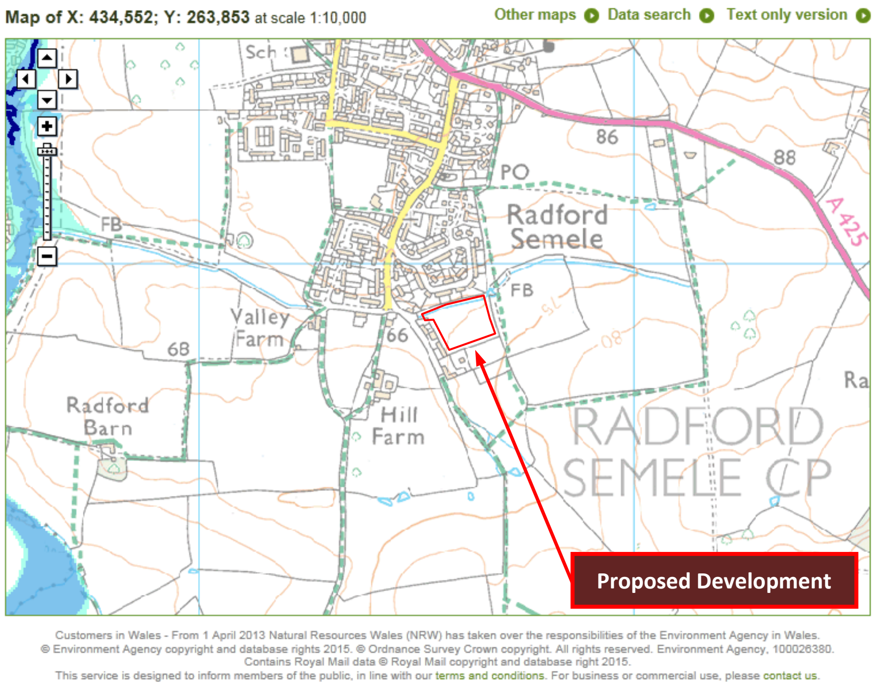


Figure 3c: EA Flood Zone Plan showing 1 in 100 & 1 in 1,000 year floodplains.

- Flooding from rivers without defences – 1 in 100 year (1%) event (Zone 3)
- Extent of extreme flood – 1 in 1,000 year (0.1%) event (Zone 2)
- Flood defences
- Areas benefiting from flood defences

3.18 The SFRA provides details of historic flooding within the area and there are no recorded incidents near the development site.

3.19 The SFRA identifies an area of flooding near this watercourse during the 1 in 200 year event. However, this item is considered in more detail in section C6 in conjunction with published EA mapping.

Coastal Flooding C5

3.20 The site lies a significant distance from the nearest tidal watercourse and the coast. As such there is no risk of tidal or coastal flooding at this location.

Overland Flow: C6

3.21 Overland flow mechanisms result from the inability of unpaved ground to infiltrate rainfall or due to inadequacies of drainage collection systems to accommodate flow directed to gullies, drainage downpipes or similar. In minor cases, local ponding type flooding may occur. In more extreme events, flows accumulate and may be conveyed across land following the topography.

3.22 Interrogation of the landform mapping and a site walk over inspection demonstrates that in the baseline situation the risk of overland flow relates primarily to the potential for run-off from the residential areas hydraulically upstream, to the west of the site.

3.23 The Environment Agency has recently produced a series of surface water flood maps for many parts of the UK. The plan containing the proposed site is reprinted as Figure 3g:

Figure 3g: Environment Agency Risk of Surface Water Flooding Mapping

3.24 The SFRA reviewed surface water flooding during the 1 in 200 year event. The plan containing the proposed site is reprinted as Figure 3h:

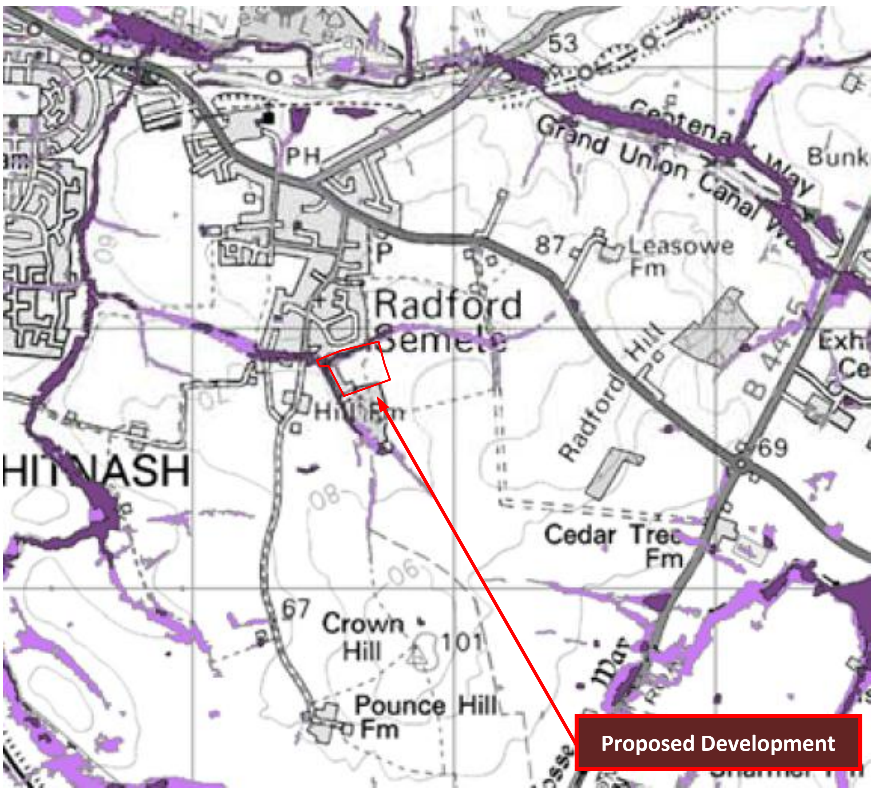


Figure 3h: SFRA Risk of Surface Water Flooding Mapping

Surface Water Flooding (>0.1m)

Deeper Surface Water Flooding (>0.3m)

3.25 The mapping provided by the EA identifies a small corridor of surface water flooding within the site boundary (which is consistent with the findings of the SFRA). The surface water flooding is shown to follow the topography of the site either side of the existing watercourse which runs through the site. However, all built development will be directed to areas that have a very low risk of flooding from surface water.

3.26 Recognising the risk of overland flow mechanisms, published guidance in the form of Sewers for Adoption 7th Edition and the Environment Agency document “Improving the Flood Performance of New Buildings: Flood Resilient Construction” et al advocate the design of developments that implement infrastructure routes through the development that will safely convey flood waters resulting from sewer flooding or overland flows away from buildings and along defined corridors. Further, to protect the proposed development, current good practice measures defined by guidance will be incorporated at the proposed development. Design levels of the site have been developed for the planning application having regard to the relevant design guidance.

3.27 When completed, the risks of further overland flow will be mitigated by providing adequate drainage systems in accordance with this document. Accordingly, upon completion the risk of an overland flow mechanism is considered low.

3.28 Surface water flooding is also noted to occur along the Valley and a site walkover indicated the presence of a further ordinary watercourse which converges with the watercourse running through the development.

3.29 From discussions with the Emergency Services we understand that fire engines can drive through static floodwaters of 500mm depth. Based on this the risks associated with surface water flooding are considered to be low.

Ground Water: C7

3.30 Ground water related flooding is fortunately quite rare, although the results of same, where present, can provide persistent problems that are problematic to resolve. Such mechanisms often develop due to construction activities that may have an unforeseen affect on the local geology or hydrogeology.

3.31 A review of the baseline and proposed landform characteristics and available data suggest groundwater flooding is likely to be a low risk mechanism. This is consistent with the findings of the SFRA.

3.32 Positive drainage systems incorporated into the proposed development further will reduce the risk as a result of permeable pipe bedding materials and filter drains incorporated as elements of the built development.

Sewerage Systems: C8

3.33 Records do not indicate the presence of any existing sewers passing through the proposed development. However, there are existing sewers within The Valley and an existing foul pumping station.

3.34 Searches with Severn Trent Water do not identify any areas at risk of sewer related flooding which have the potential to impact upon the proposed development.

3.35 Flood risk associated with sewer flooding is therefore considered to be of a low probability.

Artificial Sources: C9

3.36 The Grand Union Canal is located circa 1km north of the site but is not considered to be within an influencing distance from the site boundary.

3.37 The risk of flooding from artificial sources is therefore considered to be low.

Flood Zoning & Probability Summary

3.38 In terms of fluvial flood risk, based on EA mapping, the proposed built development lies in Flood Zone 1, being land that lies outside the 1 in 1,000 year (0.1%AEP) flood risk area.

3.39 However, the SFRA has identified a narrow corridor of land either side of the ordinary watercourse which runs through the proposed site at risk of flooding during the 1 in 200 year event. To minimise any residual flood risk, it is proposed to keep all built development (apart from essential infrastructure) beyond the extents of this corridor.

3.40 An assessment of other potential flooding mechanisms show the land to have a low probability of flooding from ground water and sewer flooding.

3.41 As a result of its Flood Zone 1 status, the proposed development land is in a preferable location for residential development when appraised in accordance with the NPPF Sequential Test and local policy.

Residual Flood Risk & Objectives

3.42 An FRA should consider the Residual Flood Risk once development activities are complete, ensuring that appropriate mitigation is proposed to ensure risks are not increased as a result of the activities. This FRA promotes, within the main body of the text, a series of proposals that will be employed to ensure post development situation is acceptable and that residual flood risk is managed. The following list summarises the main proposals that will adequately control residual flood risk:

- All built development (apart from essential infrastructure) will be within Flood Zone 1.
- All built development (apart from essential infrastructure) will be situated beyond the extents of the 1 in 1000 year flood risk area either side of the ordinary watercourse which runs through the site as determined by the EA mapping.
- Compliance with guidance in terms of flood routing and resilience for new developments.
- Provision of a multi-tier storm water SuDS management system (See Section 4). Provision of ongoing maintenance for SuDS features, ordinary watercourse and existing artificial water bodies.
- Connection to a point of adequacy on the foul water drainage network with completion of necessary downstream reinforcements to ensure adequate conveyance and treatment capacity. (See Section 5).
- Adoption and associated ongoing maintenance of development storm and foul drainage system.
- Setting finished floor levels for all dwellings at least 150mm above existing ground levels.

Summary

3.43 All dwellings on-site will lie in fluvial Flood Zone 1 and hence have a low probability of flood risk.

3.44 The proposed residential development would be considered as ‘more vulnerable’ land use in terms of flood risk. The NPPF flood risk vulnerability and flood zone compatibility matrix indicates that ‘more vulnerable’ development is appropriate in Flood Zone 1.

3.45 Assessment of overland flow, ground water and sewer flooding mechanisms does not suggest other than a low risk of flooding at the site.

3.46 It may be concluded that the proposed development complies with NPPF: Development and Flood Risk in terms of appropriateness of the land use and flood zoning.

4 SURFACE WATER DRAINAGE STRATEGY

Background

4.1 To understand the baseline provision for storm drainage in the area, a copy of the Severn Trent Water sewerage network records has been obtained.

4.2 The land is presently not serviced by a positive storm water drainage network. The existing regime currently drains to the ordinary watercourse which runs through the site.

Drainage Options

4.3 The following paragraphs in this section outline the proposed drainage strategy to meet national and local design requirements and guidance.

4.4 Current guidance[1] requires that new developments implement means of storm water control, known as SuDS (Sustainable Drainage Systems), to maintain flow rates discharged to the surface water receptor at the pre-development 'baseline conditions' and improve the quality of water discharged from the land.

4.5 It is proposed to implement a SuDS scheme consistent with local and national policy at the proposed development.

4.6 The SFRA underpins national guidance on the provision of storm water drainage, encouraging the use of sustainable means of drainage at new developments.

4.7 When appraising suitable storm water discharge options for a development site, Part H of the Building Regulations (and associated guidance) provides the following search sequence for identification of the most appropriate drainage methodology.

"Rainwater from a system provided pursuant to sub-paragraphs (1) or (2) shall discharge to one of the following, listed in order of priority -

(a) an adequate soakaway or some other adequate infiltration system; or where that is not reasonably practicable,

(b) a watercourse; or where that is not reasonably practicable,

(c) a sewer."

4.8 Dealing with the search order in sequence:

(a) Source control systems treat water close to the point of collection, in features such as soakaways, porous pavements, infiltration trenches and basins. The use of same can have the benefit of discharging surface water back to ground rather than just temporarily attenuating peak flows before discharging it to a receiving watercourse or sewer.

As source control measures generally rely upon the infiltration of surface water to ground, it is a prerequisite that the ground conditions are appropriate for such. Intrusive site investigations (by way of soak away testing) will be completed at detailed design stage to review the viability of an infiltration based drainage strategy.

[1] NPPF, CIRIA C522, C609, C697 et al.

(b) Next in the search sequence, defined by Part H, is discharge to a watercourse or suitable receiving water body. Where coupled with appropriate upstream attenuation measures, this means of discharge can provide a sustainable drainage scheme that ensures that peak discharges and flood risk in the receiving water body are not increased.

An existing ordinary watercourse runs through the site which forms a potential receptor for storm water discharge and as such, has the potential to receive flows from the proposed development once restricted to the pre-existing 'greenfield' rates of run-off.

(c) Last in the search sequence is discharge to a sewer. In the context of SuDS this is the least preferable scheme as it relies on 'engineered' methods to convey large volumes of water from development areas, has a higher likelihood of flooding due to blockage and provides less intrinsic treatment to the water.

4.9 Web based soil mapping suggests that ground conditions are clay-rich and by extension that infiltration potential on site may be limited, although this can be confirmed further through soakage testing at the detailed design stage.

4.10 The search sequence outlined above indicates that discharge to the existing ordinary watercourse within the site boundary is the most appropriate receptor of storm water from the proposed development, having the potential to employ source control measures and detention features to control peak discharges to no greater than the baseline conditions.

4.11 Proposals have been developed to inform the strategic drainage network across the development. It is proposed that the drainage system for the site utilise a multi SuDS system including detention features and where appropriate, source control in the form of porous paving as the primary storm water management scheme.

4.12 Accordingly, a plan showing the conceptual drainage masterplan for the site is contained in the Appendix.

4.13 Coupled with the storm water control benefits, the use of SuDS can also provide betterment on water quality. National guidance in the form of CIRIA 609 outlines that by implementing SuDS, storm water from the site can be polished to an improved standard thus ensuring the development proposals have no adverse effects on the wider hydrology.

4.14 The following paragraphs outline the potential SuDS features appropriate for use on this site and their place within a multi-tiered system.

Primary Drainage Systems (source control)

4.15 At the head of the drainage network, across the site, source control measures will be implemented to reduce the amount of run-off being conveyed directly to piped drainage systems. Due to the underlying stratum primarily consisting of what are clay rich soils, infiltration based systems are not expected to be feasible.

4.16 The primary aims of the Primary Drainage System will therefore be:

- Reduction in peak discharges to the agreed site wide run-off rate from the development areas.
- Provide water quality treatment where appropriate.

4.17 Through consultations at the pre-planning stage, it has been agreed that the nature of source control measures to be implemented will need to remain flexible, providing a 'toolkit' of options to reach an agreed target for peak discharge reduction and water treatment. The following paragraphs describe a number of options available at the reserved matters stage.

Permeable Paving

4.18 Permeable Paving is approved by many Local Authorities for implementation on the development road network and can act as a receptor for surface water run-off from nearby house roofs. However, the system is perhaps best suited to manage parking areas and shared surfaces where block paving is typically used as the surface treatment and ongoing maintenance can be ensured by way of a management company or the like.

4.19 There is little need for underground pipes or gullies, and the attenuation afforded within the sub-base layer helps to reduce the volume of storage required elsewhere.

Figure 4a: Permeable paving

Filter Strips

4.20 Filter strips have been used in the drainage of highways alike for many years. The absence of traditional pipe work in such a system frees the drainage design to employ shallow gradients on both channels and drains, which in turn also act as a means of passive treatment to improve water quality.

4.21 Highways within the development could potentially be amended to incorporate filter drains. Alternatively, filter strips can be used to collect flows from areas such a group of house. Figure 4b below shows an example of a filter strip in a road corridor.

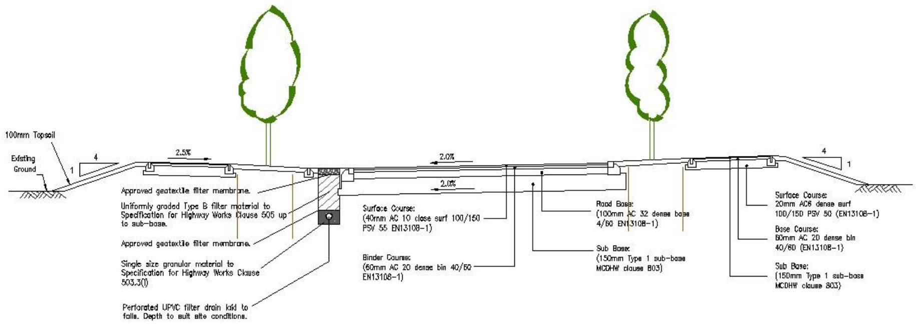


Figure 4b: Filter Strip along highway

Ditches

4.22 Ditches may be used along highways and in common areas to infiltrate, attenuate and convey flows from hard surfaces across the development before being discharged in to the secondary system. Linear features, such as ditches and filter strips provide an efficient means of improving water quality.

Attenuation Drainage Systems

4.23 Attenuation drainage systems collect partially treated, excess, water from the primary, source control systems at a local level, thereafter providing both flow and water quality attenuation and flow conveyance through the site towards the main outfall.

4.24 It is anticipated that basins will be utilised and designed to primarily be normally dry with permanently wet forebay coupled with low flow channels to convey run-off in periods of low rainfall, which will in turn provide the passive treatment benefits offered within the remainder of the surface water management network.

4.25 The primary aims of the basin will therefore be:

- Final flow and water quality conditioning
- Provide landscaping, amenity and ecological benefits

Figure 4c: Storage Basin

Preliminary Drainage Proposals

4.26 Preliminary assessment of the requirements for storm drainage have been based on the following criteria:

Application Site Area:	1.62 ha
Net Developable Area:	1.37 ha
Impermeability – Residential:	0.55
Sewer design return period[2]	1 in 1 years
Sewer flood protection[2]	1 in 30 years
Fluvial / Development flood protection[1]	1 in 100 years
M5-60[3]	19.00mm
Ratio r[2]	0.400
Minimum cover to sewers[1]	1.2 m
Minimum velocity[1]	1.0 m/sec
Pipe ks value[1]	0.6 mm
Allowance for climate change[4]	30%

[2] Sewers for Adoption 7th Edition
[3] Wallingford Report
[4] NPPF requirements for residential development

4.27 National policy dictates that new developments control the peak discharge of storm water from a site to the baseline, undeveloped, site conditions. Over very large development areas, the baseline rate of run-off is normally estimated using the FEH methodologies. However, Paragraph 3.1.2 of the FEH guidance states:

"The frequency estimation procedures can be used on any catchment, gauged or ungauged, that drains an area of at least 0.5km^2. The flood estimation procedures can be applied on smaller catchments only where the catchment is gauged and offers simple flood peak or flood event data"

4.28 On undeveloped and ungauged catchments of less than 0.5km2 in area, it is correct to complete baseline site discharge assessments using the nationally accepted IoH124 methodology for small rural catchments. Local policy is to employ IoH124 in a manner set out by CIRIA C697. This methodology requires that, for catchments of less than 50ha, the IoH assessment is completed for a 50ha area with the results linearly interpolated to determine the flow rate value based on the ratio of the development to 50ha.

4.29 The overall application boundary is below the 50ha threshold, thus the IoH124 methodology is therefore the most appropriate for appraising the baseline run-off from the development.

4.30 The baseline IoH run-off rates are shown on Figure 4d below.

Event	IoH 124 (50ha)	IoH 124 Scaled to 1ha
1 in 1 year (l/s)	125.1	2.50
1 in 100 year (l/s)	387.2	7.74

Figure 4d: Baseline run off rates

4.31 In order to determine the permitted rates of run-off from the development, the future impermeable catchment areas must be derived. This has been based on an RMO measured ratio from previous projects.

4.32 In accordance with the SFRA document and NPPF guidance, it is proposed to implement a drainage strategy that provides attenuation of peak storm water discharges from the developed land to the baseline rate determined using IoH124 methodology. The calculations for this are shown in Figure 4e below:

Catchment	Land Use	Developable Area (ha)	Impermeable Area (ha)	Existing 100 Year Run-off (l/s)	Proposed 100 Year Run-off (l/s)
North	Residential	1.37	0.75	10.6	5.0
Total		**1.37**	**0.75**		

Figure 4e: Run-off calculation for proposed catchments.

4.33 Using these methods, development at the site will comply with the requirements set out in paragraph 9 of the Technical Guide to the National Planning Policy Framework (NPPF), with the discharge of surface water from the proposed developments not exceeding that of the existing greenfield sites, thus ensuring that there is no material increase in the flood risk to surrounding areas.

4.34 Assessments have thereafter been completed to determine the characteristics of proposed SuDS features to be situated within the development. Best practice methods have been employed by performing detention routing calculations for both the 1 in 1 and 1 in 100 year inlet and outlet return periods. Employing the lower and upper end return periods with common characteristics provides for detention that will ensure peak outflows are within the baseline return discharges for the full range of storm events. The summary calculations are contained in the Appendix.

4.35 Calculations demonstrate that storm water detention storage of circa 523m3 will be required to attenuate storm water discharges from the site during the critical 1 in 100 (+30%) year event storm. This will limit the peak discharges to 5.0l/s, as estimated by the IoH124 calculations above, representing a 47% reduction on peak greenfield rates. Figure 4f, below summarises the overall detention requirements. The summary calculations are contained within the Appendix and will be subject to refinement and further review at the detailed design stage.

Catchment Area (ha)	Impermeable Area (ha)	1 in 100 Year Run-off (l/s)	Detention Volume for 1 in 100 Year Event (m^3)	SUDS Type
1.37	0.75	5.0	523	Detention Basin/swale

Figure 4f: Summary run-off & detention assessment output.

4.36 A side overflow weir will be provided on the detention features, at a level above the 1 in 100 year + 30% flood level to allow more extreme event flows to safely be conveyed away from properties, while at the same time not increasing flood risk to surrounding areas, in line with current good practice recommendations. The detailed design stage will provide further detail into the positioning of overflows and direction of flow.

4.37 A conceptual layout for the drainage system has been developed to accord with the design requirements. While this FRA informs the general principles of the proposed drainage system, at detailed design stage, each device will be individually designed for the site characteristics developed for this application.

4.38 The above feature has been designed to accommodate a 1 in 100 (+30%) year event storm across the site.

4.39 The proposed strategic drainage masterplan is shown illustratively on drawing R10024-DR-01 contained in the Appendix.

Water Quality

4.40 Impermeable surfaces collect pollutants from a wide variety of sources including cleaning activities, wear from car tyres, vehicle oil and exhaust leaks and general atmospheric deposition (source: CIRIA C609). The implementation of SuDS in development drainage provides a significant benefit in removal of pollutant from development run-off.

4.41 In most cases, contaminants become attached to sediment particles either before entering the water body or upon entry. CIRIA 609 reports that up to 90% of certain contaminants, usually trace elements, are transported in this way leaving a dissolved concentration of circa 10%.

4.42 Many SuDS systems rely on the infiltration of water through the ground layer into permeable sub soils or through sedimentation in low flow storage basins. This settling and filtering of contaminated run off through a fine grained matrix separates the suspended contaminated sediment from the body of water subsequently causing the water to leave the SuDS device in a more polished form than how it entered; porous paving is a prime example of this.

4.43 Furthermore, by implementation of SuDS features it is possible to optimize overall pollutant removal as water will undergo this process of filtering before being discharged to an appropriate receptor. The overall percentage of removal can be calculated individually for each differing SuDS technique, this is shown by the formula below:

Overall pollutant removal = (TPLxC1) + (RPLxC2) + (RPLxC3) +…..for each other control in series

Where: TPL – Total Pollutant Load
RPL – Remaining Pollutant Load (after previous treatment(s))
C(x) – Suds Control removal efficiency

Figure 4h: Pollutant removal formula as set out in CIRIA C609

4.44 At present, the site and surrounding area does not benefit from any additional measures of stormwater treatment, except for the ordinary watercourse itself.

4.45 Due to the need to provide wider sustainability benefits and view the development at a strategic level, SuDS will be implemented to passively treat run off from the development so as to have a positive impact on the surrounding natural environment.

4.46 The site will employ porous paving and detention basins as these are widely accepted to be of high pollutant removal efficiency (CIRIA 609).

4.47 As the site is not presently served by any means of storm water treatment mechanisms, by providing the afore mentioned SuDS within the proposed development it will be possible to maintain present water quality in the area and thus the development can be seen to be having no significant environmental impact in relation to water.

Implementation Proposals

4.48 The conceptual drainage proposals have been developed in a manner that will allow the site wide system to be designed to encourage passive treatment of discharged flows and to improve the water quality by removing the low level silts, oils and metal associated with urban run-off. Final design will provide for appropriate geometry and planting to maximise this benefit.

4.49 The storm water management features will be constructed and operational for each phase of this build programme prior to the first occupation of each phase of new houses across the site.

4.50 The storm water management features to be implemented will be designed to enhance the biodiversity and landscape character of the site, while also providing amenity space and acting as a functional feature to control storm discharges from the site and improve water quality.

4.51 It has previously been the case that the functionality of the storm water management system would be ensured by ongoing maintenance, completed by the Local Authority, Drainage Authority, or a private maintenance company as appropriate.

4.52 It was usual for the following maintenance regime to be implemented:

Frequency	Operation
Post major storm events	Inspection and removal of debris.
Every two months	Grass mowing (growing season) & litter removal.
Annual	Weeding & vegetation maintenance. Minor swale clearance. Sweeping of permeable pavements.
2 years	Tree pruning.
5-10 years	De-silting of channels. Remove silt around inlet and outlet structures.
15-20 years	Major vegetation maintenance and watercourse channel works.

Figure 4i: Framework maintenance of detention / retention system

4.53 The Floods and Water Management Act gained royal ascent in April 2010. This confers the responsibility to adopt and maintain the SuDS systems to the Local Authority by requiring SuDS Approving Bodies (SAB's) to be set up within each council.

4.54 The SAB will have a duty to adopt the drainage systems and in accordance with Schedule 3; Para 22 of the Floods and Water Management Act:

22 (1) Where an approving body adopts a drainage system it becomes responsible for maintaining the system.
(2) In maintaining the system the adopting body must comply with national standards for sustainable drainage.

4.55 The SAB will therefore be responsible for developing their framework management plan for maintenance and operation procedures; adjusting the nature of the processes and timing as necessary to ensure the successful operation of the drainage systems.

4.56 In circumstances whereby the SAB is not established, then robust arrangements will be put in place for management of the SUDS features.

4.57 The conceptual drainage masterplan proposals outlined in this report will be used for final drainage design and detailing. The storm water management system will be constructed and operational prior to occupation of the relevant phase of development.

Summary

4.58 An outline strategy for storm drainage at the site has been developed to meet both national and local policy. The above options outline the viability of the site to employ means of drainage to comply with NPPF guidance, together with the SFRA and other national and local guidance.

4.59 The development drainage system will manage storm water by way of a SuDS management train and ensure peak discharges from the developed land are no greater than the appraised baseline rates. The system will also provide improvements to the quality of water discharged from the development.

Objectives

4.60 The key objectives for the site drainage will be:

- Implementation of a sustainable drainage scheme in accordance with current national and local policy together with principles of good practice design.
- Control of peak discharges from the site to a rate no greater than the baseline conditions, during all storm events.
- Development of storm water management proposals that improve water quality and biodiversity of the site.
- Implementation of an appropriate maintenance regime.
- Implementation of the storm water management system prior to first occupation of dwellings.

5 FOUL WATER DRAINAGE STRATEGY

Background

5.1 A copy of the Severn Trent Water sewerage network records has been obtained which confirms the presence of adopted, foul sewers running in The Valley and through the site.

Design Criteria / Network Requirements

5.2 Peak design discharges have been calculated based on the current development criteria and the following:

Residential domestic peak	=	4,000 litres / dwelling / day (peak)

Assessed in accordance with SFA 7th Edition requirements, the development will have a design peak discharge of approximately 1.85/s.

Network Requirements / Treatment Requirements / Options

5.3 A pre-development enquiry has been made to Severn Trent Water to agree the point of connection and to confirm available capacity, however it is considered unlikely that the receiving sewer system would need any significant improvement to accommodate such minor additional flows.

Implementation Proposals

5.4 Water companies have a statutory obligation through the Water Industry Act 1991, 2003 et al, to provide capital investment in strategic treatment infrastructure to meet development growth. This investment planning is managed and regulated by OFWAT through the Asset Management Plan (AMP) process. This five yearly cyclical process requires that water companies allocate finances to a range of strategic projects to meet their statutory obligations.

5.5 The proposed gravity drainage network across the site will be designed to current Sewers for Adoption 7th Edition Standards, employing an agreed of point of connection within the Severn Trent Water network. The system will be offered for the adoption of Severn Trent Water under S104 of the Water Industry Act 1991.

Summary

5.6 A site drainage strategy has been developed that meets with current regulatory requirements by discharging drainage to a sewerage network with capacity to accommodate the flows.

5.7 Once development is complete, the network conveying flows from the site will be adopted by Severn Trent Water and maintained as part of their statutory duties.

Objectives

5.8 The key development objectives required for the site drainage scheme are:

- Implementation of a drainage scheme to convey water to the local Severn Trent Water network which is designed and maintained to an appropriate standard.

6 SUMMARY

6.1 This FRA has identified no prohibitive engineering constraints in developing the proposed site at The Valley. The document demonstrates the ability of the proposed development to comply with national, regional and local guidance in the form of NPPF, the SWJPU SFRA and CIRIA guidance et al.

6.2 In terms of fluvial flood risk, the proposed built development lies in Flood Zone 1, being land that lies outside the 1 in 1,000 year (0.1%AEP) flood risk area.

6.3 Additionally, all built development will be situated beyond the extents of the 1 in 1,000 year (0.1%AEP) flood risk area corridor either side of the ordinary watercourse which runs through the site.

6.4 A storm water management system will be employed that results in peak flow discharges from the developed areas of the site being reduced to baseline greenfield run off rates. Proposals are outlined that show the strategic management system, and the FRA outlines additional source control features that will be implemented where appropriate.

6.5 Foul drainage proposals are being developed in consultation with Severn Trent Water that provide for a connection to the existing network within the site.

7 LIMITATIONS

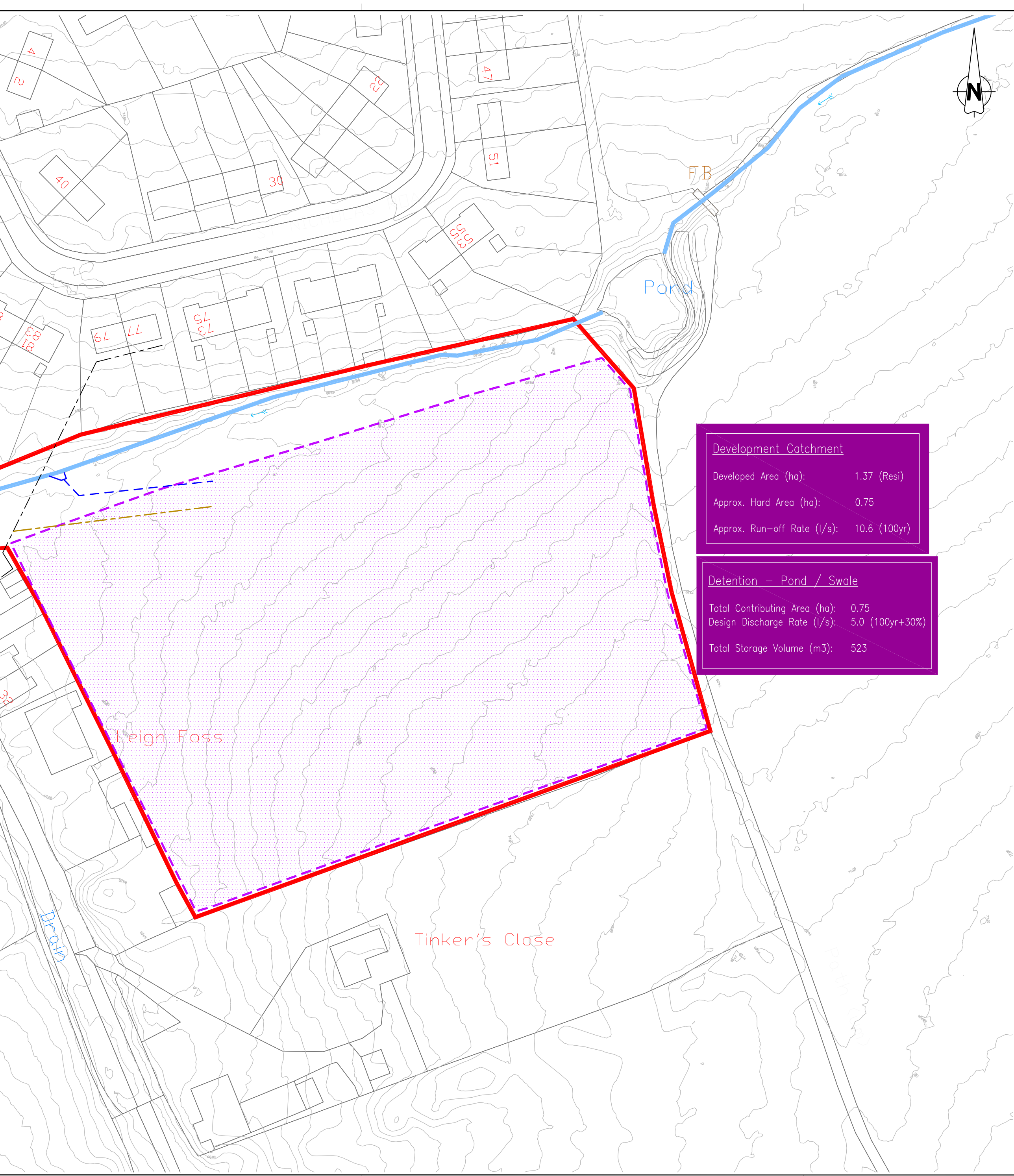
7.1 The conclusions and recommendations contained herein are limited to those given the general availability of background information and the planned usage of the site.

7.2 Third party information has been used in the preparation of this report, which RMO, by necessity assumes is correct at the time of writing. While all reasonable checks have been made on data sources and the accuracy of data, RMO accepts no liability for same.

7.3 The benefits of this report are provided solely to Protech Developments for the proposed development land at The Valley only.

7.4 RMO excludes third party rights for the information contained in the report.

APPENDICIES



NOTES:

1. DO NOT SCALE OFF THIS DRAWING.
2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL SCHEME SPECIFIC DRAWINGS, SPECIFICATIONS AND SCHEDULES.
3. SURVEY INFORMATION HAS BEEN PROVIDED BY A THIRD PARTY. RMO CONSULTANTS LIMITED CANNOT BE HELD RESPONSIBLE FOR THE ACCURACY OF THIS INFORMATION.
4. DETAILS OF EXISTING SURFACE WATER AND FOUL WATER SEWERS HAVE BEEN TAKEN FROM RECORDS PROVIDED BY SEVERN TRENT WATER. THEIR ROUTE IS ILLUSTRATIVE ONLY. FOR FIRM DETAILS REFER TO SEVERN TRENT WATER ASSET PLANS.
5. THE SURFACE AND FOUL WATER DRAINAGE STRATEGY SHOWN ON THIS DRAWING IS ILLUSTRATIVE AND IS SUBJECT TO DETAILED DESIGN AND APPROVAL FROM THE RELEVANT STATUTORY BODIES.
6. ALL CONNECTION POINTS TO THE EXISTING SEWERAGE NETWORK ARE SUBJECT TO SECTION 106 APPROVAL (WATER INDUSTRY ACT 1991).
7. THE CATCHMENT SHOULD UTILISE SUSTAINABLE DRAINAGE MEASURES SUCH AS BUT NOT LIMITED TOO POROUS PAVING, FILTER STRIPS AND SWALES.
8. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE FLOOD RISK ASSESSMENT.
9. DETENTION VOLUMES ARE PRELIMINARY AND SUBJECT TO REFINEMENT FOLLOWING DETAILED DESIGN.

KEY:

- APPLICATION BOUNDARY
- ORDINARY WATERCOURSE
- EXISTING FOUL WATER SEWER
- CATCHMENT AREA
- PROPOSED FOUL WATER SEWERS
- PROPOSED SURFACE WATER SEWERS
- EXISTING CONTOURS 0.5M INTERVALS

Rev.	Date	Revision details	Drawn	Checked	Approved

RMO
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71 Winbrook
Bewdley

- Civil & Structural Engineers
- Development Consultants
- Project Managers

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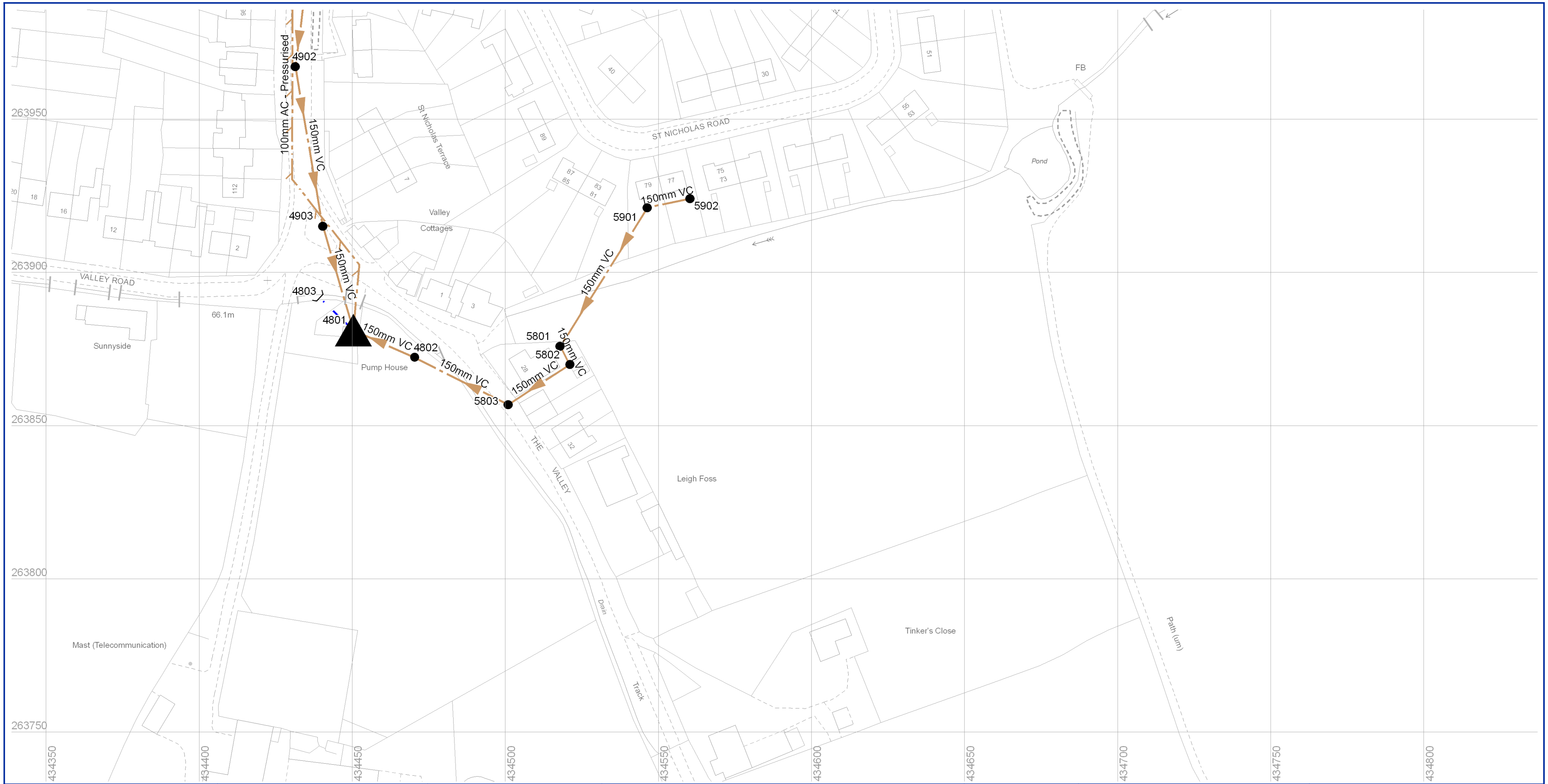
Client
PROTECH DEVELOPMENTS

Project
PROPOSED DEVELOPMENT
THE VALLEY
RADFORD SEMELE

Title
ILLUSTRATIVE
SURFACE & FOUL WATER
STRATEGY PLAN

Drawn	Checked	Approved
NW	RM	RM
Original drg. size: A1	Date: 27/05/15	Scale: 1:500@A1

Drawing Status	Drawing Number	Rev.
PRELIMINARY	R10024/DR/100	-



Abandoned Gravity Sewer
Private Combined Gravity Sewer
Private Foul Gravity Sewer
Private Surface Water Gravity Sewer
Public Combined Gravity Sewer
Public Foul Gravity Sewer
Public Surface Water Gravity Sewer
Trunk Combined Gravity Sewer
Trunk Foul Use Gravity Sewer
Trunk Surface Water Gravity Sewer
Combined Use Pressurised Sewer
Foul Use Pressurised Sewer
Surface Water Pressurised Sewer
Highway Drain
Combined Lateral Drain (SS)
Foul Lateral Drain (SS)
Surface Water Lateral Drain (SS)

All Private Sewers are shown in magenta
All section 104 sewers are shown in green
All Sewers that have been transferred to Severn Trent Water after the 1st October 2011, but have not been surveyed and confirmed by Severn Trent Water are shown in orange

Culverted Watercourse
Cable, Earthing
Cable Junction
Cable, Optical Fibre/Instrumentation
Cable, Low Voltage
Cable, High Voltage
Cable, Other
Housing, Building
Housing, Kiosk
Disposal Site
Sewage Treatment Works
Housing, Other
Pipe Support Structure
Sewage Pumping Facility
Sewer Facility Connection Inlet / Outlet

Blind Shaft
Combined Use Manhole
Flushing Chamber
Foul Use Manhole
Grease Trap
Head Node
Hydrobrake
Lamphole
Outfall
Overflow
Penstock
Petrol Interceptor

Sewer Chemical Injection Point
Sewer Junction
Sewerage Air Valve
Sewerage Hatch Box Point
Sewerage Isolation Valve
Soakaway
Surface Water Manhole
Vent Column
Waste Water Storage
Pre-1937 Properties

MATERIALS

- \- NONE
- AC - ASBESTOS CEMENT
- BR - BRICK
- CC - CONCRETE BOX CULVERT
- CI - CAST IRON
- CO - CONCRETE
- CSB - CONCRETE SEGMENTS (BOLTED)
- CSU - CONCRETE SEGMENTS (UNBOLTED)
- DI - DUCTILE IRON
- GRC - GLASS REINFORCED CONCRETE
- GRP - GLASS REINFORCED PLASTIC
- MAC - MASONRY IN REGULAR COURSES
- MAR - MASONRY RANDOMLY COURSED
- PE - POLYETHLENE
- PF - PITCH
- PP - POLYPROPYLENE
- PSC - PLASTIC STEEL COMPOSITE
- PVC - POLYVINYL CHLORIDE
- RPM - REINFORCED PLASTIC MATRIX
- SI - SPUN (GREY) IRON
- ST - STEEL
- U - UNKNOWN
- VC - VITRIFIED CLAY
- XXX - OTHER

CATEGORIES

- W - WEIR
- C - CASCADE
- DB - DAMBOARD
- SE - SIDE ENTRY
- FV - FLAP VALVE
- BD - BACK DROP
- S - SIPHON
- HD - HIGHWAY DRAIN
- S104 - SECTION 104

SHAPE

- C - CIRCULAR
- E - EGG SHAPED
- O - OTHER
- R - RECTANGLE
- S - SQUARE
- T - TRAPEZOIDAL
- U - UNKNOWN

PURPOSE

- C - COMBINED
- E - FINAL EFFLUENT
- F - FOUL
- L - SLUDGE
- S - SURFACE WATER

N E S W

SEVERN TRENT WATER

Severn Trent Water Limited
Asset Data Management
PO Box 5344
Coventry
CV3 9FT
Telephone: 0845 601 6616

SEWER RECORD

O/S Map scale: 1:1250

Date of issue: 10.08.15

This map is centred upon:
O / S Grid reference:

x : 434587

y : 263859

Disclaimer Statement:

1. Do not scale off this Map.

2. This map and any information supplied with it is furnished as a general guide, is only valid at the date of issue and no warranty as to its correctness is given or implied. In particular this Map and any information shown on it must not be relied upon in the event of any development or works (including but not limited to excavations) in the vicinity of Severn Trent Water's assets or for the purposes of determining the suitability of a point of connection to the sewerage or distribution systems.

3. On **1 October 2011** most private sewers and private lateral drains in Severn Trent Water's sewerage area, which were connected to a public sewer as at 1 July 2011, transferred to the ownership of Severn Trent Water and became public sewers and public lateral drains. A further transfer takes place on 1 October 2012 (date to be confirmed).
Private pumping stations, which form part of these sewers or lateral drains, will transfer to the ownership of Severn Trent Water on or before 1 October 2016.
Severn Trent Water does not possess complete records of these assets.
These assets may not be displayed on this Map.

Sewer Node

Sewer Pipe Data

REFERENCE	*COVER LEVEL*	*INV LEVEL UPSTR*	*INV LEVEL DOWNSTR*	*PURP*	*MATL*	*SHAPE*	*MAX SIZE*	*MIN SIZE*	*GRADIENT*	*YEAR LAID*
SP34634802	66.35	nil	64.16	F	VC	C	150	nil	0.00	nill
SP34634901	71.28	69.55	67.58	F	VC	C	150	nil	11.21	nill
SP34634902	68.94	67.54	64.62	F	VC	C	150	nil	18.07	nill
SP34634903	66.53	64.61	64.16	F	VC	C	150	nil	78.76	nill
SP34635801	nil	nil	nil	F	VC	C	150	nil	0.00	nill
SP34635802	nil	nil	64.67	F	VC	C	150	nil	0.00	nill
SP34635803	65.93	64.68	nil	F	VC	C	150	nil	0.00	nill
SP34635901	69.63	68.63	nil	F	VC	C	150	nil	0.00	nill
SP34635902	69.81	68.81	68.72	F	VC	C	150	nil	159.11	nill
SP34644001	72.38	70.77	69.59	F	VC	C	150	nil	16.95	nill
SP34645002	77.36	76.18	75.01	S	VC	C	150	nil	39.14	nill

MATERIALS

-	- NONE
AC	- ASBESTOS CEMENT
BR	- BRICK
CC	- CONCRETE BOX CULVERT
CI	- CAST IRON
CO	- CONCRETE
CSB	- CONCRETE SEGMENTS (BOLTED)
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U	- UNKNOWN

PURPOSE

C	- COMBINED
E	- FINAL EFFLUENT
F	- FOUL
L	- SLUDGE
S	- SURFACE WATER

TABULAR KEY

A. Sewer pipe data refers to downstream sewer pipe.

B. Where the node bifurcates (splits) X and Y indicates downstream sewer pipe.

C. Gradient is stated a 1 in...

SEVERN TRENT WATER

Severn Trent Water Limited
Asset Data Management
PO Box 5344
Coventry
CV3 9FT
Telephone: 0845 601 6616

SEWER RECORD DATA TABLE

O/S Map scale:	1:1750	**This map is centred upon: O / S Grid reference:**	
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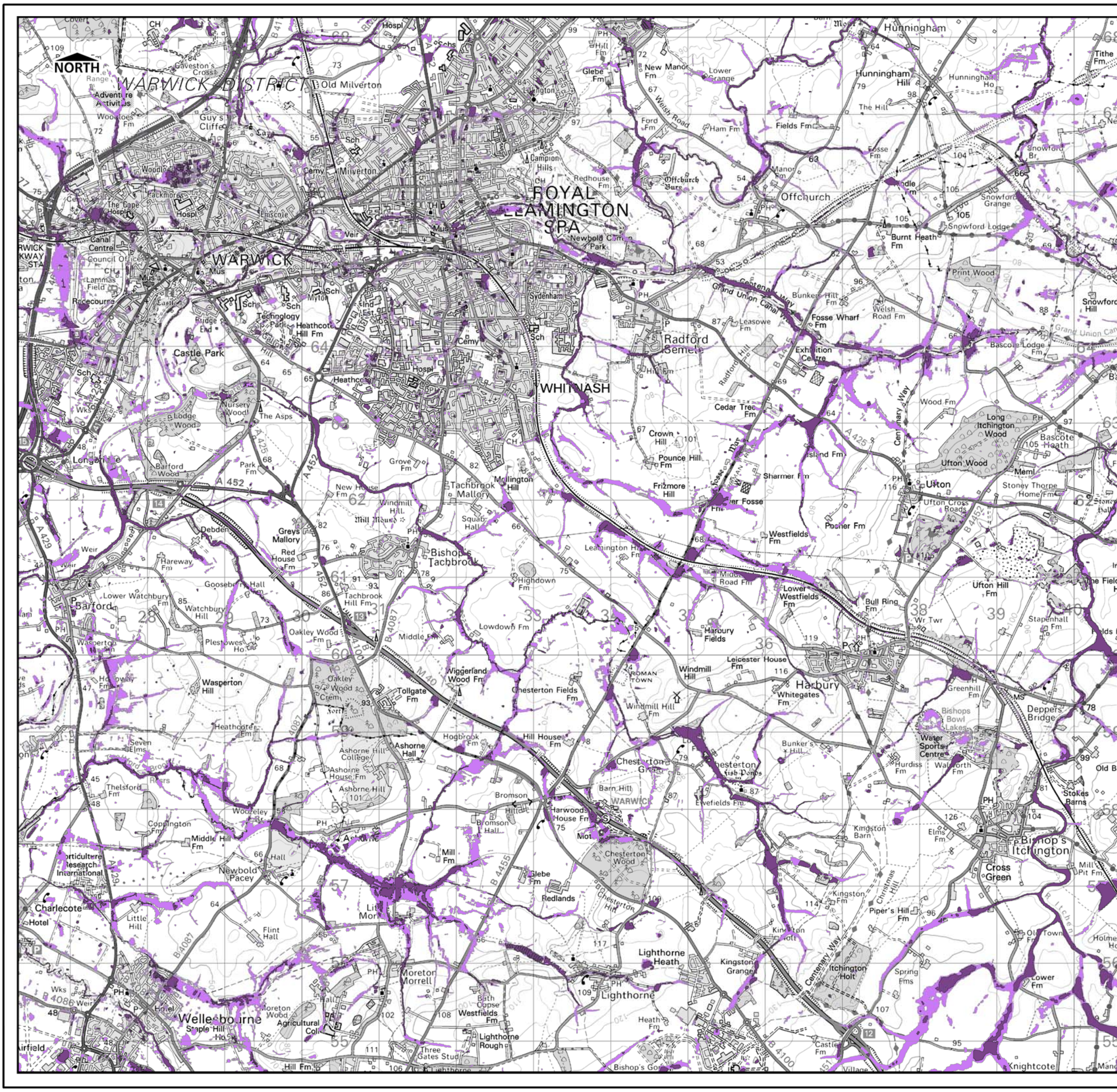
Sheet No.	2 of 2	**y :**	263859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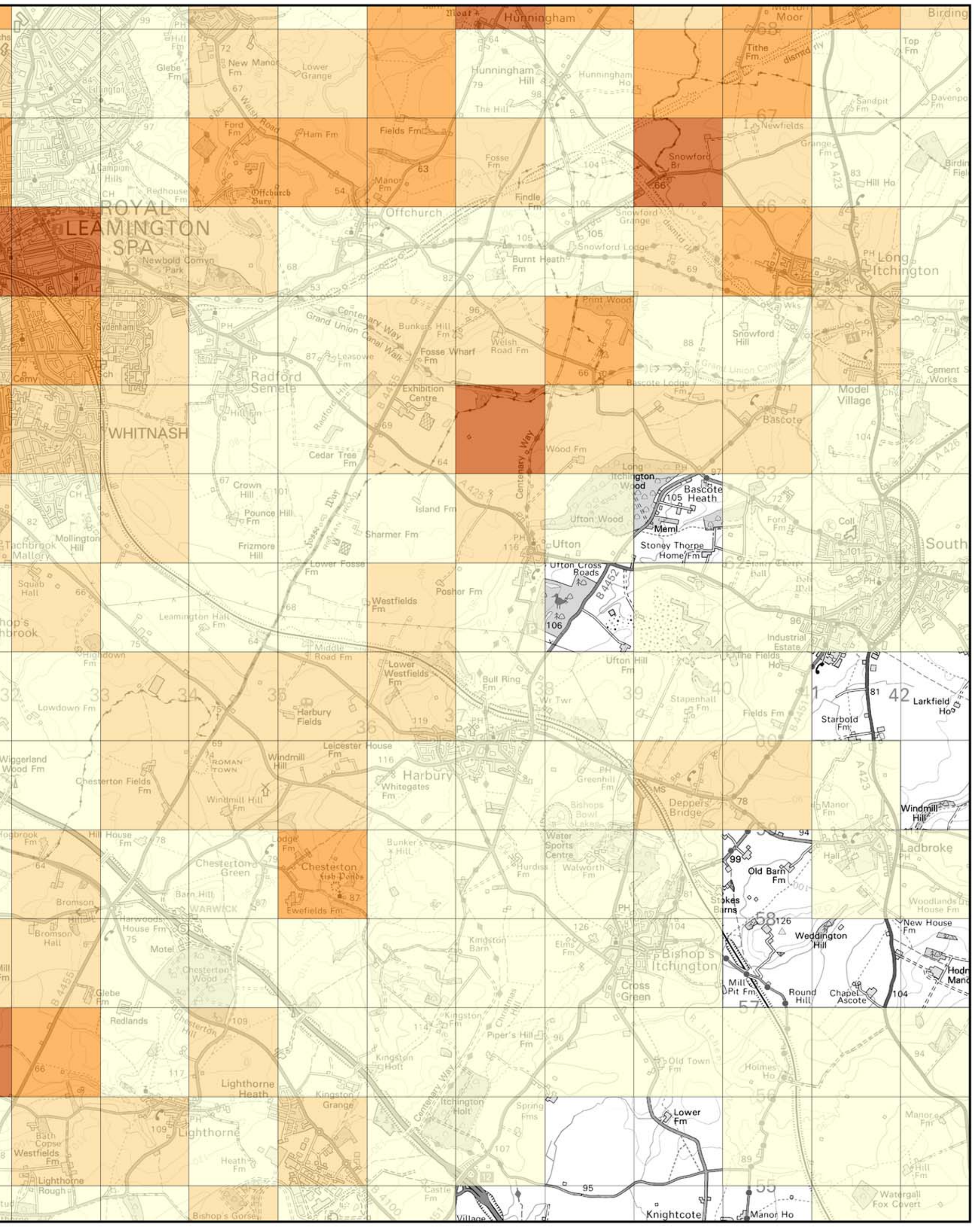
ROYAL LEAMINGTON SPA
WARWICK
WHITNASH
Old Milverton
Offchurch
Hunningham
Radford Semele
Bishop's Tachbrook
Harbury
Bishop's Itchington
Barford
Wellesbourne
Lighthorne
Lighthorne Heath
Charlecote
Newbold Pacey
Ufton
Castle Park
Grand Union Canal
Centenary Way



THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED

LEGEND

Warwickshire CC

Area Susceptible to Groundwater Flooding

- <25%
- >= 25% < 50%
- >= 50% < 75%
- >= 75%

OVERVIEW

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Level 1 Strategic Flood Risk Assessment

North Warwickshire Borough Council

Warwickshire County Council

Stratford-on-Avon DC, Warwickshire CC, North Warwickshire BC, Rugby BC

Scale at A3 1:50,000	Date Sept 2013	Drawn by: DS Approved by: GH

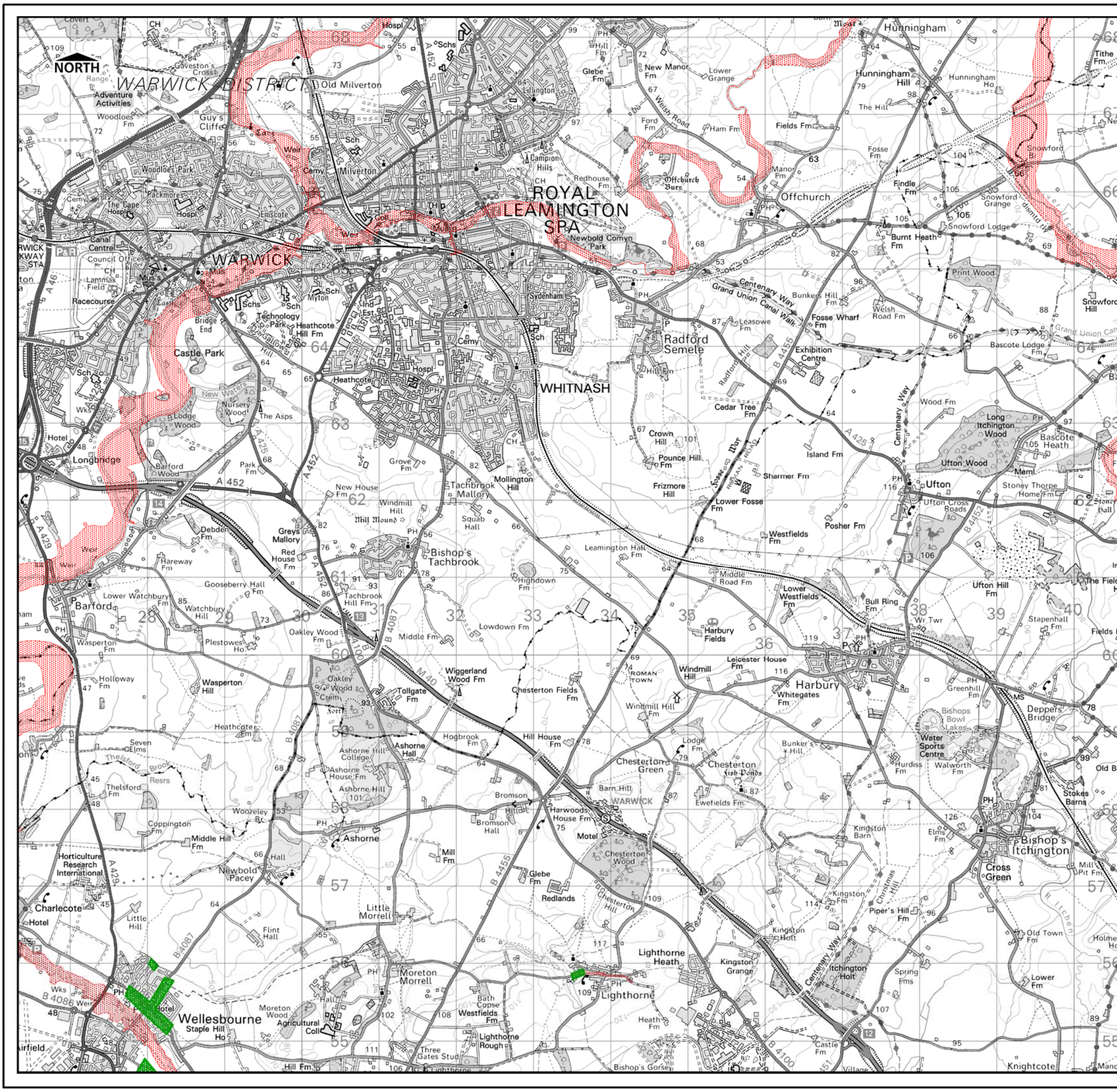
Areas Susceptible to Groundwater Flooding

Consultants

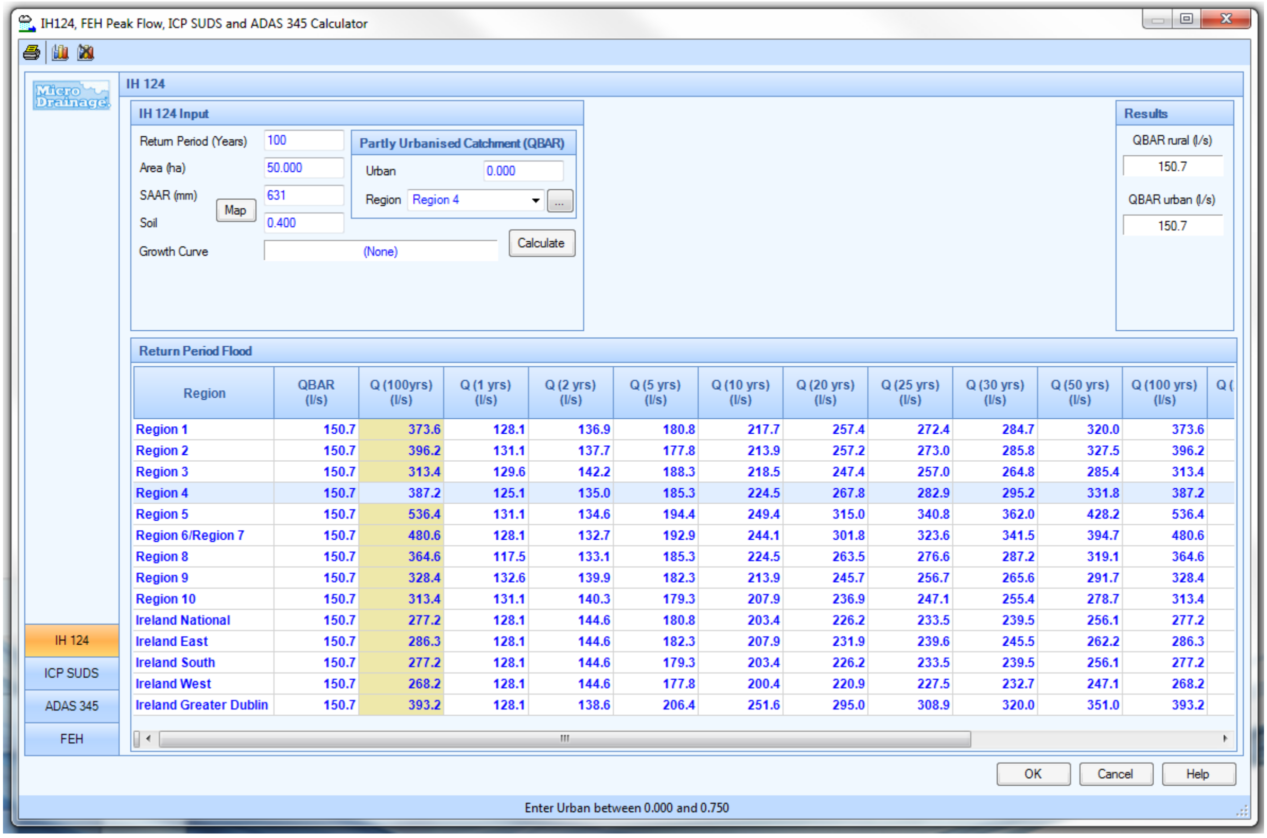
URS
6 - 8 Greencoat Place
London
SW1P 1PL

Figure A3 xi

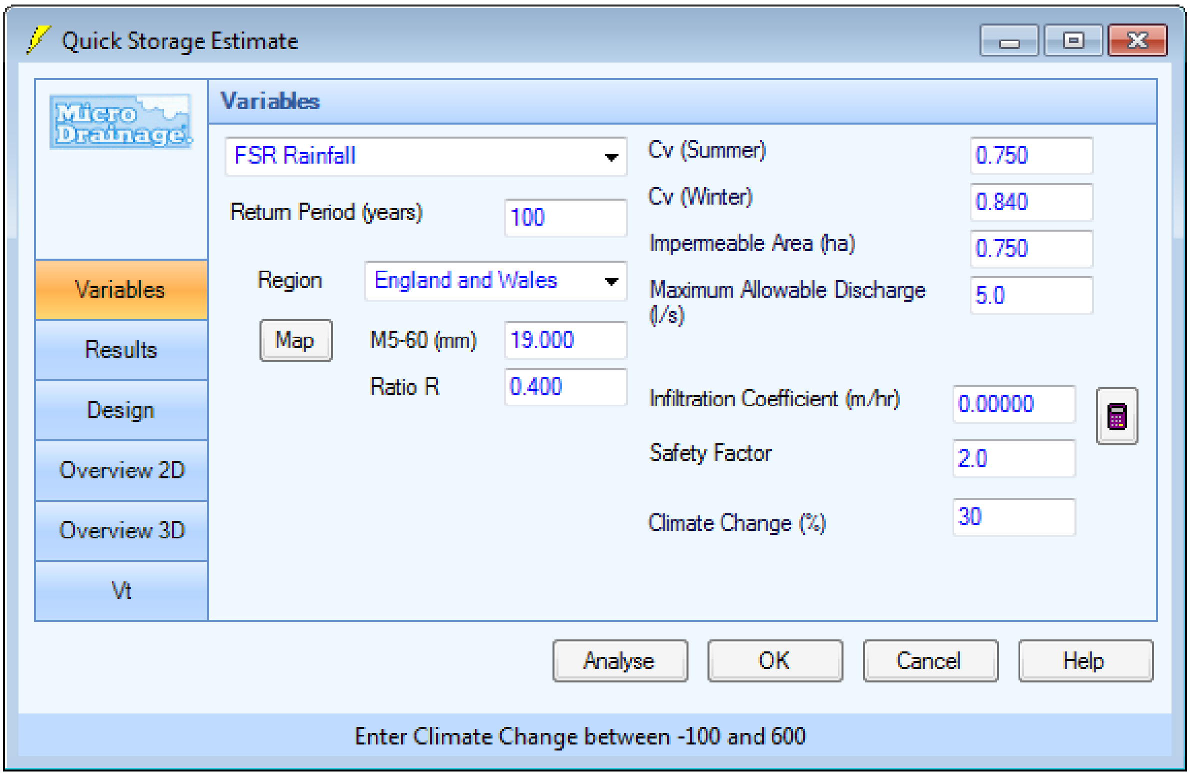
Version 1



NORTH
WARWICK DISTRICT
ROYAL LEAMINGTON SPA
WARWICK
WHITNASH
Old Milverton
Milverton
Offchurch
Hunningham
Radford Semele
Bishop's Tachbrook
Tachbrook Mallory
Harbury
Ufton
Bishop's Itchington
Cross Green
Wellesbourne
Charlecote
Barford
Longbridge
Castle Park
Ashorne
Newbold Pacey
Moreton Morrell
Little Morrell
Lighthorne
Lighthorne Heath
Chesterton Green
Chesterton
Deppers Bridge
Long Itchington Wood
Ufton Wood
Bascote Heath
Grand Union Canal Walk
Centenary Way



Region	QBAR (l/s)	Q (100yrs) (l/s)	Q (1 yrs) (l/s)	Q (2 yrs) (l/s)	Q (5 yrs) (l/s)	Q (10 yrs) (l/s)	Q (20 yrs) (l/s)	Q (25 yrs) (l/s)	Q (30 yrs) (l/s)	Q (50 yrs) (l/s)	Q (100 yrs) (l/s)
Region 1	150.7	373.6	128.1	136.9	180.8	217.7	257.4	272.4	284.7	320.0	373.6
Region 2	150.7	396.2	131.1	137.7	177.8	213.9	257.2	273.0	285.8	327.5	396.2
Region 3	150.7	313.4	129.6	142.2	188.3	218.5	247.4	257.0	264.8	285.4	313.4
Region 4	150.7	387.2	125.1	135.0	185.3	224.5	267.8	282.9	295.2	331.8	387.2
Region 5	150.7	536.4	131.1	134.6	194.4	249.4	315.0	340.8	362.0	428.2	536.4
Region 6/Region 7	150.7	480.6	128.1	132.7	192.9	244.1	301.8	323.6	341.5	394.7	480.6
Region 8	150.7	364.6	117.5	133.1	185.3	224.5	263.5	276.6	287.2	319.1	364.6
Region 9	150.7	328.4	132.6	139.9	182.3	213.9	245.7	256.7	265.6	291.7	328.4
Region 10	150.7	313.4	131.1	140.3	179.3	207.9	236.9	247.1	255.4	278.7	313.4
Ireland National	150.7	277.2	128.1	144.6	180.8	203.4	226.2	233.5	239.5	256.1	277.2
Ireland East	150.7	286.3	128.1	144.6	182.3	207.9	231.9	239.6	245.5	262.2	286.3
Ireland South	150.7	277.2	128.1	144.6	179.3	203.4	226.2	233.5	239.5	256.1	277.2
Ireland West	150.7	268.2	128.1	144.6	177.8	200.4	220.9	227.5	232.7	247.1	268.2
Ireland Greater Dublin	150.7	393.2	128.1	138.6	206.4	251.6	295.0	308.9	320.0	351.0	393.2


Quick Storage Estimate
Micro Drainage
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Variables
FSR Rainfall
Return Period (years)
100
Region
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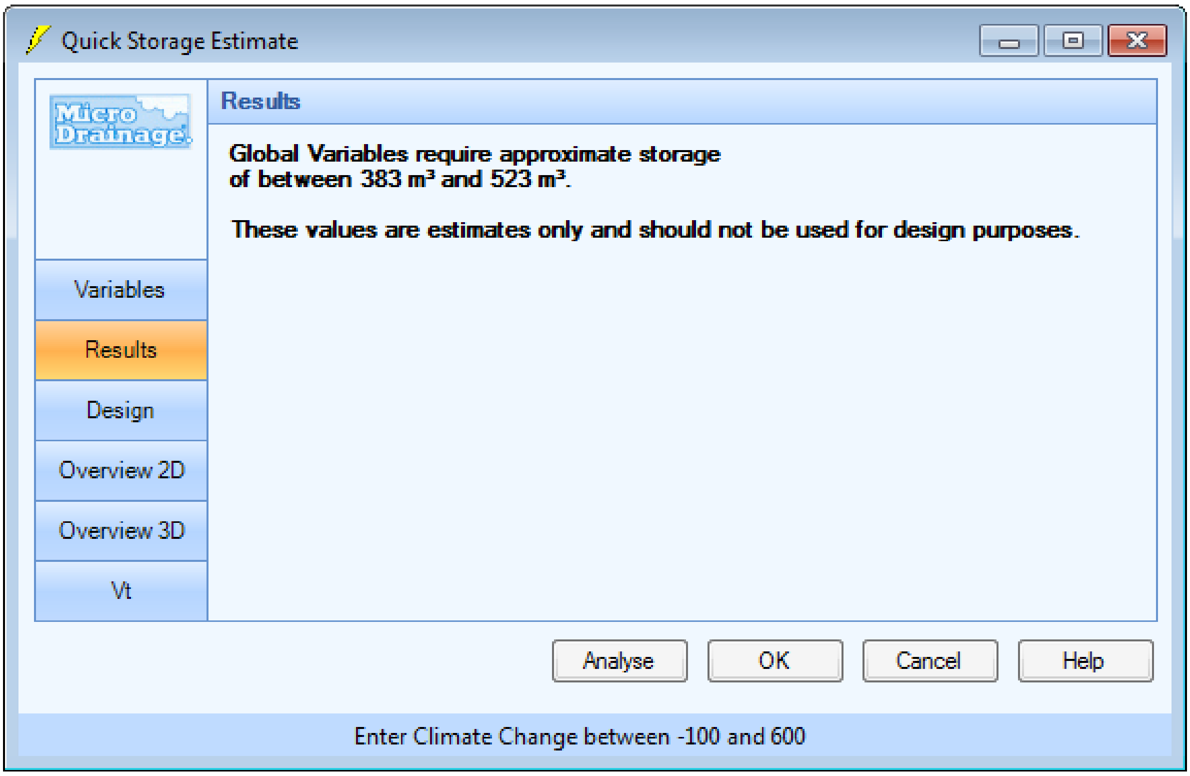
Map
M5-60 (mm)
19.000
Ratio R
0.400
Cv (Summer)
0.750
Cv (Winter)
0.840
Impermeable Area (ha)
0.750
Maximum Allowable Discharge (l/s)
5.0
Infiltration Coefficient (m/hr)
0.00000
Safety Factor
2.0
Climate Change (%)
30
Analyse
OK
Cancel
Help
Enter Climate Change between -100 and 600


Quick Storage Estimate
Micro Drainage
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Results
Global Variables require approximate storage
of between 383 m³ and 523 m³.
These values are estimates only and should not be used for design purposes.
Analyse
OK
Cancel
Help
Enter Climate Change between -100 and 600