Forge Engineering Design Solutions

FLOOD RISK ASSESSMENT
FRA 1

Residential Development
Blossom Fields
Bodicote

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Introduction

Policy 103 of the National Planning Policy Framework (NPPF) requires that when determining planning applications, local planning authorities should ensure flood risk is not increased elsewhere and only consider development appropriate in areas at risk of flooding where, informed by a site-specific flood risk assessment (FRA), compliant with the technical guidance to the NPPF, "Planning Practice Guidance Flood Risk and Costal Change" (PPG FRCC), following the Sequential Test, and if required the Exception Test, it can be demonstrated that:

- within the site, the most vulnerable development is located in areas of lowest flood risk unless there are overriding reasons to prefer a different location; and
- development is appropriately flood resilient and resistant, including safe access and escape routes where required, and that any residual risk can be safely managed, including by emergency planning; and it gives priority to the use of sustainable drainage systems

Forge Engineering Design Solutions Ltd was commissioned by the applicant, Mr O Wells, to carry out a site-specific FRA to support an outline planning application to Cherwell District Council (CDC) for the proposed residential development at Blossom Fields, Bodicote, in compliance with the NPPF.

Site Location, Main Rivers, Watercourses and Flood Zones

The site is located to the west of Oxford Road, the A4260. The site can be located by Grid Coordinates 446700mE, 237330mN. The site covers an area of approximately 4.50 hectares.

The site is bound by other residential dwellings to the north west, commercial properties to the north east and east, and agricultural land to the south east, south and south west. See site Location Maps in Appendix 1.

The nearest Main Rivers are the Sor Brook and the River Cherwell, which are located approximately 500m south west and 2000m east of the site, respectively. Other surface water features within the vicinity of the site are the Oxford Canal approximately 1700m east of the site and a reservoir approximately 360m south west of the site.

The Environment Agency's (EA) Indicative Flood Zone Map indicates that the site is located in Flood Zone 1, which has a Low risk of fluvial flooding from Main Rivers. See Environment Agency's Indicative Flood Zone Maps in Appendix 1.

Therefore, this FRA has been carried out in accordance with the EA's FRA Guidance Note 1 for Development within a Critical Drainage area or greater than 1 hectare (ha) in Flood Zone 1. The FRA should address the following issues:

- Surface water runoff should not increase flood risk to the development or third parties. This should be done by using a Sustainable Drainage Systems (SuDS) to attenuate to at least pre-development runoff rates and volumes or where possible achieving betterment in the surface water runoff regime.

- An allowance for climate change needs to be incorporated, which means adding an extra amount to peak rainfall (20% for commercial development, 30% for residential).

- The residual risk of flooding needs to be addressed should any drainage features fail or if they are subjected to an extreme flood event. Overland flow routes should not put people and property at unacceptable risk. This could include measures to manage residual risk such as raising ground or floor levels where appropriate.

The EA is operating a risk based approach to planning consultations. As the site lies in Flood Zone 1 and is between 1 and 5 ha the EA do not always make a bespoke response to the proposed development.

However, to assist the Local Planning Authority reviewing the FRA, the EA recommend a pro-forma be completed that will act as a summary of the surface water drainage scheme on the proposed development site and asks the developer to confirm that surface water flood risk will be adequately managed on site so as to not cause an increase in flood risk.

The LPA should review the FRA with the pro-forma. To assist the LPA the pro-forma has been completed and included in Appendix 1 of this FRA.

Existing Development

The existing development consists of an agricultural field and short section of asphalt existing access road. See Existing Site Plan in Appendix 2.

The total site covers an area of approximately 45,000m^2 (4.50 ha). The majority of the site is covered with permeable agricultural land.

Less than 1% of the site is covered with impermeable asphalt hardstanding. Therefore, for the purpose of this FRA and for the design of the surface water management strategy, the site has been considered to be 100% permeable.

Proposed Development

The proposed development includes the construction of approximately 95 new dwellings with associated infrastructure and open amenity areas. See Proposed Site Plan in Appendix 2.

At the outline planning stage it is assumed that 50% of the site could become impermeable, which is a worst case scenario. Therefore, the impermeable areas could cover a total area of approximately 22,500m^2, and the permeable areas could cover a total area of approximately 22,500m^2.

Topographical Survey

Ground levels at the site to Ordnance Datum are shown on the topographical survey included in Appendix 3.

The site levels range from 102.270 Above Ordnance Datum (AOD) at the middle of the south western boundary of the site up to 114.130m AOD in the south eastern area of the site. The average site level is approximately 108.200m AOD.

The site is located in a natural valley. The valley floor slopes down towards the south western boundary of the site, to a level of approximately 102.27mAOD, from the north eastern boundary of the site.

The sides of the valley slope down from 112.000m AOD in the north western boundary of the site and, down from 114.130m AOD in the south eastern area of the site.

Existing Site Drainage

As well as infiltrating into the ground at its source, surface water at the site flows across the site in a northerly and southerly direction to the valley at the middle of the site, at the Greenfield run-off rate, which then flows into the Sor Brook via overland flow and existing surface water drainage ditches. See topographical survey in Appendix 3 and Thames Water Asset Location Plans in Appendix 4.

Geology, Hydrogeology and Permeability

The British Geological Survey Maps indicate that the site is not underlain by any superficial drift geology. The site is directly underlain by the Lower Jurassic Lias Group bedrock geology, which consists of varying quantities of Mudstone, Siltstone, Limestone and Sandstone.

BRE 365 Soil Infiltration Tests were carried out in June 2014, which included six trial pits excavated to depths between 1.000m and 2.250m.

The site investigation (SI) included three BRE 365 Soil Infiltration test pits the for surface water management strategy design purposes and three to establish if ground water was present at a depth approximately 1.000m below any potential soakaways.

The SI identified that the site was overlain by approximately 0.20m to 0.30m of topsoil, which was in turn underlain by a weathered Marlstone, to depths between 0.300m and 2.250m, which is contains iron-rich limestone and is orange brown in colour. Towards the base of the deeper trial pits the Marlstone started to become a bluish colour as it became un-weathered Marlstone.

The groundwater table was not encountered in 5 of the 6 trial pits, which were excavated to a maximum depth of 2.250m. A very small amount of groundwater seepage was encountered in TP4, which was excavated to a depth of 2.250m. BRE365 Soil Infiltration Tests identified an average soil permeability rate of 3.15×10^{-6}m/s, which is a moderate infiltration rate and suitable for infiltration techniques such as soakaways, porous paving, infiltration basins and grass swales.

The Environment Agency's aquifer maps identify that the site is located over a Secondary A Aquifer. These aquifers are 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. This Secondary A Aquifer would be located within the Marlstone bedrock.

Strategic Flood Risk Assessment

West Oxfordshire District Council (WODC) and Cherwell District Council (CDC) carried out a joint Level 1 Strategic Flood Risk Assessment (SFRA) for their districts, and published the final report in April 2009.

The aim of WODC and CDC's SFRA is to assess and map the different levels and types of flood risk in the study area for the land use planning process.

The objectives of the SFRA were:

• To provide an assessment of the impact of all potential sources of flooding in accordance with PPS25 using the information available, including an assessment of any future impacts associated with climate change;

• To enable planning policies to be identified to minimise and manage local flooding issues;

• To provide information required to apply the Sequential Test for identification of land suitable for development in line with the principles of PPS25;

• To provide baseline data to inform the Sustainability Appraisal (SA) of the Development Plan Documents (DPDs) with regard to catchment-wide flooding issues which affect the Study Area;
• To provide sufficient information to allow the Councils to assess flood risk for specific development proposal sites to include minerals and waste sites, thereby setting out the requirements for site specific Flood Risk Assessments (FRAs);

• To enable the Councils to use the SFRA as a basis for decision making at the planning application stage;

• To provide recommendations of suitable mitigation measures including the objectives of Sustainable Drainage Systems (SuDS);

• Where necessary, provide technical assessments to demonstrate that development located in flood risk areas are appropriate and in line with the requirements of the exception test;

• Present sufficient information to inform the Councils of the acceptability of flood risk in relation to emergency planning capability.

Please note that Planning Policy Statement 25 (PPS25) has been superseded by the National Planning Policy Framework (NPPF) and the technical guidance to the NPPF, PPG RFCC.

The SFRA states that new development or intensification of existing development will not be permitted within areas at risk from flooding which is likely to:

• Impede the flow of flood water;
• Result in the net loss of floodplain storage;
• Increase the risk of flooding elsewhere

The proposed development has been designed to comply with the above planning and flood risk mitigation requirements.

Surface Water Management Strategy

SuDS

The implementation of a surface water management strategy for new developments can ensure that there is no increase of flood risk as a result of the proposed development by avoiding the creation of, reducing and delaying the discharge of rainfall run-off to watercourses and public sewers using SuDS techniques.

The use of the SuDS management train and infiltration techniques also allows for the management of potential pollution to controlled waters, through sedimentation and infiltration. SuDS ensure that surface water run-off cannot discharge directly into controlled waters such as groundwater and watercourses, and consequently reduces the risk of pollution.

The existing site's Greenfield surface water run-off rate can be maintained through the utilisation of SuDS. SuDS aim to mimic the natural drainage processes whilst also removing pollutants from urban run-off at the source before entering a watercourse. There are a wide range of SuDS infiltration techniques. These include, but are not limited to;

- Soakaways (Recharge groundwater/aquifer)
- Filter strips adjacent to roads (Re-charge groundwater/aquifer).
- Swales around the site and adjacent to roads (Re-charge groundwater/aquifer and biodiversity)
- Pervious paving of road and car parks (Re-charge groundwater/aquifer)

There are other forms of SuDS that do not use infiltration, which can assist in the reduction of the post-development surface water run-off. Examples of these are;

- Rainwater harvesting tanks and rainwater harvesting butts (water conservation)
- Above ground attenuation ponds and detention basins (amenity and biodiversity areas)
- Below ground geo-cellular attenuation tanks
- Green Roof (attenuation)

SuDS, can be used to mitigate flooding or pollution. They also provide environmental benefits. Some of the environmental benefits are listed below:

- The hydraulic benefits, including peak flow rate reductions, storm run-off volume reductions, and enhancements to river base flow and aquifer recharge.
- The pollutant loading reductions achieved by the system, and associated benefits to in-stream ecology, human health, and human value perceptions.
- The amenity and recreational benefit enjoyed by those who live close to the SUDS scheme.
- The additional value of properties adjacent or within view of the SUDS scheme.
- The ecological value of the SUDS schemes themselves.

One or more of the above SuDS techniques should be utilized in the surface water management strategy to minimise the surface water run-off from the site and the impacts of the development on the surrounding area.

The SuDS Management Train as set out in the SuDS Manual (CIRIA C697), which provides best practice guidance on the planning, design, construction and maintenance of SuDS, should be utilized in the SuDS design to mimic natural catchment processes as closely as possible. It uses SuDS drainage techniques in series to incrementally reduce pollution, flow rates and volumes.

The hierarchy of techniques that should be considered in developing the management train are as follows:

1. **Prevention** – the use of good site design and site housekeeping measures to prevent run-off and pollution (e.g. sweeping to remove surface dust and detritus from car parks), and rainwater reuse/harvesting. Prevention policies should generally be included within the site management plan.
2. **Source control** – control of run-off at or very near its source (e.g. soakaways, other infiltration methods, green roofs, pervious pavements).
3. **Site control** – management of water in a local area or site (e.g. routing water from building roofs and car parks to a large soakaway, infiltration or detention basin).
4. **Regional control** – management of run-off from a site or several sites, typically in a balancing pond or wetland.

Wherever possible, storm water should be managed in small, cost-effective landscape features located within small sub-catchments rather than being conveyed to and managed in large systems at the bottom of drainage areas (end of pipe solutions).

The techniques that are higher in the hierarchy are preferred to those further down so that prevention and control of water at source should always be considered before site or regional controls.

Climate Change

Paragraph 100 of the NPPF requires Climate Change to be considered with regards to flood risk and recommends the national precautionary sensitivity ranges for peak rainfall intensities, peak river flows, offshore wind speeds and wave heights that should be applied to new developments:

<table>
<tr><th>Parameter</th><th>1990-2025</th><th>2025-2055</th><th>2055-2085</th><th>2085-2115</th></tr>
<tr><td>Peak Rainfall intensity</td><td>+5%</td><td>+10%</td><td>+20%</td><td>+30%</td></tr>
<tr><td>Peak River Flow</td><td>+10%</td><td colspan="3">+20%</td></tr>
<tr><td>Offshore wind speed</td><td colspan="2">+5%</td><td colspan="2">+10%</td></tr>
<tr><td>Extreme wave height</td><td colspan="2">+5%</td><td colspan="2">+10%</td></tr>
</table>

Climate change is expected to increase the risk of fluvial flooding due to a 20% increase in river flows, and surface water run-off is expected to increase due to a 30% increase in rainfall intensities.

Developments should not increase flood risk at the site or the surrounding area and, where possible, they should aim to reduce existing flood risk by incorporating SuDS to reduce the surface water run-off rate of the site.

The surface water management strategy should ensure that the new surface water drainage system at the site is capable of attenuating the 1 in 100 year storm event including a 30% allowance for climate change, while limiting the surface water discharge rate from the site to the site's existing run-off rate or where possible the Greenfield run-off rate.

Existing and Proposed Developments' Surface Water Run-off without SuDS

The development site covers an area of approximately 45,000m^2 (4.50ha), and is located within a sloping valley.

Consequently, an increase in impermeable area, without mitigating SuDS techniques, could result in an increase in surface water run-off and an increase in flood risk at the site and surrounding areas.

The existing site has been assumed to have permeable areas totalling 45,000m^2 (4.50ha) and no impermeable areas. See the Existing site plan in Appendix 2.

The proposed development was predicted to include permeable areas totalling 22,500m^2 (2.250ha) and potentially a total impermeable area of approximately 22,500m^2 (2.250ha). See the Proposed site plan in Appendix 2.

Therefore, without mitigating SuDS, there could be a significant increase in the impermeable areas at the site of 22,500m^2, which equates to 50% of the site area, and a significant increase in the resultant surface water run-off.

This could result in a significant increase in flood risk to the site or the surrounding areas.

Consequently, the development proposals should incorporate SuDS to mitigate the potential increase in impermeable area and the impacts of Climate Change.

Institute of Hydrology (IOH) Surface Water Run-Off Calculations

Greenfield run-off rates are calculated to determine the theoretical rate of discharge from the Greenfield site to surrounding areas and receiving watercourses in the vicinity.

The calculation of peak rates of run-off from Greenfield areas is related to catchment size.

As stated in The SuDS Manual, the existing site's estimated Greenfield run-off rate was calculated using the Institute of Hydrology's Report No. 124 methodology for sites with an area between 0 ha and 50 ha:

$QBAR_{rural} = 0.00108\ AREA^{0.89}\ SAAR^{1.17}\ SOIL^{2.17}$ (IHR 124 equation 7.1)

Where,

0.00108 is a conversion factor for the units used
AREA is the site catchment area in km^2
SAAR is the Standard Average Annual Rainfall
SOIL is the soil index classification.

The run-off rate is calculated for a 50 ha ($0.5km^2$) catchment using the site's catchment details, and then interpolated using the site's total area to calculate the site's Greenfield run-off rate.

Using a SAAR of 654mm and SOIL of 0.400, the estimated existing site's Greenfield surface water run-off rate peak flow is:

$QBar_{rural} = 0.00108 \times 0.50^{0.89} \times 654^{1.17} \times 0.400^{2.17} = 0.1571$ cumecs / 50 ha

which equates to $QBar_{Rrural} = 157.1$ l/s/ 50 ha

which equates to $QBar_{Greenfield} = 3.142$ l/s/ha,

and for a site area of 4.50 ha = 14.1 l/s

For the site's catchment area of 4.50ha and specified storm events, the site's estimated Greenfield run-off rates and volumes are calculated to be:

Storm Event 1 in n year	Growth Curve Factor	Estimated Site's Run-off Rate Peak Flows (l/s)	Estimated Site's Run-off Peak Volume (m^3)
$QBAR_{Greenfield}$	-	14.1	304.6
1 in 1 year	0.85	12.0	259.2
1 in 30 year	2.27	32.0	691.2
1 in 100 year	3.19	45.0	972.0
1 in 100 year + 30% CC	4.15	58.5	1263.6

The IOH 124 method requires that Brownfield run-off rates are calculated using the Greenfield Run-off rates and an adjustment for urbanisation, to allow for the Brownfield impermeable areas, which is demonstrated below for the proposed development site;

The ratio of $QBar_{Brownfield}$ to $QBar_{Greenfield}$ is:

$(1+URBAN)^{2NC}[1+URBAN((21/CIND)-0.3)]$

Where,

NC is the Rainfall continentality factor which is a function of SAAR
CIND is the catchment index = 102.4 SOIL+0.28(CWI-125)
CWI is the Catchment Wetness Index which is a function of SAAR from FSR Report
URBAN is the fraction of the catchment that is impermeable

NC = 0.92-(0.00024 x 654) = 0.76
CWI = 92.1
CIND = (102.4 x 0.400) + 0.28(92.1-125) = 31.7
URBAN = 0.50

The ratio of $QBar_{Brownfield}$ to $QBar_{Greenfield}$ $= (1+0.50)^{1.52}[1+0.50((21/31.7)-0.3)]$
$= 2.19$

For the site's catchment area of 4.50 ha and specified storm events, the site's proposed Brownfield run-off rates and volumes (without mitigating SuDS) are calculated to be:

Storm Event 1 in n year	Growth Curve Factor	Proposed Site's Run-off Rate Peak Flows(l/s)	Proposed Site's Run-off Peak Volume (m^3)
$QBAR_{Proposed}$	-	30.9	667.4
1 in 1 year	0.85	26.3	568.1
1 in 30 year	2.27	70.1	1514.2
1 in 100 year	3.19	98.6	2129.8
1 in 100 year + 30% CC	4.15	128.2	2769.1

Therefore, there could be a significant increase in the site's surface water run-off rates and volumes, which could create an increase in flood risk. Consequently, the development proposals should mitigate this increase by implementing SuDS.

Proposed Surface Water Management Strategy

The proposed surface water management strategy (SWMS) aims to not increase, and where practicable reduce the rate of run-off from the site as a result of the proposed development, in accordance with sustainable drainage principles and the published WODC and CDC SFRA.

BRE 365 Infiltration Tests were carried out at the site to enable the design of the preliminary SuDS and to confirm its feasibility. The test results are included in Appendix 5. The average permeability rate was $3.15x10^{-6}$m/s (0.011 m/hr), which is a moderate infiltration rate.

Firstly, in accordance with the SuDS Management Train as set out in The SuDS Manual (CIRIA C697), it is proposed to mitigate any increase in surface water run-off created by implementing “Prevention” in the SuDS design.

Accordingly, it is proposed to include areas of porous paving, gravel paths and maximise soft landscaped areas to minimise any increase in post development impermeable areas and their surface water run-off.

Secondly, it is proposed to implement “Source Control” infiltration techniques such as soakaways and porous paving to manage surface water run-off from roofs and roads at their source.

And finally it is proposed to implement “Site Control” infiltration techniques such as porous paving and infiltration basins to manage surface water run-off from footways and access roads.

The Flood and Water Management Act 2010, Sewers for Adoption and The SuDS Manual require that, as a minimum, the SuDS should be designed to manage and attenuate the 1 in 30 year storm event so that there is no flooding of the site.

However, new developments should also mitigate Climate Change, so SuDS should be designed for exceedence and, be designed to manage and attenuate the 100 year storm event including a 30% allowance for Climate Change.

Surface Water run-off can be attenuated above ground as long as there is no flooding to buildings. Infiltration basins are proposed to be implemented to attenuate and infiltrate surface water above ground, where required.

The average dwelling roof area including garages, is approximately 75.0m^2 (0.0075 ha). For the proposed 95 dwellings this equates to a total impermeable roof area of approximately 7,125m^2.

Using Windes MicroDrainage, an impermeable area of 0.0075 ha, the 100 year plus 30% Climate Change storm event and an average permeability rate of 3.15×10^{-6}m/s (0.01134 m/hr), the average soakaway size to mitigate the impermeable roof area needs to have a net storage capacity of approximately 4.05m^3.

Therefore, cellular soakaways could be used which have 95% voids or greater. A typical cellular soakaway, with zero discharge, would have dimensions of approximately 2.0m x 4.5m x 0.5m deep, which has a net attenuation volume of 4.3m^3, which is greater than the required 4.05m^3. See MicroDrainage calculations in Appendix 5.

Allowing for driveways, parking areas and turning areas to be constructed of either porous paving, or gravel, impermeable areas could be kept to a minimum, therefore, implementing "Prevention" as part of the SuDS system. There would be no contributing areas or surface water run-off from these areas.

Parking areas serving two or more properties should be constructed of porous paving, so that there is no increase in impermeable area and they are self-draining. They are also suitable for adoption by Oxfordshire County Council, which is the SuDS Approval Body (SAB).

Private driveways could be constructed of either gravel or porous paving to suit the budget of the development to enable impermeable areas and resultant surface water run-off to be kept to a minimum. Roof water could also be discharged to porous driveways to reduce the sizes of the soakaways in the back gardens.

95 dwellings would have a combined impermeable area of approximately 7,125m^2. Based on the above prevention and source control mitigation techniques, the remaining impermeable access roads, footways, and footpaths could have a combined contributing impermeable area of approximately 13,250m^2 (1.325 ha).

The proposed system can be optimised by using the porous paved roads and turning areas to manage and dispose of surface water from some of the dwelling roofs, footways and impermeable access roads.

It is generally considered that porous paving can manage and dispose of water from an area twice its size. The proposed porous paved roads and turning areas cover an area of approximately 3800m^2 (0.3800 ha), which equates to an impermeable area of approximately 7600m^2 (0.7600 ha).

Using Windes MicroDrainage, an impermeable area of 0.7600 ha, the 100 year plus 30% Climate Change storm event and an average permeability rate of $3.15x10^{-6}$m/s (0.01134 m/hr), the area of porous paving required at a typical depth of 0.400m is 3,075m^2, which is less than the porous paved area proposed. See MicroDrainage calculation sin Appendix 5.

It is proposed that the main access roads, footways and footpaths are of a standard impermeable construction to allow for service corridors. It is proposed to discharge highways surface water run-off to grassed swales and infiltration basins in the amenity open areas.

Based on surface water from 7,125m^2 being disposed to soakaways and run-off from 7600m^2 being disposed of porous paved roads, the remaining impermeable area to be mitigated is approximately 7,775m^2 (0.7775 ha).

Using Windes MicroDrainage, an impermeable area of 0.7775 ha, the 100 year plus 30% Climate Change storm event and an average permeability rate of 3.15x10^{-6}m/s (0.01134 m/hr), the minimum required cumulative grass infiltration basin volume required would be approximately 452.0m^3, based on an infiltration basin depth between 0.20m and 0.30m.

This volume would allow all surface water run-off to be attenuated and infiltrated with zero surface water run-off for during the 100 year plus 30% Climate Change storm event.

Assuming the depths of the grass infiltration basins are between 0.2m and 0.3m deep, the approximate area required would be 1,808m^2.

Based on the proposed development site's layout, the cumulative infiltration basin area available is approximately 2360m^2.

The actual infiltration basin(s) plan area could be adjusted to suit the final detailed design layout, allowing for the minimum attenuation volume and a maximum depth of 0.3m.

The above SuDS are sized to mitigate the 100 year storm including a 30% allowance for climate change with zero outflow.

Subsequently, 50% of the site would not have a Greenfield run-off rate and the site's post development run-off rate could be reduced to approximately 7.05 l/s, which is 50% of the existing site's Greenfield run-off rate of 14.18 l/s.

As 100% of the existing site would currently discharge surface water at the Greenfield run-off, reducing the run-off rate to 50% of the Greenfield run-off rate, and mitigating Climate Change would provide significant betterment as less water would be discharged to the existing drainage ditches and the Sor Brook.

Consequently, the proposed SuDS could provide a significant reduction in flood risk at and down river of the site.

See proposed SWMS Plan in Appendix 5.

The proposed SuDS surface water management strategy ensures that:

- there is no increase in run-off as a result of the proposed development,
- there is no increased flood risk as a result of the proposed development,
- there is a decrease in the site's overall run-off rate and volume
- the site's run-off rate is reduced to less than the Greenfield run-off rate
- betterment can be provided with regards to flood risk.

Assessment of Flood Risk from All Potential Sources

Flooding of a site can occur from several sources, including, watercourses such as Main Rivers, Ordinary Watercourses and streams, tidal seas and estuaries, groundwater, sewers, surface water run-off and failure of water infrastructure. The risk of flooding to the site from each source has been assessed in turn.

Main Rivers

The nearest Main Rivers are the Sor Brook and the River Cherwell, which are located approximately 500m south west and 2000m east of the site, respectively.

The SFRA states that, the River Cherwell rises at Charwelton in Northamptonshire. Its general course is flowing from north to south through the centre of the District passing through Banbury, Upper Heyford, and Kidlington before flowing to Oxford where the Cherwell meets the River Thames. The river drains a total catchment area of 906 km^2 with a mean annual rainfall of 682 mm.

Tributaries that flow to the River Cherwell include the Hanwell Brook, the Sor Brook, the Bloxham Brook and the River Swere all flowing from the West and the River Ray flowing from the East. The confluence of the River Cherwell with the River Thames is located about 5km beyond the Cherwell District southern boundary.

Land use across the catchment is predominately rural (less than 2% of the catchment is classified as ‘urban’) and includes the two main urban centres of Banbury and Bicester.

The EA Indicative Flood Zone Map indicates that the site is located in Flood Zone 1, which has a Low risk of fluvial flooding from Main Rivers. That is land having a less than 1 in 1,000 annual probability of river or sea flooding. See Environment Agency’s Indicative Flood Zone Maps in Appendix 1.

The Sequential Test looks at the Flood Risk Vulnerability and Flood Zone Compatibility of a development.

Table 3 of the PPG FRCC, identifies the development types that are appropriate in each flood zone, subject to the requirements of the EA National Standing Advice and the Application of the Sequential Test.

Flood Risk Vulnerability Classification	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone 1	√	√	√	√	√
Flood Zone 2	√	√	Exception Test	√	√
Flood Zone 3a	Exception Test	√	X	Exception Test	√
Flood Zone 3b Functional FZ	Exception Test	√	X	X	X

Key:
√ Development is appropriate
X Development should not be permitted

The residential development is classified as More Vulnerable development and the commercial development is classified as Less Vulnerable, in accordance with Table 2: Flood Risk Classification of PPG FRCC.

Therefore, based on Table 3 of the PPG FRCC the developments classifications and land use are appropriate for the flood zone at the site.

The SFRA does not have any records of the site flooding due to Main Rivers. Due to the distance and change in ground levels between the site and the main rivers it is unlikely that the site is at risk of flooding from Main Rivers.

Therefore, the site is perceived to have a Low risk of fluvial flooding from Main Rivers.

Ordinary Watercourses and Streams

There are no known ordinary watercourses or streams in the immediate vicinity of the site. The SFRA does not have any records of flooding from watercourses or streams.

Therefore, the site is perceived to have a Low risk of fluvial flooding from ordinary watercourses and streams.

Coastal or Estuarine

The site is not located near the coastline or an estuary. Consequently, the site is at low risk of tidal flooding.

Groundwater

The SFRA states that, the underlying superficial geology of the area is predominantly clay, particularly in the north. This results in flashy runoff and rapid responses of fluvial systems to rainfall events. In the locality of Bicester there are outcrops of shale which are more permeable.

There are locations within the District that are affected by high water tables and are susceptible to seasonal spring fed activity such as Mollington. This may result in standing water on low lying ground that is unable to reach a ditch or watercourse and is unable to percolate through the ground due to seasonally high water perched groundwater levels.

Settlements at most risk of groundwater flooding are those that lie at the base of steep sided valleys such as Bodicote, Hook Norton and Steeple Aston where the potential for receiving and passing on ground water likely to cause flooding is the greatest.

However, the site is not known to be affected by high ground water tables and, as demonstrated by the permeability tests, surface water is able to percolate through the ground. The proposed layout of the site takes into consideration the findings of the SFRA and proposes swales and infiltration basins along the valley floor.

The SFRA does not have records of the site flooding due to groundwater.

There are no other known records of the site being flooded due to groundwater. This indicates that the risk of groundwater flooding at the site is low.

Sewers and highway drains

The Thames Water Asset plans, included in Appendix 4, identify that there is a public foul water sewer located in the public highway adjacent to the site.

Sewer flooding generally results in localised short term flooding caused by intense rainfall events overloading the capacity of sewers. Flooding can also occur as a result of blockage, poor maintenance or structural failure.

The SFRA indicates that the site is in a low incident area with regards to sewer flooding

There are no other known records of the site being flooded, due to surcharging of sewers. This indicates that the risk of flooding at the site due to surcharging of local sewers is Low.

Any new drainage on site should be constructed to comply with the current Building Regulations Approved Document H and Sewers for Adoption, to ensure that sewer surcharging is mitigated.

Surface water and Overland Flow

The SFRA states that, during periods of prolonged rainfall events and sudden intense downpours, overland flow from adjacent higher ground may ‘pond’ in low-lying areas of land without draining into watercourses, surface water drainage systems or the ground.

The settlements of Kidlington, Launton, Ambrosden, Arncott, Blackthorn, Charlton-on-Otmoor, Fencott, Mercott, Wendlebury, Westonon- the-Green, Caulcot, Noke and Oddington are all located on low lying impervious ground where there may be limited surface water drainage and therefore may be at increased risk of flooding from overland flow.

One of the main issues with pluvial flooding is that in areas with no history, relatively small changes to hard surfacing and surface gradients can cause flooding (garden loss and reuse of brownfield sites for example).

As a result, continuing development could mean that pluvial and surface water flooding can become more frequent and, although not on the same scale as fluvial flooding, it can still cause significant disruption.

Although the WODC SFRA has records of other areas experiencing surface water flooding, it does not have any records of the proposed development site experiencing surface water flooding.

The surface water management strategy, based on site specific permeability tests, has demonstrated that by utilising SuDS it is feasible to mitigate surface water run-off as a result of the proposed development.

The proposed SuDS can provide betterment by reducing the post-development's surface water run-off rate to below the existing Greenfield run-off rate, and consequently reduce flood risk to the site and the surrounding areas.

There are no other known records of the property being flooded due to surface water. This indicates that the risk of flooding at the site due to surface water flooding is low.

Water Infrastructure failure

The WODC SFRA has identified that flooding may result from the failure of engineering installations such as flood defence, land drainage pumps, sluice gates and floodgates.

Hard defences may fail through the slow deterioration of structural components such as the rusting of sheet piling, erosion of concrete reinforcement and toe protection or the failure of ground anchors. Such deterioration is often difficult to detect, so that failure when it occurs is often sudden and unexpected. Failure is more likely when the structure is under maximum stress, such as extreme fluvial events when pressures on the structure are at its most extreme.

The Oxford Canal is located approximately 1,700m east of the, to the east of the M40. A small reservoir is located approximately 360m south west of the site.

Therefore, the risk of flooding from water infrastructure failure is believed to be Low.

Main River Bylaw Distance

In accordance with the Land Drainage Act 1976, The Water Resources Act 1991 and the Environment Act 1995 a Flood Defence Consent must be separately obtained from the EA for any work in, over, under or within the Bylaw distance of a Main River.

This is to ensure that the work activities do not cause or make existing flood risk worse, interfere with the EA's work, and do not adversely affect the local environment, fisheries or wildlife.

The nearest Main Rivers are the Sor Brook and the River Cherwell, which are located approximately 500m south west and 2000m east of the site, respectively.

Therefore, the proposed development works would not require a Flood Defence Consent grated by the EA.

Impacts Elsewhere, Run-Off Generation, River and Coastal Morphology

The existing site has been assumed to have a permeable area totalling 45,000m^2 (4.50ha) and no impermeable area. See the Existing site plan in Appendix 2.

The proposed development has been predicted to have permeable areas totalling 22,500m^2 (2.250ha) and a total impermeable area of approximately 22,500m^2 (2.250ha). See the Proposed site plan in Appendix 2.

Therefore, without mitigating SuDS, there would a significant increase in the impermeable areas at the site of 22,500m^2, which equates to 50% of the site area, and a significant increase in the resultant surface water run-off.

Therefore, without mitigating SuDS, there could be a significant increase in flood risk to the site or the surrounding areas as a result of the proposed development.

Consequently, the development proposals should incorporate SuDS to mitigate the increase in impermeable area and the impacts of Climate Change.

Impact Mitigation Measures

Surface water from impermeable areas is proposed to be attenuated and discharged to ground via infiltrating SuDS techniques such as soakaways, swales, infiltration basins and porous paving.

The feasibility of these proposals has been confirmed using BRE 365 Infiltration tests carried out at the site for the purpose of the preliminary drainage design included in this FRA.

Consequently, the proposed development can provide significant betterment, due to the zero outflow from the SuDS, by reducing the site's surface water run-off rate to less than the existing Greenfield run-off rate.

Residual Risks after Mitigation Measures are in Place

Due to the significant betterment provided by the proposed development, by the reduction in the site's surface water run-off, the residual risks are perceived to be low.

Due to the site layout and topography and location of porous paved roads and parking areas, overland flow routes should not put people and property at an unacceptable risk.

Oversized infiltration basins and swales are located on the lower areas of the site to catch any exceedence outside the piped network.

Pollution Prevention

It is important to focus on the treatment and protection of the groundwater (aquifer) during and after the construction phase of the proposed development, with regards to pollution prevention. Most pollution incidents are avoidable. Careful planning can reduce the risk of pollution.

The majority of measures needed to prevent pollution cost very little, especially if they are included at the planning stage, and in some cases are just a matter of good practice with regard to the storage and use of materials. In contrast, the costs of cleaning up a pollution incident can be very high.

Potential pollutants of concern include, but are not limited to silt, cement, concrete, fuel, oils, sewage, waste water and waste materials. It is intended to implement the advice provided in the EA's construction Pollution Prevention Guidelines (PPG) during the construction of the proposed development as best practice methodologies.

The following EA Pollution Prevention Guidelines should be implemented as part of the development proposals; PPG3 "Use and design of oil separators in surface water drainage systems", PPG5 "Works in, near or liable to affect watercourse", PPG6 "Work at construction sites" for mitigation measures required for preventing pollution during the construction phase.

Conclusions and Recommendations

Policy 103 of the National Planning Policy Framework (NPPF) requires that when determining planning applications, local planning authorities should ensure flood risk is not increased elsewhere and only consider development appropriate in areas at risk of flooding where, informed by a site-specific flood risk assessment (FRA), compliant with the technical guidance to the NPPF (PPG FRCC), following the Sequential Test, and if required the Exception Test, it can be demonstrated that:

- within the site, the most vulnerable development is located in areas of lowest flood risk unless there are overriding reasons to prefer a different location; and
- development is appropriately flood resilient and resistant, including safe access and escape routes where required, and that any residual risk can be safely managed, including by emergency planning; and it gives priority to the use of sustainable drainage systems

The site is located to the west of Oxford Road, the A4260, and can be located by Grid Coordinates 446700mE, 237330mN. The site covers an area of approximately 4.50 hectares.

The site is bound by other residential dwellings to the north west, commercial properties to the north east and east, and agricultural land to the south east, south and south west.

The nearest Main Rivers are the Sor Brook and the River Cherwell, which are located approximately 500m south west and 2000m east of the site, respectively.

The Environment Agency's (EA) Indicative Flood Zone Map indicates that the site is located in Flood Zone 1, which has a low risk of fluvial flooding from Main Rivers.

Therefore, in accordance with the NPPF and based on Table 3 of the PPG FRCC the development's classifications and land use are appropriate for the flood zone at the site.

The SFRA does not have records of the site flooding due to groundwater. This indicates that the risk of groundwater flooding at the site is low.

The SFRA does not have records of the site flooding due to surface water. This indicates that the risk of surface water flooding at the site is low.

The development should incorporate SuDS to mitigate any increase in surface water run-off to ensure there is no increase in flood risk as a result of the proposed development.

The SFRA does not have records of the site flooding due to sewers. This indicates that the risk of sewer flooding at the site is low.

The risk of flooding from water infrastructure failure is anticipated to be low.

This site-specific FRA has identified that the development proposals, which incorporates a SuDS surface water management strategy, ensures that:

- there is no increase in run-off as a result of the proposed development,
- there is no increased flood risk as a result of the proposed development,
- there is a decrease in the overall site's run-off rate and volume,
- the site's run-off rate is reduced to less than the Greenfield run-off rate,
- betterment can be provided with regards to reduction in flood risk,
- the development proposals comply with the EA's requirements
- the development proposals comply with the NPPF and the PPG FRCC.

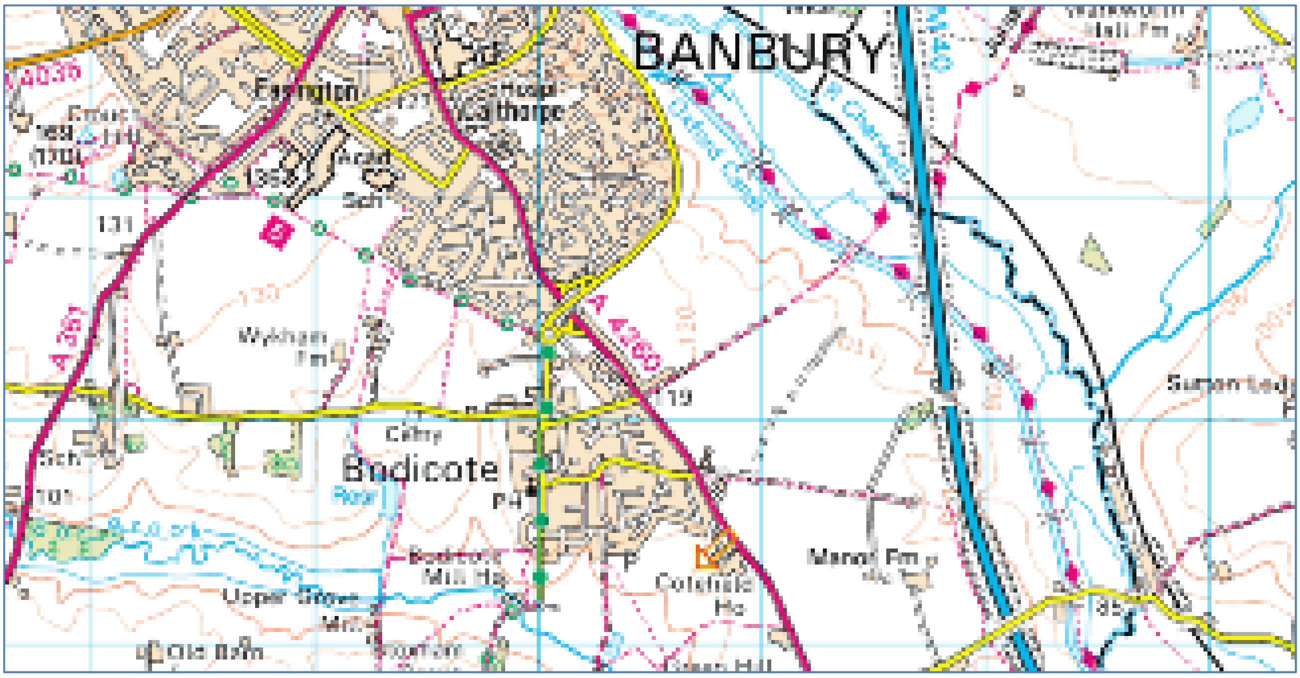
Based on the findings of this site specific FRA, the proposed SuDS SWMS is feasible and consequently the development proposals are considered acceptable.

APPENDIX 1

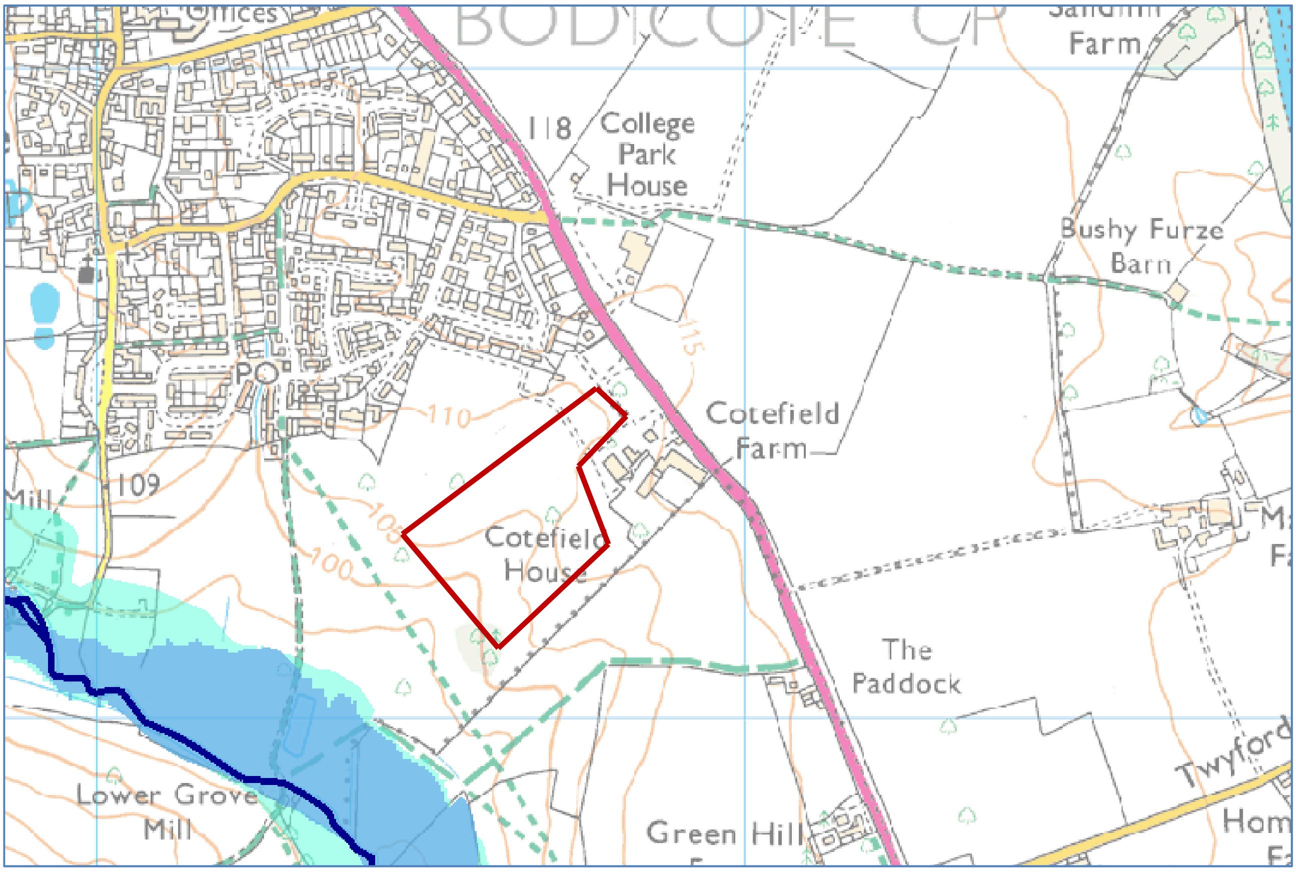
Site Location Maps

Cotefield Farm, Oxford Road, Bodicote, Oxfordshire, OX15 4AQ

Grid Reference 446700mE, 237330mN



Environment Agency Indicative Main River Flood Zone Maps



Key:

Flood Zone 3 - Medium to High Risk

Flood Zone 2 - Low to Medium Risk

Flood Zone 1 - None to Low

Flood Defence Protected Area

Flood Defence

Main River

Site Location

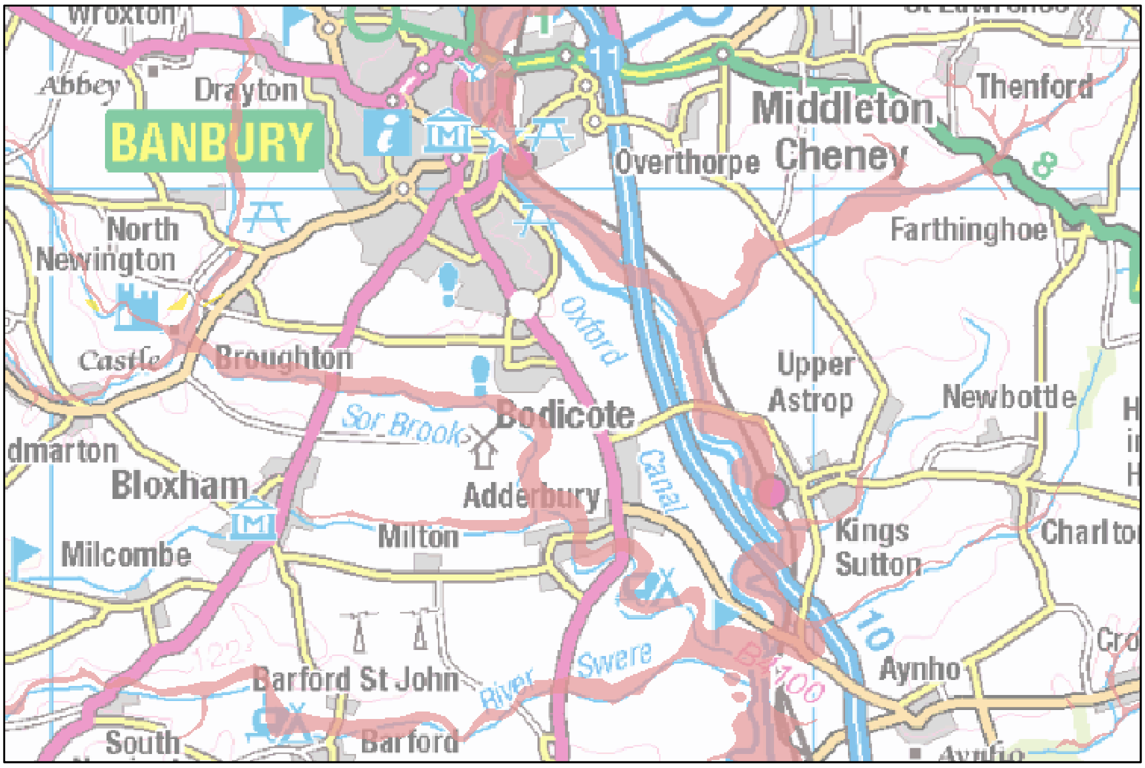
British Geological Survey Maps

Superficial Drift Geology – NONE

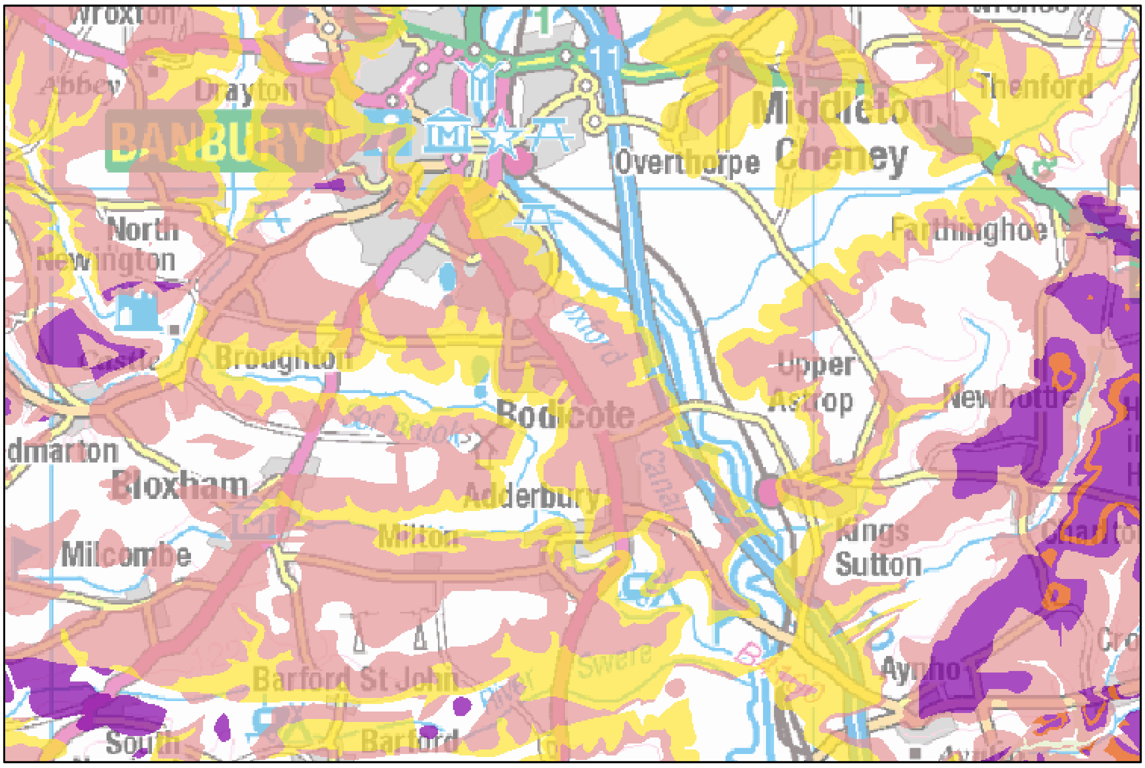
Bedrock Geology – Lias Group – Varying quantities of Mudstone, Siltstone, Limestone and Sandstone

Environment Agency Aquifer Maps

Superficial Drift Geology – NONE



Bedrock Geology – Secondary A Aquifer – Minor Aquifer



ENVIRONMENT AGENCY WEST THAMES - SURFACE WATER PRO-FORMA

This pro-forma accompanies our surface water guidance note on sites between 1 and 5 hectares. The developer should complete this form and return to the Local Planning Authority and indicate where the evidence is provided within their submission documents for the answers given

Site Name	Blossom Fields, Bodicote, Oxfordshire, OX15 4AQ
Site Size	4.50 ha
Development Type (Green/Brown field)	Combination of Greenfield and Brownfield

Discharge Rates	**Existing**	**Proposed**	**Difference Between Existing and Proposed**	**Which Document or Plan is this information contained in**
1 in 1	14.1	30.9	16.8	
Qbar(1 in 2)	12.0	26.3	14.3	
1 in 30	32.0	70.1	38.1	
1 in 100	45.0	98.6	53.6	Flood Risk Assessment
1 in 100 +Climate change (proposed only)		128.2		
Discharge Volumes				
1 in 1	304.6	667.4	362.8	
Q Bar (1 in 2)	259.2	568.1	308.9	
1 in 30	691.2	1514.2	823.0	
1 in 100	972.0	2129.8	1157.8	
Proposed 1 in 100 +Climate change		2769.1		

Then above section should only show small increases in discharge rate if an increase in discharge volume is shown – otherwise there should be no increase. Note that an increase in discharge volume may be shown in the above table - but how this is being attenuated on site and discharged so as to not increase flood risk should be set out below. If an increase in discharge rate or volume is shown, or if an increase was predicted but has been designed in to the system, please answer the following questions.

Discharge Rates (The final scheme should show no increase in discharge rates. If a small increase in rate is shown to address trickle or Q-Bar discharge, then		**Which Document or Plan is this information contained in**
How are increases in discharge rate being dealt with?	All impermeable roofs and hardstandings are proposed to be discharged to infiltrating SuDS which attenuate surface water run-off while it infiltrates into the ground. All SuDS are designed with zero run-off up to and including the 100 year storm including a 30% allowance for Climate Change.	Flood Risk Assessment
What storage volume is required as a result of restricting discharge rate?	The difference between the existing 100 year storm event volume and the proposed 100 year storm plus 30% Climate Change is 2769.1– 972.0 = 1797.1 m^3.	Flood Risk Assessment
Where has this volume been provided on site?	This volume is being provided by the source control SuDS techniques, which are designed with zero run-off up to and including the 100 year storm including a 30% allowance for Climate Change. The proposed SuDS have been designed for exceedence and consequently, have a combined attenuation volume of 1454.5 m^3, which is greater than the required 1205.8m^3.	Flood Risk Assessment

Discharge Volumes (Where an increase in volume is shown, that increase in volume must be either attenuated and trickle discharged at 2l/s/ha. Or, the whole of the sites discharge rate must be restricted to Qbar) (Qbar is the run off rate for the site as if it was a Greenfield site i.e. assuming it is undeveloped). Qbar will be higher if the geology of the site is less permeable.		**Which Document or Plan is this information contained in**
Which method has/will be used to control additional discharge volumes?	The increase in volume is proposed to be attenuated in the infiltrating SuDS techniques.	Flood Risk Assessment
What is the Qbar/Trickle Discharge Rate?	Due to the zero discharge SuDS for all impermeable areas, only the remaining grassed and gravelled permeable areas will have a run-off equal to the greenfield run-off rate. Therefore, the proposed site's discharge rate will be approximately 50% less than the existing site's calculated Greenfield Run-off rate of 14.1 l/s for the total site, i.e. 70.05 l/s.	Flood Risk Assessment
As a result of restricting rate, what additional attenuation storage volume was/is required?	Although not required, additional attenuation storage volume is provided by the oversized infiltrating SuDS. An additional buffer volume of approximately 248.7 m^3 for storms greater than the 100 year storm plus 30% Climate Change is provided.	Flood Risk Assessment
Where on site will/has this attenuation be provided?	Attenuation will be provided at source at strategic locations across the site using source control SuDS techniques.	Flood Risk Assessment
How will rates be restricted (Hydrobrake etc)?	Rates are restricted by infiltrating SuDS techniques with zero discharge up to and including the 100 year storm including a 30% allowance for Climate Change.	Flood Risk Assessment

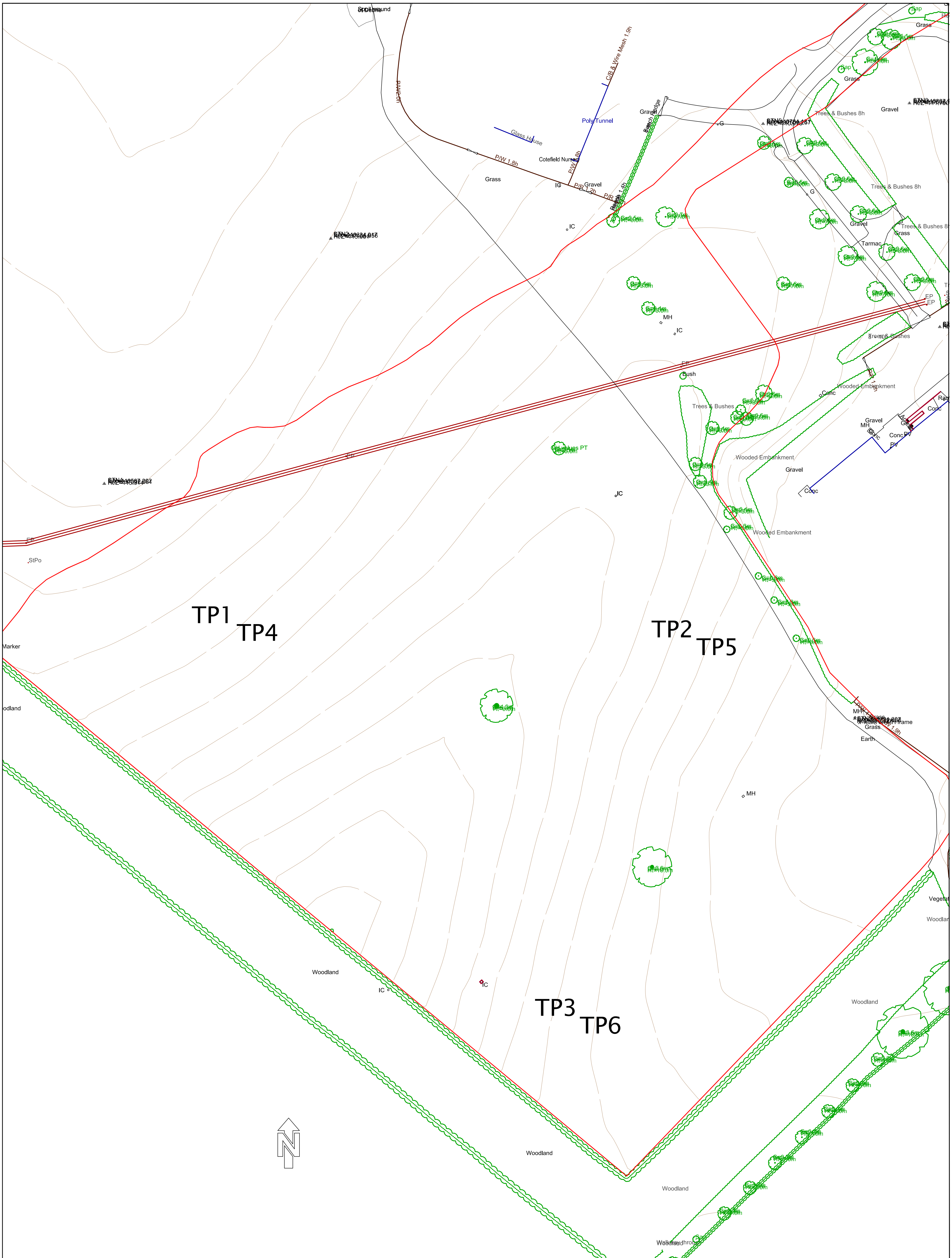
Please also confirm		Which Document or Plan is this information contained in
No flooding of pipe network will occur in the 1 in 30 event	No flooding of pipe network will occur in the 1 in 30 event	Flood Risk Assessment
Any flooding or exceedence outside the pipe network will be safely contained on site and not increase flooding elsewhere (please indicate on a plan the location of any flooding).	Exceedence can be contained in the, porous paving, infiltration basins and swales that are strategically located around the site, which are oversized and have zero outfow.	Flood Risk Assessment
Which SuDS methods have been used on site.	Soakaways, porous paving, swales and infiltration basins.	Flood Risk Assessment
If infiltration is proposed - That infiltration rates are acceptable (Provide rate).	The average permeability rate was $3.15x10^{-6}$m/s (0.0.01134 m/hr), which is a moderate infiltration rate.	Flood Risk Assessment
That infiltration devices or their attenuation areas are appropriately sized.	All infiltrating SuDS are designed with zero run-off up to and including the 100 year storm including a 30% allowance for Climate Change.	Flood Risk Assessment

The above form should be completed using evidence from the Flood Risk Assessment and site plans. It should serve as a summary sheet of the drainage proposals and should clearly show that the proposed rate and volume as a result of development will not be increasing. If there is an increase in rate or volume, the rate or volume section should be completed to set out how the additional rate/volume is being dealt with.

This form is completed using factual information from the Flood Risk Assessment and Site Plans and can be used as a summary of the surface water drainage strategy on this site.

Form Completed By…Deborah Prichard…………………………………………..,
Company………………Forge Engineering Design Solutions Ltd……………….,
Date:……………………31.012.14.

APPENDIX 2



Client:	Project:	Title:	Drawn by:	Checked by:	Size:
Mr R Bratt	Blossom Fields	Existing Site Plan	DKP	DKP	A3
	Project Ref:		Date: 31.12.14	Scale: 1:1000	
	FEDS-214026		Dwg.no: FEDS-214026-001		Rev: B

Forge Engineering Design Solutions
Forge House
30 Digging Lane
Fyfield, Abingdon
Oxfordshire, OX13 5LY
tel: 01865 362 780
info@f-eds.co.uk
www.f-eds.co.uk

Client:	Project:	Title:	Drawn by:	Checked by:	Size:
Mr R Bratt	Blossom Fields	Proposed Site Plan	DKP	DKP	A3
			Date: 31.12.14	Scale: 1:1000	
	Project Ref: FEDS-214026		Dwg.no: FEDS-214026-002		Rev: B

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30 Digging Lane
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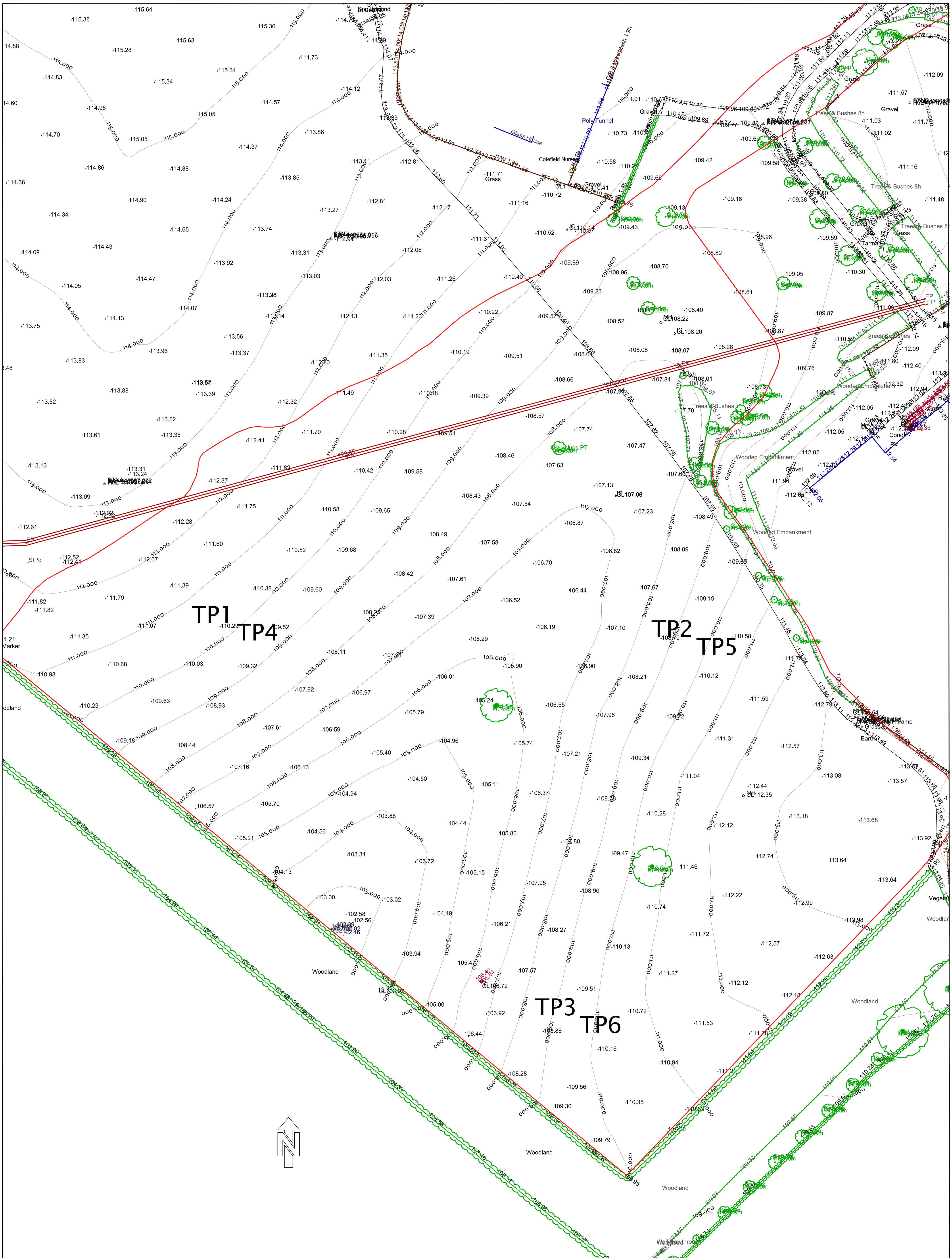
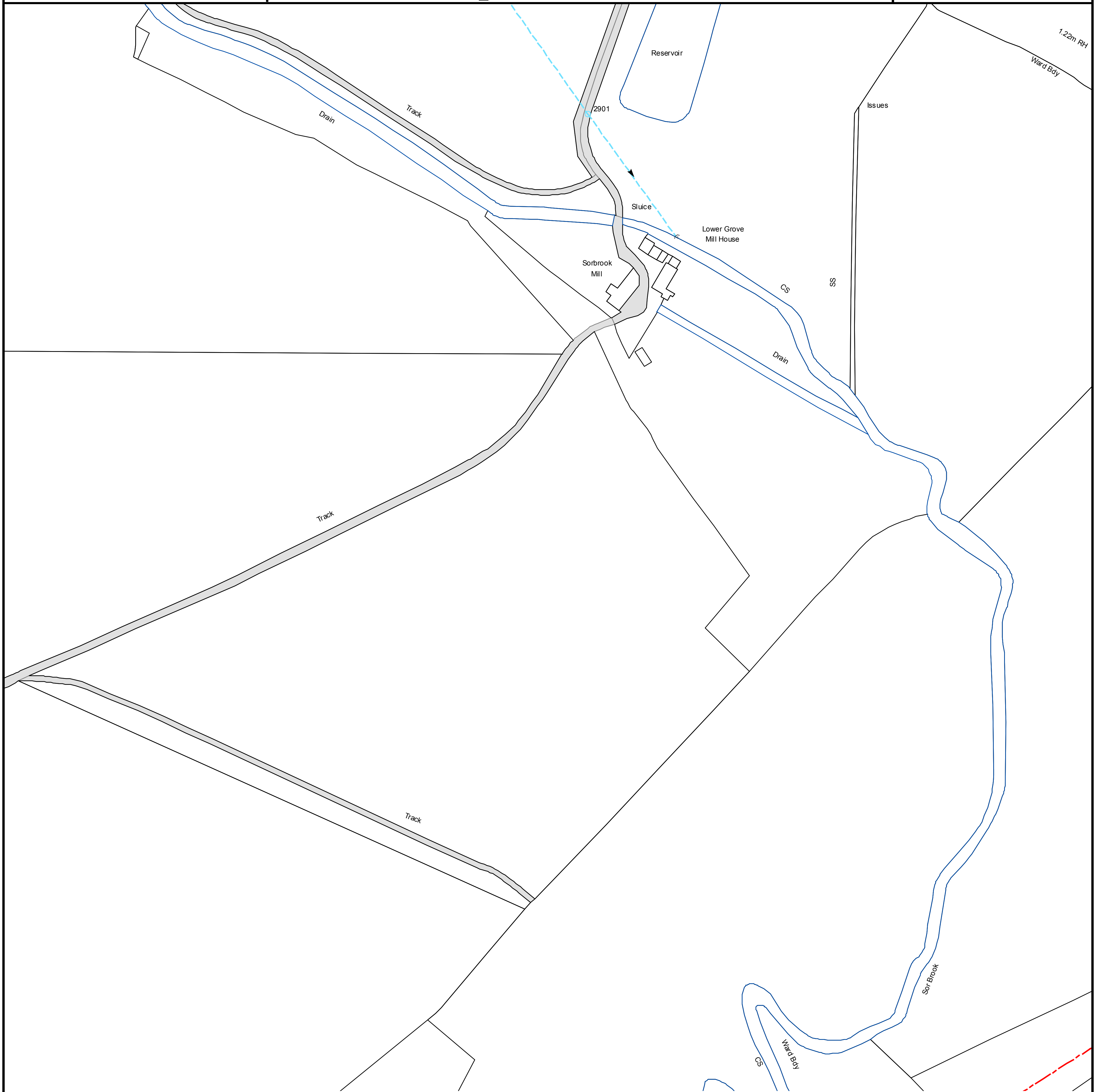
APPENDIX 3



Client:	Project:	Title:	Drawn by:	Checked by:	Size:	
Mr R Bratt	Blossom Fields	Topographical Survey	DKP	DKP	A3	Forge Engineering Design Solutions Forge House 30 Digging Lane Fyfield, Abingdon Oxfordshire, OX13 5LY tel: 01865 362 780 info@f-eds.co.uk www.f-eds.co.uk
	Project Ref: FEDS-214026		Date: 31.12.14	Scale: 1:1000		
			Dwg.no: FEDS-214026-003		Rev: B	

APPENDIX 4

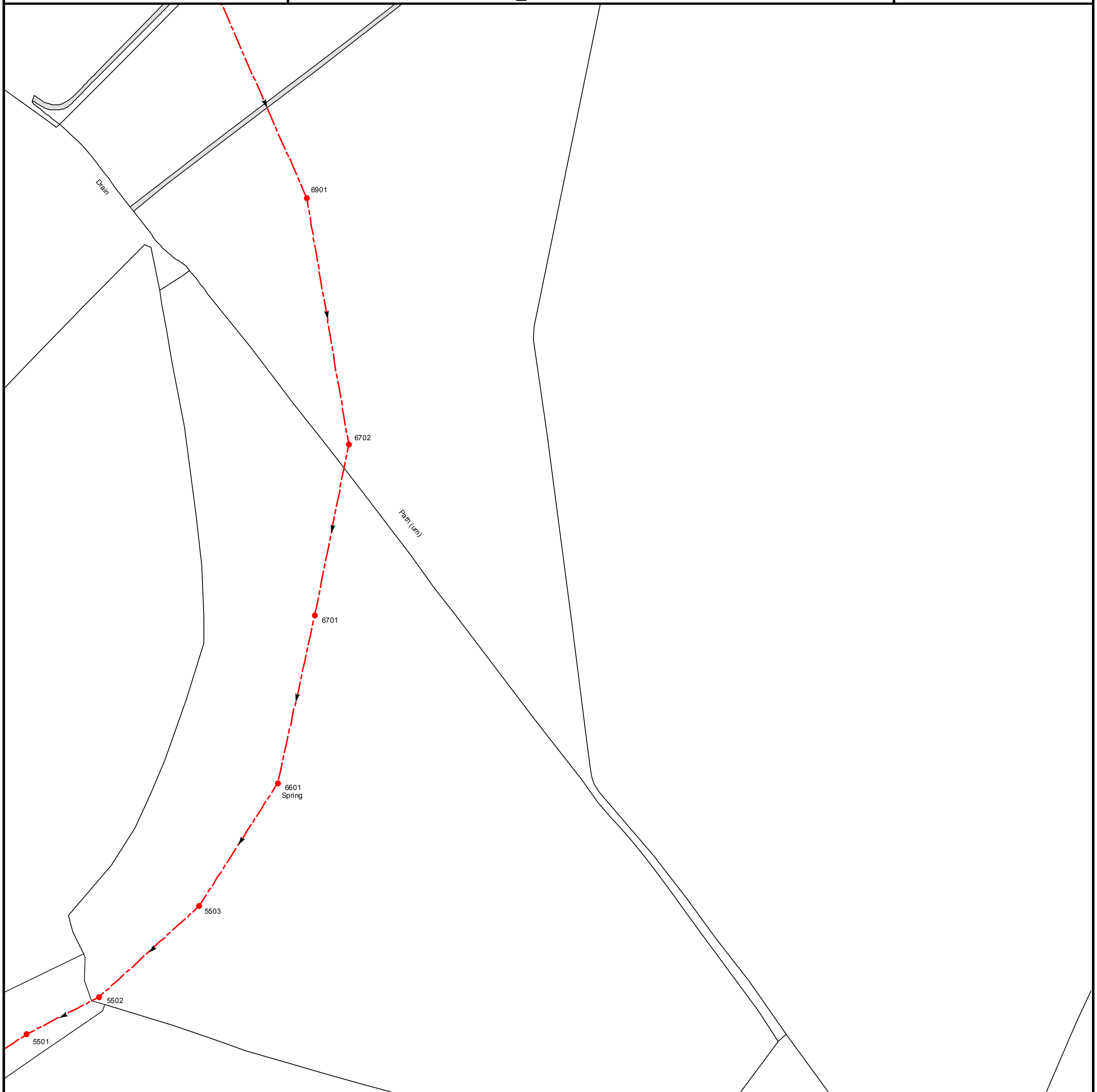
Asset Location Search Sewer Map - ALS/ALS Standard/2013_2459550 | SP4636NW



The width of the displayed area is 500m and the centre of the map is located at OS coordinates 446250,236750

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

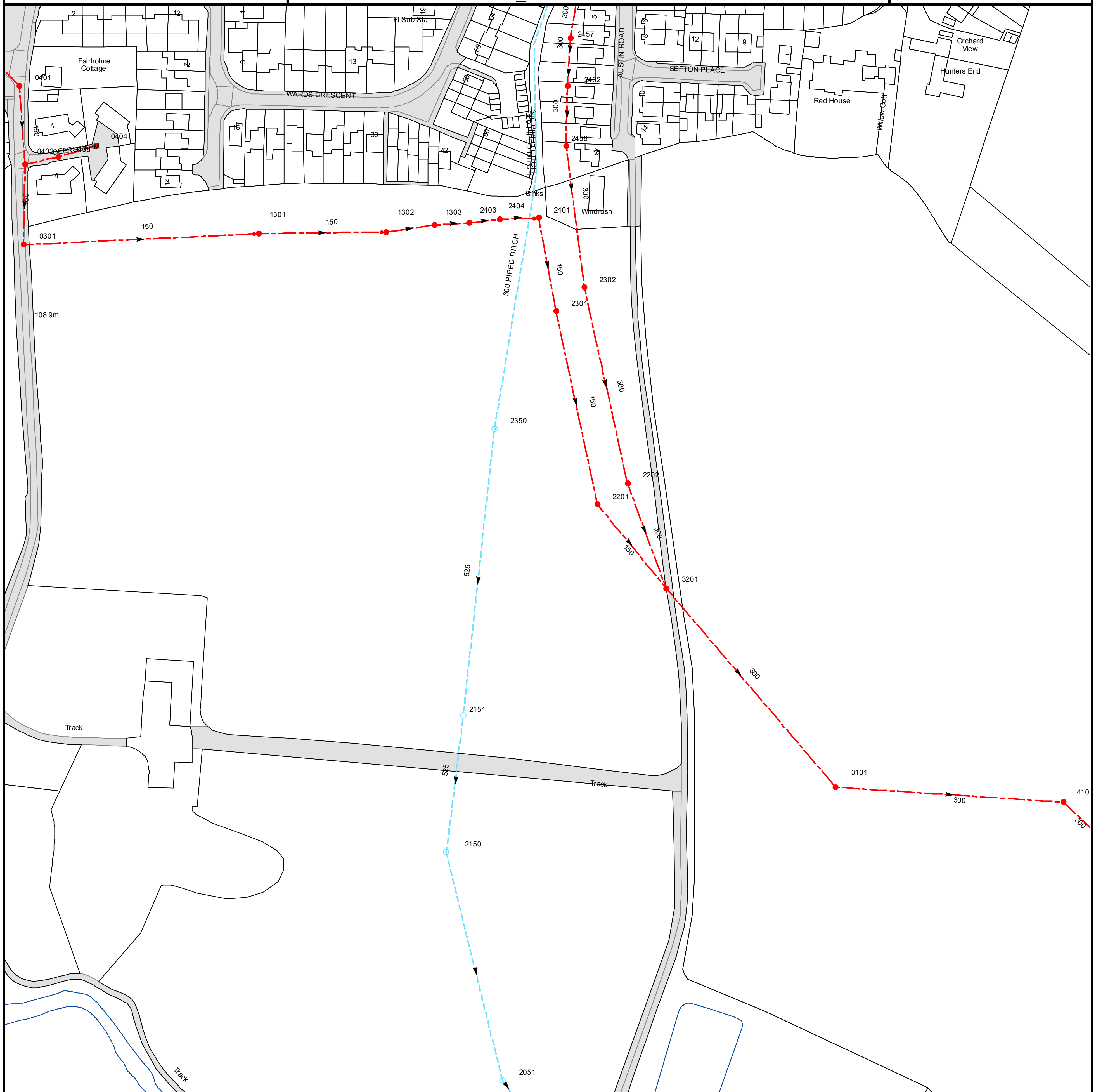
Asset Location Search Sewer Map - ALS/ALS Standard/2013_2459550 | SP4636NE



The width of the displayed area is 500m and the centre of the map is located at OS coordinates 446750,236750

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

Asset Location Search Sewer Map - ALS/ALS Standard/2013_2459550	SP4637SW



The width of the displayed area is 500m and the centre of the map is located at OS coordinates 446250,237250

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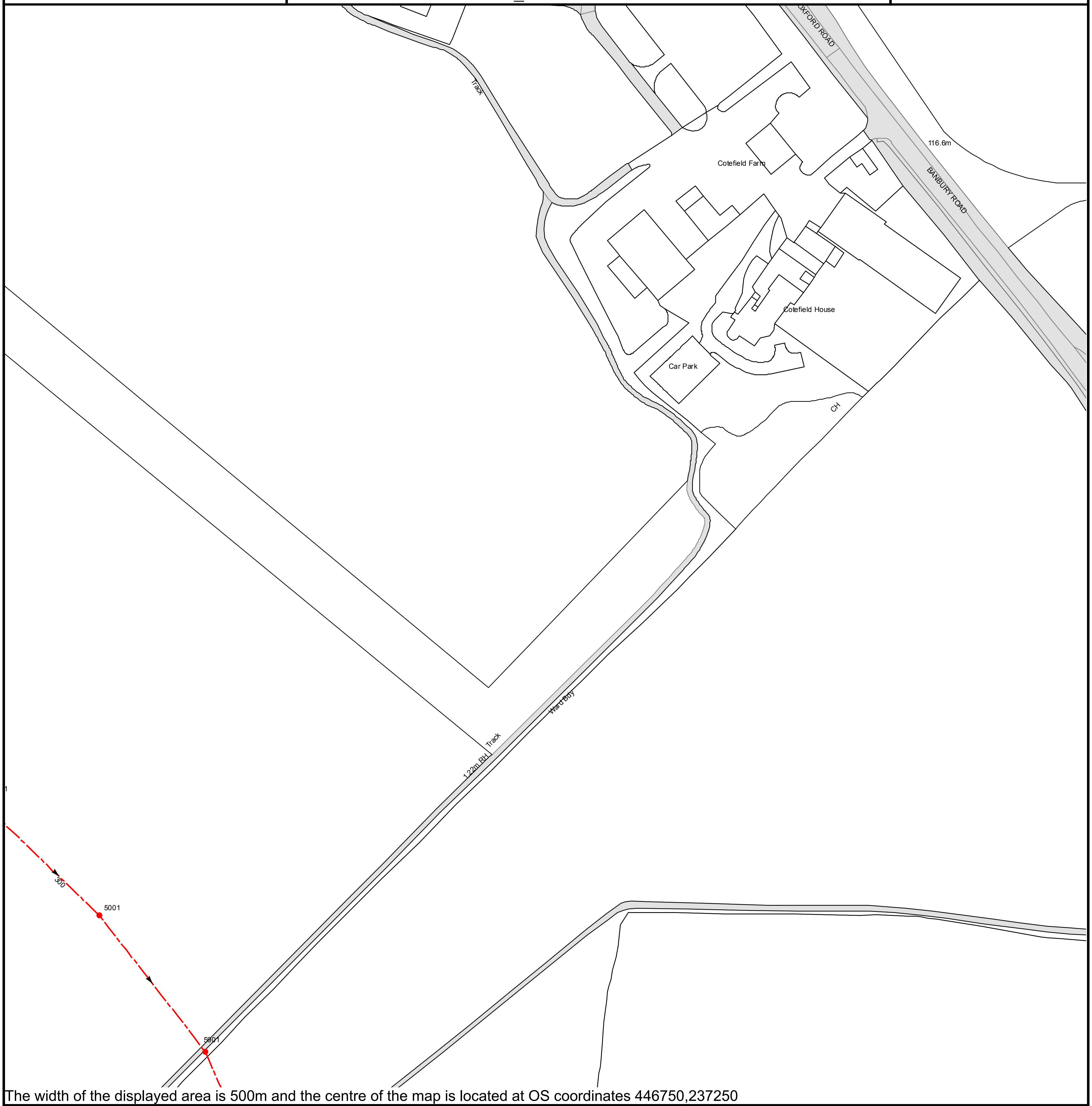
Asset Location Search Sewer Map - ALS/ALS Standard/2013_2459550	SP4637SE



The width of the displayed area is 500m and the centre of the map is located at OS coordinates 446750,237250

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ALS Sewer Map Key

Public Sewer Types (Operated & Maintained by Thames Water)

Foul: A sewer designed to convey waste water from domestic and industrial sources to a treatment works.

Surface Water: A sewer designed to convey surface water (e.g. rain water from roofs, yards and car parks) to rivers or watercourses.

Combined: A sewer designed to convey both waste water and surface water from domestic and industrial sources to a treatment works.

- Trunk Surface Water
- Trunk Foul
- Storm Relief
- Trunk Combined
- Vent Pipe
- Bio-solids (Sludge)
- Proposed Thames Surface Water Sewer
- Proposed Thames Water Foul Sewer
- Gallery
- Foul Rising Main
- Surface Water Rising Main
- Combined Rising Main
- Sludge Rising Main
- Proposed Thames Water Rising Main
- Vacuum

Sewer Fittings

A feature in a sewer that does not affect the flow in the pipe. Example: a vent is a fitting as the function of a vent is to release excess gas.

- Air Valve
- Dam Chase
- Fitting
- Meter
- Vent Column

Operational Controls

A feature in a sewer that changes or diverts the flow in the sewer. Example: A hydrobrake limits the flow passing downstream.

- Control Valve
- Drop Pipe
- Ancillary
- Weir

End Items

End symbols appear at the start or end of a sewer pipe. Examples: an Undefined End at the start of a sewer indicates that Thames Water has no knowledge of the position of the sewer upstream of that symbol, Outfall on a surface water sewer indicates that the pipe discharges into a stream or river.

- Outfall
- Undefined End
- Inlet

Other Symbols

Symbols used on maps which do not fall under other general categories

- Public/Private Pumping Station
- Change of characteristic indicator (C.O.C.I.)
- Invert Level
- Summit

Areas

Lines denoting areas of underground surveys, etc.

- Agreement
- Operational Site
- Chamber
- Tunnel
- Conduit Bridge

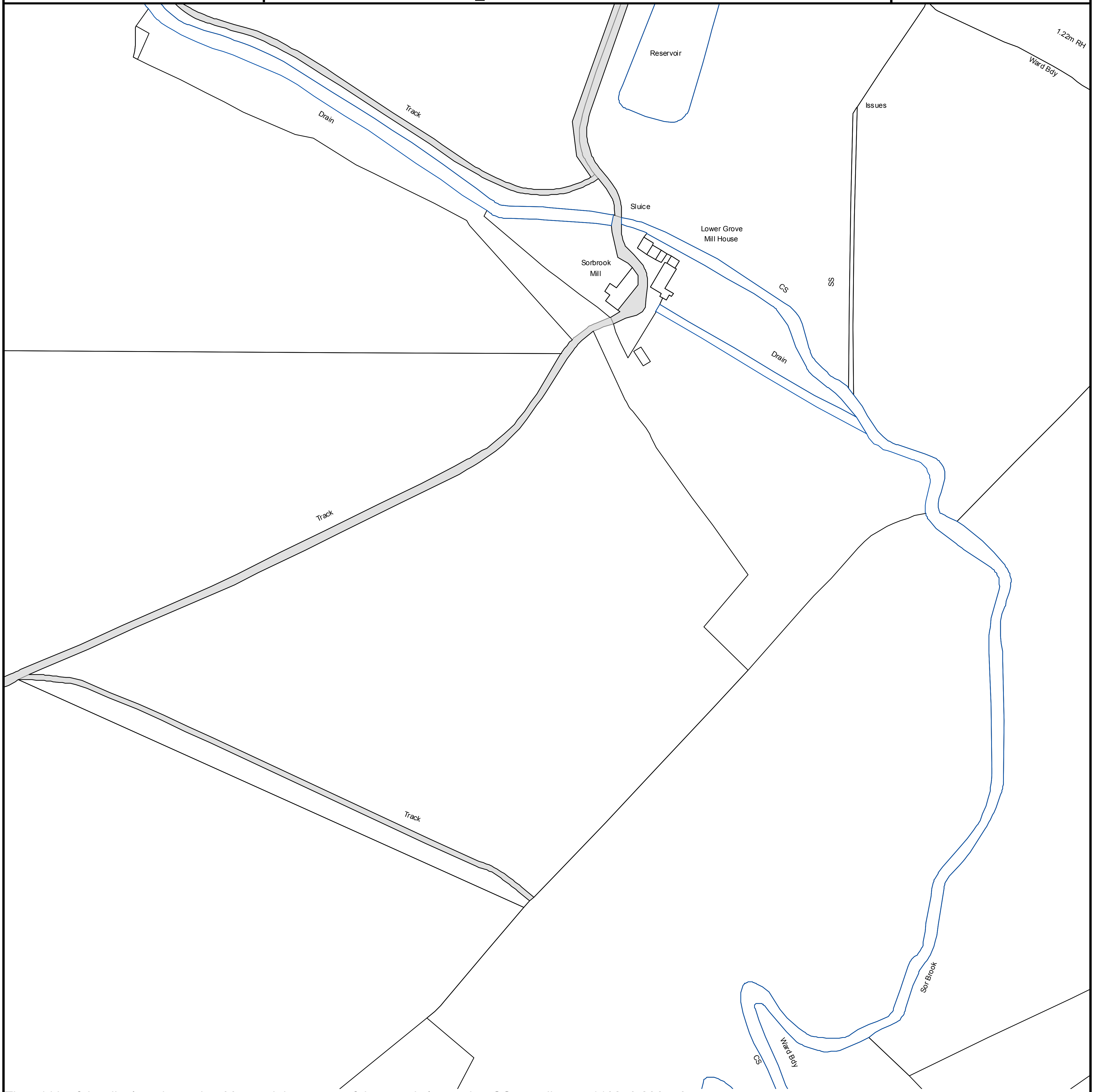
Other Sewer Types (Not Operated or Maintained by Thames Water)

- Foul Sewer
- Surface Water Sewer
- Combined Sewer
- Gulley
- Culverted Watercourse
- Proposed
- Abandoned Sewer

Notes:

1) All levels associated with the plans are to Ordnance Datum Newlyn.
2) All measurements on the plans are metric.
3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate direction of flow.
4) Most private pipes are not shown on our plans, as in the past, this information has not been recorded.
5) 'na' or '0' on a manhole level indicates that data is unavailable.
6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in milimetres. Text next to a manhole indicates the manhole reference number and should not be taken as a measurement. If you are unsure about any text or symbology present on the plan, please contact a member of Property Insight on 0845 070 9148.

Asset Location Search Water Map - ALS/ALS Standard/2013_2459550	SP4636NW



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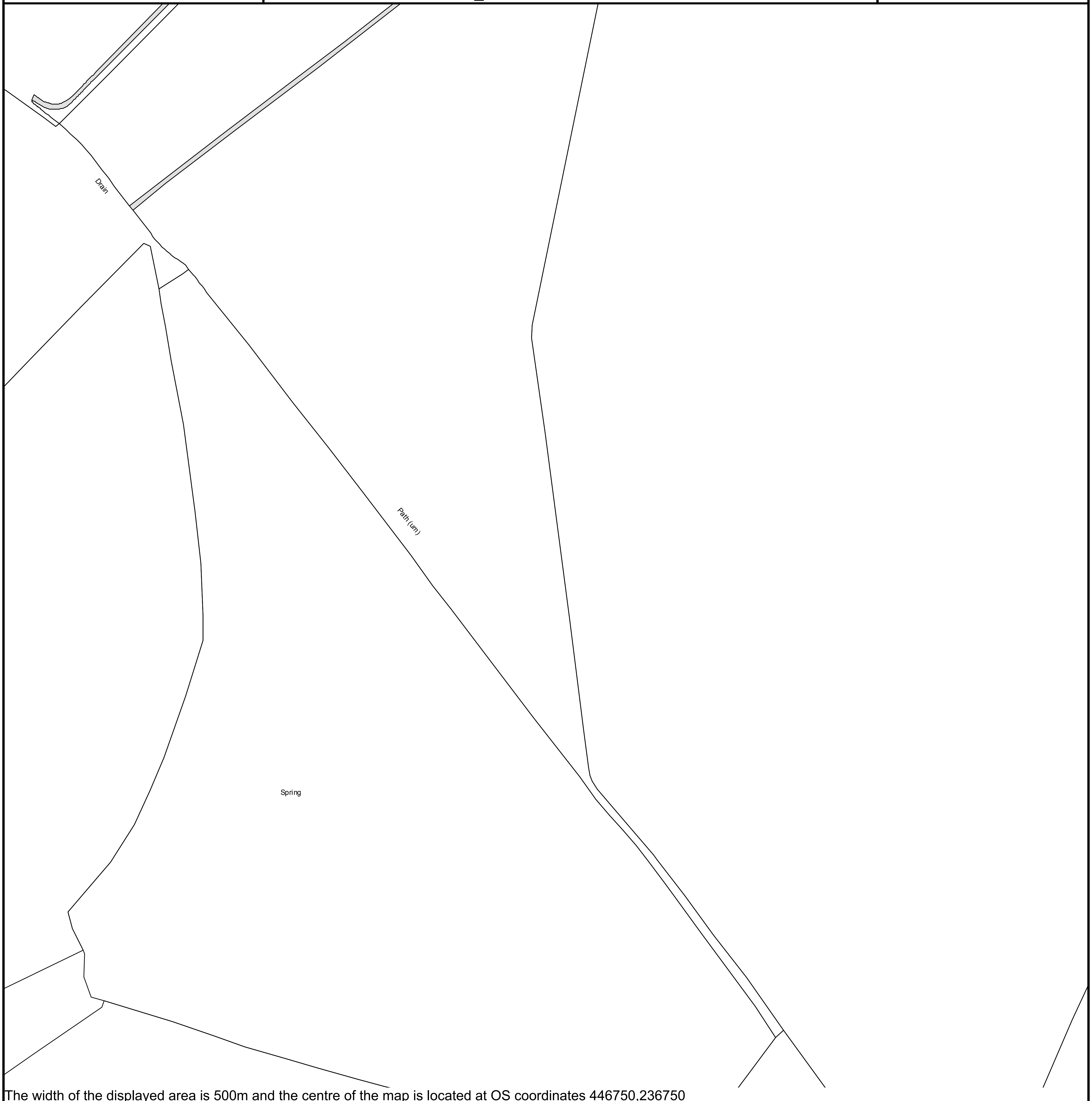
Asset Location Search Water Map - ALS/ALS Standard/2013_2459550	SP4636NE



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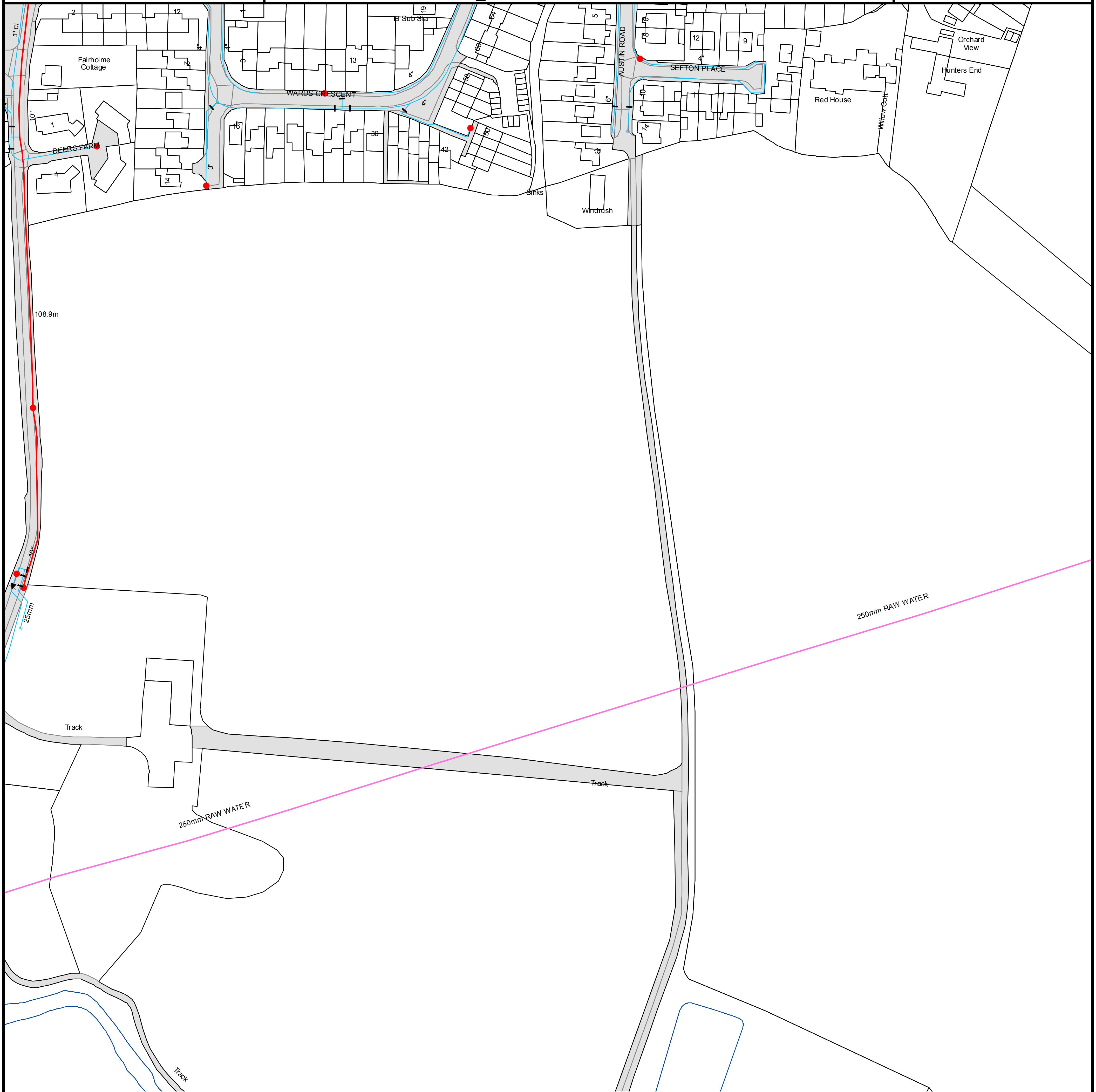
Asset Location Search Water Map - ALS/ALS Standard/2013_2459550	SP4637SW



The width of the displayed area is 500m and the centre of the map is located at OS coordinates 446250,237250

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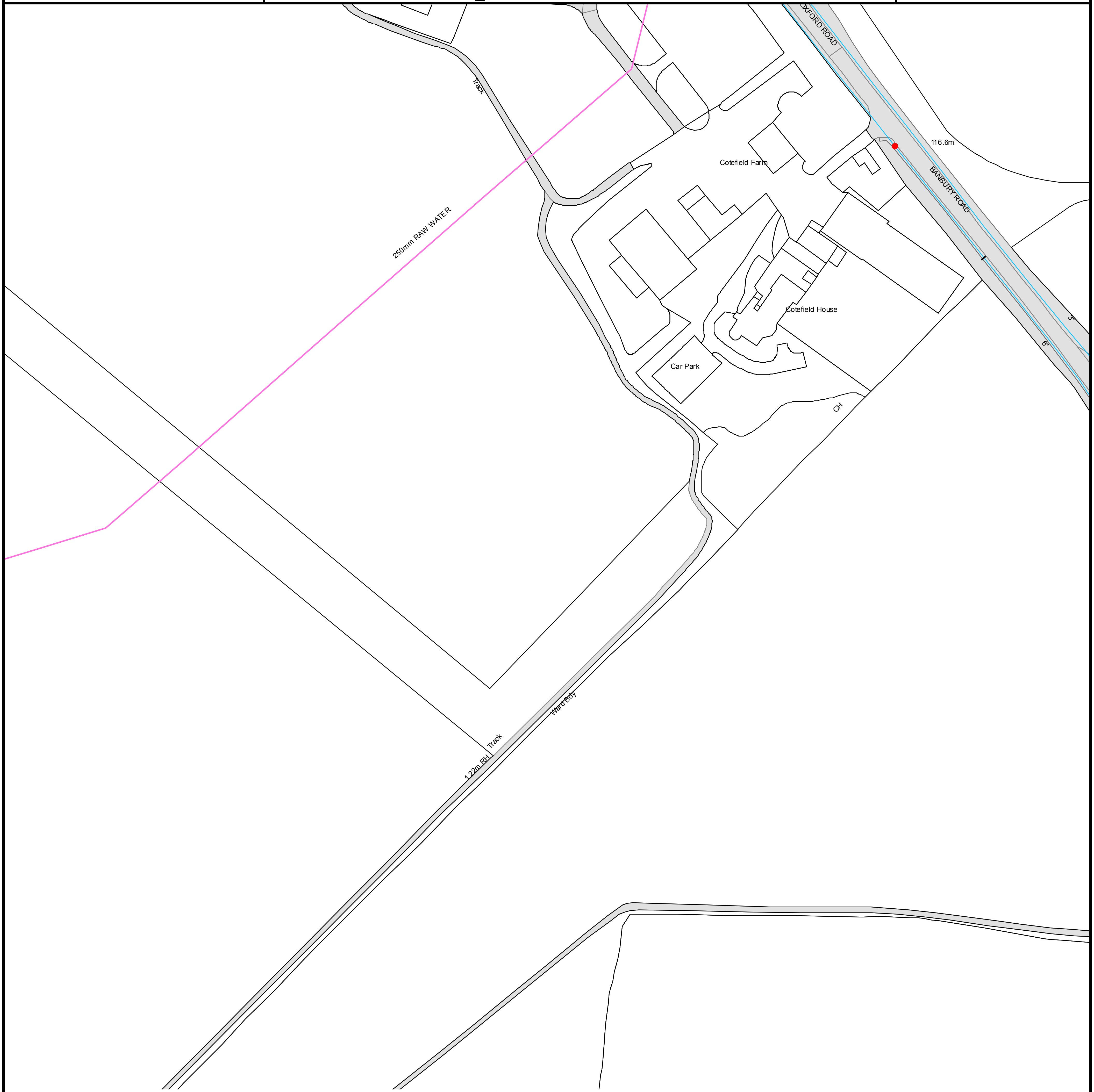
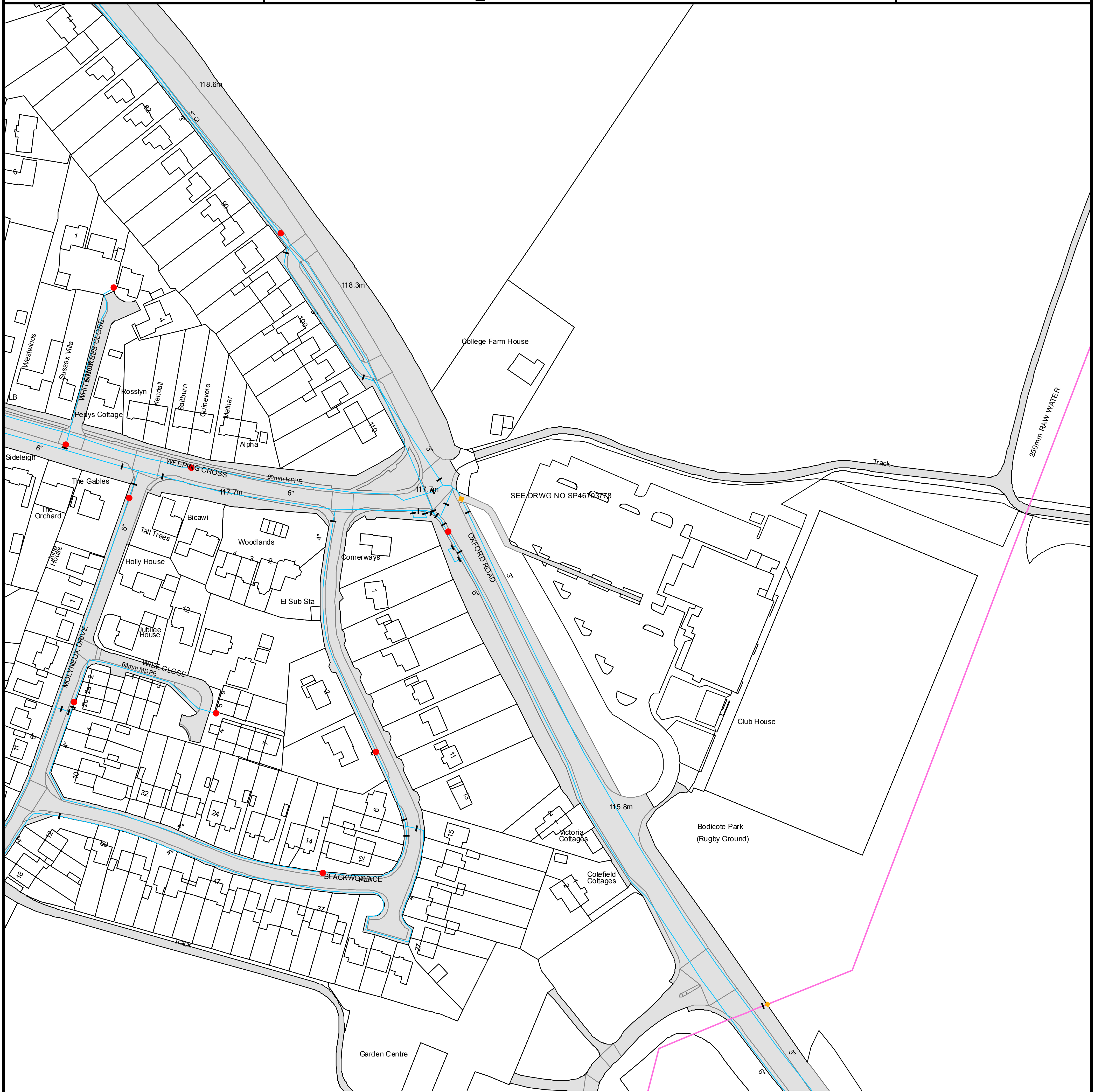
Asset Location Search Water Map - ALS/ALS Standard/2013_2459550	SP4637SE



The width of the displayed area is 500m and the centre of the map is located at OS coordinates 446750,237250

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

Asset Location Search Water Map - ALS/ALS Standard/2013_2459550 | SP4637NE



The width of the displayed area is 500m and the centre of the map is located at OS coordinates 446750,237750

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

ALS Water Map Key

Water Pipes (Operated & Maintained by Thames Water)

4"
Distribution Main: The most common pipe shown on water maps. With few exceptions, domestic connections are only made to distribution mains.

16"
Trunk Main: A main carrying water from a source of supply to a treatment plant or reservoir, or from one treatment plant or reservoir to another. Also a main transferring water in bulk to smaller water mains used for supplying individual customers.

3" SUPPLY
Supply Main: A supply main indicates that the water main is used as a supply for a single property or group of properties.

3" FIRE
Fire Main: Where a pipe is used as a fire supply, the word FIRE will be displayed along the pipe.

3" METERED
Metered Pipe: A metered main indicates that the pipe in question supplies water for a single property or group of properties and that quantity of water passing through the pipe is metered even though there may be no meter symbol shown.

Transmission Tunnel: A very large diameter water pipe. Most tunnels are buried very deep underground. These pipes are not expected to affect the structural integrity of buildings shown on the map provided.

Proposed Main: A main that is still in the planning stages or in the process of being laid. More details of the proposed main and its reference number are generally included near the main.

PIPE DIAMETER	DEPTH BELOW GROUND
Up to 300mm (12")	900mm (3')
300mm - 600mm (12" - 24")	1100mm (3' 8")
600mm and bigger (24" plus)	1200mm (4')

Valves

- General Purpose Valve
- Air Valve
- Pressure Control Valve
- Customer Valve

Hydrants

- Single Hydrant

Meters

- Meter

End Items

Symbol indicating what happens at the end of a water main.

- Blank Flange
- Capped End
- Emptying Pit
- Undefined End
- Manifold
- Customer Supply
- Fire Supply

Operational Sites

- Booster Station
- Other
- Other (Proposed)
- Pumping Station
- Service Reservoir
- Shaft Inspection
- Treatment Works
- Unknown
- Water Tower

Other Symbols

- Data Logger

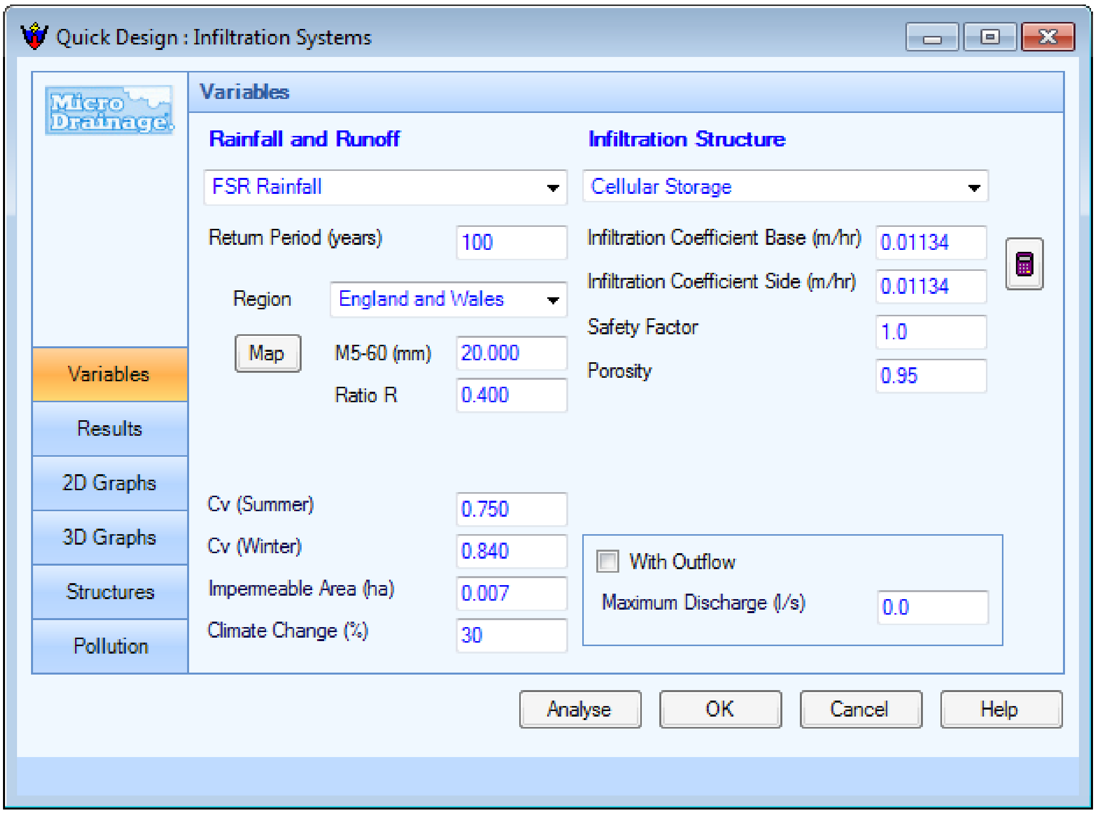
Other Water Pipes (Not Operated or Maintained by Thames Water)

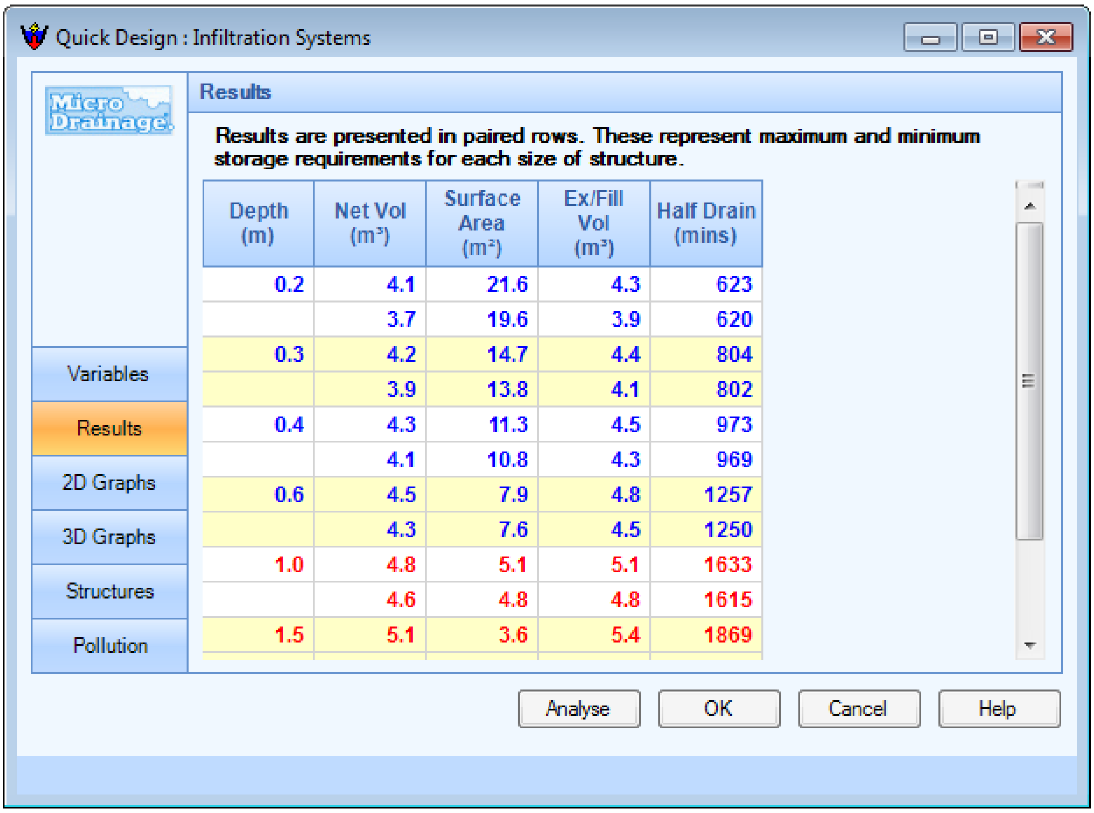
Other Water Company Main: Occasionally other water company water pipes may overlap the border of our clean water coverage area. These mains are denoted in purple and in most cases have the owner of the pipe displayed along them.

Private Main: Indicates that the water main in question is not owned by Thames Water. These mains normally have text associated with them indicating the diameter and owner of the pipe.

APPENDIX 5

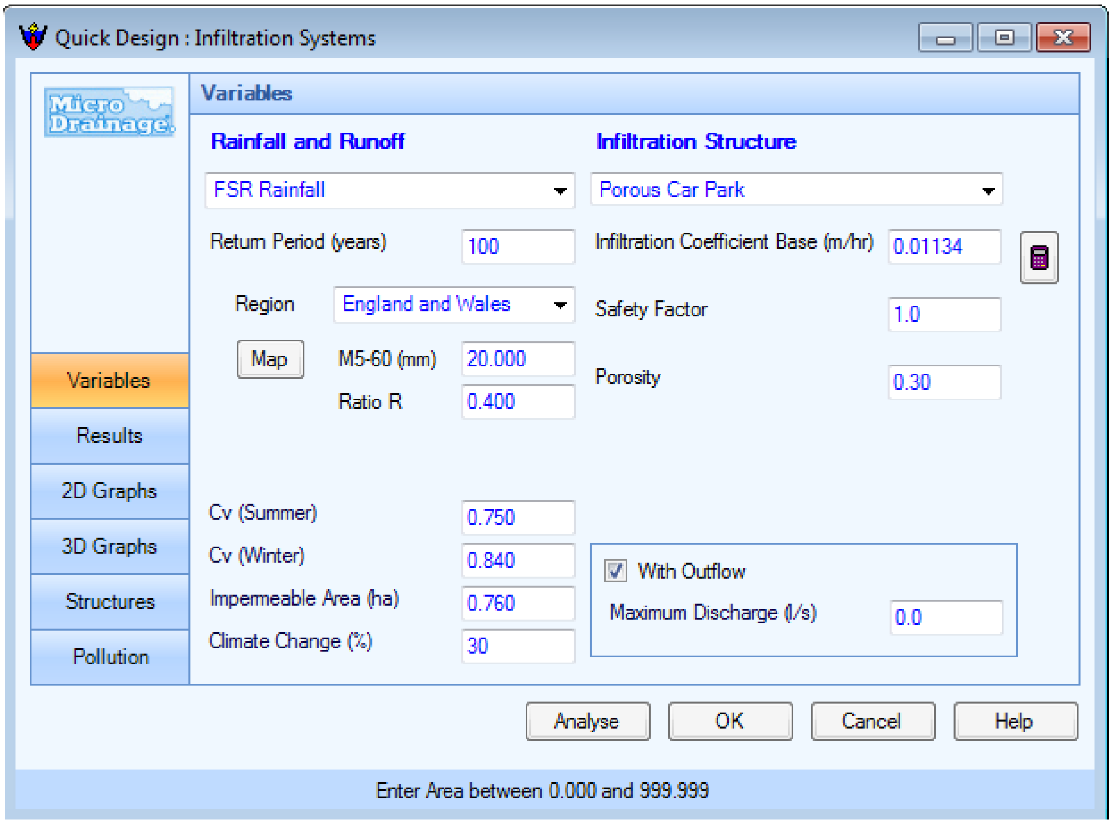
House Soakaway

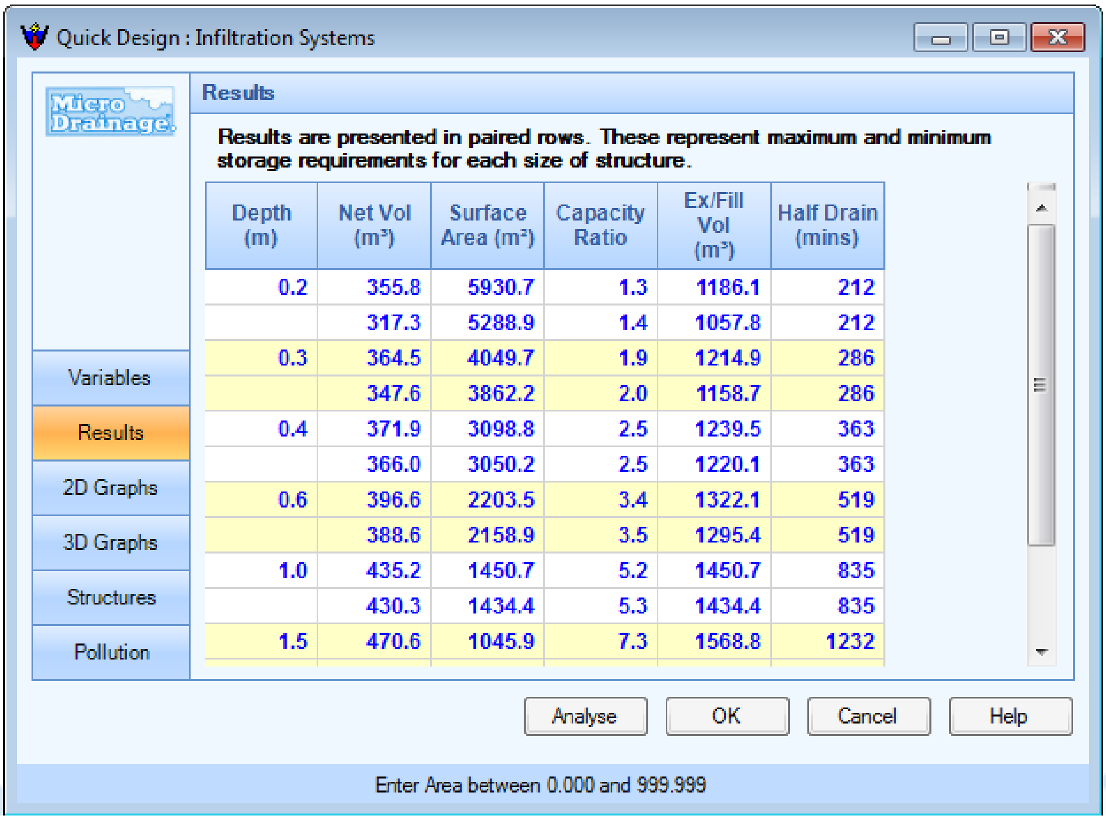




Depth (m)	Net Vol (m³)	Surface Area (m²)	Ex/Fill Vol (m³)	Half Drain (mins)
0.2	4.1	21.6	4.3	623
	3.7	19.6	3.9	620
0.3	4.2	14.7	4.4	804
	3.9	13.8	4.1	802
0.4	4.3	11.3	4.5	973
	4.1	10.8	4.3	969
0.6	4.5	7.9	4.8	1257
	4.3	7.6	4.5	1250
1.0	4.8	5.1	5.1	1633
	4.6	4.8	4.8	1615
1.5	5.1	3.6	5.4	1869

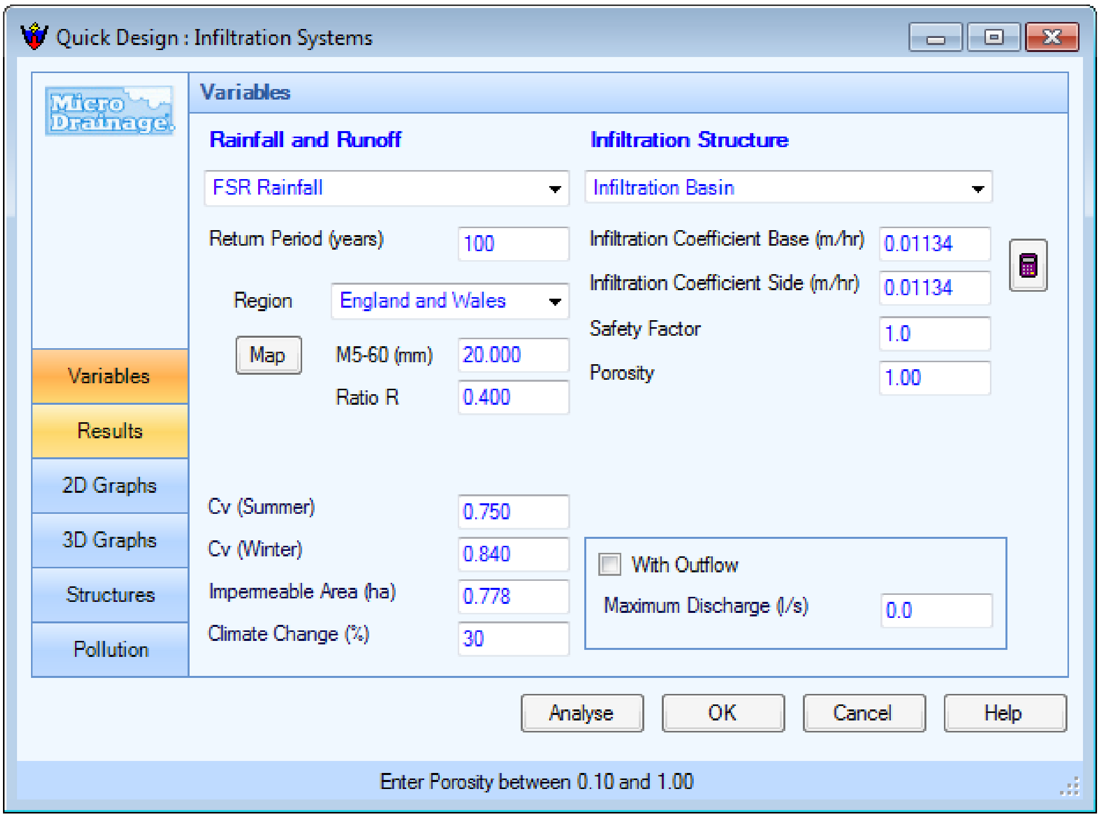
Porous Paved Areas

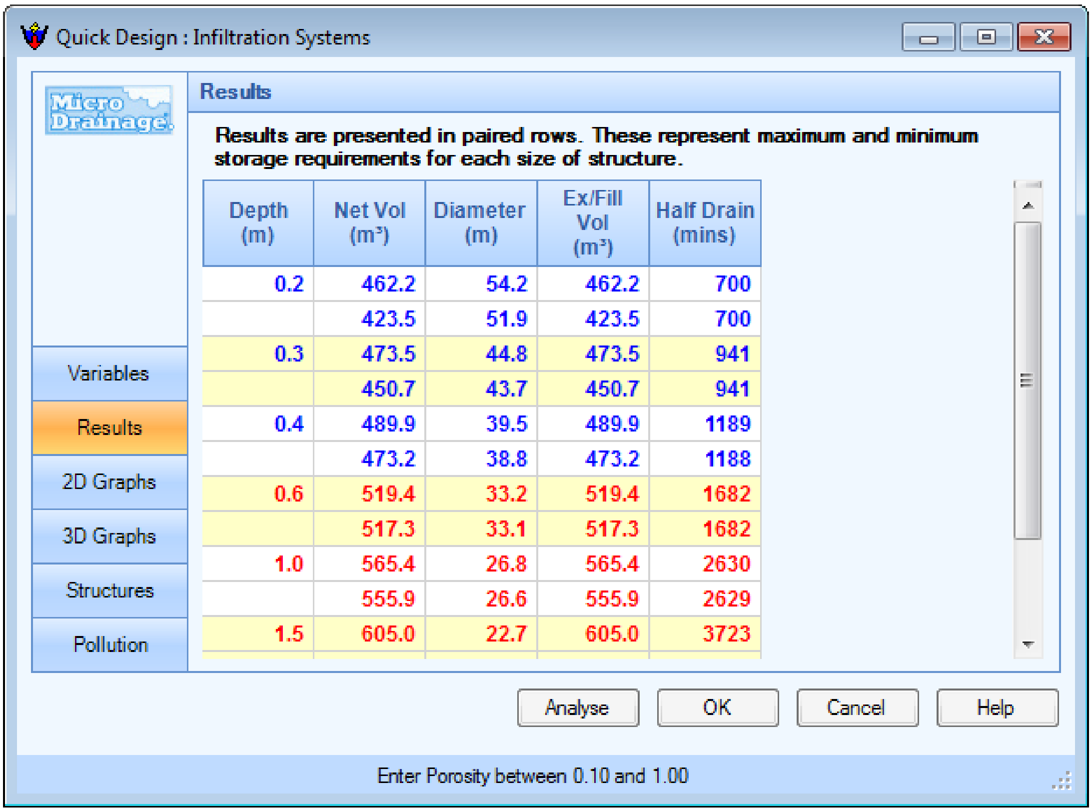




Depth (m)	Net Vol (m³)	Surface Area (m²)	Capacity Ratio	Ex/Fill Vol (m³)	Half Drain (mins)
0.2	355.8	5930.7	1.3	1186.1	212
	317.3	5288.9	1.4	1057.8	212
0.3	364.5	4049.7	1.9	1214.9	286
	347.6	3862.2	2.0	1158.7	286
0.4	371.9	3098.8	2.5	1239.5	363
	366.0	3050.2	2.5	1220.1	363
0.6	396.6	2203.5	3.4	1322.1	519
	388.6	2158.9	3.5	1295.4	519
1.0	435.2	1450.7	5.2	1450.7	835
	430.3	1434.4	5.3	1434.4	835
1.5	470.6	1045.9	7.3	1568.8	1232

Infiltration Basin





Depth (m)	Net Vol (m³)	Diameter (m)	Ex/Fill Vol (m³)	Half Drain (mins)
0.2	462.2	54.2	462.2	700
	423.5	51.9	423.5	700
0.3	473.5	44.8	473.5	941
	450.7	43.7	450.7	941
0.4	489.9	39.5	489.9	1189
	473.2	38.8	473.2	1188
0.6	519.4	33.2	519.4	1682
	517.3	33.1	517.3	1682
1.0	565.4	26.8	565.4	2630
	555.9	26.6	555.9	2629
1.5	605.0	22.7	605.0	3723

Client:	Project:	Title:	Drawn by:	Checked by:	Size:
Mr R Bratt	Blossom Fields	Proposed SuDS Surface Water Management Strategy	DKP	DKP	A3
	Project Ref:		Date: 31.12.14	Scale: 1:1000	
	FEDS-214026		Dwg.no: FEDS-214026-004		Rev: B

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