ENVIRONMENT - WATER

NEWLAND HOMES
COLLIN LANE, WILLERSEY

FLOOD RISK ASSESSMENT

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REVISION STATUS

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EXECUTIVE SUMMARY

This Flood Risk Assessment (FRA) is compliant with the requirements set out in the National Planning Policy Framework (NPPF) and the associated Technical Guidance (March, 2012). It has been produced on behalf of Newland Homes in respect of a planning application for residential development at Collin Lane, Willersey (approximate grid reference: SP100396).

This report demonstrates that the proposed development is at an acceptable level of flood risk, subject to the recommended flood mitigation strategies being implemented.

The proposed development area lies entirely within Flood Zone 1 as shown on Environment Agency mapping. The site also lies outside the area at risk of flooding from reservoir failure, groundwater and sewers. Environment Agency mapping however, shows the site to be at risk from surface water flooding associated with the adjacent watercourses and is therefore at high risk from local 'ordinary watercourses'.

The mitigation measures have been shown to alleviate fluvial flood risk within the site, while also offering reduced flood risk to the existing properties downstream of the site. This is in exchange for a marginal increase to in-channel flood levels downstream of the site. This arrangement considered to be a significant betterment, and significantly reduced out of bank flooding is considered to be a fair exchange for increased water levels within the channel.

It is advised in accordance with best building practice that all development finished floor levels are raised a minimum of 600mm above the adjacent 100 year plus climate change flood level or 150mm above surrounding ground levels whichever is most conservative.

The SFRA states that for both greenfield and brownfield sites the development runoff volumes and peak flow rates leaving the site should be attenuated to the greenfield discharge conditions and that drainage systems should be designed to accommodate all storm events up to and including the 1 in 100 year event including climate change.

Surface water in excess of the discharge rate will be stored on site up the 1 in 100 year storm (with an allowance for climate change) through the use of two attenuation ponds. It is recommended that SuDS are utilised to provide this storage while also providing a minimum of two levels of treatment prior to outfalling from the site. The site will continue to discharge to the watercourses within the site.

In compliance with the requirements of National Planning Policy Framework, and subject to the mitigation measures proposed, the development could proceed without being subject to significant flood risk. Moreover, the development will not increase flood risk to the wider catchment area as a result of suitable management of surface water runoff discharging from the site.

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1.0 INTRODUCTION

Summary Information

1.1 This Flood Risk Assessment (FRA) is compliant with the requirements set out in the National Planning Policy Framework (NPPF) and the associated Planning Practice Guidance (March, 2014). The FRA has been produced on behalf of Newland Homes in respect of a planning application for the proposed residential development at Collin Lane, Willersey.

Site Name	Collin Lane
Location	Willersey
NGR (approx)	SP100396
Application Site Area (ha)	3.0
Development Type	Residential
NPPF Vulnerability	More Vulnerable
EA Flood Zone	Flood Zone 1
EA Office	South East: West Thames
Local Planning Authority	Cotswold District Council

Table 1.1 Site Summary

Sources of Data

1.2 The report is based on the following information :

(i) Site Layout Plan
(ii) Topographic Survey provided by BWB Consulting
(iii) OS Mapping
(iv) Environment Agency Correspondence
(v) Hydraulic Modelling undertaken by BWB Consulting
(vi) Local Authority Surface Water Flood Risk Maps
(vii) Strategic Flood Risk Assessment
(viii) Web Based Soil Mapping
(ix) Severn Trent Sewer Records
(x) British Geological Survey Drift & Geology Maps

Existing Site

1.3 The proposed development area is located north west of Willersey, north of Collin Lane. **Figure 1.1** has been included for reference to show the site location.

1.4 The existing site is considered to be largely greenfield agricultural fields, with the addition of the nursery in the 1970's. There is an embanked dismantled railway to the north of the site and 5 properties. A playing field is to the east with open fields and an electrical substation to the west.

1.5 The closest Main River defined by the Environment Agency is the Badsey Brook. This is situated approximately 2.2km south west of the site.

1.6 A topographic survey can be viewed in

1.7

1.8

1.9 Appendix A; it illustrates the site to have a range of levels between 70-65m AOD. The land generally falls towards the north and toward the watercourses within the site.

1.10 The site is expected to be underlain by the Lias Formation and Charmouth Mudstone Formation with no superficial deposits expected to be present in this location. The soil type situated on the site is predicted to be lime-rich loamy and clayey soils with impeded drainage.

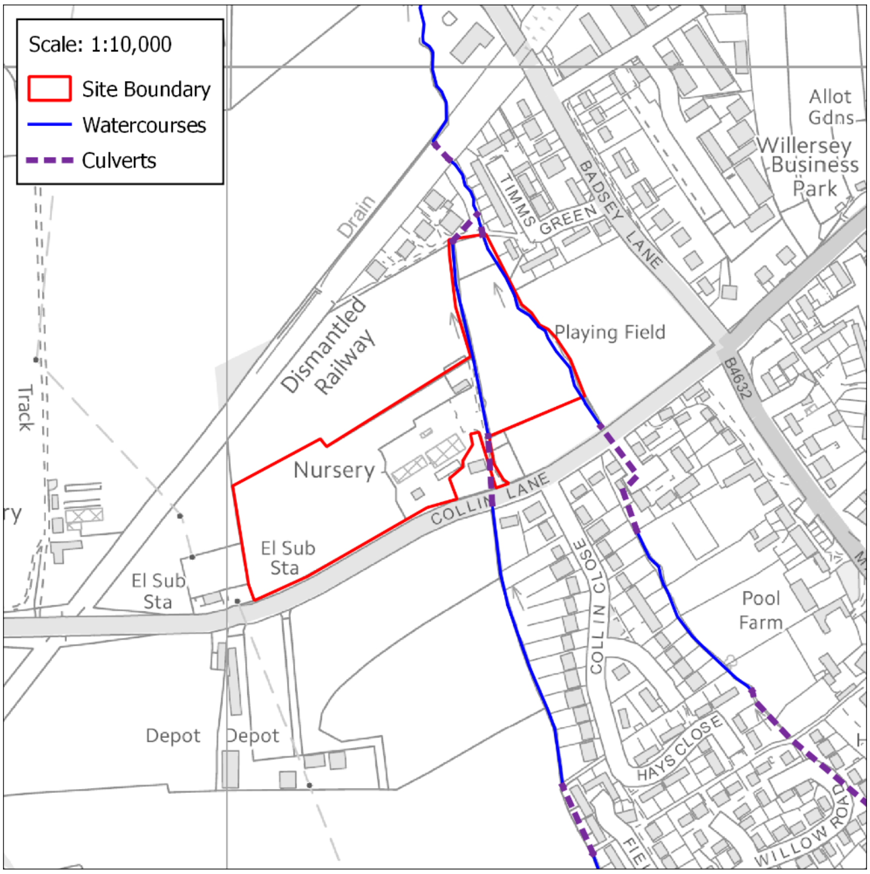

Figure 1.1 Site Location Map

Proposed Development

1.12 The current development plan is outlined in

1.13

1.14

1.15 Appendix B it includes 50 residential dwellings.

Flood Risk Planning Policy

National Planning Policy Framework

1.16 The NPPF[1] sets out the Government's national policies on different aspects of land use planning in England in relation to flood risk. A supporting Planning Practice Guidance document is also available[2].

1.17 The Planning Practice Guidance sets out the vulnerability to flooding of different land uses. It encourages development to be located in areas of lower flood risk where possible, and stresses the importance of preventing increases in flood risk off site to the wider catchment area.

1.18 The Planning Practice Guidance also states that alternative sources of flooding, other than fluvial (river flooding), should also be considered when preparing a Flood Risk Assessment.

1.19 This Flood Risk Assessment is written in accordance with the NPPF.

[1] National Planning Policy Framework, CLG, March 2012
[2] Planning Practice Guidance, March 2014

NPPF Flood Zones

1.20 Flood Zone mapping prepared by the Environment Agency identifies areas potentially at risk of flooding from fluvial or tidal sources without taking into account the presence of flood defences or structures such as culverts or minor watercourses. An extract from the mapping is included as **Figure 1.2.**

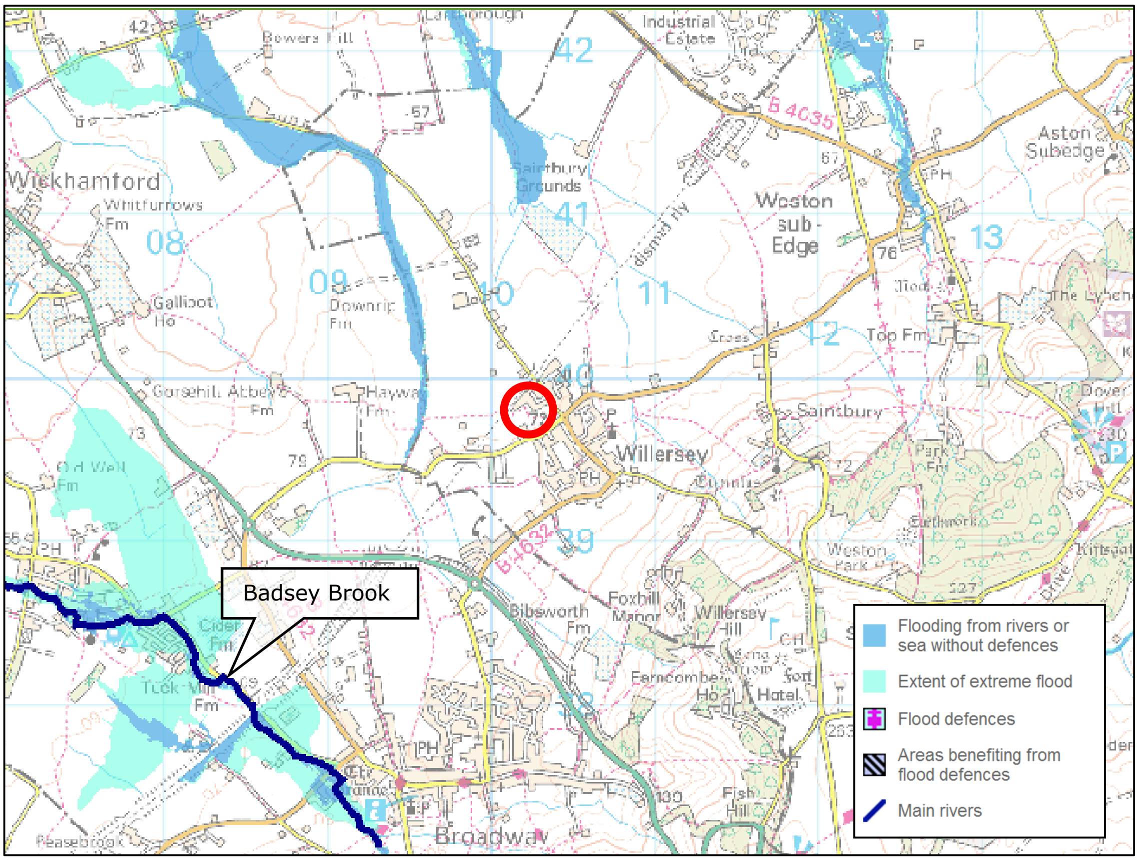

Figure 1.2 Environment Agency Indicative Flood Zones Map

1.21 The Environment Agency Flood Zone mapping shows the site to be located entirely within Flood Zone 1 (Low Probability). This Flood Zone is defined in the NPPF as land assessed as having a less than 1 in 1000-year annual probability of river/tidal flooding.

Other Relevant Policy and Guidance

Strategic Flood Risk Assessment

1.22 The Cotswold Strategic Flood Risk Assessment[3] (SFRA), produced in 2008 identifies possible mitigation measures and illustrates any potential development areas. The SFRA identifies the proposed development area as a potential employment site.

[3] Cotswold Strategic Flood Risk Assessment, Halcrow, 2008, available at: http://www.gloucestershire.gov.uk/extra/CHttpHandler.ashx?id=28377&p=0

1.23 Groundwater emergence maps indicate areas towards the southern extent of the District, near Cirencester, to be susceptible to groundwater emergence. The site itself is in the lowest category of risk of groundwater flood emergence and there is no historical record of groundwater flooding.

1.24 The properties at risk of flooding from the public sewerage system shown on the DG5 register have been summarised within the SFRA. The DG5 register shows two properties within the postcode WR12 7 (Willersey have been reported as affected by flooding of sewers, however the level of risk is reported as low. The postcode area also includes properties which fall outside of the council boundary and is not street specific.

1.25 The SFRA states that for both greenfield and brownfield sites the development runoff volumes and peak flow rates leaving the site should be attenuated to the greenfield discharge conditions and that drainage systems should be designed to accommodate all storm events up to and including the 1 in 100 year event including climate change.

1.26 For any development site containing or located adjacent to a watercourse without flood zone information, it is recommended that a minimum 8m development easement from the top of bank is applied and a site specific FRA is undertaken.

Surface Water Management Plan

1.27 The first edition Surface Water Management Plan (SWMP) was produced by Halcrow and Richard Alitt Associates Ltd in March 2010[4], with the aim of testing the SWMP guidance that was due to be released by DEFRA. The SWMP identified key areas within Gloucestershire which had been affected by fluvial flooding.

1.28 Within the Cotswold District, surface water flooding was identified as an issue for a number of areas. The severe flooding that occurred in the summer of 2007 affected many properties within the towns and villages and as a result the Cotswold District Council undertook a 'Flooded Homes Survey' which identified the worst affected areas and assessed the mechanisms of flooding within these areas.

1.29 The survey included detailed information regarding the source of flooding, the location and depth of the floodwater. The data collected was reviewed and the top twenty priority areas were identified with the worst affected areas including Moreton-in-Marsh, Fairford and Welford. Within these areas it was concluded that the exact source of the flooding was not always clear, although overwhelmed sewers, road gullies or blocked drains were thought to be the typical causes, in conjunction with significant fluvial influences.

1.30 The Second Phase Report was completed by Hyder in 2008 in response to the 2007 flooding that took place within the Cotswold District[5]. The report focuses on the top 20 list of areas that were identified in the Phase 1 Report for further investigation. This phase of work was mainly informed by local residents and councillors. Willersey was one of the top 20 areas identified for further investigation and the flooding identified there was surface water (sewers) and river flooding.

[4] Gloucestershire First Edition Surface Water Management Plan Pilot. Halcrow/RAA. March 2010
[5] Cotswold District Council. Review and Response to the Summer 2007 Flood in the Cotswold District. Hyder. 2008.

1.31 On the 20th July 2007, 36 properties within Willersey were flooded. The properties were spread out across the village. Overland flow from the watercourse adjacent to Timms Green, east of the site, was reported to flood 3 bungalows.

2.0 POTENTIAL SOURCES OF FLOOD RISK

2.1 The table below identifies the potential sources of flood risk to the site, and the impacts which the development could have in the wider catchment. These are discussed in greater detail in the forthcoming section. The mitigation measures proposed to address flood risk issues and ensure the development is appropriate for its location are discussed within **Section 3.0**.

Flood Source	Potential Risk				Description
	High	Medium	Low	None	
Pluvial runoff	X				Environment Agency Mapping shows the site to be at risk from surface water flooding associated with the adjacent watercourses.
Fluvial	X				The site is located in Flood Zone 1, but is at high risk from local 'ordinary watercourses'
Canals				X	The site is significantly removed from the nearest canal.
Groundwater			X		The site is underlain by an impermeable stratum.
Reservoirs and waterbodies				X	The site is shown to fall outside of the area at risk of reservoir failure.
Sewers			X		Due to the limited sewer network in proximity to the site and the topography of the site it is unlikely to present a flood risk.
Effect of Development on Wider Catchment		X			The development will increase the area of impermeable surfaces leading to a potential increase in runoff. It could also impede local flood routes, unless mitigated.

Table 2.1 Potential Pre-Mitigation Sources of Flood Risk

Pluvial Flood Risk

2.2 The SWMP identifies that there have been recorded surface water flooding incidents in Willersey with two single point incidents and a polygon shown on the map in the vicinity of the site.

2.3 Surface water flood risk mapping has been prepared by the Environment Agency (**Figure 2.1**) using information from Lead Local Flood Authorities where it is available. The mapping shows the western half of the site is mainly within an area of very low risk from surface water flooding. This is defined as having a less than 1 in 1000-year annual probability of surface water flooding.

2.4 However, the eastern half of the site is shown to be at medium and high risk of flooding. Medium risk is defined as having between 1 in 100 year and 1 in 30 year annual probability of surface water flooding and high risk is defined as having a greater than 1 in 30 year probability of surface water flooding.

2.5 A comparison of the flood maps against Ordnance Survey mapping shows that the surface water flooding is associated with the two minor watercourses, and is in fact an indication of the potential fluvial floodplain. Therefore it is proposed to fully assess and mitigate the risk as part of the fluvial assessment discussed within the forthcoming report.

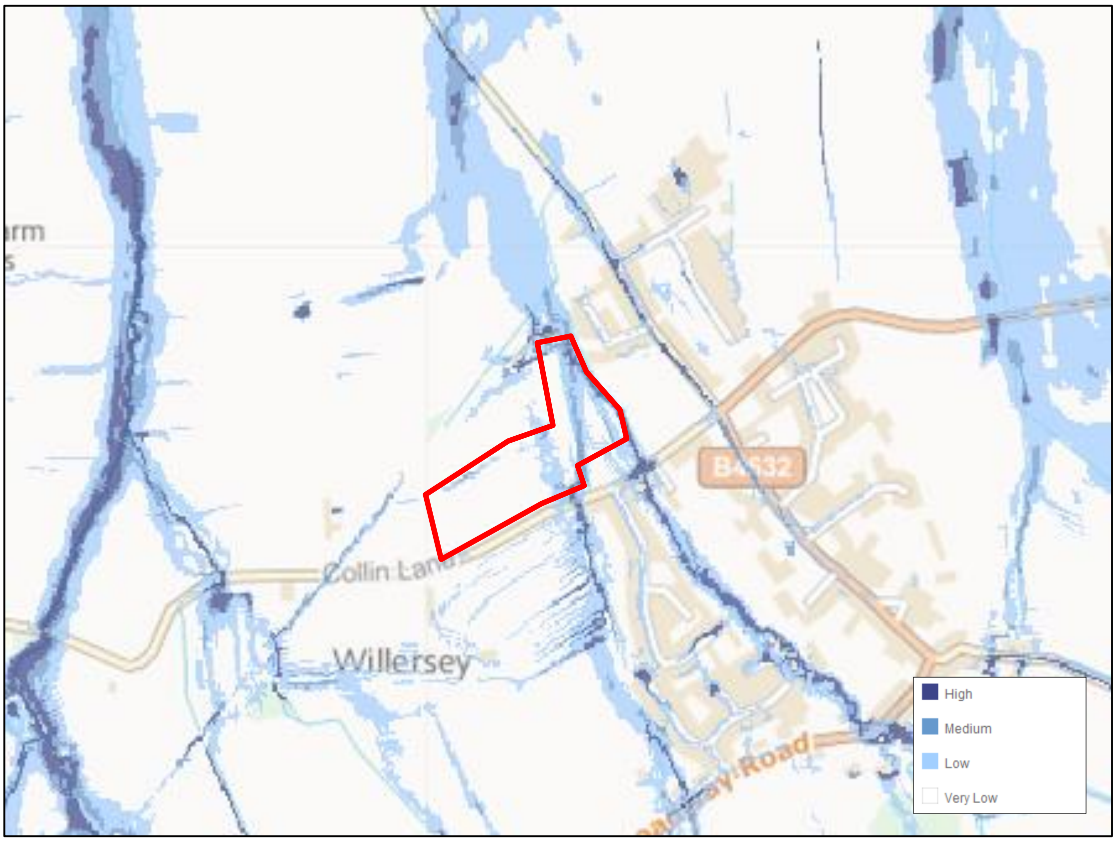

Figure 2.1 Flood Map for Surface Water

Fluvial Flood Risk

Main Rivers

2.6 The Badsey Brook is the closest Main River to the site; it is located approximately 2.2km to the southwest. **Figure 1.2** shows Flood Zones 2 and 3 are situated to the southwest of the site, but importantly do not encroach beyond the site boundary or onto the site access/egress route.

Minor Watercourses

2.7 There are two minor watercourses within the vicinity of the site; their locations are shown in **Figure 1.1**.

2.8 Through conducting a review of available flooding information from Cotswold District Council, it has been established that Willersey and in particular the area of the site is subject to fluvial flooding from the watercourses present, which resulted in property flooding occurring in July 2007, though full details of this are not available.

Hydraulic Modelling

2.9 As identified above, the site is shown to potentially fall within the floodplain of the two minor watercourses. In order to understand the risk to the site, it was necessary to undertake a hydraulic flood modelling exercise. A technical note with the full details of the modelling is available in Appendix G, there is a summary below of the findings.

2.10 The Flood Estimation Handbook (FEH) shows that the two watercourses fall within the same topographic catchment. An estimation of the likely flood flows produced by this catchment was undertaken using the FEH statistical analysis and Revitalised Flood Hydrograph (ReFH) rainfall-runoff model.

2.11 The ReFH proved to provide the more conservative flows and so was adopted in the hydraulic modelling exercise. Peak flows are summarised in **Table 2.2**. These flows are split between the two watercourses (Western: 46%, Eastern, 54%).

Return Period	Annual Exceedance Probability (AEP)	Peak Flows (m^3/s) ReFH Method
2 (QMED)	50.0%	0.64
20	20.0%	1.24
75	1.3%	1.68
100	1.0%	1.79
1000	0.1%	3.29

Table 2.2 Catchment Flood Flows

2.12 A site specific dynamically linked 1D-2D hydraulic model of the watercourses and floodplain was produced within 'TUFLOW'. This extended from the southern side of Willersey (upstream of Broadway Road, and 500m upstream of the site) to Badsey Lane (250m downstream of the site). It included both the eastern and western braches of the watercourse.

2.13 The channel and hydraulic structures were modelled in the one-dimensional (1D) model domain. Cross-sections were surveyed at regular intervals in locations which captured the general condition and shape of the open watercourses.

2.14 Environment Agency 1m resolution LiDAR DTM (Digital Terrain Model) data was used as a base for the two-dimensional (2D) floodplain; this has undergone a filtering process to remove buildings and vegetation to provide a bare earth ground model. A 3.0m resolution grid was adopted; this is considered to be more than sufficient given the semi-rural nature of the floodplain.

2.15 Although the 3.0m cell size will pick up most of the significant topographic features, the river banks were reinforced using a 'Z-line'. This was primarily informed from the watercourse survey, but where survey coverage was limited the LiDAR data was used to supplement bank levels.

2.16 The ReFH flood hydrographs were applied to the model in a 'lumped' approach. This will result in a conservative assessment, as all the flows generated in the lower reaches of the catchment, downstream of the site, will be applied upstream of the site.

2.17 The hydraulic model has confirmed that the eastern half of the site is at fluvial flood risk. Flooding of the site is initiated upstream the site because of the restrictive nature of the culverts under Collin Lane. Shallow flood routes (under 150mm deep) enter the site from the south, and exit via the northern boundary – this is illustrated within **Figure 2.2**.

2.18 Full drawings of modelled flood extents and depths are available in the hydraulic modelling technical note, available in **Appendix C** and mitigation measures to address this risk are outlined in **Section 3.0.**

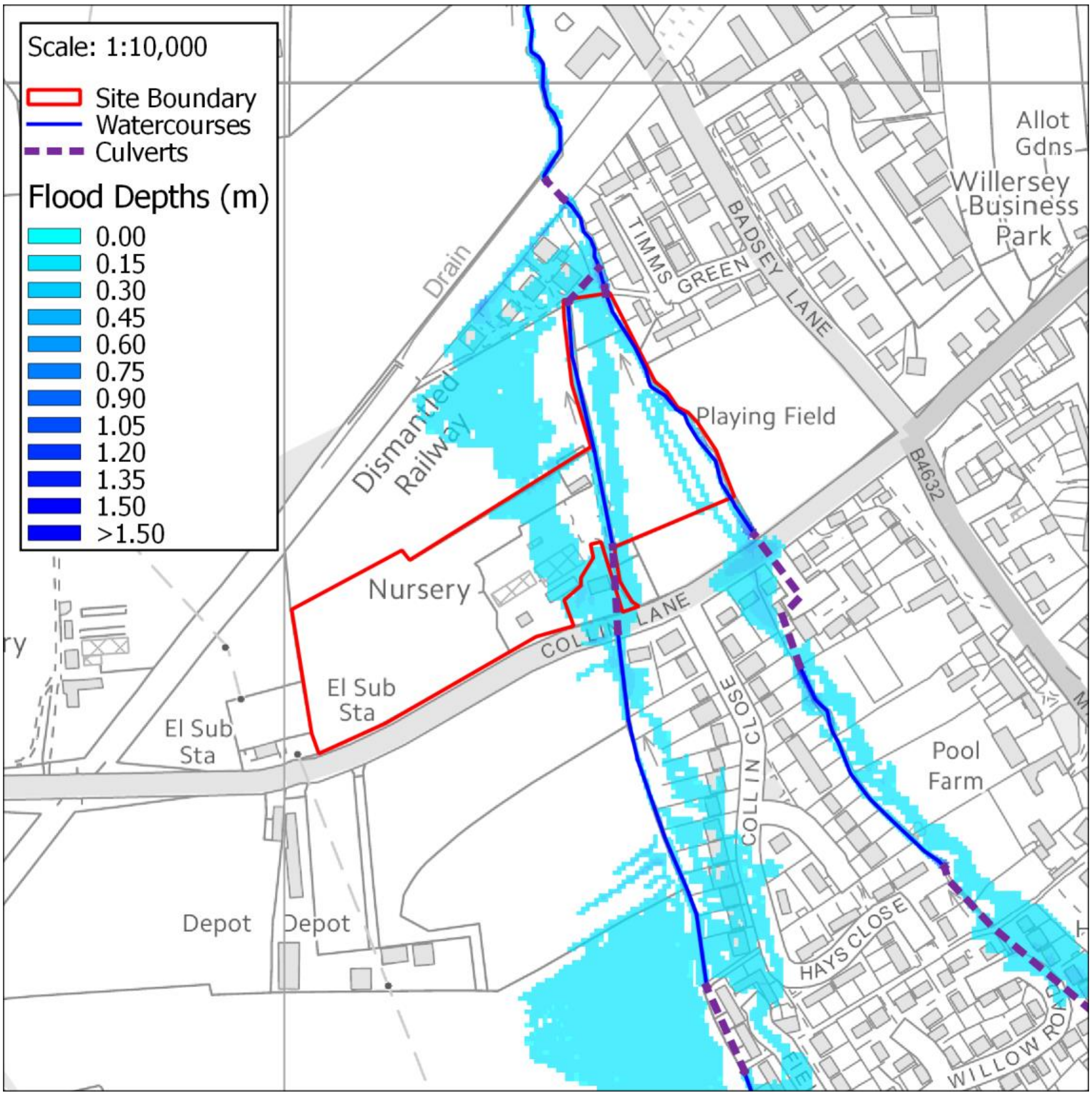

Figure 2.2 1 in 100 + Climate Change Modelled Flood Depths

Flood Risk from Canals

2.19 No canals are in close proximity to the site which would present a flood risk.

Groundwater Flood Risk

2.20 The SFRA shows the site to lie in an area not susceptible to groundwater flooding. The area is underlain by Mudstone which is designated a Secondary Undifferentiated Aquifer. The soil type situated on the site is predicted to be lime-rich loamy and clayey soils with impeded drainage. As such, groundwater is unlikely to pose a significant flood risk to the site

Flood Risk from Reservoirs/Waterbodies

2.21 Reservoir failure flood risk mapping has been prepared by the Environment Agency, this shows the largest area that might be flooded if a reservoir were to fail and release the water it holds. The map displays a worst case scenario and is only intended as a guide. An extract from the mapping is included as **Figure 2.3**. It demonstrates the site to lie outside the maximum area at risk.

Figure 2.3 Environment Agency Reservoir Failure Flood Risk Map

Flood Risk from Sewers

2.22 Correspondence with Severn Trent has provided the sewer records for the site and the surrounding area, which are included in **Appendix D**. The records provided identify a public foul sewer within the site boundary to the east of Hopefield. The sewer record extract also shows that there are limited surface water sewers serving the area.

2.23 Due to the limited sewer network in proximity to the site and the topography of the site the risk of sewers surcharging onto the site if they become blocked or overwhelmed is minimal.

Effect of Development on Wider Catchment

Development Drainage

2.24 The proposed development will increase the impermeable surface area; this could lead to an increased rate and volume of surface water runoff, which has the potential to cause a flood risk to the site and elsewhere. Mitigation measures outlined in **Section 4.0** should be adhered to.

Impedance of Flow Routes and Loss of Floodplain

2.25 Any development within the fluvial floodplain on the site could lead to flows being diverted on to third party land, unless mitigated as part of the development proposals.

3.0 FLOOD RISK MITIGATION

3.1 **Section 2.0** has identified the sources of flooding which could potentially pose a risk to the site and the proposed development. This section of the FRA sets out the mitigation measures which are to be incorporated within the proposed development to address and reduce the risk of flooding to within acceptable levels.

Site Arrangements

3.2 There are several mitigation options which are recommended below to alleviate the shallow overland flows which occur due to the undersized culverts under Collin Lane. The strategy involves intercepting the shallow flood routes on the southern boundary, and re-directing them into the watercourses.

3.3 Drawing BMW/2315/WSK05 within **Appendix C** gives a detailed plan of each of the mitigation measures, as well the proposed impacts which these have on the site, as well as others on the floodplain.

3.4 The mitigation measures have been shown to alleviate fluvial flood risk within the site, while also offering reduced flood risk to the existing properties downstream of the site. This is in exchange for a marginal increase to in-channel flood levels downstream of the site. Detailed site layout plans in **Appendix B** show how these mitigation measures will be implemented.

3.5 This arrangement considered to be a significant betterment, and significantly reduced out of bank flooding is considered to be a fair exchange for increased water levels within the channel.

Widening of existing flood corridor

3.6 It is also proposed to formalise the floodplain within the site in a flood corridor. This will be created within the 8m standoff from bank top. A 5m wide shelf will be scraped adjacent to the existing watercourse, this will allow for additional water during high flow events, as illustrated in Figure **3.1** below.

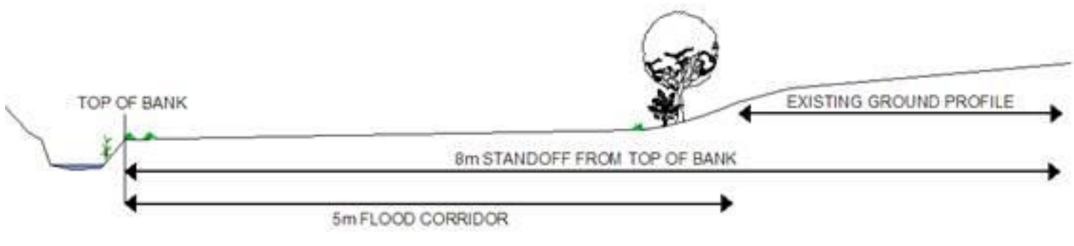

Figure 3.1 - Typical cross section of enhanced flood corridor.

Intercepting Swale Features

3.7 In order to intercept the overland flow routes from both the eastern and western watercourses two interceptor features are required. These will take the form of 1m deep swales which direct any overland flow which comes from third party land back into the watercourse. The exact locations of these swale features are shown in drawing BMW/2315/WSK05 available in **Appendix C**. In order to mitigate the risk of any spill from these features it is proposed that a bund is located on the downstream side of the swales, built using the spoil from digging the trenches. The western most swale feature is required to be culverted under the proposed access road; directing overland flow into the new proposed flood corridor at the northern end of the site.

3.8 In addition to this, it is necessary to increase the length of the culvert which the main western watercourse flows through. This extension will prevent any water from spilling out into the site and direct flow into the proposed flood corridor on the northern side of the proposed access road.

Finished Floor Levels

3.9 To mitigate any residual risk of flood it is recommended that finished floor levels of the properties are raised a minimum of 600mm above the 1 in 100 + climate change flood level. Finished floor levels of each proposed building are shown in the layout drawings in **Appendix B**.

Ground Levels

3.10 Ground levels should be profiled to encourage pluvial runoff and overland flows away from the built development and access egress routes, and towards the nearest positive drainage point.

Surface Water Drainage

3.11 A surface water drainage system should be formulated to intercept and attenuate runoff on the site up to and including the 1 in 100 year plus climate change storm event, thereby helping to mitigate the pluvial flood risk on the site as well as the impact on the site in the wider catchment. This is discussed in greater detail within **Section 4.0**.

4.0 OUTLINE SURFACE WATER DRAINAGE ASSESSMENT

Existing Site Runoff

4.1 The majority of the site is currently agricultural fields; therefore the site has been considered greenfield within this assessment. The site topography implies that runoff is currently directed to the two minor watercourses.

Proposed Site Runoff

4.2 Strategic level soil mapping has suggested the soil type to be clayey with impeded drainage; this suggests soakaways may not be a viable drainage solution. For the purposes of this report it is assumed that soakaway is not appropriate or limited – this represents a worst-case scenario of the drainage conditions in terms of storage and associated costs.

4.3 It is proposed that the site continue to discharge to the watercourses within the site.

4.4 The SFRA discusses the surface water runoff conditions post-development; it states:

'for both greenfield and brownfield sites the development runoff volumes and peak flow rates leaving the site should be attenuated to the greenfield discharge conditions and that drainage systems should be designed to accommodate all storm events up to and including the 1 in 100 year event including climate change'

4.5 The site currently drains to the watercourses which flow through the site and therefore it is proposed for the development to continue to drain in this manner. In accordance with the SFRA guidance it is proposed to restrict the development runoff to the greenfield QBAR rate – as illustrated within **Table 4.1**. The greenfield rate has been calculated for both the east and west areas of the site.

Return Period (Yrs)	Runoff Rate (l/s)			
	Existing (East)	Proposed (East)	Existing (West)	Proposed (West)
QBAR	3.6	3.6 (5)	7.2	7.2
30	7.1		14.1	
100	9.3		18.5	

Table 4.1 Existing and Proposed Runoff Rates

Attenuation Volumes and Sustainable Drainage Systems

4.6 The storage volumes required to restrict runoff to the greenfield rate have been considered for return periods up to and including the 100 year + climate change event and have based upon an anticipated development density of approximately 65%. Due to the proposed residential land use; a climate change provision has been identified as +30%.

4.7 Quick Storage Estimates have been calculated using Micro Drainage WinDes software, the methods are included as **Appendix E**. **Table 4.2** shows the results of these calculations; they indicate the maximum volume of storage required for the 100-years +30% (climate change) for the site as a whole is 1941m^3. However in order to fully utilise the two watercourses, the site has been split into two separate catchments and will be treated as separate areas.

Return Period (Yrs)	Estimated Storm Water Storage Range (m^3)			
	East		West	
	Min	Max	Min	Max
30	194	328	388	656
100	287	458	575	916
100+CC	398	647	797	1294

Table 4.2 Proposed Attenuation Volumes

4.8 Surface water runoff may be reduced by minimising the impermeable area through the use of porous surfaces, maximising the amount of vegetated area and above ground storage alongside the use of Sustainable Drainage Systems (SuDS) to manage and treat flows prior to discharge.

4.9 For the purpose of this indicative drainage assessment it is proposed that the 1 in 100 plus climate change volume would be attenuated within the eastern and western catchments of the site as calculated within **Table 4.2**.

Eastern Catchment

4.10 The eastern catchment is proposed to be served by a pond in the north of the site which provides a total volume of approximately 400m^3. The intended rate of discharge to the ditch would be 3.6l/s however, a control structure limiting flows to less than 5.0l/s would be impractically small, and it is therefore proposed to adopt a fixed discharge rate of 5.0l/s. This is in-line with DEFRA and EA recommendations[6].

Western Catchment

4.11 The volume to be attenuated for the western catchment is proposed to be within a basin which would provide a total storage of 800m^3. The intended rate of discharge from this area of the site would be 7.2l/s. The proposed shape of the pond is as shown in **Appendix F** in order to allow surface water from across the entire area to drain towards the pond. It will have a depth of 1m.

4.12 The details of the proposed attenuation basins and SuDS are available in the site layout (**Appendix B**).

6 2013, Kellagher. Preliminary rainfall runoff management for developments – Technical Report. W5-074/A/TR/1, Revision E. Environment Agency / Defra.

5.0 SEQUENTIAL TEST AND EXCEPTION TEST

5.1 The Sequential Test is a risk-based application intended to direct new development to areas of lowest possible flood risk, and ensuring development is located within an appropriate Flood Zone. This is done by classifying land use according to its vulnerability to the potential impacts of flooding.

5.2 Table 2 of the Planning Practice Guidance classifies land use. Under these classifications the proposed development use; residential, is considered to be 'More Vulnerable'.

5.3 Table 3 of the Planning Practice Guidance identifies that a 'More Vulnerable' development within Flood Zone 1 is considered to be 'appropriate' and the does not need to be considered under the Exception Test.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 This Flood Risk Assessment (FRA) is compliant with the requirements set out in the National Planning Policy Framework (NPPF) and the associated Technical Guidance (March, 2012). The FRA has been produced on behalf of Newland Homes in respect of a planning application for the proposed commercial/industrial development at Collin Lane, Willersey.

6.2 This report demonstrates that the proposed development is at an acceptable level of flood risk, subject to the recommended flood mitigation strategies being implemented. The identified risks and mitigation measures are summarised within **Table 6.1**:

Flood Source	Risk	Proposed Mitigation Measure
Fluvial	High	Development lies wholly within Flood Zone 1. However two watercourses run through the site, which are caused to spill by undersized culverts under Collin Lane. Mitigation measures to prevent flooding of the site include two interceptor swale features, the culverting of a small reach of existing watercourse under the proposed access road and the widening of the flood corridor of the western watercourse in the northern section of the site. Further mitigation will be provided by raising finished floor levels a minimum of 600mm above the 100 year plus climate change event flood level or 150mm above the surrounding ground levels (whichever is most conservative), and profiling ground levels to direct overland flows away from the built development.
Pluvial runoff	High	The risk of the pluvial flooding on the site will be mitigated through the implementation of a surface water drainage system designed to the 1 in 100 year plus climate change standard. Further mitigation will be provided by raising finished floor levels a minimum of 600mm above the 100 year plus climate change event flood level or 150mm above the surrounding ground levels (whichever is most conservative), and profiling ground levels to direct overland flows away from the built development.
Groundwater	Low	Any residual risk posed by groundwater sources will be mitigated by raising finished floor levels a minimum of 150mm above surrounding ground levels, and profiling ground levels to direct overland flows away from the built development.
Sewers	Medium	The risk of the external sewer capacity being exceeded is low Any residual risk will be mitigated through raising the development a minimum of 150mm above the surrounding ground levels.
Impact of the Development	Medium	The impact of the development on flood risk in the wider catchment will be mitigated by restricting runoff from the development at greenfield rates, and through the use of SuDS.

Table 6.1 Summary of FRA

6.3 In compliance with the requirements of National Planning Policy Framework, and subject to the mitigation measures proposed, the development could proceed without being subject to significant flood risk. Moreover, the development will not increase flood risk to the wider catchment area as a result of the flood mitigation strategies being implemented and suitable management of surface water runoff discharging from the site.

APPENDIX A

TOPOGRAPHICAL SURVEY

STATION COORDINATES

STN NAME	EASTINGS (m)	NORTHINGS (m)	HEIGHT (m)
B1	410053.750	239554.381	71.845
B2	410173.066	239627.708	71.802
B3	410229.483	239645.974	71.452
B4	410273.743	239656.633	71.956
B5	410210.642	239706.574	70.417
B6	410205.049	239750.566	69.699
B7	410169.784	239664.476	70.926

NOTES

1. DO NOT SCALE THIS DRAWING. ALL DIMENSIONS MUST BE CHECKED/ VERIFIED ON SITE. IF IN DOUBT ASK.
2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS, ENGINEERS AND SPECIALISTS DRAWINGS AND SPECIFICATIONS.
3. ALL DIMENSIONS IN METRES UNLESS NOTED OTHERWISE. ALL LEVELS IN METRES UNLESS NOTED OTHERWISE.
4. ANY DISCREPANCIES NOTED ON SITE ARE TO BE REPORTED TO THE ENGINEER IMMEDIATELY.
5. NO SCALE FACTOR HAS BEEN APPLIED TO THIS SURVEY, THEREFORE THE OS COORDINATES ARE TO BE TREATED AS ARBITRARY. PLEASE REFER TO SURVEY STATION INFORMATION BELOW FOR ON SITE CONTROL ESTABLISHMENT.
6. ALL COORDINATES AND HEIGHT DATA RELATE TO OSGB36 UNLESS OTHERWISE STATED. CONTROL STATIONS ARE COORDINATED BY MEANS OF GPS RECEIVING REALTIME CORRECTIONS VIA OS SMART NET.
7. ALL MANHOLE DATA IS COLLECTED FROM GROUND LEVEL THEREFORE DISCREPANCIES MAY OCCUR. MORE ACCURATE DATA IS ONLY ACHIEVABLE VIA CONFINED SPACE ENTRY.
8. WHILST EVERY EFFORT WAS MADE TO ATTEMPT TO LIFT THE MANHOLES , DUE TO THE NATURE OF THE SITE THIS WAS UNACHIEVABLE.
9. OS LICENSE NUMBER: 100022432

LEGEND

OS Buildings
Surveyed Buildings
Buildings / walls
Kerb line
Edge of surface
Canopy / Overhang
Line Marking
Centre Line
Barrier
Security Fence
Panel Fence
Open Fence
Hedge
Overhead Powerline
Contour Lines

Chamber
0.25 Flow direction and pipe diameter
1 Station and Name
BM 100.00 Benchmark
BH 1 Borehole
TH 1 Trial Hole
Tree / Bush / Sapling
Area of Undergrowth / Extent of Tree Canopy
Gate
Body of Water
Slope Arrow

AV	Air Valve	IC	Inspection Chamber
Bg	Back Gully	IFL	Internal Floor Level
BO	Bollard	IL	Invert Level (as a reduced level)
BS	Bus Stop	LB	Litter Bin
BT	British Telecom	LP	Lamp Post
CL	Cover Level	MH	Manhole
Cmp	Cable Marker Post	Mkr	Service Marker
CTV	Cable TV	PB	Post Box
DK	Drop Kerb	P.Inv Ø0.25	Pipe Invert (diameter)
Elec	Electric	RE	Rodding Eye
EP	Electricity Post	SP	Sign Post
ER	Earth Rod	ST	Stop Tap
FH	Fire Hydrant	SV	Stop Valve
FL	Floodlight	TCB	Telephone Call Box
FFL	Finished Floor Level	THL	Threshold Level
FP	Flagpole	TL	Traffic Light
FS	Flagstaff	TP	Telegraph Post
Gas	Gas	UTR	Unable to Raise
GV	Gas Valve	WL	Water Level
GY	Gully	WM	Water Meter
ht	Height	WO	Wash Out

Rev	Date	Details of issue / revision	Drw	Rev
C1	24/06/14	Drawing Issue	JM	JMG

ISSUES & REVISIONS

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■ Nottingham | 0115 924 1100
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Client
NEWLAND HOMES

Project Title
COLLIN LANE WILLERSEY

Drawing Title
EXISTING SITE PLAN

Scale	1:1000	Drawn	JM
Size	A1	Reviewed	JMG

Drawing Status
CONSTRUCTION

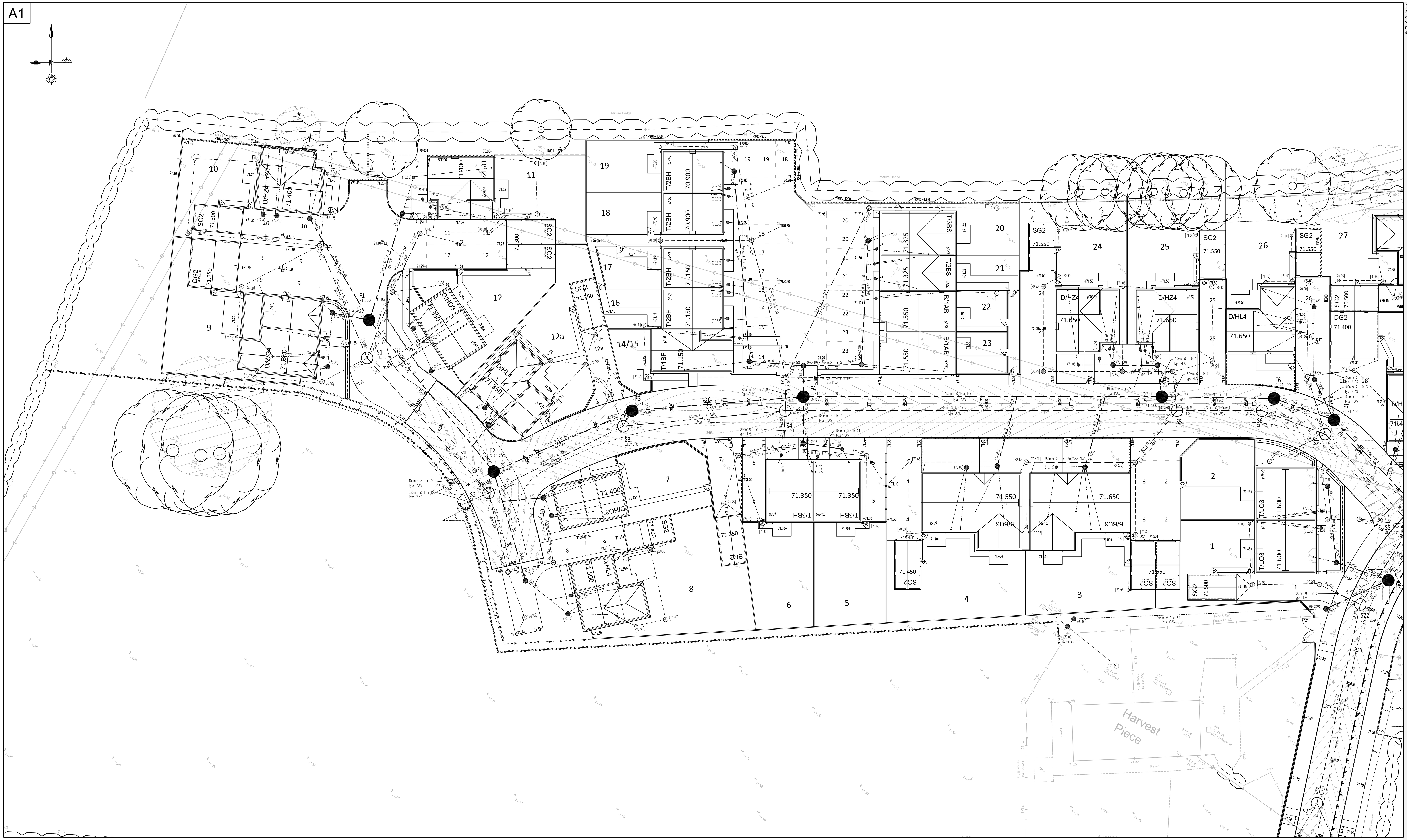
Drawing No.
BMW/2315/001

Revision
C1

APPENDIX B

PROPOSED DEVELOPMENT DRAWINGS

INCLUDING DRAINAGE LAYOUT



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3. For external works finishes refer to drawing 141 - 1 to 8.
4. For finished level details refer to drawing 143 - 1 to 8.
5. For construction details to private areas refer to drawings 151 to 156.

ADOPTABLE DRAINAGE NOTES

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8. Manhole covers & frames shall be ductile iron with a minimum square opening of 675x675mm. Covers shall be double triangle for 675mm square openings and be provided with loose bolted connections. Frame depth shall be 150mm.
9. The use of ladders or steps in manholes, wet wells and valve chambers shall comply with the following: Mild steel plastic encapsulated manhole single steps shall not be used in manholes of a greater depth than 1.0m. Mild steel plastic encapsulated double steps may be provided in manholes up to 3.0m in depth. Ladders shall be provided in accordance with BS4211 in manholes between 3.0 to 6.0m deep.
10. Hot dipped galvanized mild steel ladders should be installed in type 1A manholes.
11. Proposed adoptable sewers are only permitted to have other sewer/gully connections and other services laid at angle of between 45 degrees and 90 degrees across the line with a vertical clearance in excess of 300mm.
12. All ironwork to be kite marked by BSI or certified by equal inspection authority.
13. Red coloured plastic marker tape at least 150mm wide shall be laid at a minimum of 200mm above the soffit of the pipe. The tape shall be printed with the words gravity sewer in bold capital letters throughout its length and at intervals not exceeding 700mm and shall incorporate a corrosion resistant tracing system for non-metallic pipes.
14. All CLAY pipework is to be Extra Strength Vitrified Clayware to BS EN 295.
15. All PLASTIC pipework is to be Thermoplastic Structured Wall pipe to BS EN 13476 Part 1 and 2 or 3, stamped SN8, no longer than 3m and if found deformed by more than 6% are to be replaced.
16. All CONC pipework is to be Class M Flexible Jointed Concrete Pipework to BS 5911 : Part 100
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Building Drainage

19. All connections to adoptable manholes from private building drainage to be 150mm diameter pipes unless otherwise specified.
20. All house drainage to be 100mm dia unless otherwise stated, and laid in accordance with current Building Regulations and BS8301 : 1985.
21. Pipes are to be either extra strength vitrified clay to BSEN295 : Part1 with flexible joints, or P.V.C. complying with the relevant provisions of BS4660, or BS5480 and kitemark certified.
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24. Backfill is to be be with selected fill free of stones larger than 40mm, lumps of clay over 100mm, timber, frozen material and vegetable matter.
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Adoptable Roads

Tactile Crossing
Road Nameplate

Sewers and Drains

Existing Public Foul Sewer
Adoptable Foul Sewer
Private Foul Drain
Existing Public Surface Water Sewer
Adoptable Surface Water Sewer
Adoptable Highway Drain or Gully Connection
Private Surface Water Drain
Land Drain
Extents of Drainage Easements.

Storm S1 | Foul F1

Manholes and Chambers

Precast Concrete Manhole (Type 1A or 2B)
Rectangular Precast Concrete Manhole (Type 3)
Inspection Chamber - Max. Depth 3m (Type 3)
Inspection Chamber - Max. Depth 2m (Type 4)

Drainage Ancillaries

G Adoptable Road Gully
YG Yard and Bottle gully
ACO Channel Drain
VP Foul Drain Vent Pipe
[22.90] Surface water invert levels
(24.50) Foul invert levels
RV Ridge Vent

Health & Safety Note :

Refer to standard detail drawings 100 to 108 for additional health & safety notes

The sub-contractor should be familiar with the contents of the geo-environmental reports and protect against any risks that arise.

The sub-contractor is responsible for obtaining copies of service and drainage record plans and taking all care to ensure that existing services are protected or disconnected

All waste material should be placed in appropriate skips or removed from site to avoid trip hazards

The following items require method statements:-

- Any excavations including safe access and support
- Working in confined spaces
- Working in or adjacent to the public highway
- Working in or connecting to live sewers
- Working near live or overhead services
- Protection to trees and landscaping
- Handling & erection of all steelwork, precast concrete units & pad stones & any units greater than 20kg in weight.
- Protection from risk of fall into all excavations and from exposed faces (including floor slabs) where changes in level where falls could cause an injury

REV		DATE	INITIAL
A	S21 to S23, S49 to S52 & F8 to F10 amended F8 to F11 correct manhole sizes indicated. Control Manhole restrictions added.	27.01.16	BJ

Newland HOMES

Collin Lane, Willersey

Drainage and Finished Levels (1 of 3)

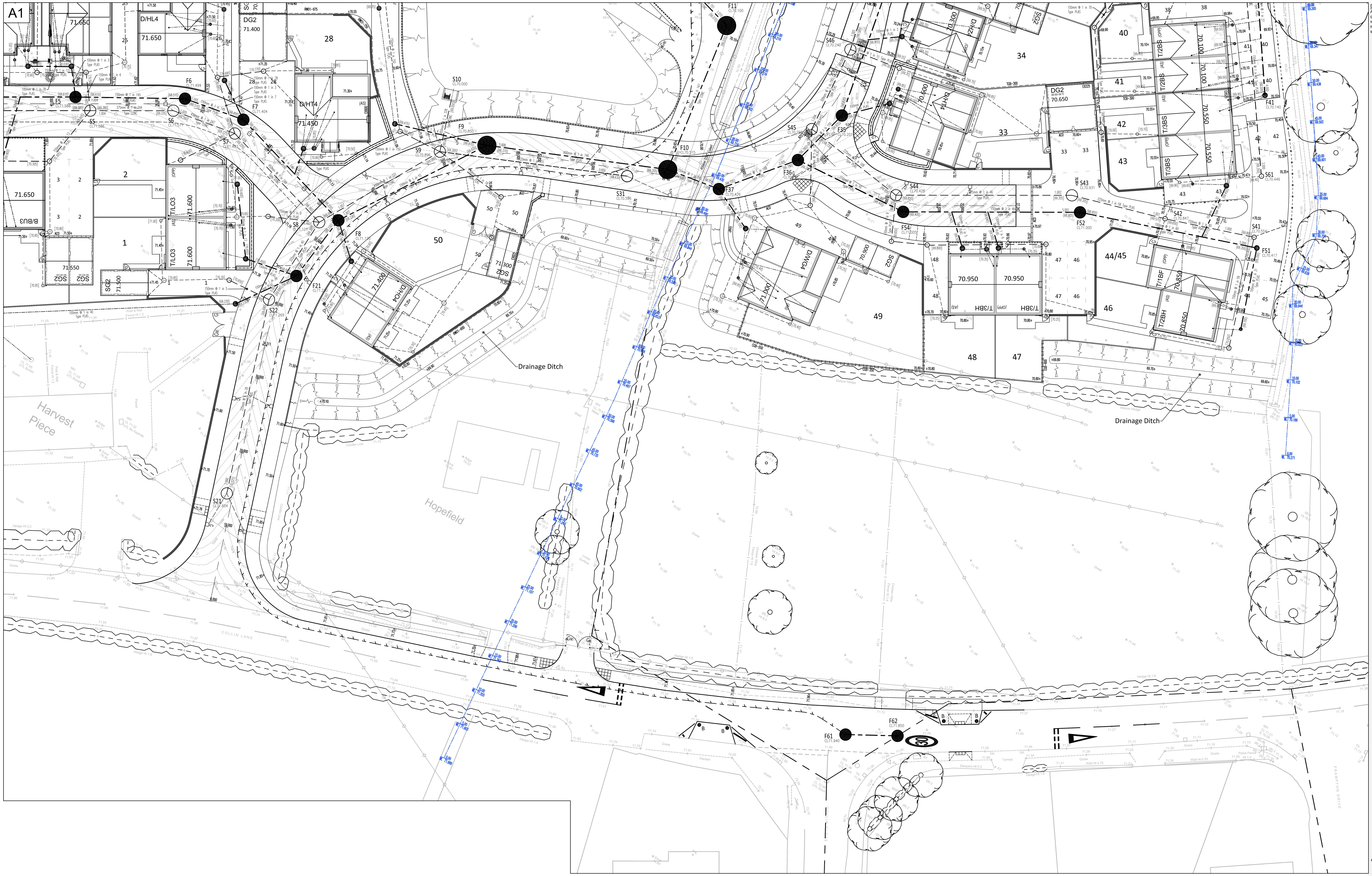
BJ
Drawn

1:250 @ A1
Scale

08.01.16
First issue

209 - 142 - 1
Drawing No.

A
Revision



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REV		DATE	INITIAL
A	S21 to S23, S49 to S52 & F8 to F10 amended F8 to F11 correct manhole sizes indicated. Control Manhole restrictions added. Plot 49 front garden levels amended.	27.01.16	BJ

Newland HOMES

Collin Lane, Willersey

Drainage and Finished Levels (2 of 3)

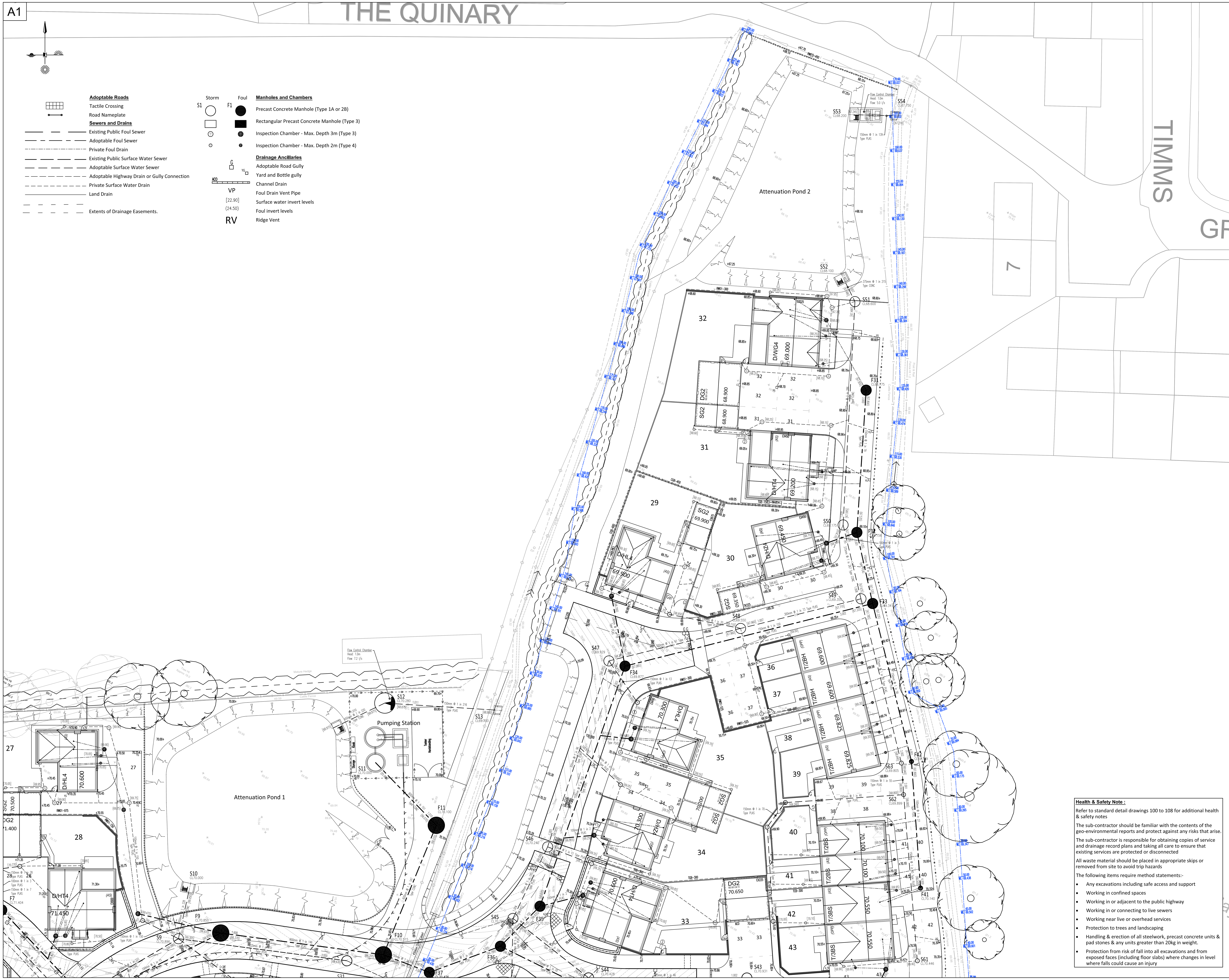
BJ
Drawn

1:250 @ A1
Scale

08.01.16
First issue

209 - 142 - 2
Drawing No.

A
Revision



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Newland HOMES

Collin Lane, Willersey

Drainage and Finished Levels (3 of 3)

BJ
Drawn

1:250 @ A1
Scale

08.01.16
First issue

715 - 142 - 3
Drawing No.

A
Revision

APPENDIX C

HYDRAULIC MODELLING TECHNICAL NOTE

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Newland Homes
Collin Lane,
Willersey

Technical Note:
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London
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4th Floor Carvers Warehouse, 77 Dale Street
Manchester, M1 2HG
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Nottingham
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NG2 3DQ
T: 0115 924 1100

DOCUMENT ISSUE RECORD

Revision	Date of Issue	Status	Author:	Checked:	Approved:
1	17/10/14	ISSUE	Robin Green	Julian O'Neill	Ben Fleming

Limitations

All comments and proposals contained in this report, including any conclusions, are based on information available to BWB Consulting during investigations. The conclusions drawn by BWB Consulting could therefore differ if the information is found to be inaccurate or misleading. BWB Consulting accepts no liability should this be the case, nor if additional information exists or becomes available with respect to this scheme.

Except as otherwise requested by the client, BWB Consulting is not obliged to and disclaims any obligation to update the report for events taking place after:-

(i) The date on which this assessment was undertaken, and
(ii) The date on which the final report is delivered

BWB Consulting makes no representation whatsoever concerning the legal significance of its findings or the legal matters referred to in the following report.

The information presented and conclusions drawn are based on statistical data and are for guidance purposes only. The study provides no guarantee against flooding of the study site or elsewhere, nor of the absolute accuracy of water levels, flow rates and associated probabilities.

This report has been prepared for the sole use of**Error! Reference source not found.**Newland Homes. No other third parties may rely upon or reproduce the contents of this report without the written permission of BWB. If any unauthorised third party comes into possession of this report they rely on it at their own risk and the authors do not owe them any Duty of Care or Skill

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CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

1.0 INTRODUCTION

1.1 BWB Consulting Ltd has been commissioned by Newland Homes to undertake a hydraulic modelling exercise to investigate the flood risk at a future development site off Collin Lane, Willersey. The modelling exercise will be used to inform the masterplanning of the site as well as in supporting a Flood Risk Assessment of the development.

1.2 The site is located on the north-eastern fringe of Willersey on the site of a former Nursery. Collin Lane runs along the southern boundary, and just to the north is a former railway embankment. A site location plan is illustrated within **Figure 1.1**.

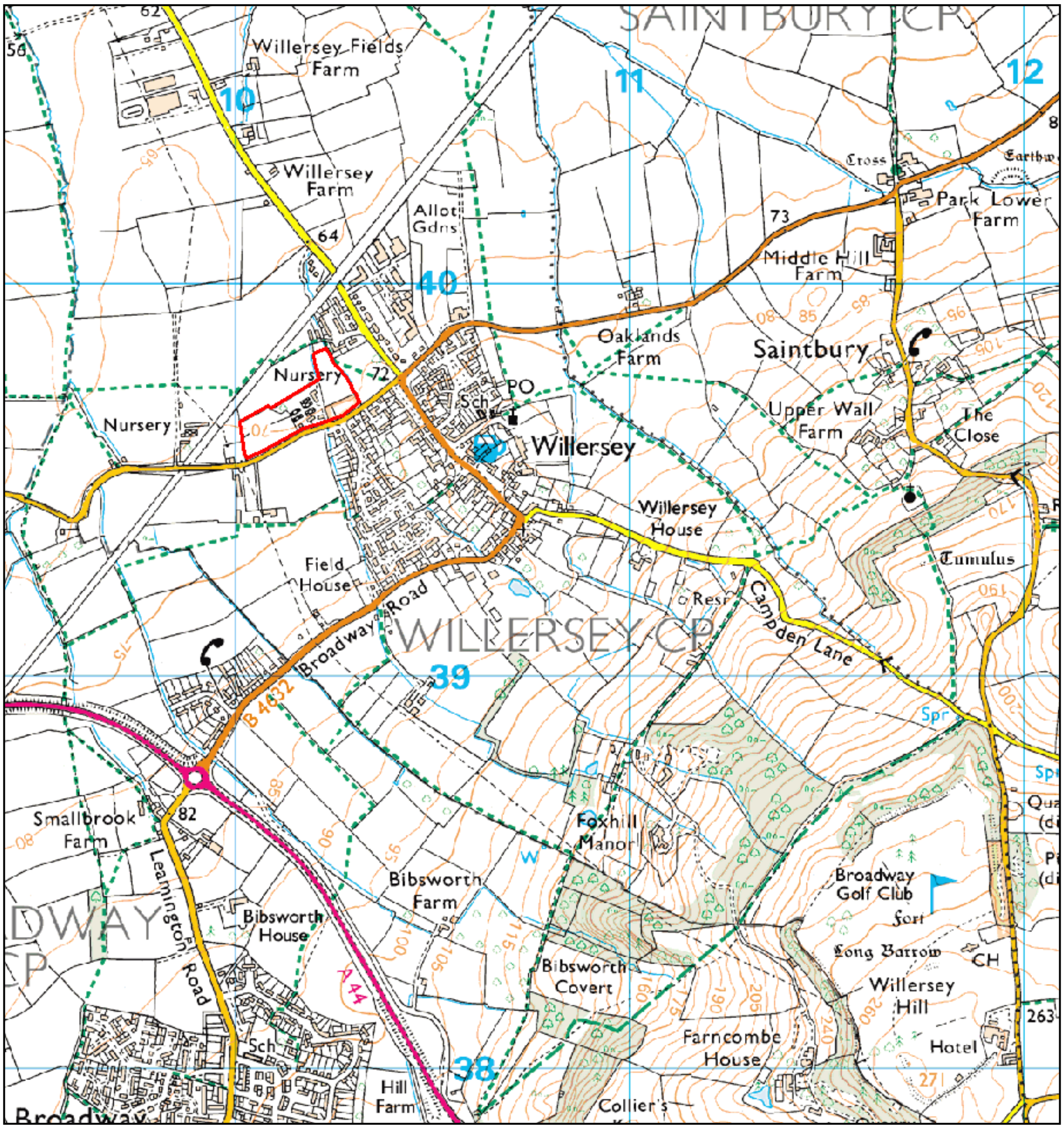


Figure 1.1 - Site Location Plan

1.3 Two unnamed watercourses flow within the vicinity of the site. One runs through the eastern proportion of site, and the second flows along the eastern site boundary. The watercourses converge just downstream of the site before being culverted through the railway embankment. For the purposes of this report the watercourses will be referred to as the Willersey Stream.

Previous Studies & Available Data

1.4 The Environment Agency Flood Maps for Planning identify that the study site is located entirely within Flood Zone 1. However, this is believed to be a result of the local watercourses being too minor to be included within the national Flood Zone coverage.

1.5 The Environment Agency Risk of Flooding from Surface Water national mapping does include the Willersey Brook catchment. This does identify two significant overland flow routes through Willersey – both of which follow the channel of the Willersey Stream. This is believed to be illustrative of the potential floodplain extents of the watercourses. The mapping (included as **Figure 1.2**) shows that the eastern proportion of the site could be subject out of bank flooding.

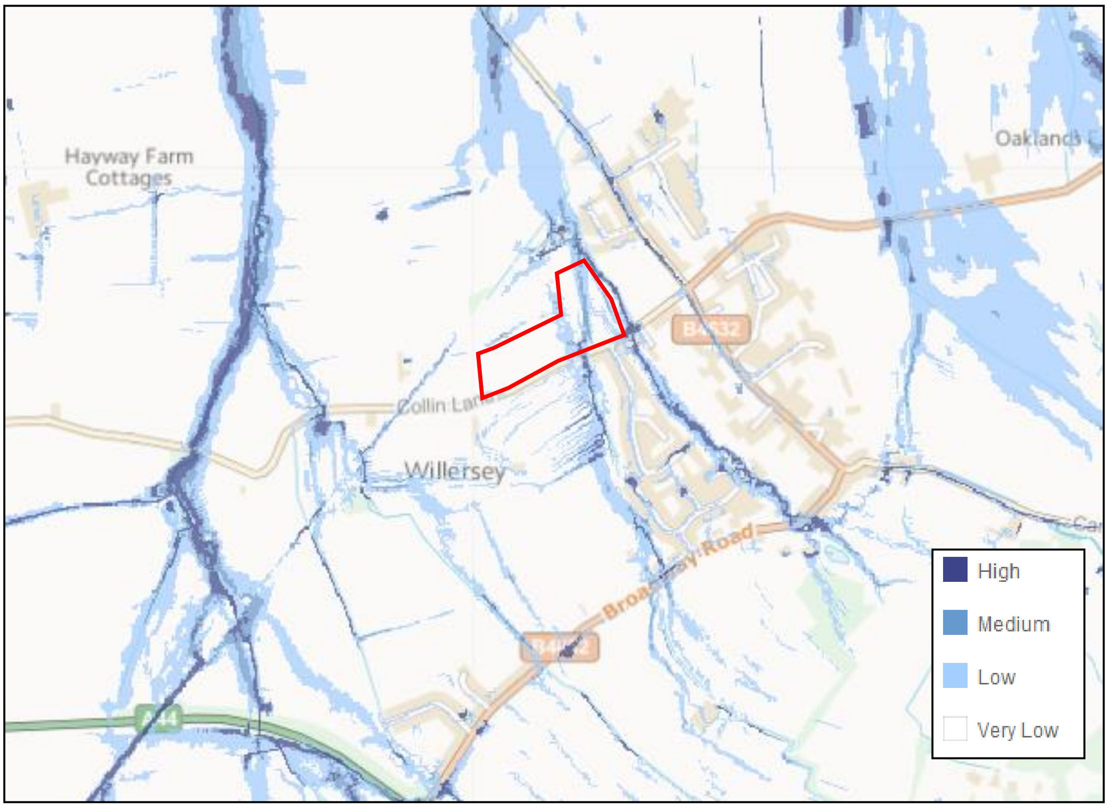


Figure 1.2 - Environment Agency Risk of Flooding from Surface Water Maps

1.6 A hydraulic model of the Willersey Stream, of sufficient detail to support a site specific Flood Risk Assessment, is not believed to be available.

1.7 An Internet search revealed that Cotswold District Council completed some flood alleviation work in Willersey in 2010. However, this is reported to have involved works to a channel system further to the east (on Campden Road).

1.8 Online newspaper articles and the SFRA identify that there is historic flooding issues in Willersey, although the exact location is not identified.

Other Sources of Data

1.9 The following additional datasets were used within the hydraulic modelling exercise:

(i) EA 1m LiDAR Digital Terrain Model (DTM)
(ii) Watercourse Cross-sectional Survey of the Willersey Stream – Appendix 2
(iii) Ordnance Survey 1:10,000 scale mapping
(iv) Photographs from a site visit undertaken in June 2014 by BWB Consulting
(v) Flood Estimation Handbook CD-ROM (version 3.0)
(vi) Hi-Flows Database (version 3.3.2)

Aim & Objectives

1.10 The primary aim of this exercise was to establish a good hydrological and hydraulic representation of the fluvial flooding mechanisms and magnitude within the site. The model will be used to inform the site layout and a Flood Risk Assessment (FRA) of the development.

1.11 To achieve this aim the following objectives were identified:

i. Create a one-dimensional (1D) hydraulic model of the watercourse through Willersey and the study site.

ii. Create a two-dimensional (2D) floodplain representation of the site and surrounding floodplain.

iii. Undertake a hydrological assessment of the catchment to estimate peak flood flows and generate flood hydrograph profiles.

iv. Simulate flood events within the combined 1D-2D model to establish a set of baseline conditions

v. Simulate sensitivity tests and residual risks within the model, to include roughness coefficients, blockage scenarios and 1 in 100 year flows.

2.0 HYDROLOGICAL ASSESSMENT

2.1 The Willersey Brook is an un-gauged catchment, therefore there are no hydrometric records of river flows or levels on which a hydrological assessment can be made.

2.2 Therefore it was necessary to undertake a hydrological analysis of the likely flood flows using the industry standard methodologies: the FEH (Flood Estimation Handbook) Statistical Analysis; and the ReFH (Revitalised Flood Hydrograph) rainfall-runoff model.

2.3 Other methodologies such as IoH124, and the Modified Rational method were dismissed due to the size and rural nature of the catchment. The FEH rainfall-runoff hydrological model was not utilised as this has been superseded by the ReFH.

Catchment Descriptors

2.4 The Willersey Brook catchment descriptors were extracted from version 3.0 of the FEH CD-ROM from downstream of the site, just upstream of Badsey Lane. Key catchment descriptors can be found in **Table 2.4** below and a map of the catchment is available in **Figure 2.1.**

Table 2.1 - FEH Catchment Descriptors

Descriptor	Value
Catchment Co-ordinates (National Grid Reference)	409950, 240150
AREA (km^2)	0.8
BFIHOST – *Base Flow Index*	0.343
FARL – *Flood attenuation from reservoirs & lakes*	1
FPEXT – *Floodplain extent*	0.108
PROPWET – *Proportion of time that soils are wet*	0.32
SAAR – *Standard Average Annual Rainfall*	679
SPRHOST – *Standard Percentage Runoff (Host soils classification)*	45.45
$URBEXT_{2000}$ – *Fraction of Urban Extent*	0.0998

2.5 A review of the FEH catchment was undertaken against the LiDAR DTM and OS mapping. This revealed that the FEH over predicts the Willersey Brook's north eastern extent – this area actually drains to a separate catchment. However, it also identified that the FEH underestimates the south western catchment extent. This is illustrated within **Figure 2.1**.

2.6 The catchment descriptors were updated with the area as defined by the LiDAR (1.13km^2). As the general shape and positioning of both the FEH and LiDAR derived catchments are relatively similar it was not considered necessary to reappraise the other descriptor values.

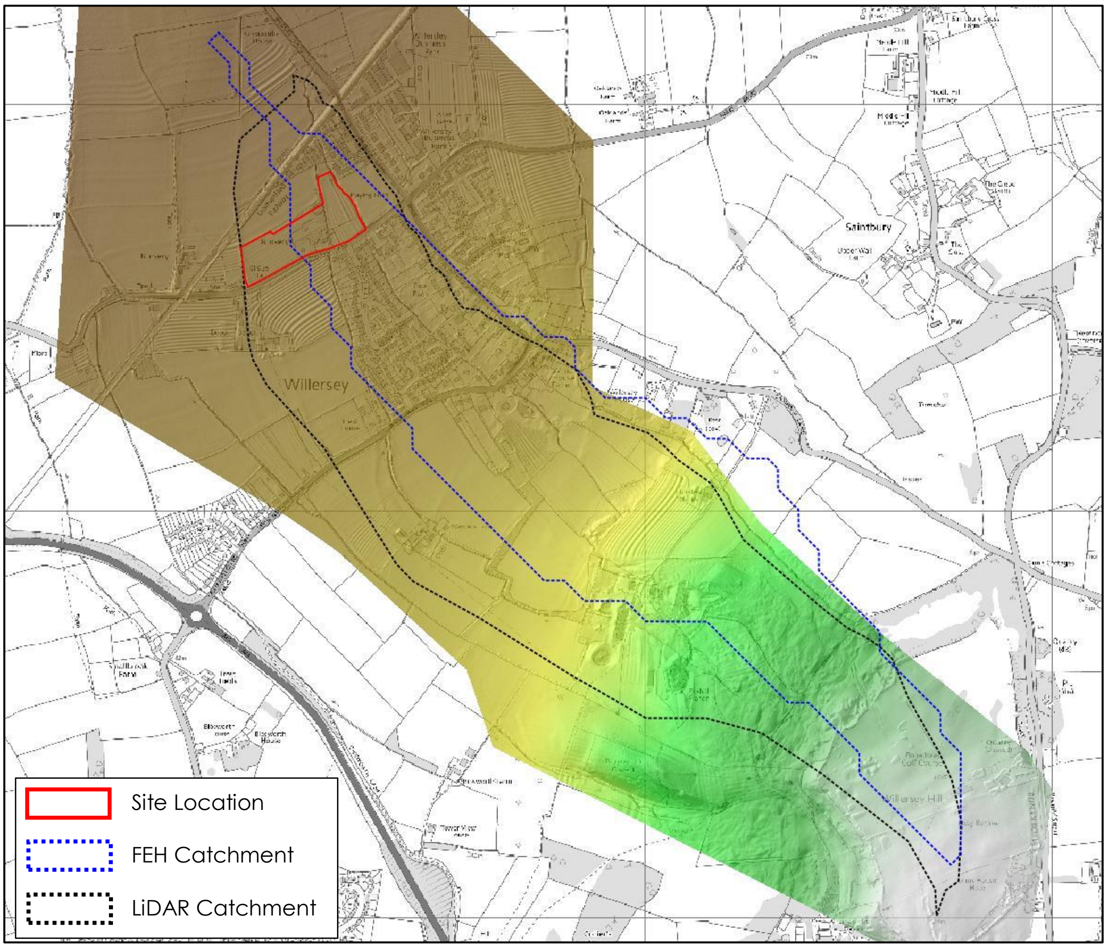


Figure 2.1 - Catchment Extents

FEH-Statistical Analysis

2.7 WINFAP version 3 was utilised to undertake a statistical analysis of the Willersey Brook using a hydrometric record of gauged catchments with similar catchment descriptors. The latest version of the Hi-Flow dataset (3.3.2, September 2012) was used to provide an up-to-date hydrometric record. **Appendix 1** contains extracts from WINFAP procedure illustrating the methodology and detailing the pooling group.

2.8 A group of hydrological similar gauged sites was generated by the software from the 'OK for Pooling' dataset. This was identified as 'heterogeneous' - this does not mean that it is inappropriate, just that it should be reviewed.

2.9 The group was reviewed to identify sites which may be inappropriate due to inaccuracies, uncertainties or limitations in their data record. Station 76011 (Coal Burn @ Coalburn) was identified to be significantly discordant when compared to the rest of the pooling group. However, upon further review it was found that the station and its record was sufficiently accurate for the purposes of this assessment. The station is identified as discordant as its growth curve is significantly steeper than the rest of the group. This has a conservative influence on the pooled growth curve, so the station was retained.

2.10 All other stations in the pooling group were also considered to be acceptable: they were all identified as having sufficient record length, and to be of sufficient hydrological similarity for the purpose of this study (i.e.: no other sites within the Hi-

Flows dataset are believed to be more representative). It is believed that the heterogeneous nature of the pooling group is a result of the limited number of small gauged sites which are available for statistical analysis.

2.11 The resultant pooling group record length totalled 505years, which meets the recommended guidelines on record length.

2.12 In line with the generally accepted approach; the ‘generalised logistic’ distribution (regarding as the best fit for most UK catchments) was selected to derive a growth curve from the pooling group.

2.13 The $URBEXT_{2000}$ value (0.0998) was updated using the national average model of urban growth to estimate the 2014 urban extent (0.1029 – moderately urbanised).

2.14 The Hi-Flows dataset was used to generate a list of potential donor sites from the “Ok for QMED & Pooling” dataset. It is the recommended procedure to use a ‘Donor Station’ to validate the estimation of QMED on the study catchment. In this instance station 54036 (Isbourne @ Hinton on the Green) was identified as being the most appropriate station to act as a donor. This increased the estimated QMED from 0.406m^3/s to 0.418m^3/s.

2.15 The software generated a growth curve from the selected distribution, and an urban adjustment factor (UAF) of 1.096 was applied. The resultant peak flows are summarised within **Table 2.2**.

Revisited Flood Hydrograph Analysis

2.16 The ReFH unit within ISIS 3.7 was utilised to undertake an estimation of the peak flows from the catchment. The critical duration of the watercourse was identified as 2.41 hours at a time step of 0.161 hours.

2.17 Due to the rural nature of the catchment a winter storm profile was adopted; all other parameters were left as default.

Table 2.2 - Summary of Peak Flows

Return Period	Annual Exceedance Probability (AEP)	Peak Flows (m^3/s)	
		FEH Statistical Analysis	ReFH
2 (QMED)	50.0%	0.418	0.640
20	20.0%	0.856	1.24
75	1.3%	1.28	1.68
100	1.0%	1.33	1.79
1000	0.1%	2.52	3.29

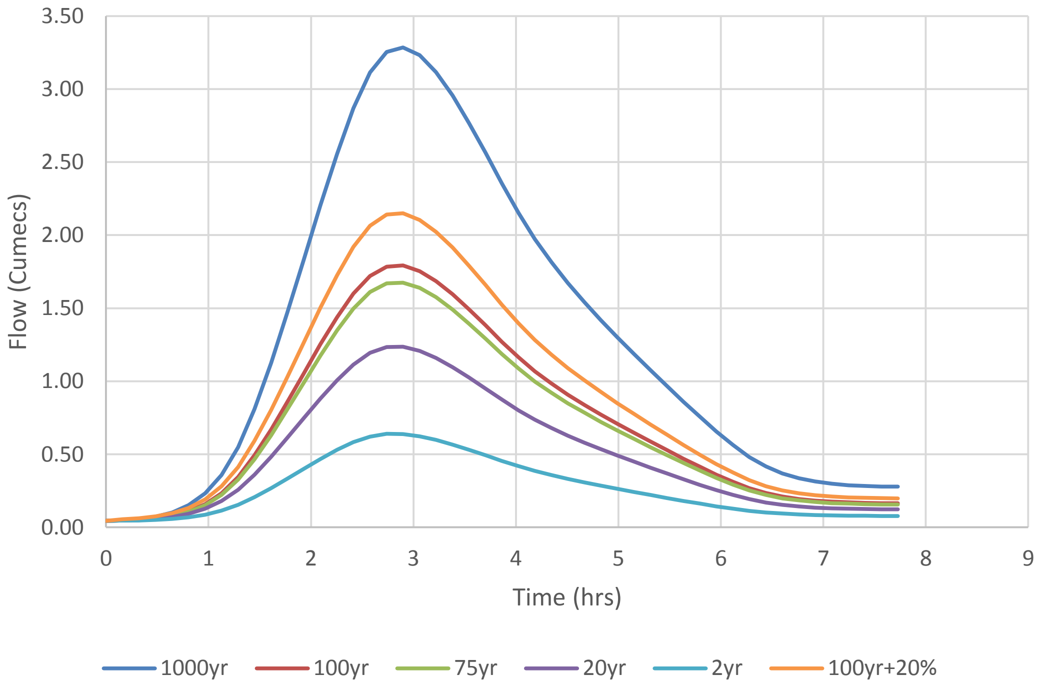


Figure 2.2 - ReFH Flow Estimates

Discussion

2.18 The results in **Table 2.2** show that the ReFH analysis produced the more conservative estimates. To facilitate a conservative analysis in the flood modelling, the higher ReFH flows will be adopted. The generated flood hydrographs are illustrated above within **Figure 2.2**.

Willersey Brook Sub-Catchments

2.19 The Willersey Brook can be split into two sub-catchments associated with the two branches of channel: the western and eastern.

2.20 The LiDAR DTM was used to identify the areas draining to each sub-catchment – this is illustrated within **Figure 2.3**.

2.21 It is believed that the catchment descriptors would not vary significantly between each sub-catchment, so the estimated flood flows for the complete catchment were distributed between them proportionally with their area.

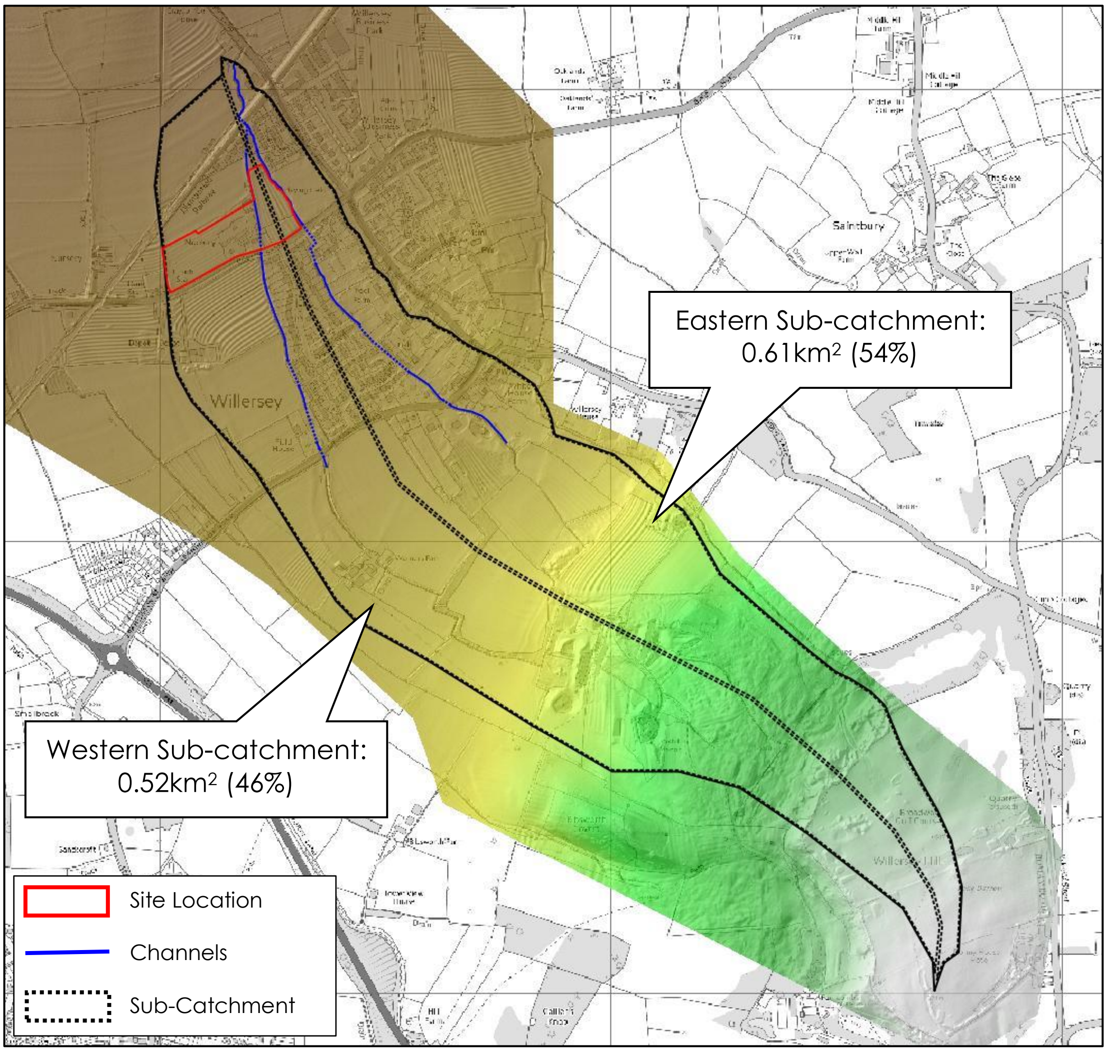


Figure 2.3 - Willersey Brook Sub-Catchments

3.0 HYDRAULIC MODEL

3.1 A dynamically linked 1D-2D modelling approach was adopted: the in-channel conditions and hydraulic structures were modelled within a 1D ESTRY domain; and the complex out-of-bank flow routing was modelled within a 2D TUFLOW domain.

ESTRY: The 1D In-Channel Model Domain

Topography

3.2 A cross-sectional watercourse survey was completed in June 2014. This extended from the southern side of Willersey (upstream of Broadway Road, and 500m upstream of the site) to Badsey Lane (250m downstream of the site). It included both the eastern and western braches of the watercourse. The surveys are included as **Annex B**.

3.3 The eastern watercourse contains five major culverted reaches/structures which are summarised below;

- 285mm diameter circular culvert under Broadway Road (NGR: 410361, 239195).
- 332mm diameter circular culvert adjacent to Field House (NGR: 410344, 239223).
- 690mm diameter circular culvert adjacent to Fields Lane (NGR: 410304, 239343).
- 495mm diameter circular culvert under Collin Lane and outfalling into the study site (NGR: 410223, 239634).
- 700mm diameter circular culvert adjacent to Timms Green and outfalling to the western watercourse channel (NGR: 410190, 239856).

3.4 The western watercourse contains five major culverted reaches/structures which are summarised below, in descending order:

- 378mm diameter circular culvert under Broadway Road (NGR: 410640, 239000).
- 900mm diameter circular culvert adjacent to Willow Road (NGR: 410550, 239371).
- 600mm diameter circular culvert under Collin Lane and outfalling next to the eastern boundary of the study site (NGR: 410341, 239615).
- 600mm diameter circular culvert adjacent to Timms Green (NGR: 410214, 239859).
- 800mm by 900mm arch culvert through the railway embankment (NGR: 410184, 239923).

3.5 The structures were modelled as circular culverts with a Manning;s 'n' roughness of 0.015 – representative of concrete culverts.

3.6 The exception to this was the railway arch culvert which was modelled as an irregular culvert using a height to width ratio calculated from the survey.

3.7 Channel cross-sections were surveyed at regular intervals in locations which captured the general condition and shape of the open watercourses. The sections were truncated at top-of-bank, at what would be the interface with the 2D floodplain (thereby avoiding double counting the conveyance of the river corridor).

3.8 The channel was fairly well vegetated with some shoals and pools throughout the majority of the surveyed reaches; this is demonstrated within **Figure 3.1**. A Manning's 'n' roughness value of 0.045 was adopted to represent these conditions.

Figure 3.1 - Photograph showing the typical condition of the channel

Boundary Conditions

3.9 A head-time boundary was used at the downstream extent of the model. This was set as a constant water level at the same level as top-of-bank. Given the 250m distance and 3m height differential between the site and the bank levels at the downstream boundary, this approach should be acceptable. The suitability of the downstream boundary is analysed as part of the forthcoming sensitivity tests.

3.10 The ReFH flood hydrographs, as described in **Section 2.0**, were used as the upstream boundary conditions (flow-time boundaries) for the two channels.

3.11 A 'lumped' approach was adopted when applying the flows to the model, whereby the hydrograph from the entire catchment was applied to the top of the model.

2D TUFLOW: Floodplain Model Domain

Topography

3.12 Environment Agency 1m resolution LiDAR DTM (Digital Terrain Model) data was used as a base for the 2D floodplain; this has undergone a filtering process to remove buildings and vegetation to provide a bare earth ground model.

3.13 A 3.0m resolution grid was adopted for the TUFLOW model; this is considered to be more than sufficient given the semi-rural nature of the floodplain, but was considered necessary due to the relatively narrow channel width.

3.14 Although the 3.0m cell size will pick up most of the significant topographic features, the river banks were reinforced using a 'Z-line'. This was primarily informed from the watercourse survey, but where survey coverage was limited the LiDAR data was used to supplement bank levels.

3.15 Buildings were modelled at ground levels allowing them to be permeable to flood water.

Roughness

3.16 Roughness coefficients for the 2D domain were assigned according to land use. These were digitised from aerial photography and Ordnance Survey 1:10,000 mapping, in accordance with standard practice for the TUFLOW software.

ESTRY Interface

3.17 The ESTRY-TUFLOW interface was digitised on top of the bank lines; a HX (External Head) boundary was adopted as the interface type. A Form Loss Coefficient (FLC) was applied to the interface to represent the energy lost as flows peel off from the watercourse to the floodplain and vice versa. Given the vegetated nature of the banks a FLC of 0.25 was adopted, this is in line with the 0.1 to 0.5 range recommended by the software developers.

3.18 The channel was removed from the TUFLOW domain using a 'code' layer, and 'NWK' and 'WLL' layers were used to display the ESTRY results within TUFLOW to aid in floodplain mapping.

Initial Conditions

3.19 To generate a stable starting position for the flood simulations, a constant low flow was run through the model in a 'base flow' simulation. After 2hrs the 1D domain had reached a stable equilibrium and a 'restart file' was generated. All the flood events use this restart file as initial conditions at t=0.

Model Calibration

3.20 As no hydrometric data or historic flood mapping were available, the model could not be directly calibrated against historic flood events.

3.21 However, it is believed that the conservative approach to the model build should offer a sufficiently robust model for the purposes of assessing flood risk at the site.

Design Events

3.22 The model was simulated against the following key design flood events:

- 1 in 20 year (5% AEP)
- 1 in 100 year (1% AEP)
- 1 in 100 year + 20% (representative of climate change)
- 1 in 1000 year (0.1% AEP)

Model Stability and Limitations

Simulation Parameters

3.23 TUFLOW version 2013-AC-iDP-w64 was used in all the simulations. All parameters were retained as default.

3.24 A time step of 1 second was adopted for the ESTRY and TUFLOW domains.

Results Parameters

3.25 TUFLOW maximum results were output for water levels, depths, and UK Hazard Rating. UK Hazard rating was derived from the following equation[1]:

*Hazard Rating = D * (V+0.5) + DF*

Where:
D = depth
V = velocity
DF = Debris Factor

3.26 **Table 3.1** identifies the recommended debris factors from FD2321/TR1. The debris factor has been set at 'Conservative', which is considered suitable for informing a Flood Risk Assessment of the site.

Table 3.1 - Guidance Debris Factors (Ref: FD2321/TR1)

Depths	Pasture/Arable	Woodland	Urban	Conservative*
0 to 0.25 m	0	0	0	0.5
0.25 to 0.75 m	0	0.5	1	1
d>0.75 m and/or v>2	0.5	1	1	1

*an additional category in TUFLOW

3.27 **Table 3.2** identifies the thresholds of the flood hazard categories as identified within DEFRA guidance document FD2320 and the "*Supplementary Note on Flood Hazard Ratings and Thresholds for Development Planning and Control Purpose*" (DEFRA, 2008) which have been adopted within this exercise.

[1] DEFRA R&D Outputs: Flood Risks to People Phase Two Draft FD2321/TR1 and TR2

Table 3.2 - Hazard to People[2]

Threshold for Flood Hazard Rating	Degree of Flood Hazard	Description
< 0.75	Low	**Caution** - "Flood zone with shallow flowing water or deep standing water"
0.75 - 1.25	Moderate	**Danger for some (i.e.: children)** - "Danger: Flood Zone with deep or fast flowing water"
1.25 - 2.0	Significant	**Danger for most people** - "Danger: Flood Zone with deep fast flowing water"
2.0 >	Extreme	**Danger for all** - "Extreme Danger: Flood Zone with deep fast flowing water"

Model Stability

3.28 Depths were reported and the model flux (flow in and out) did not show any evidence of an unstable/fluctuating ESTRY-TUFLOW interface – albeit due to the low flows the flux rarely exceeded the minimum value of 1m^3/s.

3.29 The ESTRY-TUFLOW mass error initially spikes at between 3 to 4% during the initial wetting at the start of the simulations. This is a typical symptom of TUFLOW models and is a result of the low volumes generally present at the start of a simulation and will not affect the peak results. Over the course of the simulation the mass error falls back to within 1 to 2%.

3.30 This is marginally outside of the typical tolerance range of 3%. However, similarly to the initial spiking, it is believed that the slightly elevated mass error is a result of the low volumes within model. This is likely to be exacerbated by the steep shallow flows generated by the topography and the small cell size necessitated by the narrow channel. Given these constraints, the mass error values are considered to be acceptable.

Limitations

3.31 The modelling exercise has made use of the available data at the time of construction and simulation.

3.32 The model contains no formal representation of the conveyance within minor watercourses or ditches other than that captured by the model grid and within the ESTRY model domain.

3.33 As no hydrometric data or recorded flood levels were available the model has not been verified or calibrated. However, a conservative approach to the model build has been adopted where appropriate, and a wide range of sensitivity tests have been undertaken to help to compensate for this limitation.

3.34 The 3.0m resolution of the model may negate any small scale topographic features, although all the significant features are believed to have been captured.

[2] 2008, DEFRA. Supplementary Note on Flood Hazard Ratings and Thresholds for Development Planning and Control Purposes.

3.35 The base line floodplain levels are derived from LiDAR which has limited accuracy (+/- 0.15m). This is considered to be more than sufficient for the purpose of this exercise, and the LiDAR has been updated with topographic survey within the study site.

3.36 In accordance with best practice, buildings were modelled at ground levels allowing them to be permeable to flood water.

3.37 This modelling exercise has been undertaken to produce a good representation of flood risk mechanisms in and around the site. It has not been designed to accurately map flooding in the wider catchment.

4.0 Baseline Results

4.1 A range of hydrological scenarios were modelled to understand the extents and depths of flooding under existing conditions. These are shown in **Appendix 5**. It is shown that during relatively low return period events (1 in 20 year – 5% AEP) there is a significant overland flood route on the site. The flows from both the eastern and western watercourses exceed the capacity of their culverts under Collin Lane.

4.2 When the western watercourse spills out of its culvert under Collin Lane the preferential flow route is not back into the watercourse channel, but via two overland flow routes; the eastern flow route takes a route through the northern portion of the site, returning to the channel at the furthest point north of the site.

4.3 There is also an eastern flow route, which is shown to run through existing buildings. In greater return period events this western flow route is extended beyond the site boundary, and is shown to inundate properties downstream of the site.

4.4 It should be noted that water within the overland flow routes is shallow, with depths shown to be under 150mm.

4.5 The site is shown to fall within the 1 in 100 year + climate change floodplain of the two watercourses. Therefore any development which is to occur on the site will require mitigation to prevent inundation of properties. A freeboard of 600mm will also be required above this flood level.

5.0 Proposed Development Modelling

5.1 Flooding on the site is shown to be shallow, with depths during the 1 in 100 + climate change under 150mm. Therefore a robust flood risk mitigation strategy has been developed to reduce the risk to an acceptable level, allowing a development of circa. 50 units on the site.

5.2 It is not feasible to increase the size of the culverts of the watercourses under Collin Lane, this would cause a number of issues with the costs associated costs likely to be prohibitive to development on the site. The mitigation optioneering was therefore limited to an onsite solution.

Results

5.3 The details of the mitigation requirements can be found below, including an explanation of how they were implemented in the model.

5.4 The proposed model was run at the same scenarios as the existing conditions and a comparison of top water levels is made available in each of the drawings in **Appendix 7**. These show that in each of the return periods up to and including the design event of 1 in 100 year + climate change, water is restricted to either the watercourse, or the proposed flood corridor and interception features. During the 1000 year event water spills onto the site, from the eastern watercourse though the proposed finished floor levels mitigate this residual risk. The western portion of the site remains dry, and there is still significant betterment in water levels downstream of the site.

5.5 During the 20 year flood event there is shown to be significant betterment on the upstream side of Collin Lane, with an existing property's garden removed from flood risk. This is also the case on the downstream side of Collin Lone, where flow remains within bank and is no longer shown to flood the property which is encompassed by the site boundary.

5.6 During the 75 year flood event there is also betterment provided to this property; though it is shown to still become inundated; albeit to a lower depth. However, during this event existing conditions show there to a number of properties located downstream of the site to become inundated. With the proposed mitigation features these are now removed from the floodplain altogether, as the overland flow which affects them is collected by the western watercourse swale feature and redirected into the channel.

5.7 Results for the 1 in 100 year + climate change scenario show the mitigation strategy to provide significant betterment to the catchment as a whole, with water levels within the inundated property which is encompassed by the site boundary shown to be lower, and the a number of properties downstream shown to be removed from the floodplain. There are shown to be minor increases in water level within the watercourse channel, though it is thought these are acceptable in exchange for the significant betterment which the strategy provides to the catchment as a whole.

5.8 It is necessary to raise finished floor levels of proposed properties in order to achieve a minimum of 600mm freeboard above the 1 in 100 + climate change flood event. While

Mitigation Strategy

5.9 This section is split into two parts, the first explain the solution to flooding caused by the western watercourse, the second section explains mitigation requirements on the eastern watercourse. These requirements are summarised in drawing BMW/2315/WSK05, available in **Appendix 6**.

Western Watercourse

Interception of overland flow

5.10 As water enters the site from the south, it is proposed that a shallow swale feature be dug to collect water and direct it back towards the channel. This was implemented as a 'z-line' feature within TUFLOW within the layer '2d_zln_propSwale_006_L.shp' this line is attributed the 'Thick' command to ensure a whole cell width is captured within the model. Its elevations are taken from points snapped to nodes along the line, which are saved in the layer '2d_zln_propSwale_006_P.shp'.

5.11 In order to route water from the swale effectively into the existing watercourse it was found to be necessary to pipe the flow from the downstream end of the swale feature under the proposed road, and back into the watercourse. This was done in the 1D domain, using an 'SX' point boundary to link flow from the 2D swale feature into the 1D culvert.

Widening of existing flood corridor

5.12 It is also proposed to formalise the floodplain within the site in a flood corridor. This will be created within the 8m standoff from bank top. A 5m wide shelf will be scraped adjacent to the existing watercourse, this will allow for additional water during high flow events, as illustrated in Figure **5.1** below.

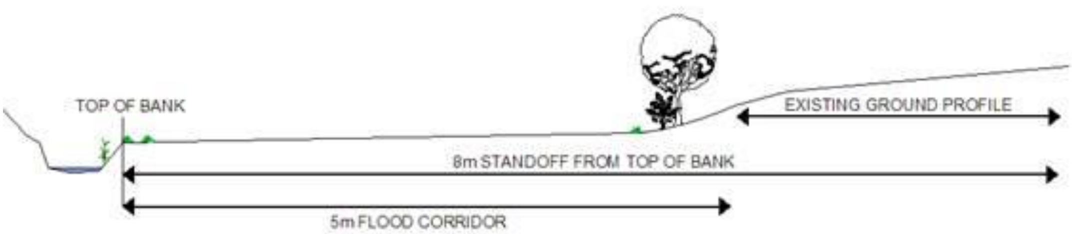


Figure 5.1 - Proposed flood corridor expansion, indicative cross section

5.13 The widening of the corridor was achieved through adjusting the sections found in the 1D domain. The watercourse itself has not been altered, though the top of the right hand bank has been lowered in order to allow the flood corridor to engage more readily, conveying water more efficiently through the site. The sections which were changed are 'R1 XS3', 'R1 XS4', and 'R1 XS5', each of these has '_prop001' appended to its file name in the proposed conditions model.

Extension of existing culvert

5.14 In order to prevent water spilling onto the site and onto the only proposed access road it is necessary to extend the existing culvert which emerges on the site, this is to be extended by approximately 30m, under the proposed road, outfalling into the watercourse downstream of the proposed road. This part of the mitigation strategy is vital to enable the intercepting swale feature to work effectively.

Eastern Watercourse

5.15 On the eastern watercourse is it is proposed to include a single swale feature intercepting overland flow located adjacent to the site boundary. This was reinforced in a similar manor to the western watercourse swale, using the spoil from the swale to create a bund to prevent any water spilling from the swale and onto the site.

Northern Boundary

5.16 It is proposed that at the northern extremity of the site there be an above ground surface water attenuation feature. It is necessary to ensure that this will not become inundated with fluvial flood water, it was therefore arbitrarily raised above the floodplain using a ‘z-shape’ layer ‘2d_zsh_RaisedDev_04_R.SHP’ with the ‘NO MERGE’ command.

6.0 Sensitivity Testing

6.1 In order to understand any residual risk to the site several sensitivity tests were undertaken. The results of which are available in **Appendix 7.** All sensitivity tests were carried out at the 1 in 100 year scenario under the proposed conditions. With drawings showing the modelled difference in top water level between the scenarios.

6.2 An increase in of flow by 20% shows there to be a modest increase in flood extent, both up and downstream of the site, with top water levels also increasing, though there only two additional properties inundated.

6.3 Three blockage scenarios were carried out, with 50% blockage of each of the three culverts undertaken separately. This was carried out through altering the 'blockage' attribute of each culvert.

6.4 BL1: A 50% blockage of the large downstream railway embankment culvert has no impact on top water level.

6.5 BL2 : this scenario is of blocking the eastern watercourse under Collin Lane. This causes a re-instatement of the overland flow route as the proposed mitigation swale cannot cope with the additional volume of water, however, it is thought that this residual risk is mitigated through the raising of floor levels across the site.

6.6 BL3: this scenario blocks both the western watercourse culvert under Collin Lane and the proposed culvert collecting water from the intercepting swale feature and outfalling it into the watercourse downstream of the proposed road, similar to BL2 this is shown to reactivate an onsite overland flow route. Though there is also an increase in water levels immediately upstream of the swale's culvert.

6.7 It was also necessary to test the implication on both an increase a decrease in floodplain and channel roughness. A 20% change was implemented for both runs.

6.8 The implication of an increase in roughness is an increase in water levels within the channel, as well as some modest increase in flood extent. Decreasing roughness by 20% shows there to be little change, though there are some minor areas where top water level is decreased within bank.

6.9 As mentioned above the downstream boundary is controlled via a HT relationship. In order to make sure that, if this relationship has been incorrectly identified this does not impact flood levels on the site of interest 500mm was added. Results show there to be a minor increase in flood extents and in channel levels at the downstream extremity of the model domain, though there is no change in water level at the site of interest.

7.0 Conclusions

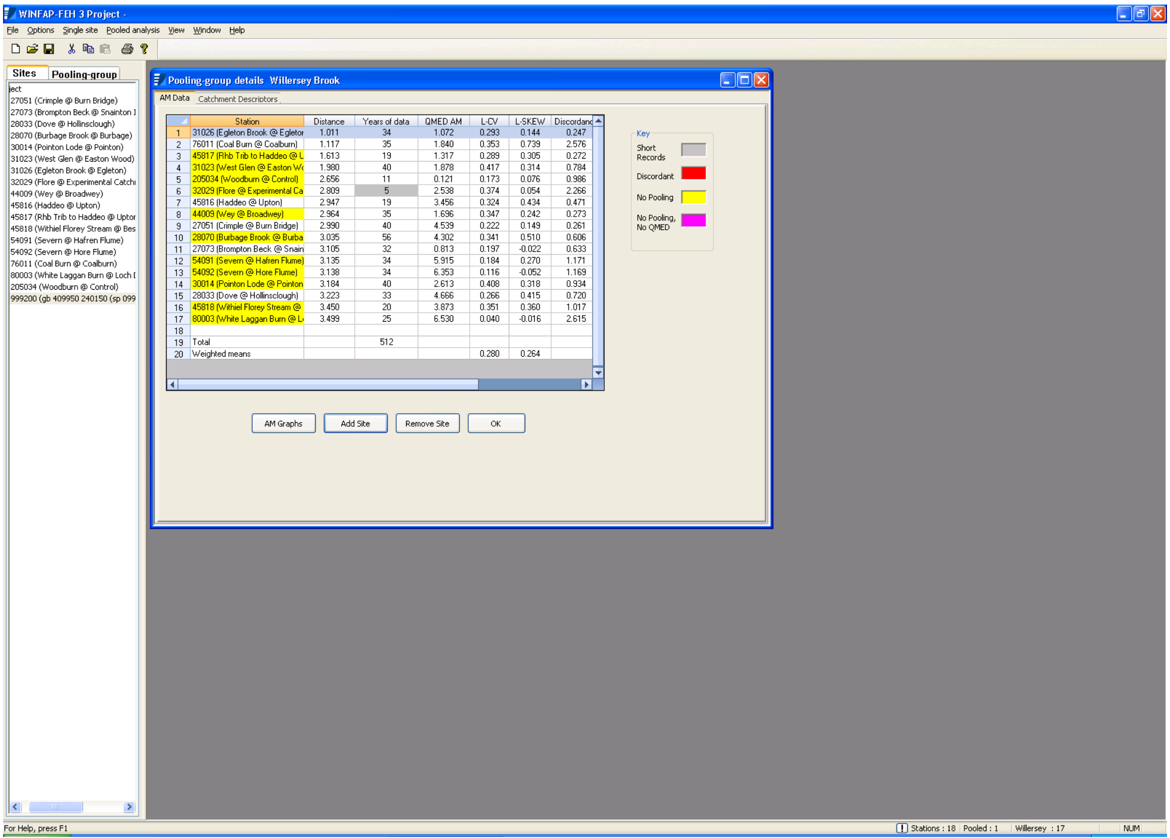
7.1 BWB were commissioned by Newland Homes to create a bespoke hydraulic model of the two watercourses which affect the site off Collin Lane, Willersey.

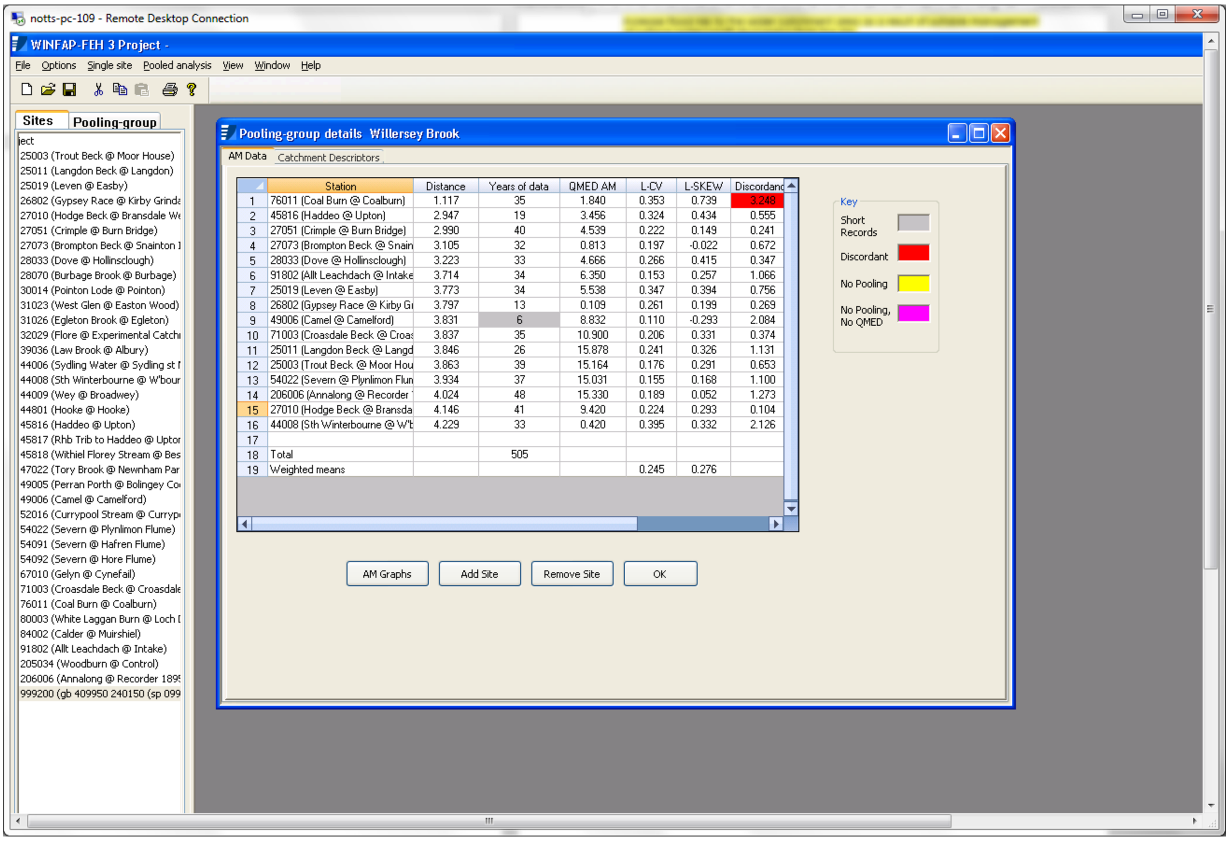
7.2 Hydrologically the catchments are complex, with the FEH-CD ROM not showing the true split in catchments. Adjustments have been applied to both the catchment descriptors and areas to ensure that what occurs in reality is reflected in the estimated flood flows which were estimated using the REFH method.

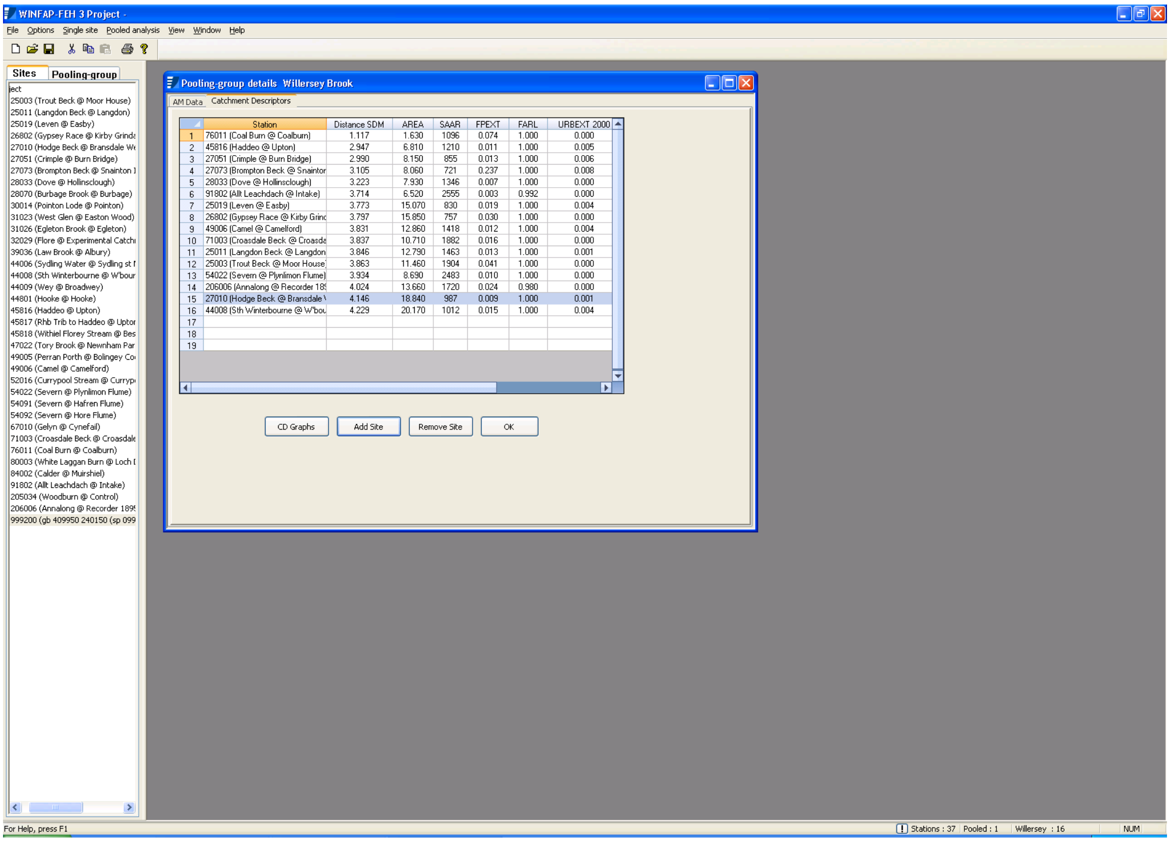
7.3 The hydraulic model was built using the latest version of the ESTRY-TUFLOW modelling software. Existing conditions show there to be two overland flow routes emanating from the culverts under Collin Lane. It was therefore necessary to develop a mitigation strategy to ensure the proposed development remain safe during the design (1 in 100 + climate change) flood event. Results show that this proposed mitigation strategy is effective, and actually reduces flood risk to others downstream of the site, whilst it does not increase flood risk to those upstream.

APPENDIX 1

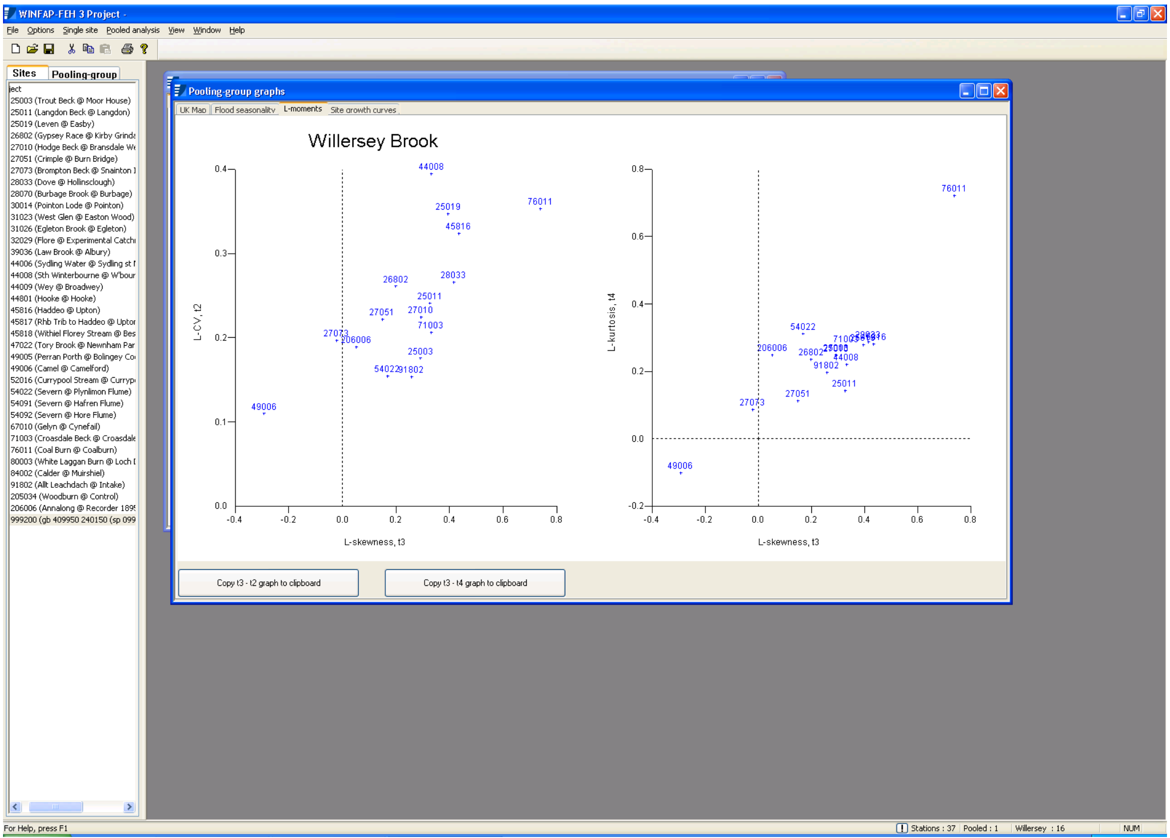
WINFAP Statistical Analysis Details

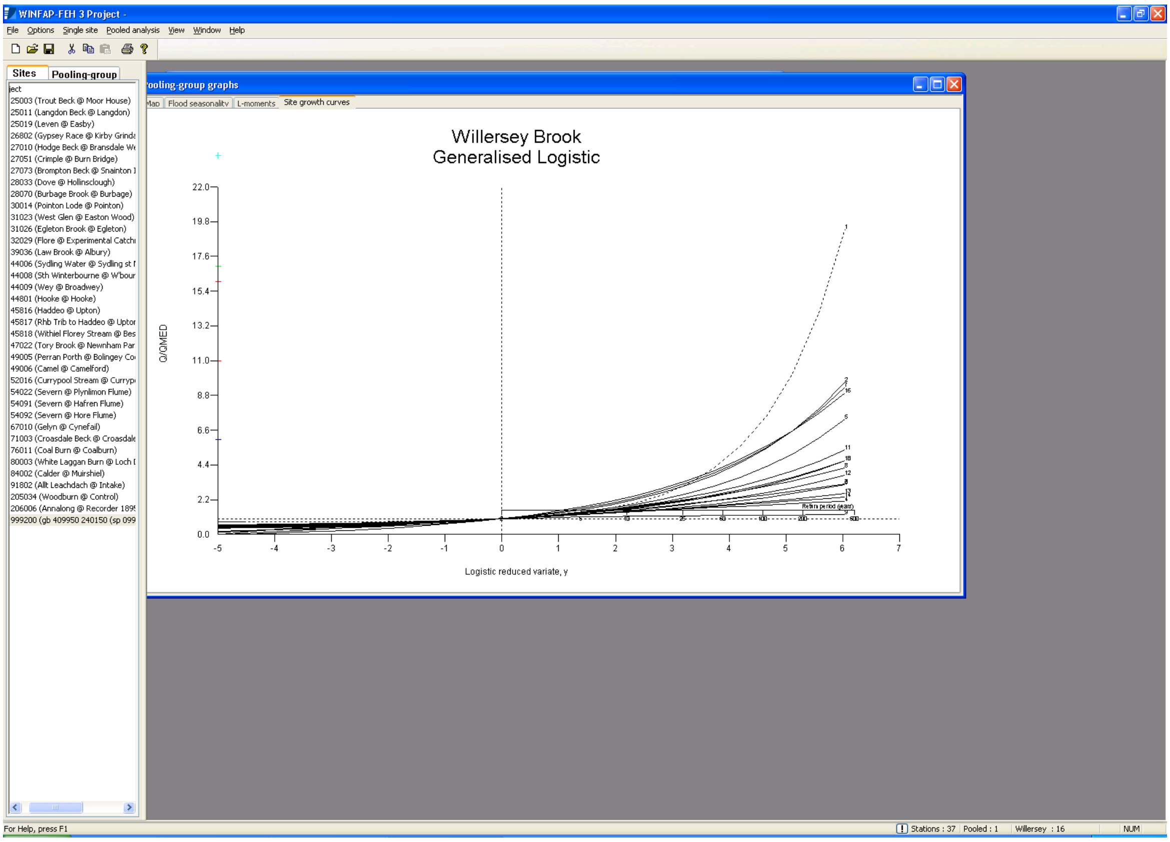

WINFAP-FEH 3 Project -
Pooling-group details Willersey Brook
AM Data
Catchment Descriptors
Station | Distance | Years of data | QMED AM | L-CV | L-SKEW | Discordanc
1 31026 (Egleton Brook @ Egleton | 1.011 | 34 | 1.072 | 0.293 | 0.144 | 0.247
2 76011 (Coal Burn @ Coalburn) | 1.117 | 35 | 1.840 | 0.353 | 0.739 | 2.576
3 45817 (Rhb Trib to Haddeo @ L | 1.613 | 19 | 1.317 | 0.289 | 0.305 | 0.272
4 31023 (West Glen @ Easton Wo | 1.980 | 40 | 1.878 | 0.417 | 0.314 | 0.784
5 205034 (Woodburn @ Control) | 2.656 | 11 | 0.121 | 0.173 | 0.076 | 0.986
6 32029 (Flore @ Experimental Ca | 2.809 | 5 | 2.538 | 0.374 | 0.054 | 2.266
7 45816 (Haddeo @ Upton) | 2.947 | 19 | 3.456 | 0.324 | 0.434 | 0.471
8 44009 (Wey @ Broadwey) | 2.964 | 35 | 1.696 | 0.347 | 0.242 | 0.273
9 27051 (Crimple @ Burn Bridge) | 2.990 | 40 | 4.539 | 0.222 | 0.149 | 0.261
10 28070 (Burbage Brook @ Burba | 3.035 | 56 | 4.302 | 0.341 | 0.510 | 0.606
11 27073 (Brompton Beck @ Snain | 3.105 | 32 | 0.813 | 0.197 | -0.022 | 0.633
12 54091 (Severn @ Hafren Flume) | 3.135 | 34 | 5.915 | 0.184 | 0.270 | 1.171
13 54092 (Severn @ Hore Flume) | 3.138 | 34 | 6.353 | 0.116 | -0.052 | 1.169
14 30014 (Pointon Lode @ Pointon | 3.184 | 40 | 2.613 | 0.408 | 0.318 | 0.934
15 28033 (Dove @ Hollinsclough) | 3.223 | 33 | 4.666 | 0.266 | 0.415 | 0.720
16 45818 (Withiel Florey Stream @ | 3.450 | 20 | 3.873 | 0.351 | 0.360 | 1.017
17 80003 (White Laggan Burn @ L | 3.499 | 25 | 6.530 | 0.040 | -0.016 | 2.615
19 Total | | 512
20 Weighted means | | | | 0.280 | 0.264
Key
Short Records
Discordant
No Pooling
No Pooling, No QMED
AM Graphs
Add Site
Remove Site
OK
For Help, press F1
Stations : 18 Pooled : 1 Willersey : 17
NUM

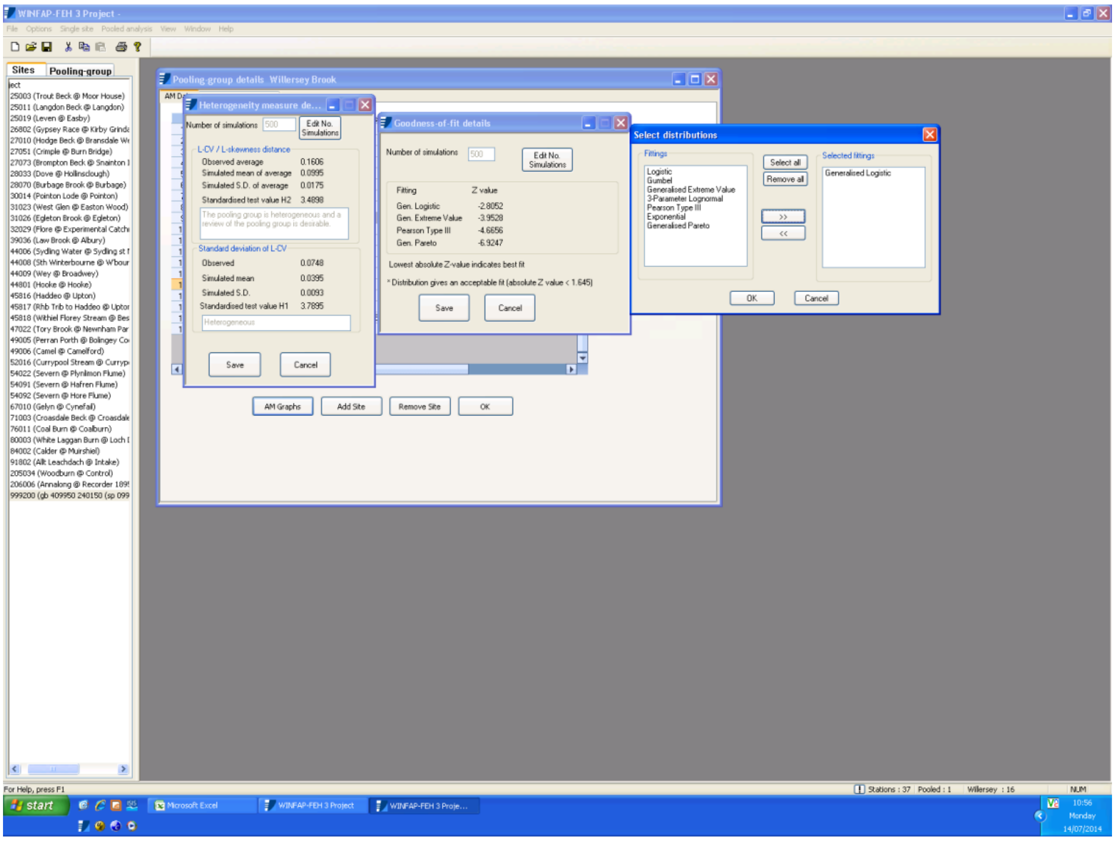

notts-pc-109 - Remote Desktop Connection
WINFAP-FEH 3 Project -
Pooling-group details Willersey Brook
AM Data
Catchment Descriptors
Station | Distance | Years of data | QMED AM | L-CV | L-SKEW | Discordanc
1 76011 (Coal Burn @ Coalburn) | 1.117 | 35 | 1.840 | 0.353 | 0.739 | 3.248
2 45816 (Haddeo @ Upton) | 2.947 | 19 | 3.456 | 0.324 | 0.434 | 0.555
3 27051 (Crimple @ Burn Bridge) | 2.990 | 40 | 4.539 | 0.222 | 0.149 | 0.241
4 27073 (Brompton Beck @ Snain | 3.105 | 32 | 0.813 | 0.197 | -0.022 | 0.672
5 28033 (Dove @ Hollinsclough) | 3.223 | 33 | 4.666 | 0.266 | 0.415 | 0.347
6 91802 (Allt Leachdach @ Intake | 3.714 | 34 | 6.350 | 0.153 | 0.257 | 1.066
7 25019 (Leven @ Easby) | 3.773 | 34 | 5.538 | 0.347 | 0.394 | 0.756
8 26802 (Gypsey Race @ Kirby Gr | 3.797 | 13 | 0.109 | 0.261 | 0.199 | 0.269
9 49006 (Camel @ Camelford) | 3.831 | 6 | 8.832 | 0.110 | -0.293 | 2.084
10 71003 (Croasdale Beck @ Croas | 3.837 | 35 | 10.900 | 0.206 | 0.331 | 0.374
11 25011 (Langdon Beck @ Langd | 3.846 | 26 | 15.878 | 0.241 | 0.326 | 1.131
12 25003 (Trout Beck @ Moor Hou | 3.863 | 39 | 15.164 | 0.176 | 0.291 | 0.653
13 54022 (Severn @ Plynlimon Flun | 3.934 | 37 | 15.031 | 0.155 | 0.168 | 1.100
14 206006 (Annalong @ Recorder | 4.024 | 48 | 15.330 | 0.189 | 0.052 | 1.273
15 27010 (Hodge Beck @ Bransda | 4.146 | 41 | 9.420 | 0.224 | 0.293 | 0.104
16 44008 (Sth Winterbourne @ W'b | 4.229 | 33 | 0.420 | 0.395 | 0.332 | 2.126
18 Total | | 505
19 Weighted means | | | | 0.245 | 0.276
Key
Short Records
Discordant
No Pooling
No Pooling, No QMED
AM Graphs
Add Site
Remove Site
OK

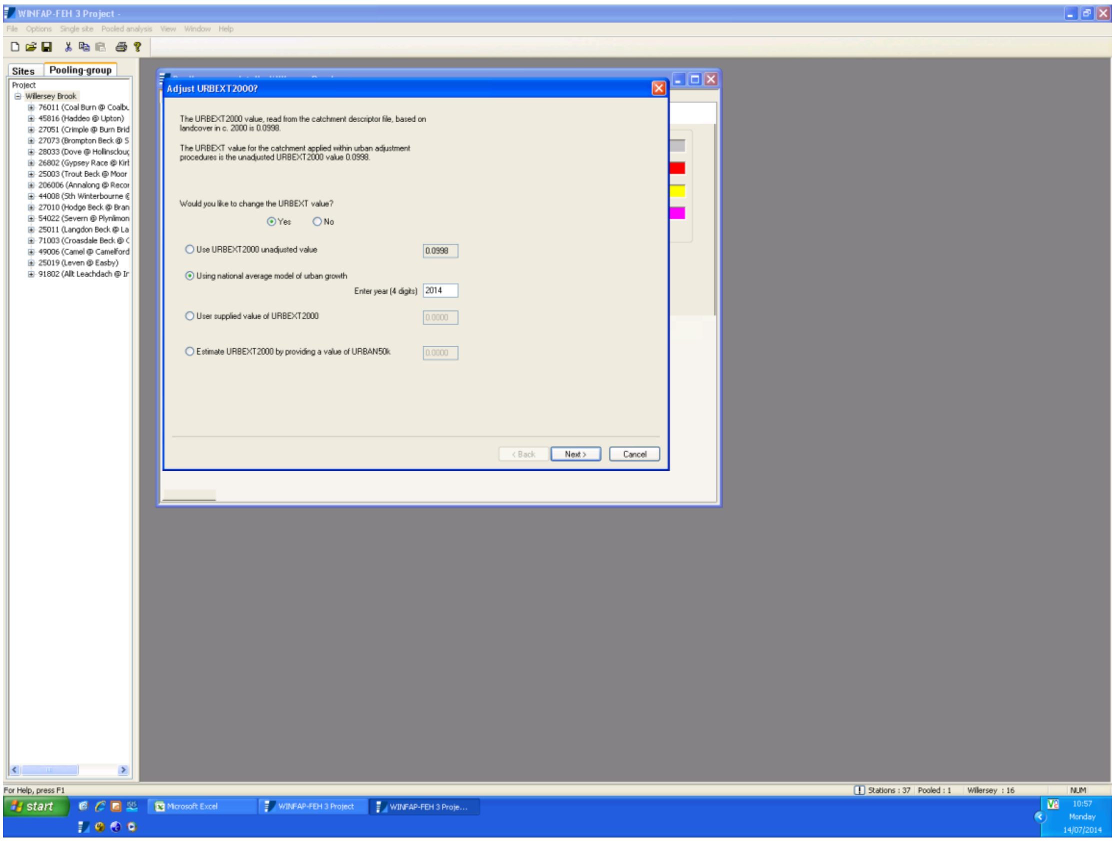


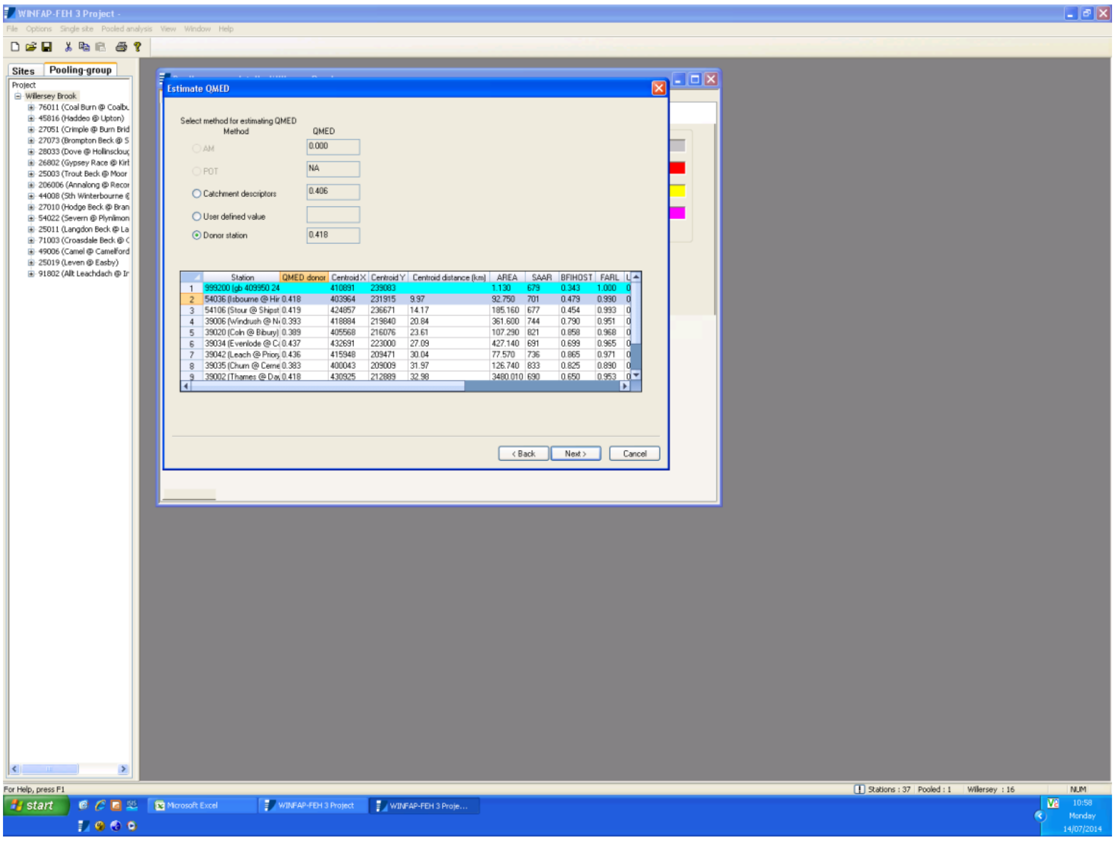
	Station	Distance SDM	AREA	SAAR	FPEXT	FARL	URBEXT 2000
1	76011 (Coal Burn @ Coalburn)	1.117	1.630	1096	0.074	1.000	0.000
2	45816 (Haddeo @ Upton)	2.947	6.810	1210	0.011	1.000	0.005
3	27051 (Crimple @ Burn Bridge)	2.990	8.150	855	0.013	1.000	0.006
4	27073 (Brompton Beck @ Snaintor	3.105	8.060	721	0.237	1.000	0.008
5	28033 (Dove @ Hollinsclough)	3.223	7.930	1346	0.007	1.000	0.000
6	91802 (Allt Leachdach @ Intake)	3.714	6.520	2555	0.003	0.992	0.000
7	25019 (Leven @ Easby)	3.773	15.070	830	0.019	1.000	0.004
8	26802 (Gypsey Race @ Kirby Grinc	3.797	15.850	757	0.030	1.000	0.000
9	49006 (Camel @ Camelford)	3.831	12.860	1418	0.012	1.000	0.004
10	71003 (Croasdale Beck @ Croasda	3.837	10.710	1882	0.016	1.000	0.000
11	25011 (Langdon Beck @ Langdon	3.846	12.790	1463	0.013	1.000	0.001
12	25003 (Trout Beck @ Moor House)	3.863	11.460	1904	0.041	1.000	0.000
13	54022 (Severn @ Plynlimon Flume)	3.934	8.690	2483	0.010	1.000	0.000
14	206006 (Annalong @ Recorder 18	4.024	13.660	1720	0.024	0.980	0.000
15	27010 (Hodge Beck @ Bransdale \	4.146	18.840	987	0.009	1.000	0.001
16	44008 (Sth Winterbourne @ W'bou	4.229	20.170	1012	0.015	1.000	0.004
17							
18							
19							

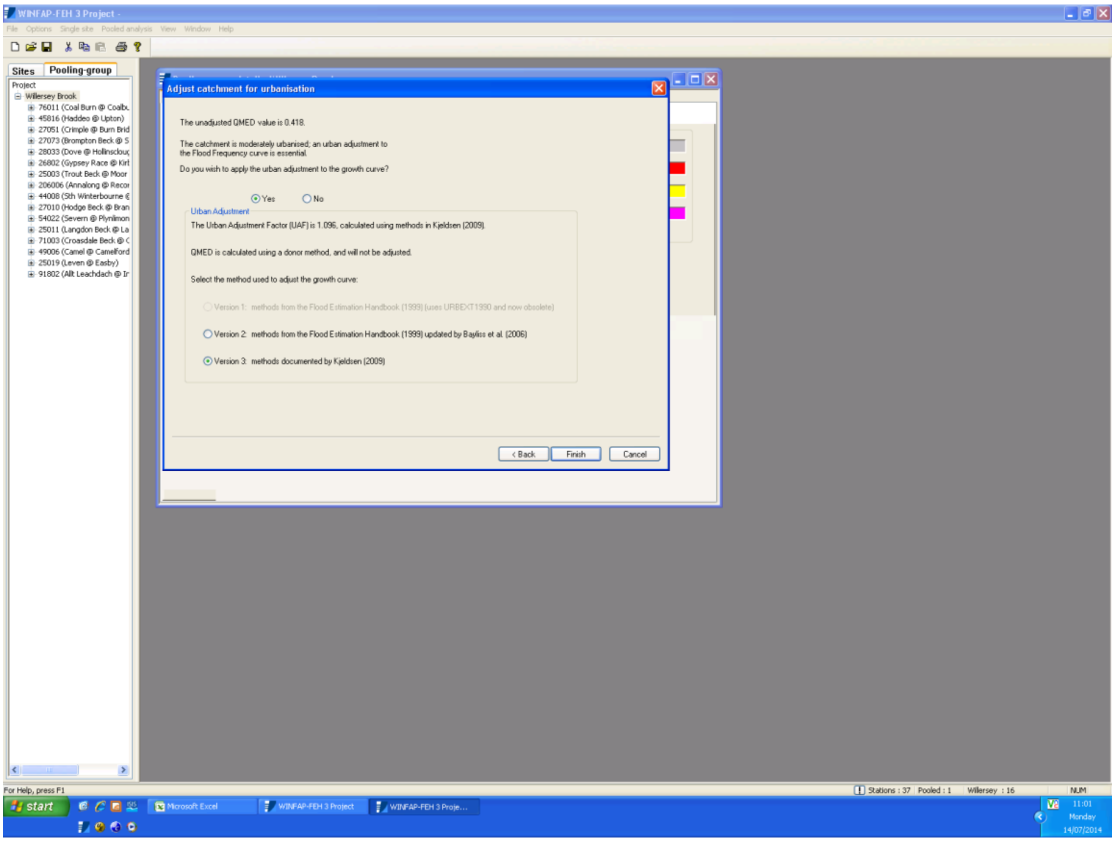


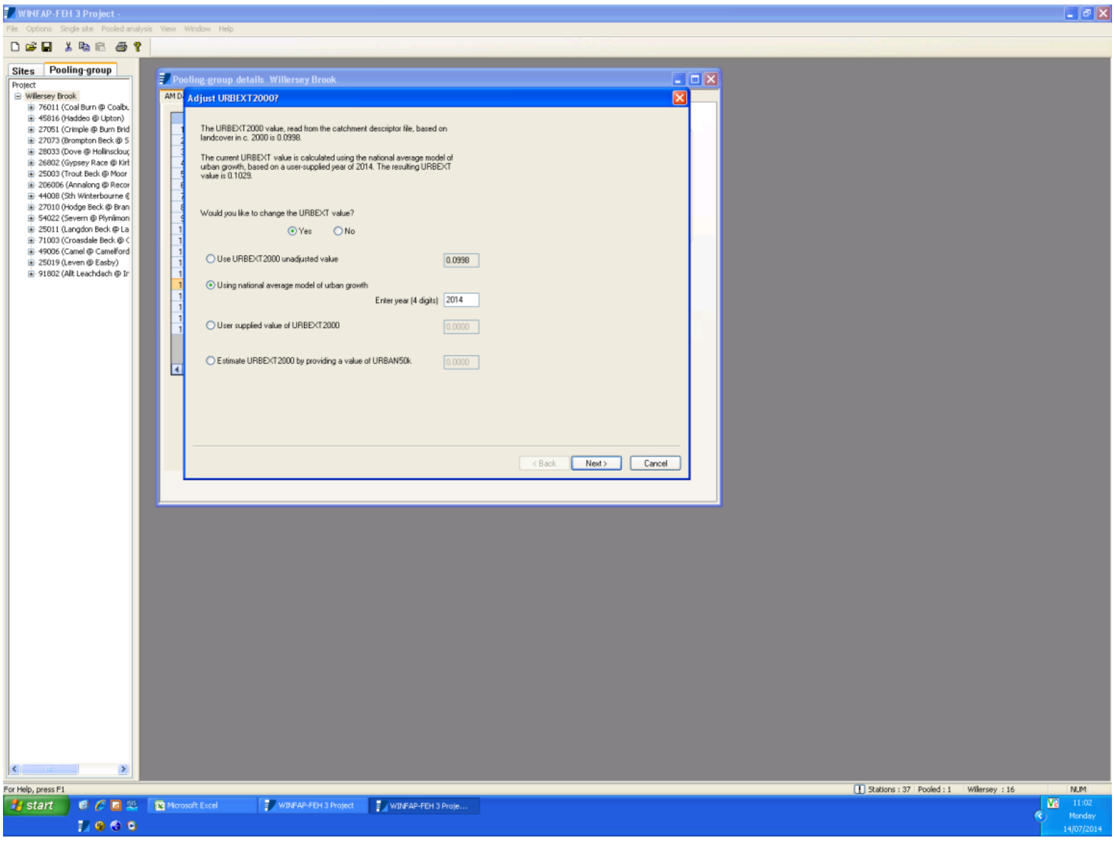


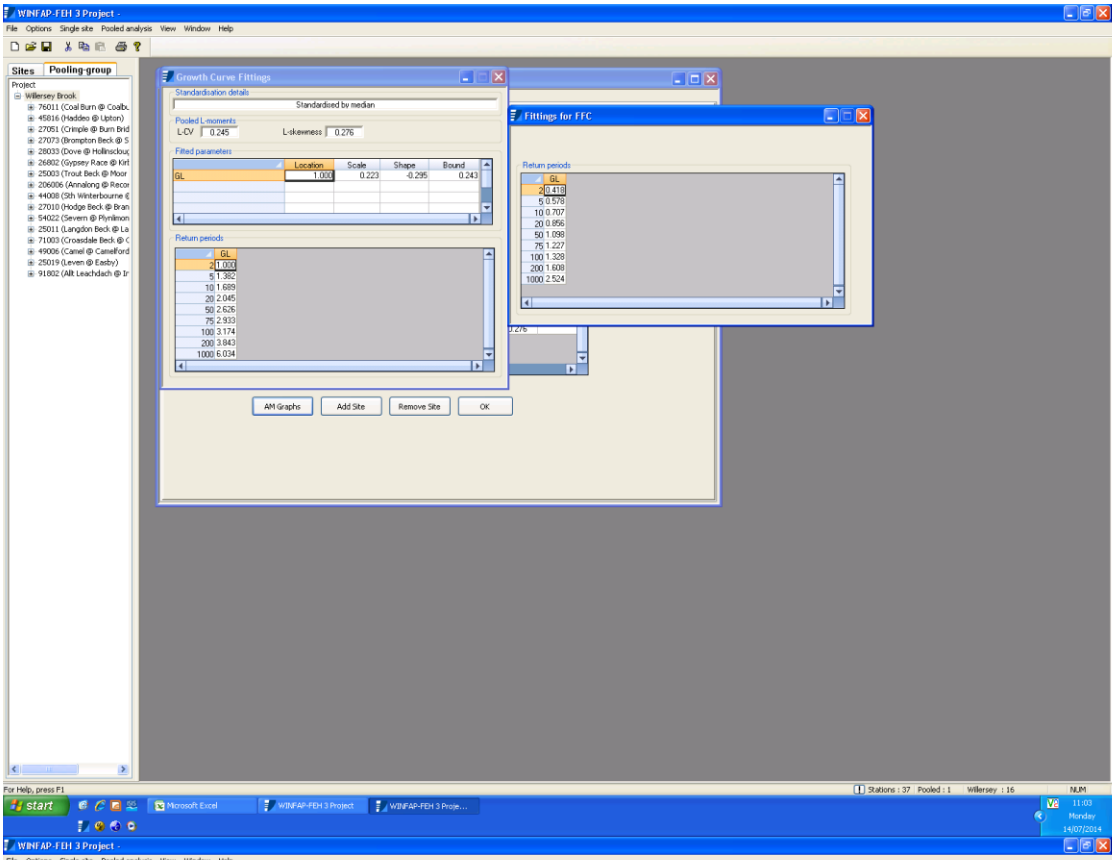


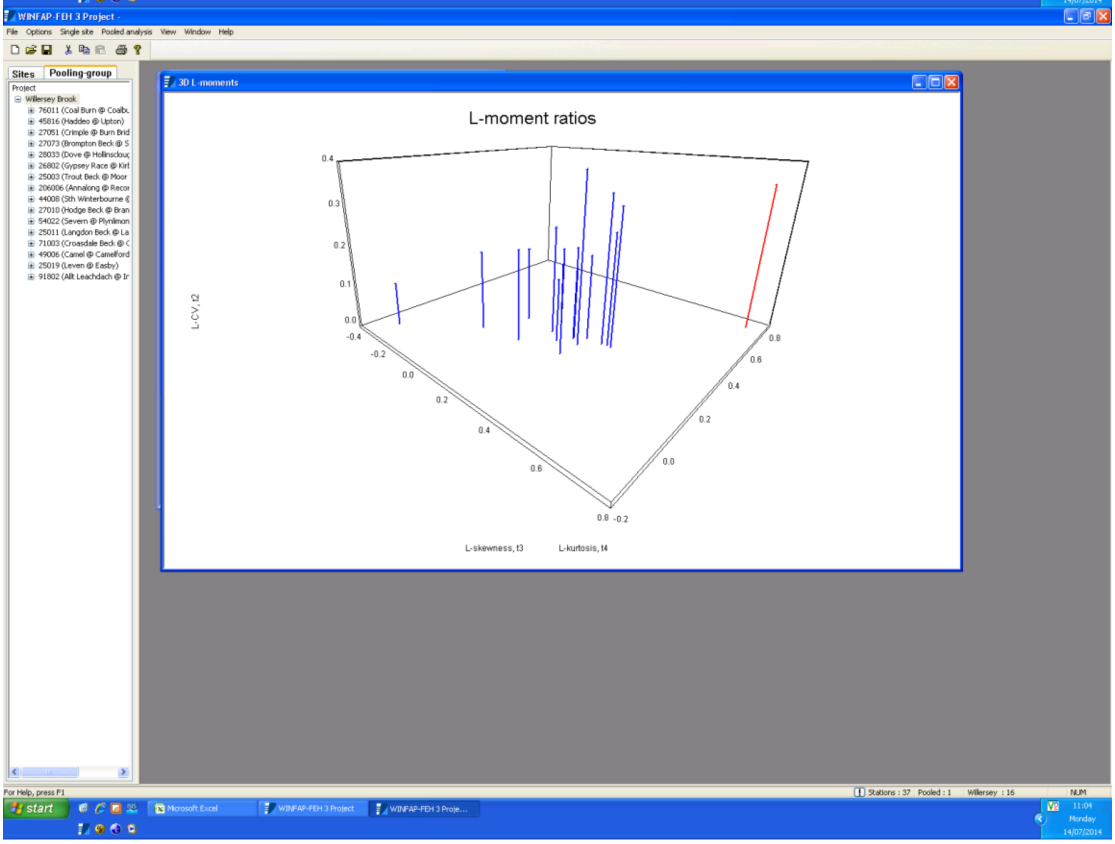

WINFAP-FEH 3 Project -
Adjust URBEXT2000?
The URBEXT2000 value, read from the catchment descriptor file, based on landcover in c. 2000 is 0.0998.
The URBEXT value for the catchment applied within urban adjustment procedures is the unadjusted URBEXT2000 value 0.0998.
Would you like to change the URBEXT value?
Yes
No
Use URBEXT2000 unadjusted value
0.0998
Using national average model of urban growth
Enter year (4 digits)
2014
User supplied value of URBEXT2000
0.0000
Estimate URBEXT2000 by providing a value of URBAN50k
0.0000
< Back
Next >
Cancel
For Help, press F1
Stations : 37
Pooled : 1
Willersey : 16
NUM
start
Microsoft Excel
WINFAP-FEH 3 Project
10:57
Monday
14/07/2014


WINFAP-FEH 3 Project -
Estimate QMED
Select method for estimating QMED
Method
QMED
AM
0.000
POT
NA
Catchment descriptors
0.406
User defined value
Donor station
0.418
Station
QMED donor
Centroid X
Centroid Y
Centroid distance (km)
AREA
SAAR
BFIHOST
FARL
1 999200 (gb 409950 24 410891 239083 1.130 679 0.343 1.000
2 54036 (Isbourne @ Hir 0.418 403964 231915 9.97 92.750 701 0.479 0.990
3 54106 (Stour @ Shipst 0.419 424857 236671 14.17 185.160 677 0.454 0.993
4 39006 (Windrush @ N 0.393 418884 219840 20.84 361.600 744 0.790 0.951
5 39020 (Coln @ Bibury) 0.389 405568 216076 23.61 107.290 821 0.858 0.968
6 39034 (Evenlode @ C 0.437 432691 223000 27.09 427.140 691 0.699 0.965
7 39042 (Leach @ Priory 0.436 415948 209471 30.04 77.570 736 0.865 0.971
8 39035 (Churn @ Cerne 0.383 400043 209009 31.97 126.740 833 0.825 0.890
9 39002 (Thames @ Day 0.418 430925 212889 32.98 3480.010 690 0.650 0.953
< Back
Next >
Cancel
For Help, press F1
Stations : 37
Pooled : 1
Willersey : 16
NUM
start
Microsoft Excel
WINFAP-FEH 3 Project
10:58
Monday
14/07/2014

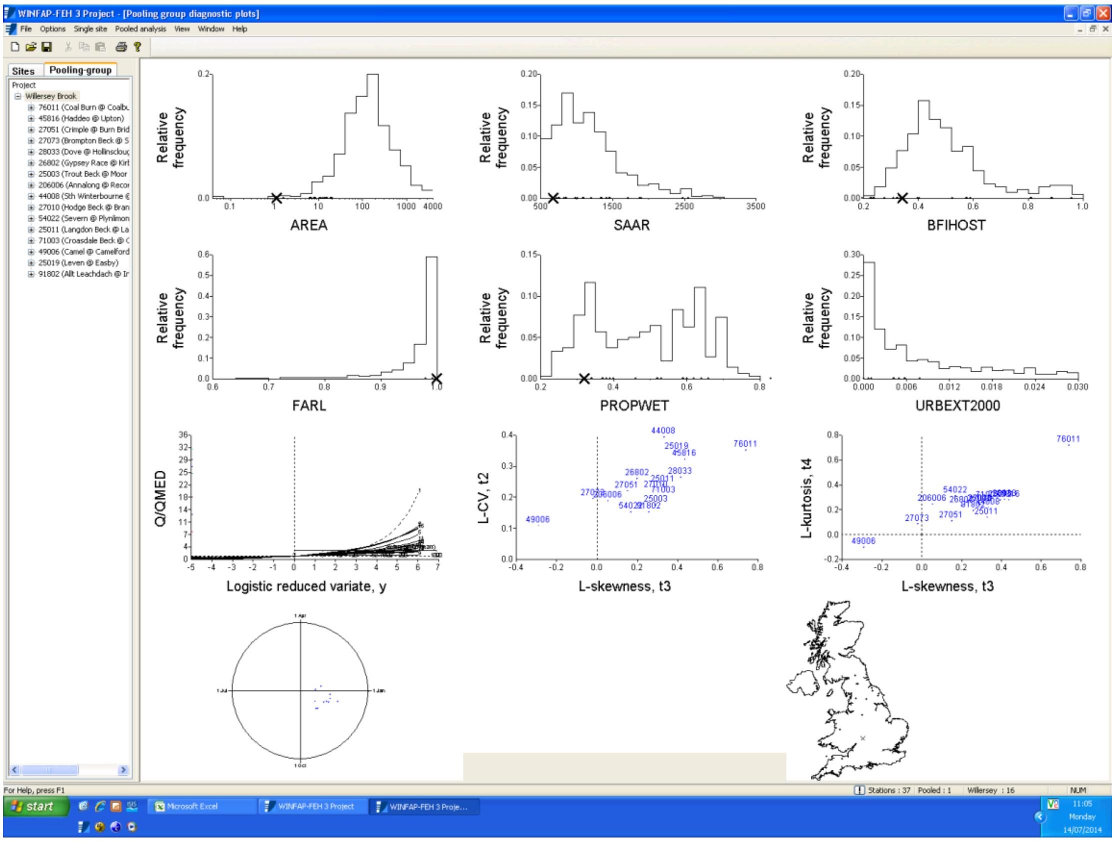

WINFAP-FEH 3 Project
Adjust catchment for urbanisation
The unadjusted QMED value is 0.418.
The catchment is moderately urbanised; an urban adjustment to the Flood Frequency curve is essential.
Do you wish to apply the urban adjustment to the growth curve?
Yes
No
Urban Adjustment
The Urban Adjustment Factor (UAF) is 1.096, calculated using methods in Kjeldsen (2009).
QMED is calculated using a donor method, and will not be adjusted.
Select the method used to adjust the growth curve:
Version 1: methods from the Flood Estimation Handbook (1999) (uses URBEXT1990 and now obsolete)
Version 2: methods from the Flood Estimation Handbook (1999) updated by Bayliss et al. (2006)
Version 3: methods documented by Kjeldsen (2009)
< Back
Finish
Cancel


WINFAP-FEH 3 Project
Pooling-group details Willersey Brook
Adjust URBEXT2000?
The URBEXT2000 value, read from the catchment descriptor file, based on landcover in c. 2000 is 0.0998.
The current URBEXT value is calculated using the national average model of urban growth, based on a user-supplied year of 2014. The resulting URBEXT value is 0.1029.
Would you like to change the URBEXT value?
Yes
No
Use URBEXT2000 unadjusted value
0.0998
Using national average model of urban growth
Enter year (4 digits)
2014
User supplied value of URBEXT2000
0.0000
Estimate URBEXT2000 by providing a value of URBAN50k
0.0000
< Back
Next >
Cancel



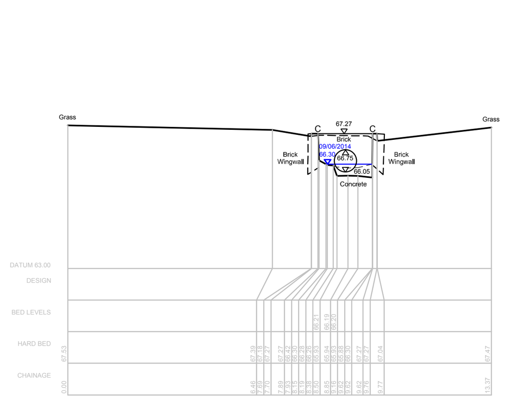


L-moment ratios
L-CV, t2
L-skewness, t3
L-kurtosis, t4

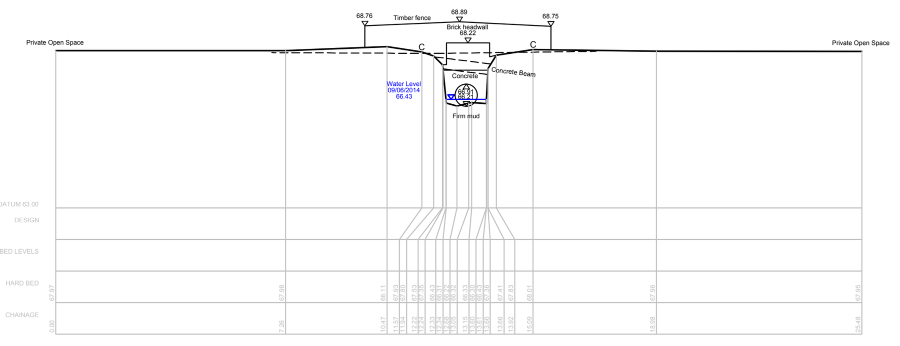

WINFAP-FEH 3 Project - [Pooling group diagnostic plots]
File Options Single site Pooled analysis View Window Help
Sites
Pooling-group
Project
Willersey Brook
76011 (Coal Burn @ Coalbu
45816 (Haddeo @ Upton)
27051 (Crimple @ Burn Brid
27073 (Brompton Beck @ S
28033 (Dove @ Hollinsclouc
26802 (Gypsey Race @ Kirl
25003 (Trout Beck @ Moor
206006 (Annalong @ Recor
44008 (Sth Winterbourne @
27010 (Hodge Beck @ Bran
54022 (Severn @ Plynlimon
25011 (Langdon Beck @ La
71003 (Croasdale Beck @ C
49006 (Camel @ Camelford
25019 (Leven @ Easby)
91802 (Allt Leachdach @ Ir
Relative frequency
AREA
SAAR
BFIHOST
FARL
PROPWET
URBEXT2000
Q/QMED
Logistic reduced variate, y
L-CV, t2
L-skewness, t3
L-kurtosis, t4
For Help, press F1
Stations : 37 Pooled : 1 Willersey : 16
NUM
start
Microsoft Excel
WINFAP-FEH 3 Project
11:05
Monday
14/07/2014

APPENDIX 2

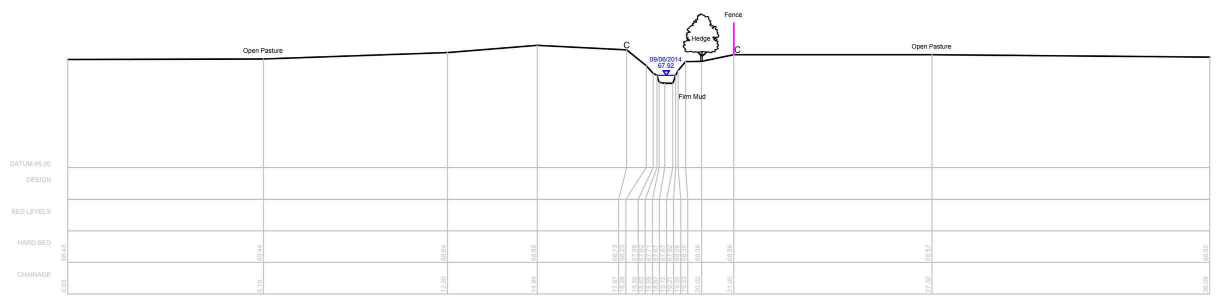
Watercourse Survey



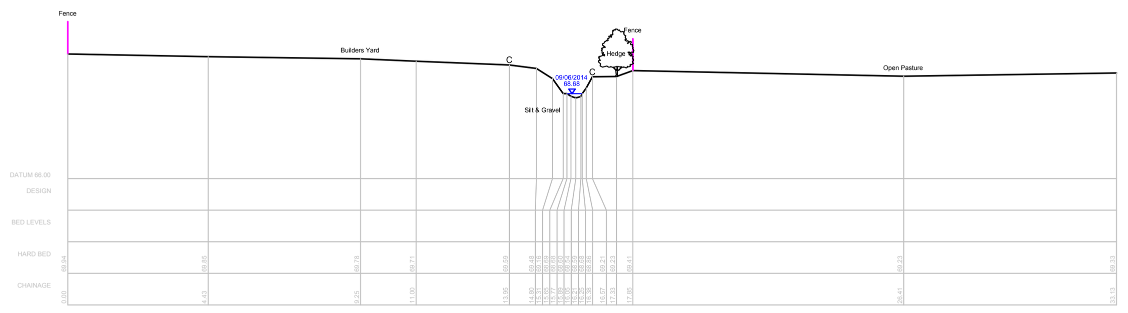
R1 XS1
410200.4mE 239883.01mN Brg 130
Chainage3.2
Culvert Exit



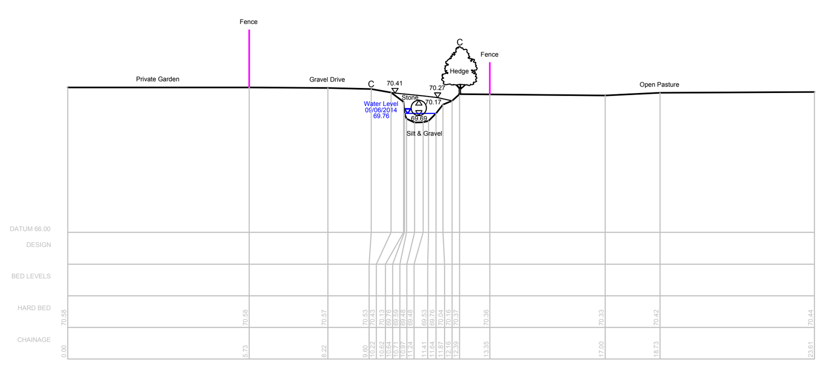
R1 XS2
410176.53mE 239851.02mN Brg 75
Chainage32.9
Culvert Entrance



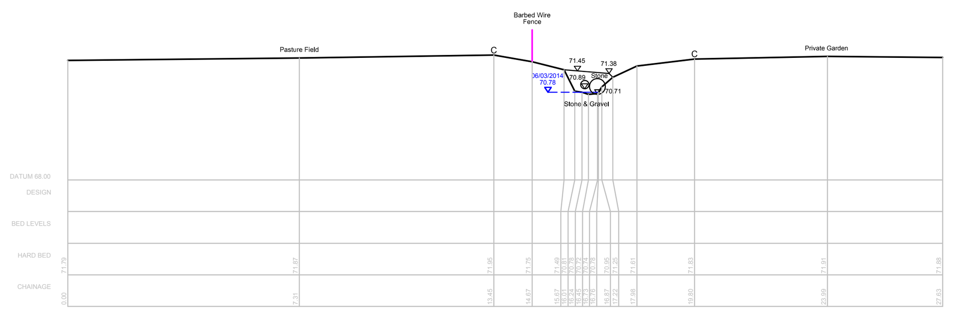
R1 XS3
410173.61mE 239812.37mN Brg 71
Chainage68.8
Open Channel



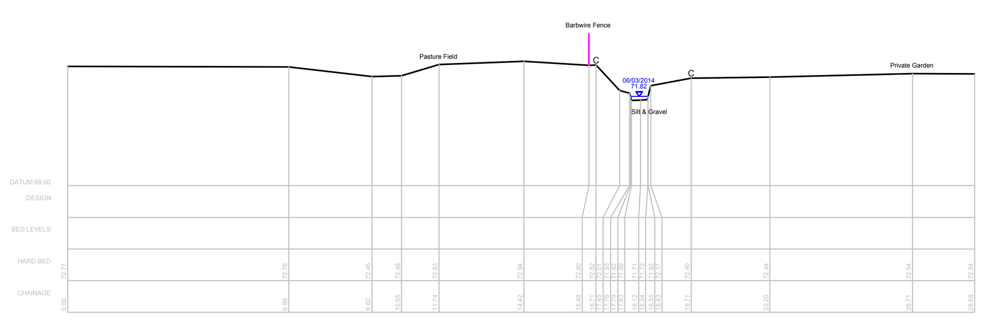
R1 XS4
410192.11mE 239749.75mN Brg 72
Chainage134.4
Open Channel



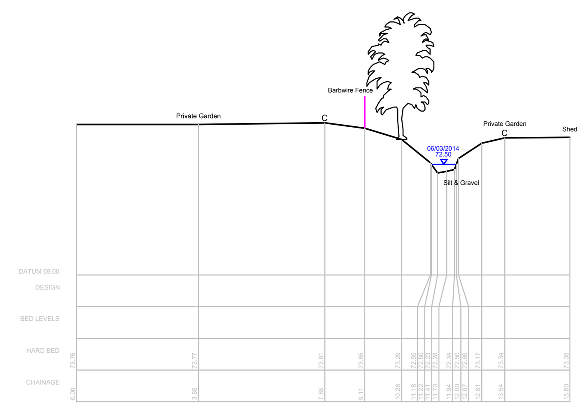
R1 XS5
410207.22mE 239687.6mN Brg 74
Chainage200.6
Culvert Exit



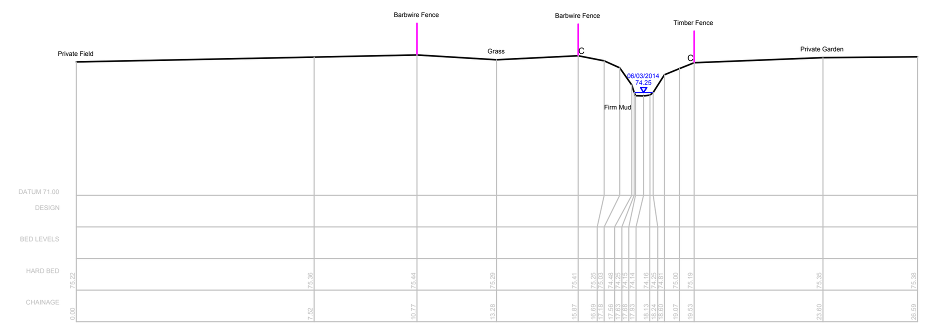
R1 XS6
410205.55mE 239633.72mN Brg 88
Chainage262
Road Culvert Entrance



R1 XS7
410211.5mE 239573.25mN Brg 83
Chainage321.2
Open Channel



R1 XS8
410226.16mE 239545.84mN Brg 72
Chainage348.6
Open Channel



R1 XS9
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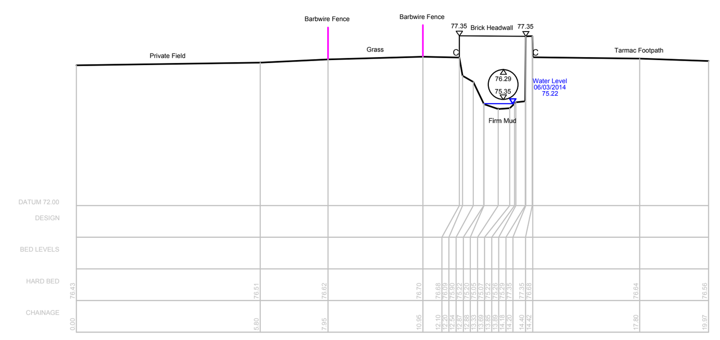
Chainage458.8
Open Channel



R1 XS10
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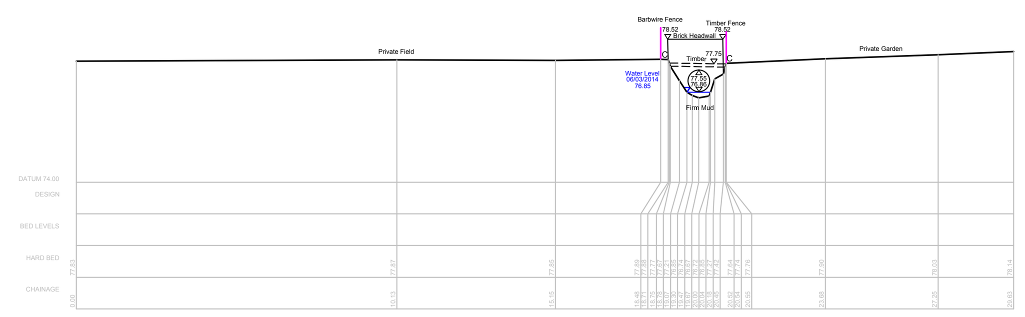
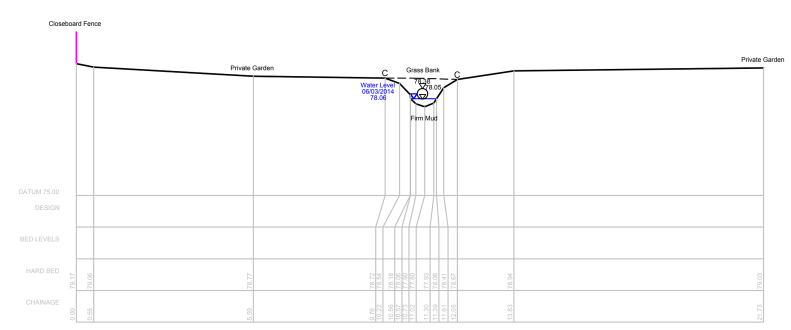
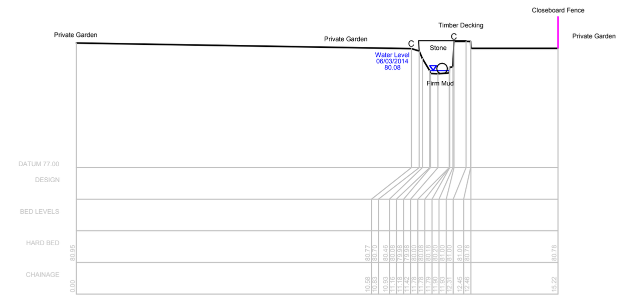
Chainage507.6
Culvert Exit



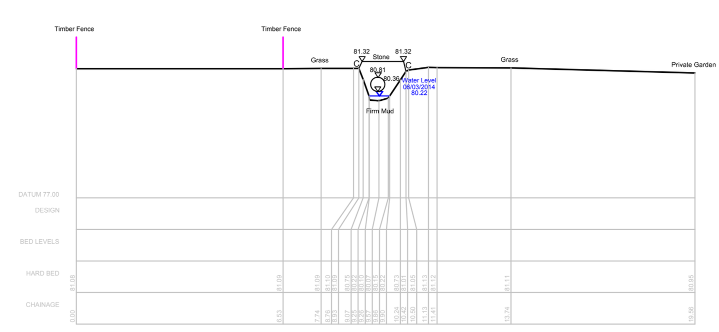
R1 XS11
410289.5mE 239331.15mN Brg 60
Chainage569.8
Culvert Entrance



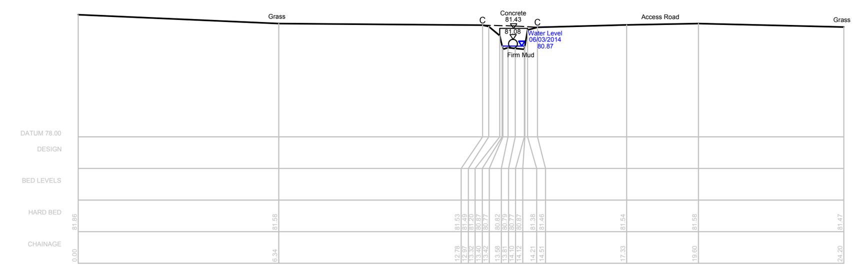
R1 XS12
410311.62mE 239287.47mN Brg 70
Chainage621.9
Culvert Exit



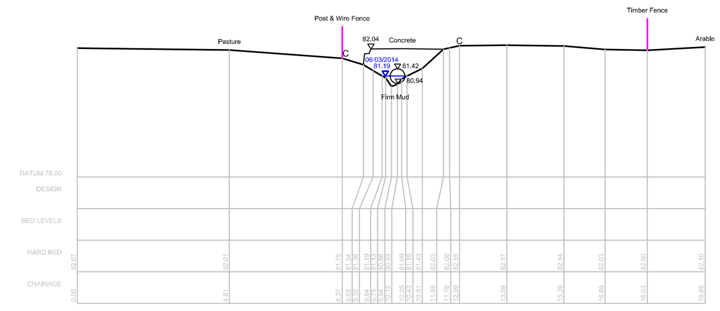
R1 XS13
410336.45mE 239209.09mN Brg 56
Chainage701.6
Culvert Entrance



R1 XS14
410341.55mE 239199.69mN Brg 76
Chainage715.9
Road Culvert Exit



R1 XS15
410347.15mE 239177.74mN Brg 66
Chainage736.5
Road Culvert Entrance



R1 XS16
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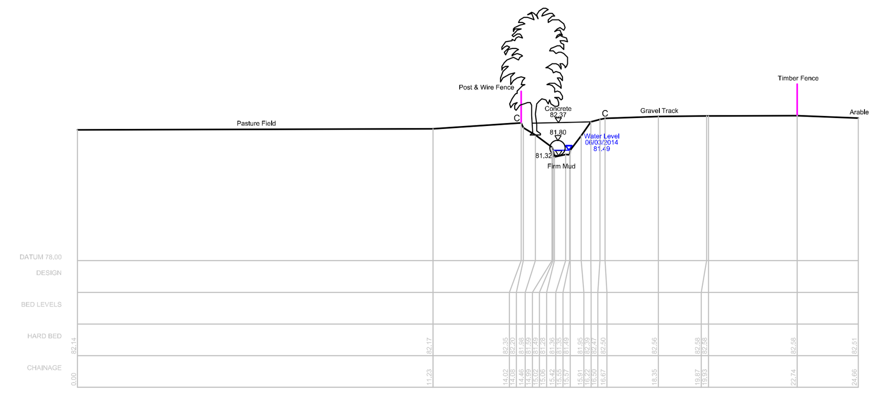
Chainage760
Culvert Exit



R1 XS17
410352.72mE 239143.75mN Brg 85
Chainage775.9
Upstream Face of Culvert

NOTES

1. DO NOT SCALE THIS DRAWING. ALL DIMENSIONS MUST BE CHECKED/ VERIFIED ON SITE. IF IN DOUBT ASK.
2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS, ENGINEERS AND SPECIALISTS DRAWINGS AND SPECIFICATIONS.
3. ALL DIMENSIONS IN METRES UNLESS NOTED OTHERWISE. ALL LEVELS IN METRES UNLESS NOTED OTHERWISE.
4. ANY DISCREPANCIES NOTED ON SITE ARE TO BE REPORTED TO THE ENGINEER IMMEDIATELY.
5. NO SCALE FACTOR HAS BEEN APPLIED TO THIS SURVEY, THEREFORE THE OS COORDINATES ARE TO BE TREATED AS ARBITRARY. PLEASE REFER TO SURVEY STATION INFORMATION BELOW FOR ON SITE CONTROL ESTABLISHMENT.
6. ORIGINAL SURVEY IN GREY IS HISTORIC DATA AND CARRIED OUT BY OTHERS.

LEGEND

OS Buildings
Surveyed Buildings
Buildings / walls
Kerb line
Edge of surface
Canopy / Overhang
Line Marking
Centre Line
Barrier
Security Fence
Panel Fence
Open Fence
Hedge
Overhead Powerline
Contour Lines

Chamber
0.25 Flow direction and pipe diameter
1 Station and Name
BM 100.00 Benchmark
BH 1 Borehole
TH 1 Trial Hole
Tree / Bush / Sapling
Area of Undergrowth / Extent of Tree Canopy
Gate
Body of Water
Slope Arrow

AV	Air Valve	50.00	Spot Level
Bg	Back Gully	IC	Inspection Chamber
BO	Bollard	IFL	Internal Floor Level
BS	Bus Stop	IL	Invert Level (as a reduced level)
BT	British Telecom	LB	Litter Bin
C	Crest	LP	Lamp Post
CL	Cover Level	MH	Manhole
Cmp	Cable Marker Post	Mkr	Service Marker
CTV	Cable TV	PB	Post Box
DC	Drainage Channel	PT	Post
DK	Drop Kerb	P.Inv Ø0.25	Pipe Invert (diameter)
DP	Down Pipe	RE	Rodding Eye
Elec	Electric	SP	Sign Post
EP	Electricity Post	ST	Stop Tap
ER	Earth Rod	SV	Stop Valve
FH	Fire Hydrant	TCB	Telephone Call Box
FL	Floodlight	THL	Threshold Level
FFL	Finished Floor Level	TL	Traffic Light
FP	Flagpole	TP	Telegraph Post
FS	Flagstaff	UTR	Unable to Raise
Gas	Gas	WL	Water Level
GV	Gas Valve	WM	Water Meter
GY	Gully	WO	Wash Out
ht	Height		

Rev	Date	Details of issue / revision	Drw	Rev
C1	25/06/14	Drawing Issue	JM	JMG

ISSUES & REVISIONS

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Client
NEWLAND HOMES

Project Title
COLLIN LANE WILLERSEY

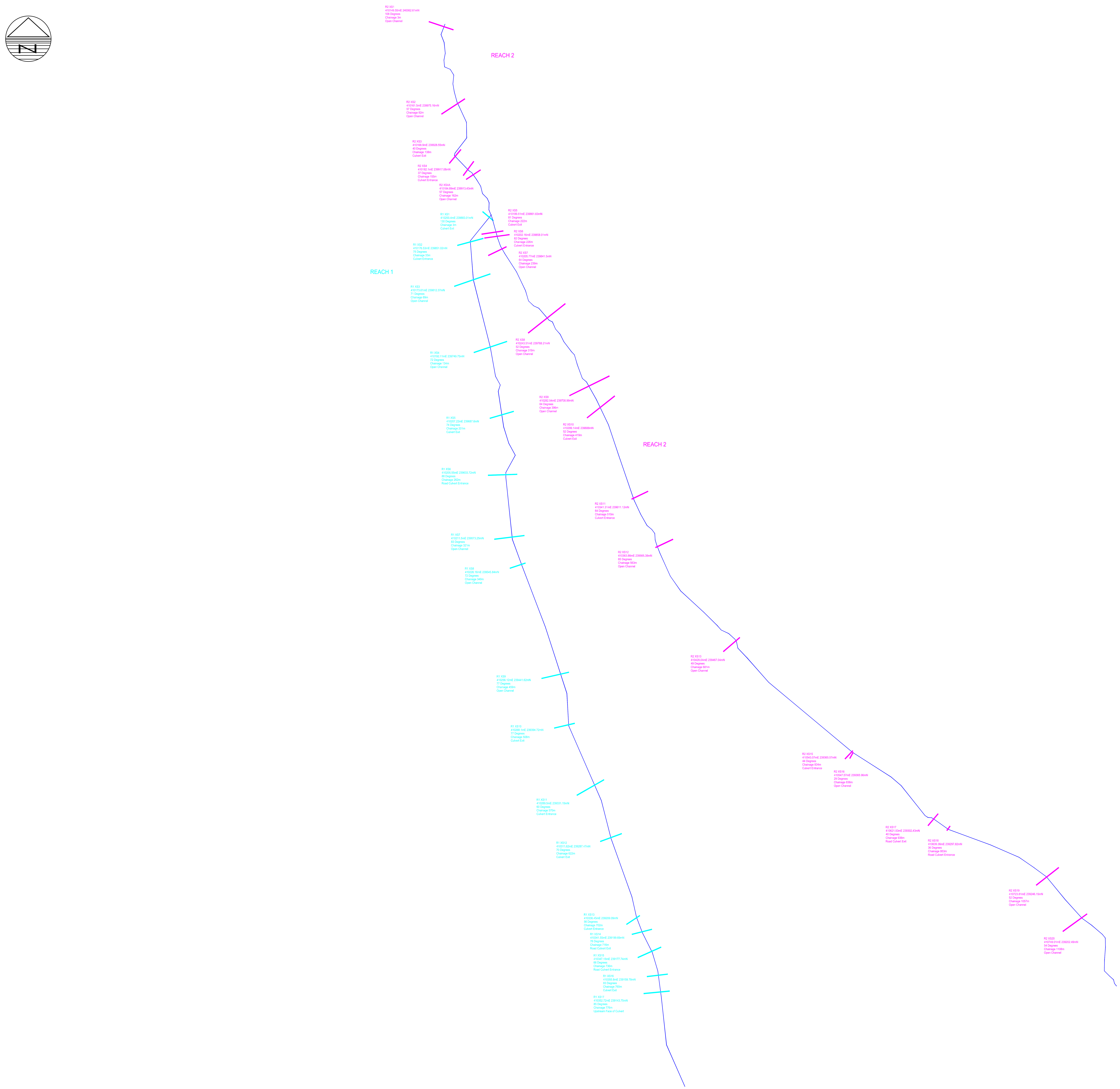
Drawing Title
REACH 1 CROSS SECTIONS

Scale	1:200	Drawn	JM
Size	A1	Reviewed	JMG

Drawing Status
CONSTRUCTION

Drawing No.
BMW/2315/002-02

Revision
C1



NOTES

1. DO NOT SCALE THIS DRAWING. ALL DIMENSIONS MUST BE CHECKED/ VERIFIED ON SITE. IF IN DOUBT ASK.
2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS, ENGINEERS AND SPECIALISTS DRAWINGS AND SPECIFICATIONS.
3. ALL DIMENSIONS IN METRES UNLESS NOTED OTHERWISE. ALL LEVELS IN METRES UNLESS NOTED OTHERWISE.
4. ANY DISCREPANCIES NOTED ON SITE ARE TO BE REPORTED TO THE ENGINEER IMMEDIATELY.
5. NO SCALE FACTOR HAS BEEN APPLIED TO THIS SURVEY, THEREFORE THE OS COORDINATES ARE TO BE TREATED AS ARBITRARY. PLEASE REFER TO SURVEY STATION INFORMATION BELOW FOR ON SITE CONTROL ESTABLISHMENT.
6. ORIGINAL SURVEY IN GREY IS HISTORIC DATA AND CARRIED OUT BY OTHERS.

LEGEND

	OS Buildings		Chamber
	Surveyed Buildings	0.25	Flow direction and pipe diameter
	Buildings / walls	1	Station and Name
	Kerb line	BM 100.00	Benchmark
	Edge of surface	BH 1	Borehole
	Canopy / Overhang	TH 1	Trial Hole
	Line Marking		Tree / Bush / Sapling
	Centre Line		Area of Undergrowth / Extent of Tree Canopy
	Barrier		Gate
	Security Fence		Body of Water
	Panel Fence		Slope Arrow
	Open Fence		
	Hedge		
	Overhead Powerline		
120	Contour Lines		
AV	Air Valve	× 50.00	Spot Level
Bg	Back Gully	IC	Inspection Chamber
BO	Bollard	IFL	Internal Floor Level
BS	Bus Stop	IL	Invert Level (as a reduced level)
BT	British Telecom	LB	Litter Bin
C	Crest	LP	Lamp Post
CL	Cover Level	MH	Manhole
Cmp	Cable Marker Post	Mkr	Service Marker
CTV	Cable TV	PB	Post Box
DC	Drainage Channel	PT	Post
DK	Drop Kerb	P.Inv Ø0.25	Pipe Invert (diameter)
DP	Down Pipe	RE	Rodding Eye
Elec	Electric	SP	Sign Post
EP	Electricity Post	ST	Stop Tap
ER	Earth Rod	SV	Stop Valve
FH	Fire Hydrant	TCB	Telephone Call Box
FL	Floodlight	THL	Threshold Level
FFL	Finished Floor Level	TL	Traffic Light
FP	Flagpole	TP	Telegraph Post
FS	Flagstaff	UTR	Unable to Raise
Gas	Gas	WL	Water Level
GV	Gas Valve	WM	Water Meter
GY	Gully	WO	Wash Out
ht	Height		

Rev	Date	Details of issue / revision	Drw	Rev
C1	25/06/14	Drawing Issue	JM	JMG

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Client
NEWLAND HOMES

Project Title
COLLIN LANE WILLERSEY

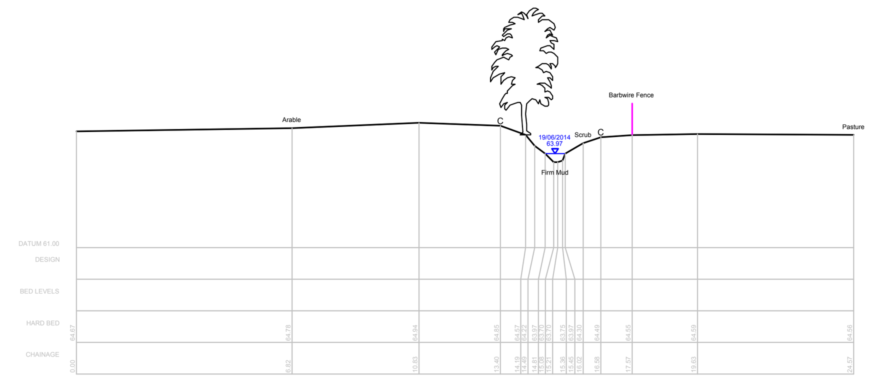
Drawing Title
SECTION LOCATION PLAN

Scale	NTS	Drawn	JM
Size	A1	Reviewed	JMG

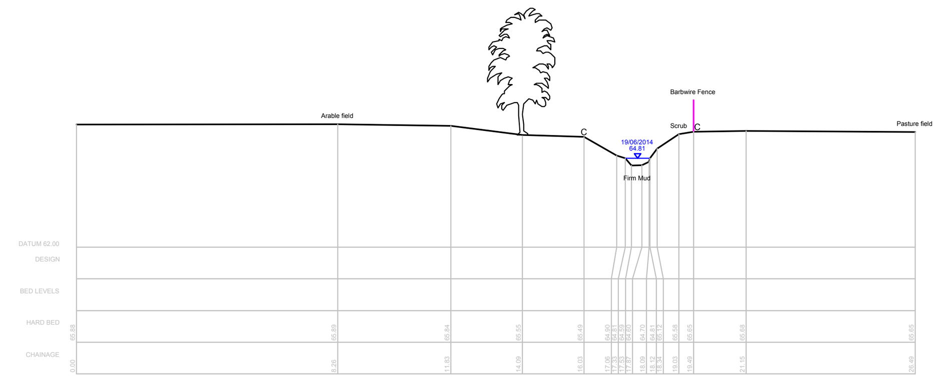
Drawing Status
CONSTRUCTION

Drawing No.
BMW/2315/002-01

Revision
C1



R2 XS1
410149.55mE 240062.61mN Brg 108
Chainage 2.6
Open Channel



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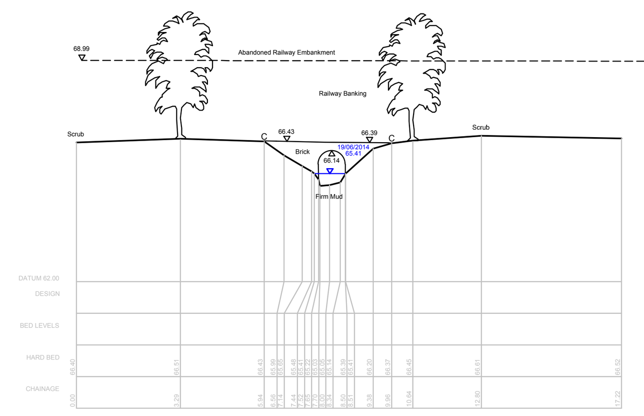
410161.5mE 239975.16mN Brg 57
Chainage 81.7
Open Channel



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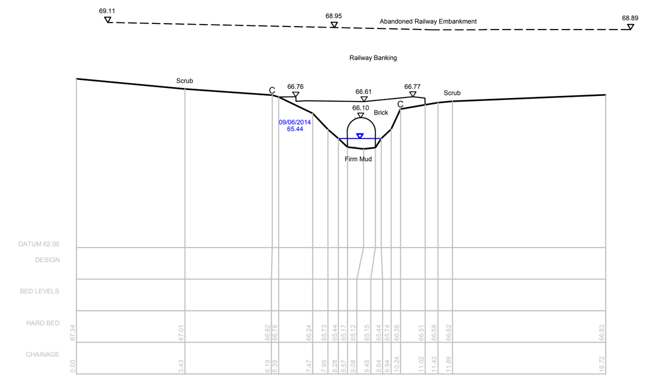
Chainage 137.7
Culvert Exit



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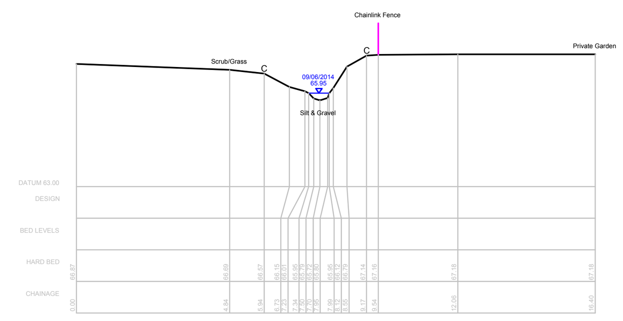
Chainage 154.9
Culvert Entrance



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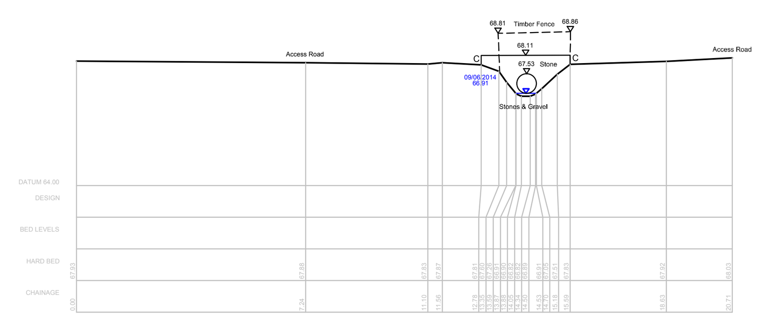
Chainage 162.2
Open Channel



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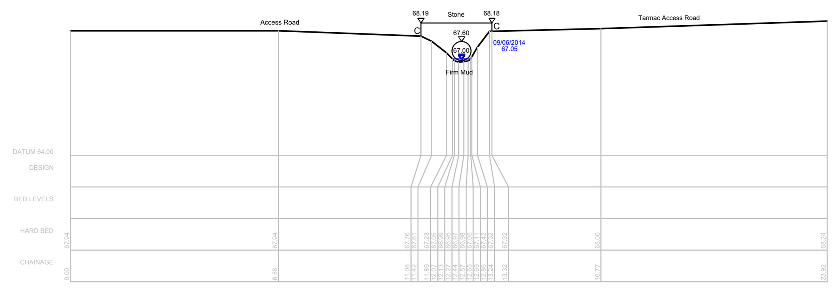
Chainage 222
Culvert Exit



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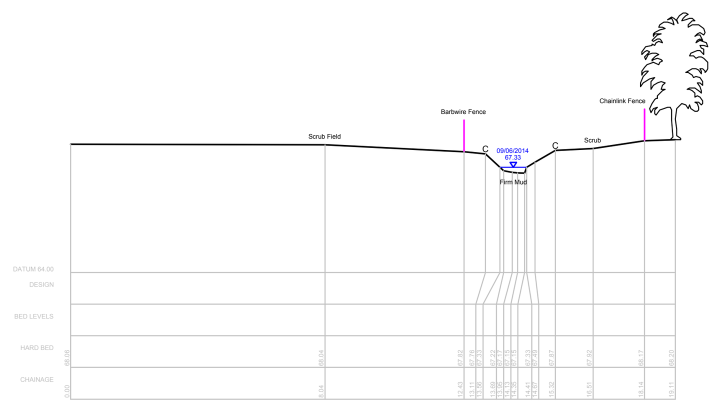
410202.16mE 239858.01mN Brg 82
Chainage 226.2
Culvert Entrance



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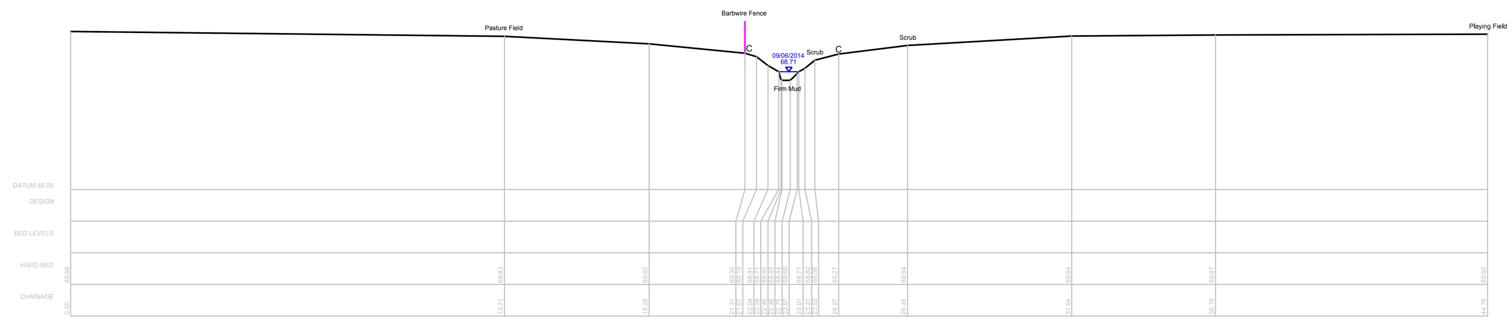
Chainage 238.9
Open Channel



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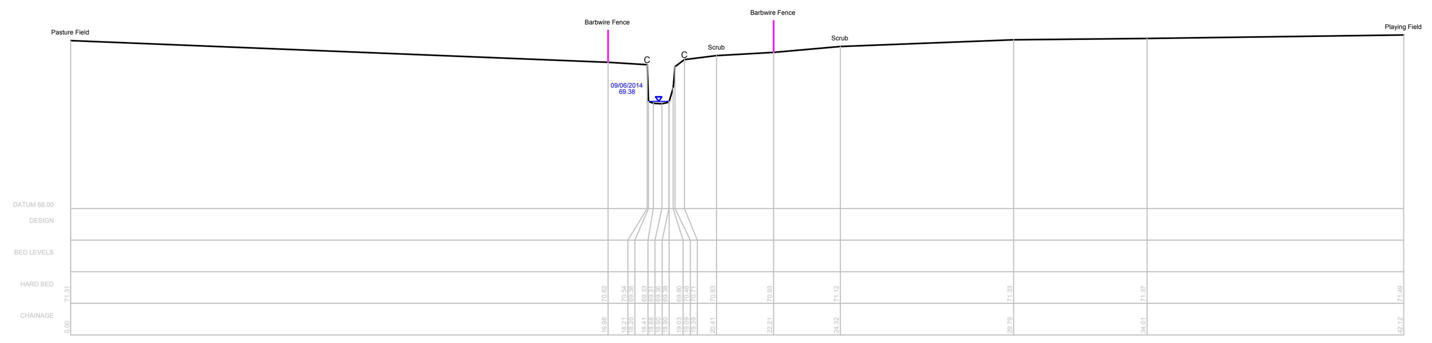
Chainage 318.7
Open Channel



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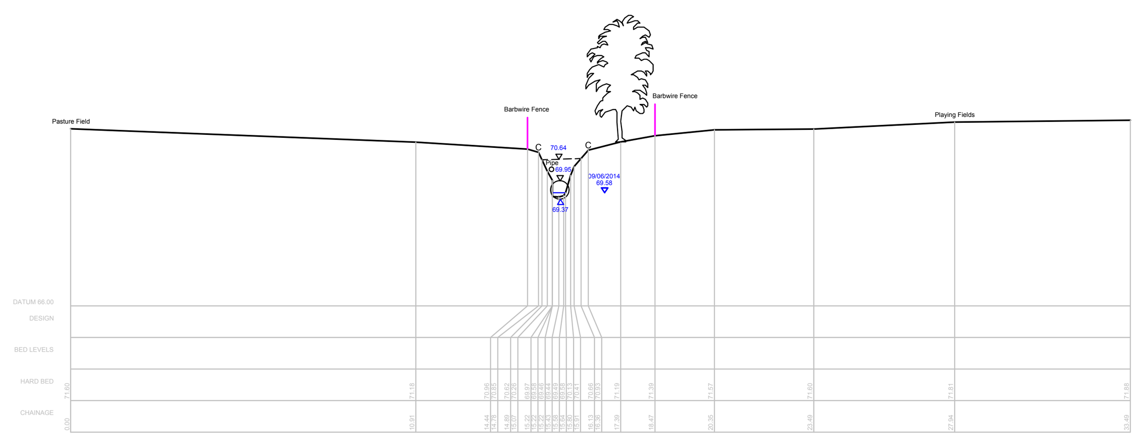
Chainage 396
Open Channel



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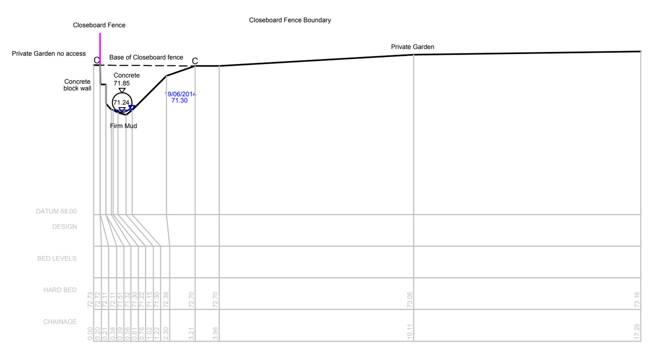
Chainage 418.9
Culvert Exit



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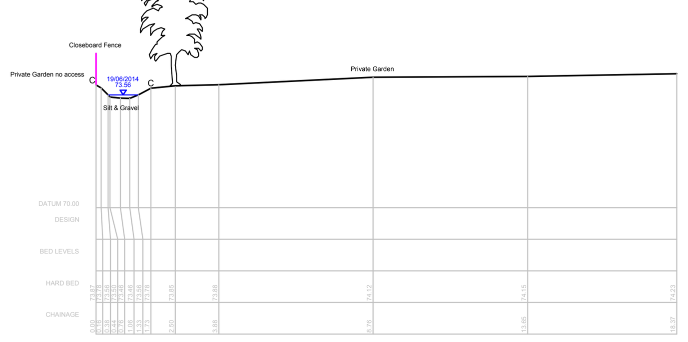
Chainage 510.4
Culvert Entrance



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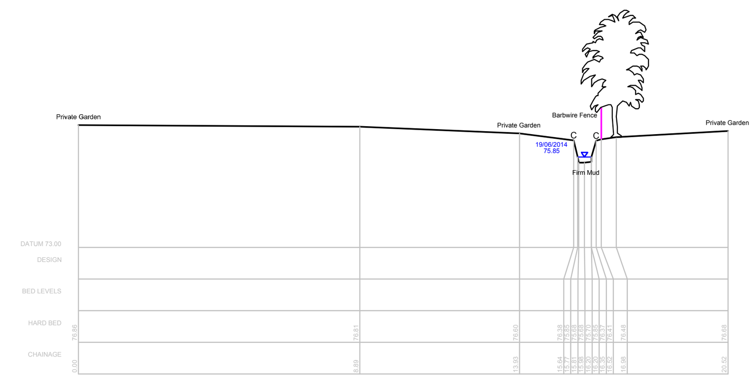
Chainage 562.6
Open Channel



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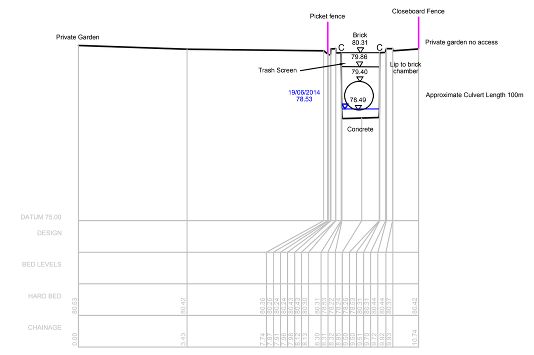
Chainage 681
Open Channel



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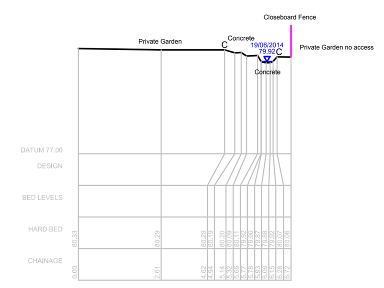
Chainage 834.1
Culvert Entrance - Approx Culvert Length 100m



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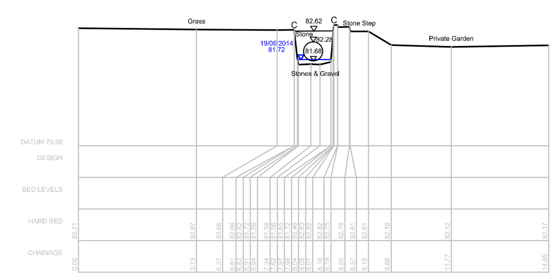
Chainage 835.5
Open Channel



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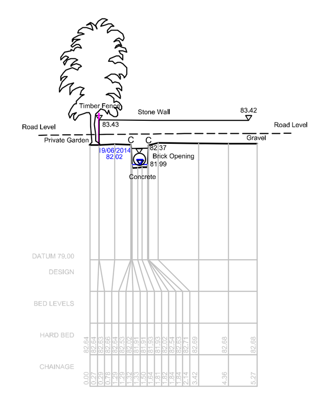
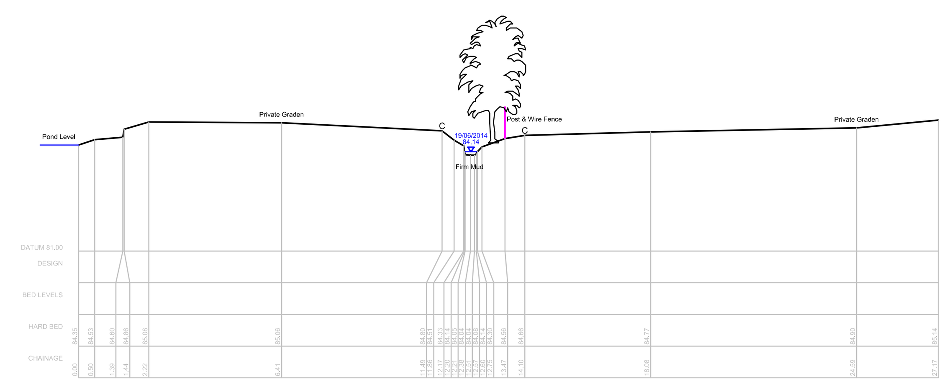
Chainage 936.1
Road Culvert Exit



R2 XS18
410639.36mE 239297.82mN Brg 36
Chainage 952.6
Road Culvert Entrance



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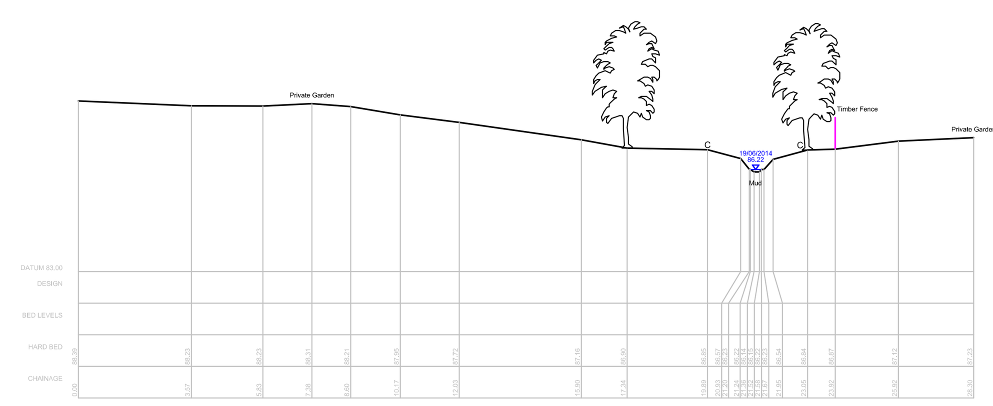
Chainage 1057.1
Open Channel



R2 XS20
410749.01mE 239202.49mN Brg 54
Chainage 1107.9
Open Channel

NOTES

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2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS, ENGINEERS AND SPECIALISTS DRAWINGS AND SPECIFICATIONS.
3. ALL DIMENSIONS IN METRES UNLESS NOTED OTHERWISE. ALL LEVELS IN METRES UNLESS NOTED OTHERWISE.
4. ANY DISCREPANCIES NOTED ON SITE ARE TO BE REPORTED TO THE ENGINEER IMMEDIATELY.
5. NO SCALE FACTOR HAS BEEN APPLIED TO THIS SURVEY, THEREFORE THE OS COORDINATES ARE TO BE TREATED AS ARBITRARY. PLEASE REFER TO SURVEY STATION INFORMATION BELOW FOR ON SITE CONTROL ESTABLISHMENT.
6. ORIGINAL SURVEY IN GREY IS HISTORIC DATA AND CARRIED OUT BY OTHERS.

LEGEND

	OS Buildings		Chamber
	Surveyed Buildings	0.25	Flow direction and pipe diameter
	Buildings / walls	1	Station and Name
	Kerb line	BM 100.00	Benchmark
	Edge of surface	BH 1	Borehole
	Canopy / Overhang	TH 1	Trial Hole
	Line Marking		Tree / Bush / Sapling
	Centre Line		Area of Undergrowth / Extent of Tree Canopy
	Barrier		Gate
	Security Fence		Body of Water
	Panel Fence		Slope Arrow
	Open Fence		
	Hedge		
	Overhead Powerline		
120	Contour Lines		
AV	Air Valve	50.00	Spot Level
Bg	Back Gully	IC	Inspection Chamber
BO	Bollard	IFL	Internal Floor Level
BS	Bus Stop	IL	Invert Level (as a reduced level)
BT	British Telecom	LB	Litter Bin
C	Crest	LP	Lamp Post
CL	Cover Level	MH	Manhole
Cmp	Cable Marker Post	Mkr	Service Marker
CTV	Cable TV	PB	Post Box
DC	Drainage Channel	PT	Post
DK	Drop Kerb	P.Inv Ø0.25	Pipe Invert (diameter)
DP	Down Pipe	RE	Rodding Eye
Elec	Electric	SP	Sign Post
EP	Electricity Post	ST	Stop Tap
ER	Earth Rod	SV	Stop Valve
FH	Fire Hydrant	TCB	Telephone Call Box
FL	Floodlight	THL	Threshold Level
FFL	Finished Floor Level	TL	Traffic Light
FP	Flagpole	TP	Telegraph Post
FS	Flagstaff	UTR	Unable to Raise
Gas	Gas	WL	Water Level
GV	Gas Valve	WM	Water Meter
GY	Gully	WO	Wash Out
ht	Height		

Rev	Date	Details of issue / revision	Drw	Rev
C1	25/06/14	Drawing Issue	JM	JMG

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Client
NEWLAND HOMES

Project Title
COLLIN LANE WILLERSEY

Drawing Title
REACH 2 CROSS SECTIONS

Scale	1:200	Drawn	JM
Size	A1	Reviewed	JMG

Drawing Status
CONSTRUCTION

Drawing No.
BMW/2315/002-03

Revision
C1

APPENDIX 3

Development Proposals

Notes

1) Do not scale directly from this drawing.

2) This drawing is be read in conjunction with all other relevant consultants information.

Scale 1:1000 @ A2

Project Name:
Land off Collin Lane, Willersey

MHP Reference:
14.316.101

Revision:
Status: FOR INFORMATION
Date: 14-11-2014

Land Off Collin Lane, Willersey 14.316.101 Layout Proposals

CHARTERED LANDSCAPE ARCHITECTS mhp

APPENDIX 4

Environment Agency Correspondence

Josepine Green
BWB Consulting Ltd
e-mail:
josephine.Green@bwbconsulting.com

Our Ref: W-5616

Date: 4 July 2014

Dear Josepine Green

Re: Product-1 FRA for land at Collin Lane, Willersey, Broadway, Worcestershire WR12 7PE. NGR: SP 10090 39654.

Thank you for your request for information that was received on 03/07/2014.

Please note:the EA cannot legally provide PDF Surfacewater Flood Maps, as they are owned by the Local Authority. Please go to our website to view them or contact the Local Authority

Please note:Product-1 only

Floodplain Map and Flood Zone classification.

No modeled flood levels and no flood event history available.

Before proceeding with this request, we will require a payment of £50 + VAT. This is not a charge for supplying the data, but a charge for the copyright licence which is set out in our Standard Notice. The Standard Notice explains how you may use the information you have asked for and will be sent to you at the same time that we send you the information.

Charging Summary

Copyright Licence Charge	=	£50.00
VAT @ 20%	=	£10.00
Total cost	=	**£60.00**

VAT Registration Number: GB 662 4901 34

Please make your cheque payable to the Environment Agency and send it to the External Relations Department, at the address below. If you prefer to pay by credit card please contact us on 01743 283412 or 01743 283410.

Once we have received your payment, we will endeavour to provide you with a full response within 10 working days. However, with complex enquiries, this is not always possible. We have 20 working days to be within our Service Commitment.

If we have not received your payment within 60 days of the date of this letter/e-mail we will assume that you no longer require the information.

If you have any queries regarding this email please contact us on the number below.

Yours sincerely

Matthew Weston
External Relations Officer

For further information please contact the Customer Services team
Tel: 01743 283410/3412
Direct e-mail:- MIDLANDSCUSTOMERSERV@environment-agency.gov.uk

Enc.
Standard Notice.

APPENDIX 5

Baseline Hydraulic Modelling Results

NOTES

1. DO NOT SCALE THIS DRAWING. ALL DIMENSIONS MUST BE CHECKED/ VERIFIED ON SITE. IF IN DOUBT ASK.

2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS, ENGINEERS AND SPECIALISTS DRAWINGS AND SPECIFICATIONS.

3. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE. ALL LEVELS IN METRES UNLESS NOTED OTHERWISE.

4. ANY DISCREPANCIES NOTED ON SITE ARE TO BE REPORTED TO THE ENGINEER IMMEDIATELY.

5. ORDNANCE SURVEY MAP REPRODUCED BY PERMISSION OF ORDNANCE SURVEY © CROWN COPYRIGHT. ALL RIGHTS RESERVED.

6. MODEL RESULTS NOT YET PEER REVIEWED THEREFORE SUBJECT TO CHANGE

KEY

FLOOD DEPTH (m)

- 0.00
- 0.15
- 0.30
- 0.45
- 0.60
- 0.75
- 0.90
- 1.05
- 1.20
- 1.35
- 1.50
- >1.50

Rev	Date	Details of issues/ revision	Drw	Rev
P1	24.09.14	PRELIMINARY ISSUE	JO'N	RG

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Client

NEWLAND HOMES

Project Title

COLLIN LANE WILLERSEY

Drawing Title

1 IN 20 YEAR FLOOD DEPTHS EXISTING CONDITIONS

Scale	NTS	Drawn	J O'Neill
Size	A3	Reviewed	R Green

Drawing Status

PRELIMINARY

Drawing No.	Revision
BMW/2315/WSK06	**P1**

NOTES

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3. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE. ALL LEVELS IN METRES UNLESS NOTED OTHERWISE.

4. ANY DISCREPANCIES NOTED ON SITE ARE TO BE REPORTED TO THE ENGINEER IMMEDIATELY.

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6. MODEL RESULTS NOT YET PEER REVIEWED THEREFORE SUBJECT TO CHANGE

KEY

Site Boundary

Flood Depths (m)

0.00
0.15
0.30
0.45
0.60
0.75
0.90
1.05
1.20
1.35
1.50
>1.50

Rev	Date	Details of issues/ revision	Drw	Rev
P1	24.09.14	PRELIMINARY ISSUE	JO'N	RG

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Client
NEWLAND HOMES

Project Title
COLLIN LANE WILLERSEY

Drawing Title
1 IN 75 YEAR FLOOD DEPTHS EXISTING CONDITIONS

Scale	NTS	Drawn	J O'Neill
Size	A3	Reviewed	R Green

Drawing Status
PRELIMINARY

Drawing No.
BMW/2315/WSK08

Revision
P1

NOTES

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6. MODEL RESULTS NOT YET PEER REVIEWED THEREFORE SUBJECT TO CHANGE

KEY

Site Boundary

Flood Depths (m)

0.00
0.15
0.30
0.45
0.60
0.75
0.90
1.05
1.20
1.35
1.50
>1.50

Rev	Date	Details of issues/ revision	Drw	Rev
P1	24.09.14	PRELIMINARY ISSUE	JO'N	RG

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Client

NEWLAND HOMES

Project Title

COLLIN LANE WILLERSEY

Drawing Title

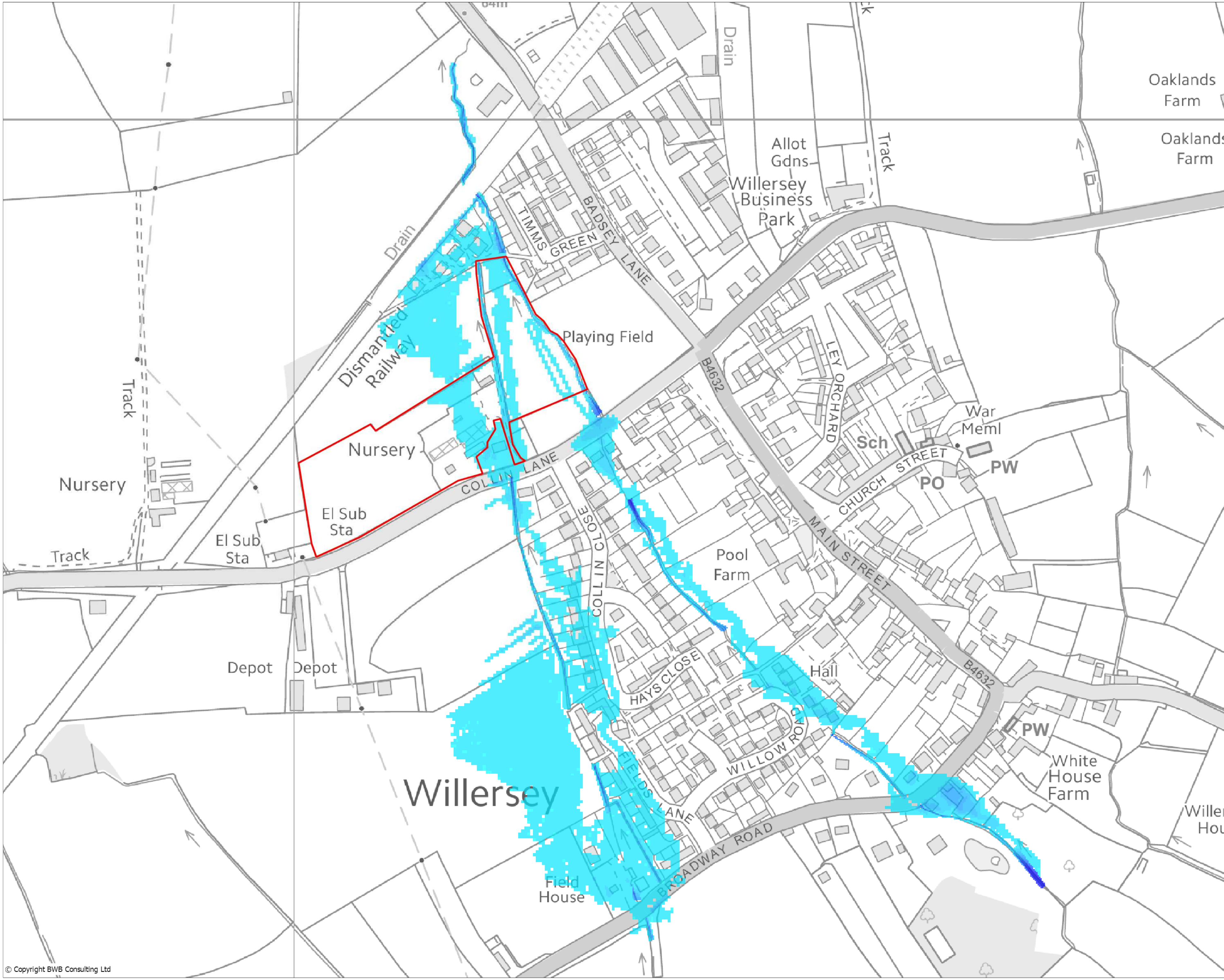
1 IN 100 YEAR FLOOD DEPTHS EXISTING CONDITIONS

Scale	NTS	Drawn	J O'Neill
Size	A3	Reviewed	R Green

Drawing Status

PRELIMINARY

Drawing No.	Revision
BMW/2315/WSK10	P1



NOTES

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2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS, ENGINEERS AND SPECIALISTS DRAWINGS AND SPECIFICATIONS.

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6. MODEL RESULTS NOT YET PEER REVIEWED THEREFORE SUBJECT TO CHANGE

KEY

Site Boundary

Flood Depths (m)

0.00
0.15
0.30
0.45
0.60
0.75
0.90
1.05
1.20
1.35
1.50
>1.50

Rev	Date	Details of issues/ revision	Drw	Rev
P1	24.09.14	PRELIMINARY ISSUE	JO'N	RG

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Client

NEWLAND HOMES

Project Title

COLLIN LANE WILLERSEY

Drawing Title

1 IN 100CC YEAR FLOOD DEPTHS EXISTING CONDITIONS

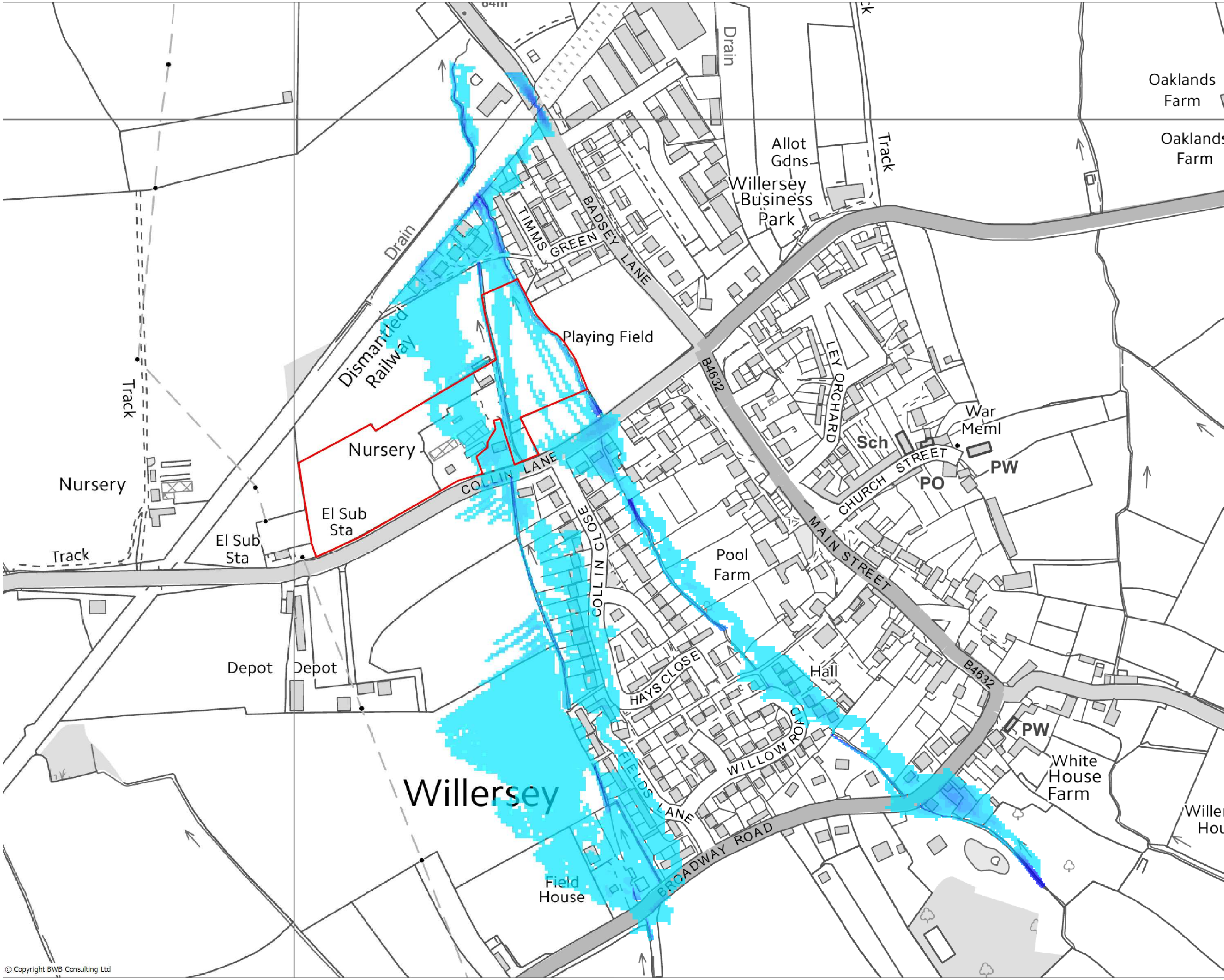
Scale	NTS	Drawn	J O'Neill
Size	A3	Reviewed	R Green

Drawing Status

PRELIMINARY

Drawing No. **BMW/2315/WSK12**

Revision **P1**



NOTES

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2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS, ENGINEERS AND SPECIALISTS DRAWINGS AND SPECIFICATIONS.

3. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE. ALL LEVELS IN METRES UNLESS NOTED OTHERWISE.

4. ANY DISCREPANCIES NOTED ON SITE ARE TO BE REPORTED TO THE ENGINEER IMMEDIATELY.

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6. MODEL RESULTS NOT YET PEER REVIEWED THEREFORE SUBJECT TO CHANGE

KEY

Site Boundary

Flood Depths (m)

0.00
0.15
0.30
0.45
0.60
0.75
0.90
1.05
1.20
1.35
1.50
>1.50

Rev	Date	Details of issues/ revision	Drw	Rev
P1	24.09.14	PRELIMINARY ISSUE	JO'N	RG

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□ Manchester | 0161 233 4260
□ Nottingham | 0115 924 1100
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Client

NEWLAND HOMES

Project Title

COLLIN LANE WILLERSEY

Drawing Title

1 IN 1000 YEAR FLOOD DEPTHS EXISTING CONDITIONS

Scale	NTS	Drawn	J O'Neill
Size	A3	Reviewed	R Green

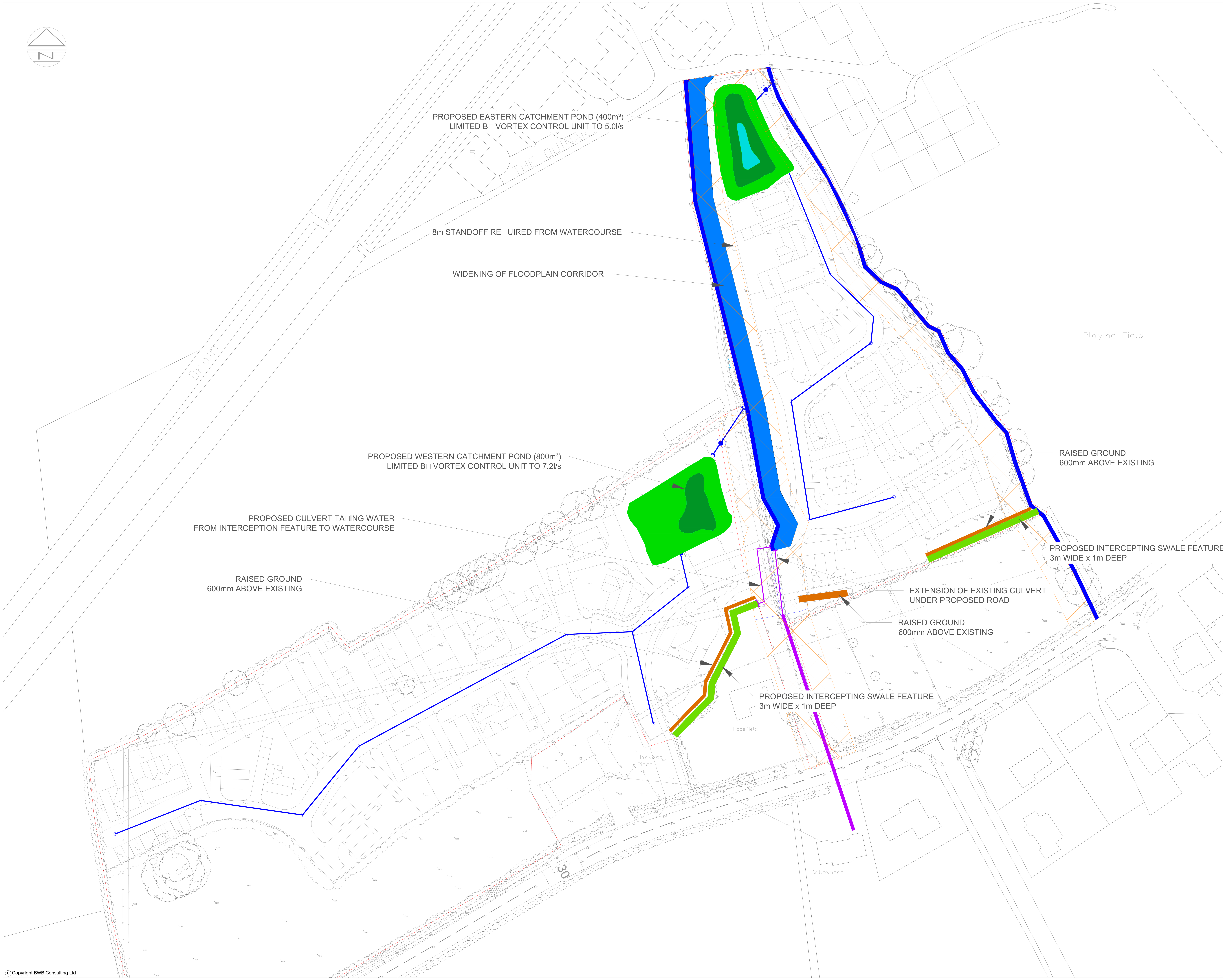
Drawing Status

PRELIMINARY

Drawing No.	Revision
BMW/2315/WSK14	P1

APPENDIX 6

Mitigation Strategy & Proposed Development Hydraulic Modelling Results



NOTES

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5. THIS DRAWING IS INDICATIVE ONL□ AND SHOULD NOT BE USED FOR CONSTRUCTION PURPOSES.

6. VOLUME RE□UIREMENTS ARE INDICATIVE AND TO BE CONFIRMED AT THE DETAILED DESIGN STAGE

KEY

- EXISTING WATERCOURSE
- PROPOSED WIDENING OF WATERCOURSE
- STANDOFF FROM WATERCOURSE REQUIREMENT (8m)
- RAISED GROUND
- SWALE FEATURE TO INTERCEPT OVERLAND FLOW ROUTE
- INDICATIVE SURFACE WATER PIPE NETWORK

Rev	Date	Details of issue / revision	Drw	Rev
P4	15.12.14	UPDATE IN LINE WITH UPDATED MASTERPLAN	JO'N	GSL
P3	20.10.14	UPDATE IN LINE WITH CLIENT COMMENTS	JO'N	RG
P2	16.10.14	GENERAL UPDATE	JO'N	GSL
P1	19.08.14	PRELIMINARY ISSUE	JO'N	RG

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Client
NEWLAND HOMES

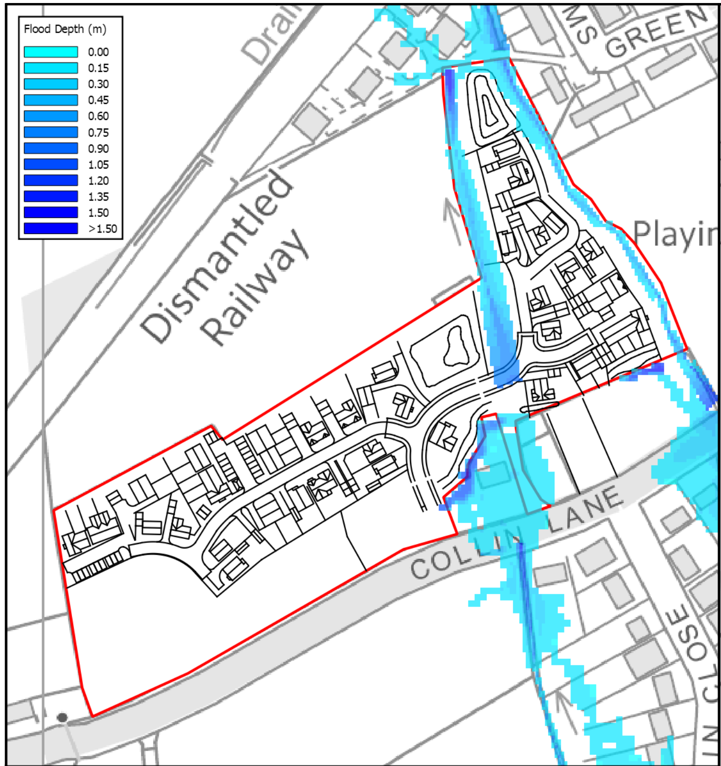
Project Title
COLLIN LANE WILLERSEY

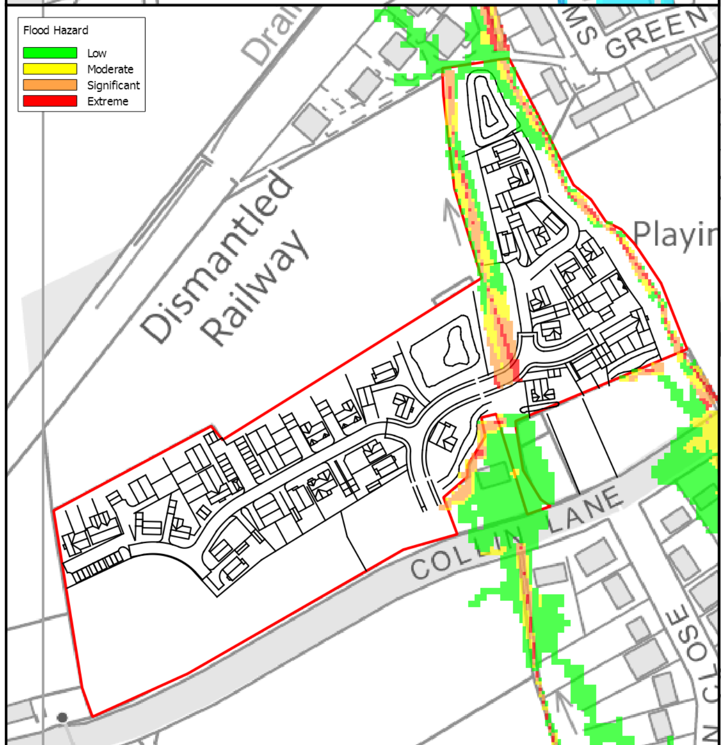
Drawing Title
FLOOD MITIGATION PLAN & OUTLINE DRAINAGE STRATEGY

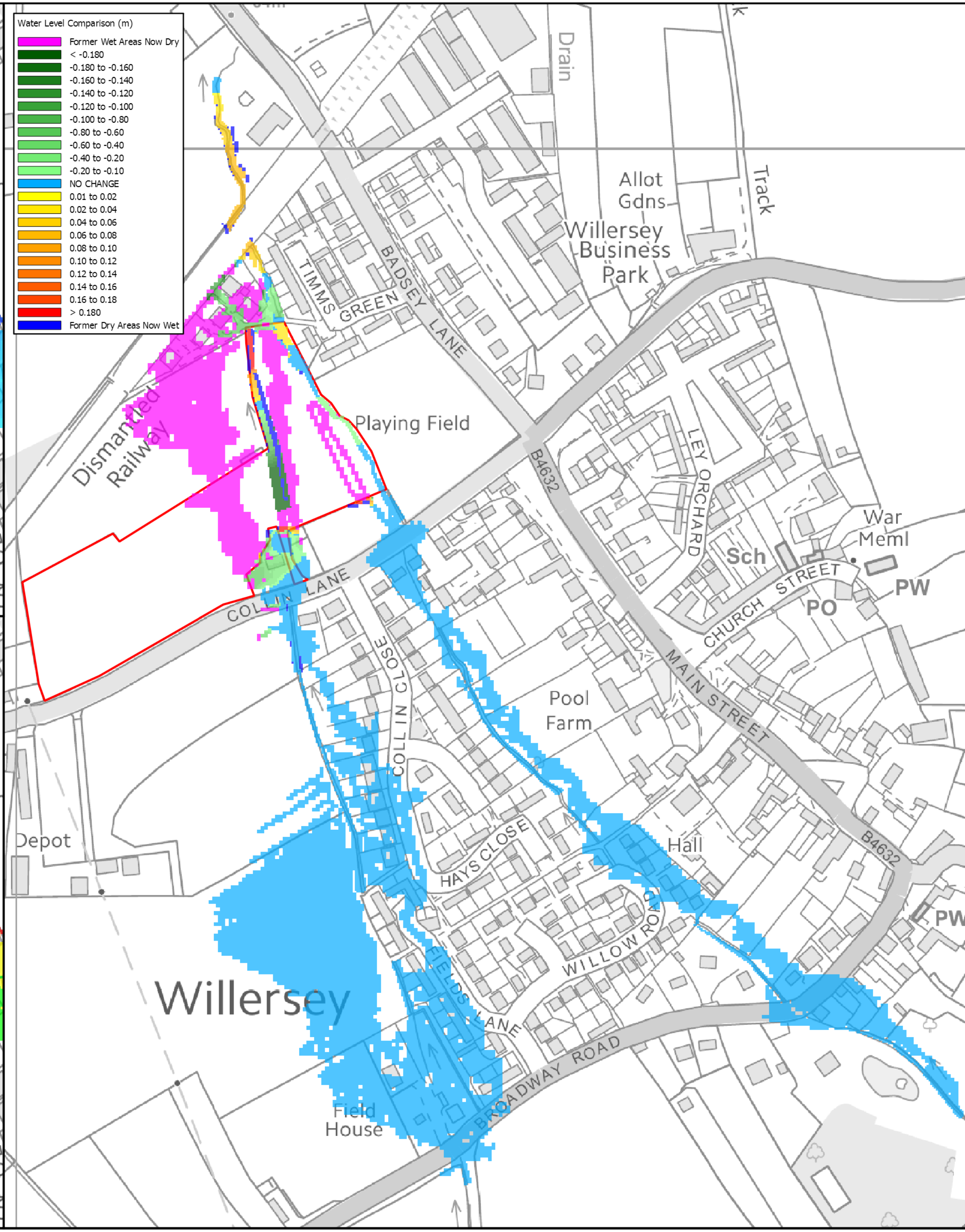
Scale	NTS	Drawn	A. Clifford
Size	A1	Reviewed	J. O'Neill

Drawing Status
PRELIMINARY

Drawing No.	Revision
BMW/2315/WSK05	P4







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KEY

Site Boundary

Rev	Date	Details of issues/ revision	Drw	Rev
P2	01.10.14	UPDATED MITIGATION MEASURES	JO'N	RG
P1	24.09.14	PRELIMINARY ISSUE	JO'N	RG

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Client

NEWLAND HOMES

Project Title

COLLIN LANE WILLERSEY

Drawing Title

1 IN 100CC YEAR FLOOD DEPTHS PROPOSED CONDITIONS INCLUDING MITIGATION

Scale	NTS	Drawn	J O'Neill
Size	A3	Reviewed	R Green

Drawing Status

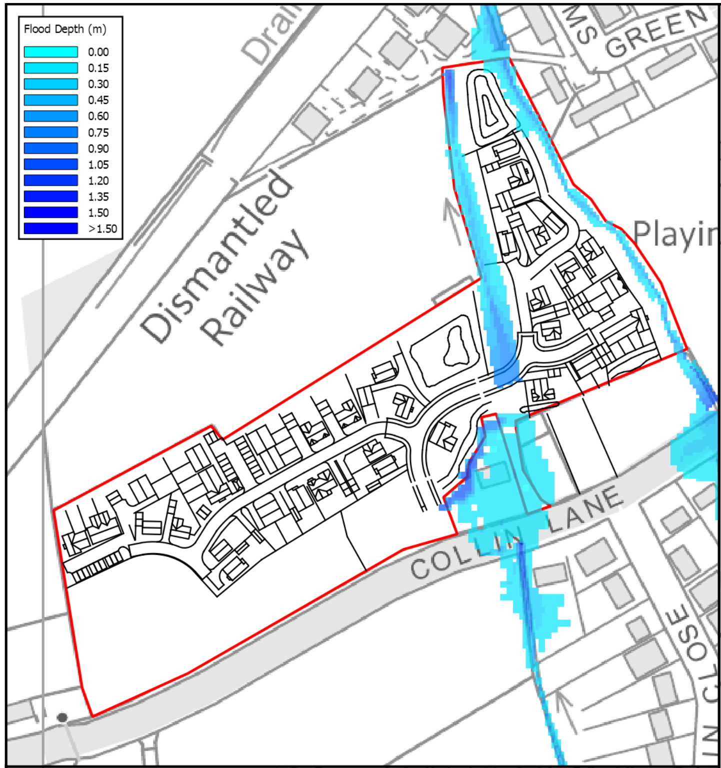
PRELIMINARY

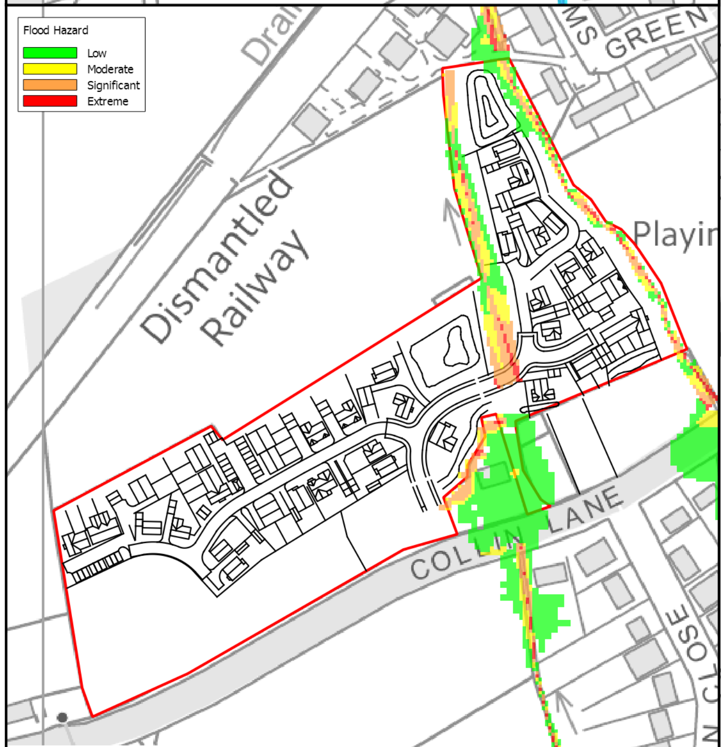
Drawing No.

BMW/2315/WSK13

Revision

P2





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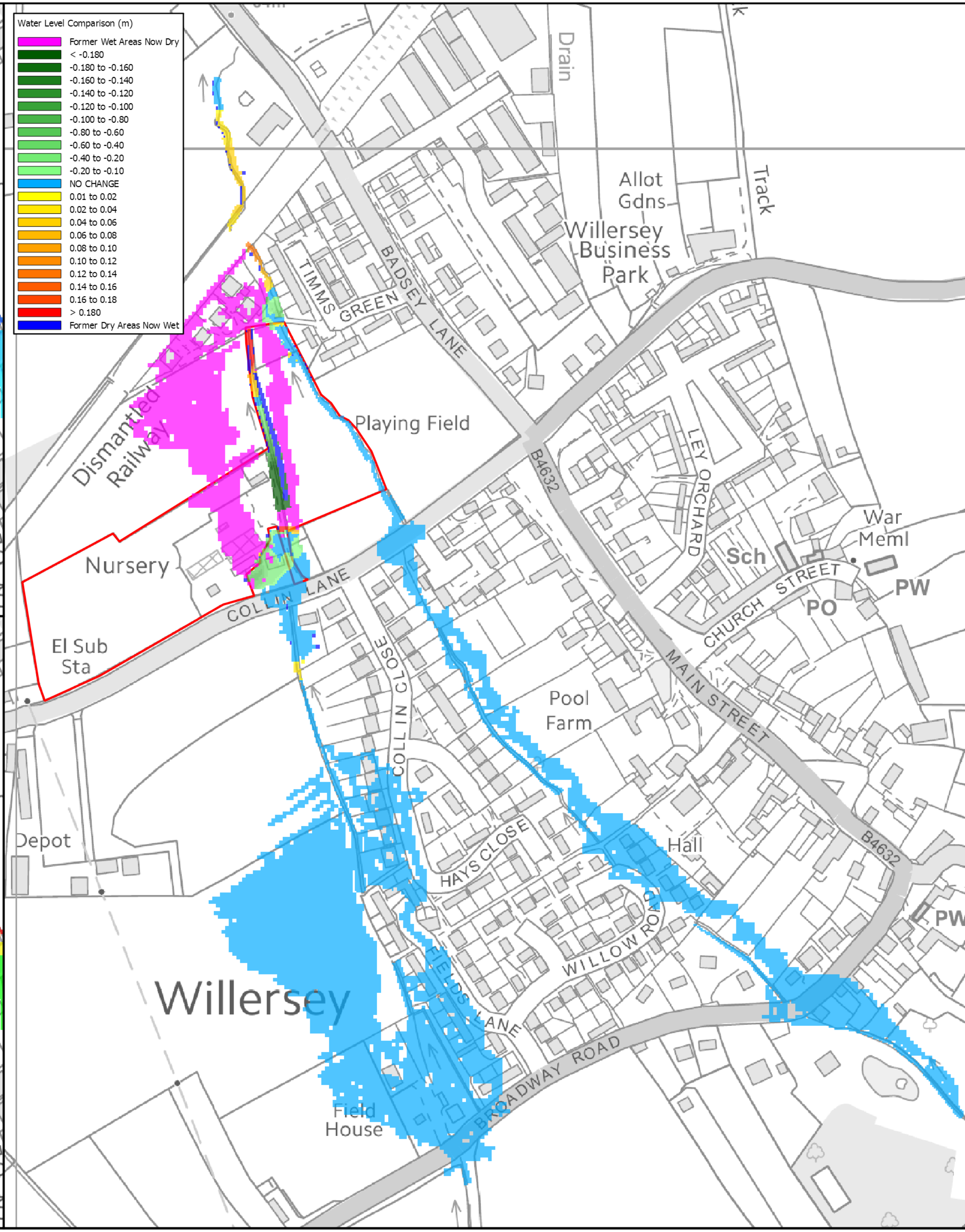

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KEY

Site Boundary

Rev	Date	Details of issues/ revision	Drw	Rev
P2	01.10.14	UPDATED MITIGATION MEASURES	JO'N	RG
P1	24.09.14	PRELIMINARY ISSUE	JO'N	RG

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Client

NEWLAND HOMES

Project Title

COLLIN LANE WILLERSEY

Drawing Title

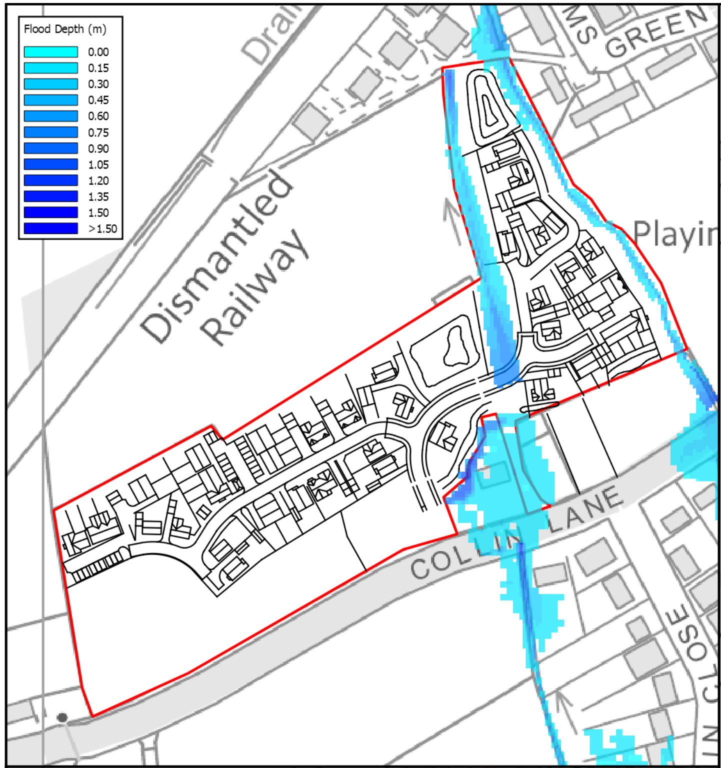
1 IN 100 YEAR FLOOD DEPTHS PROPOSED CONDITIONS INCLUDING MITIGATION

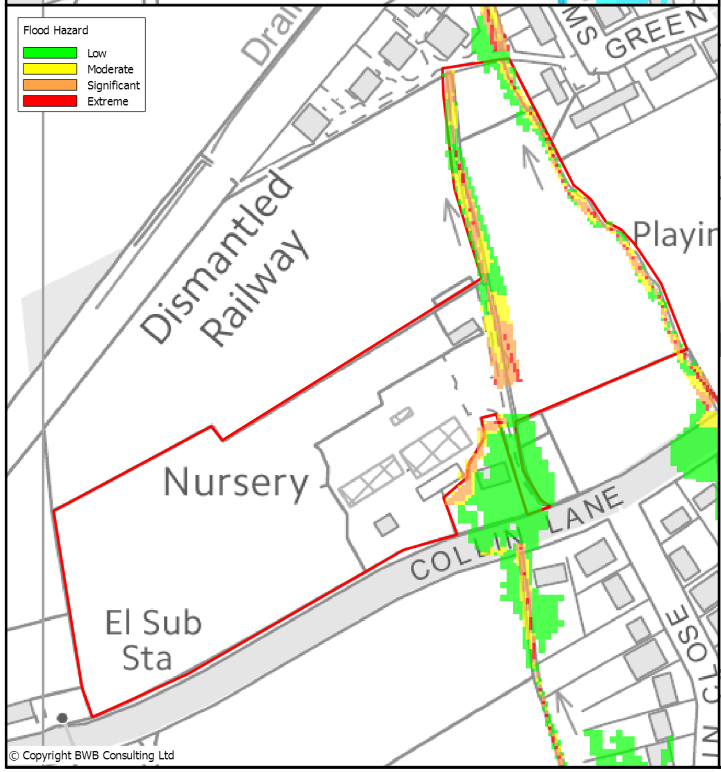
Scale	NTS	Drawn	J O'Neill
Size	A3	Reviewed	R Green

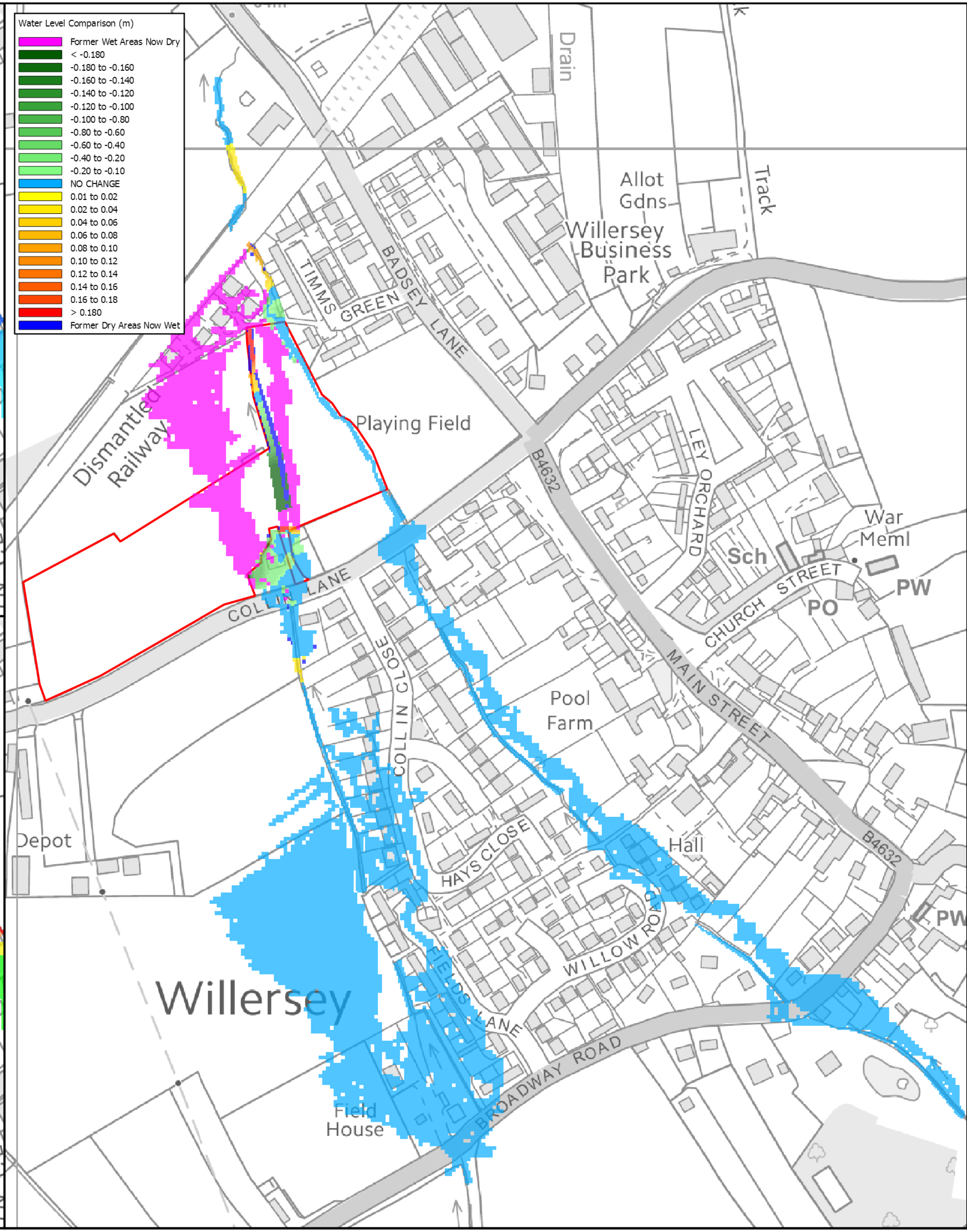
Drawing Status

PRELIMINARY

Drawing No.	Revision
BMW/2315/WSK11	P2







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KEY

Site Boundary

Rev	Date	Details of issues/ revision	Drw	Rev
P2	01.10.14	UPDATED MITIGATION MEASURES	JO'N	RG
P1	24.09.14	PRELIMINARY ISSUE	JO'N	RG

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Client

NEWLAND HOMES

Project Title

COLLIN LANE WILLERSEY

Drawing Title

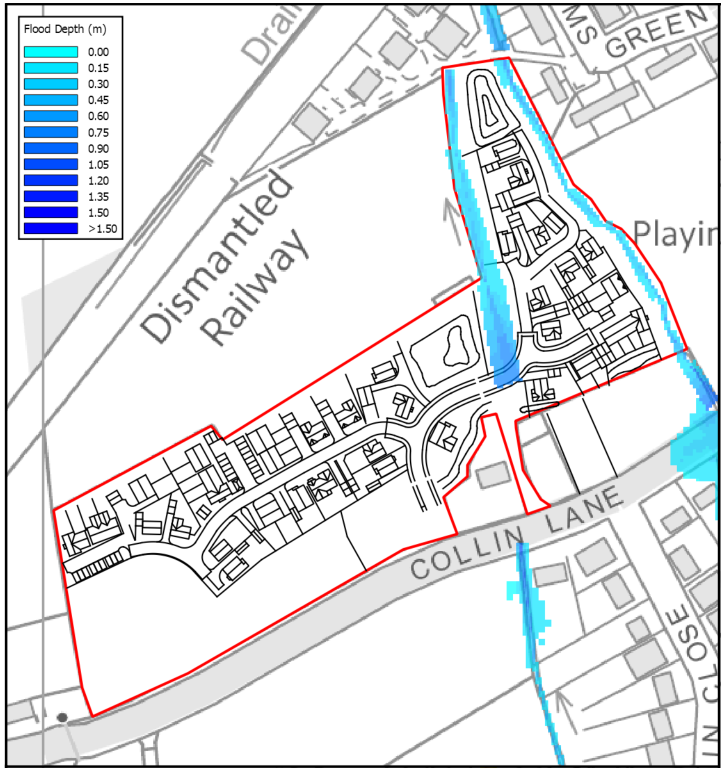
1 IN 75 YEAR FLOOD DEPTHS PROPOSED CONDITIONS INCLUDING MITIGATION

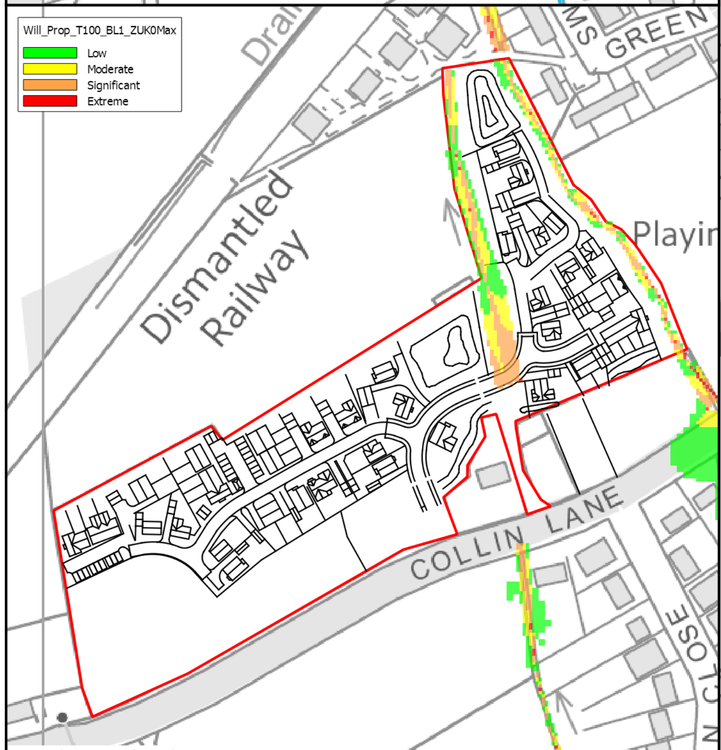
Scale	NTS	Drawn	J O'Neill
Size	A3	Reviewed	R Green

Drawing Status

PRELIMINARY

Drawing No.	Revision
BMW/2315/WSK09	P2





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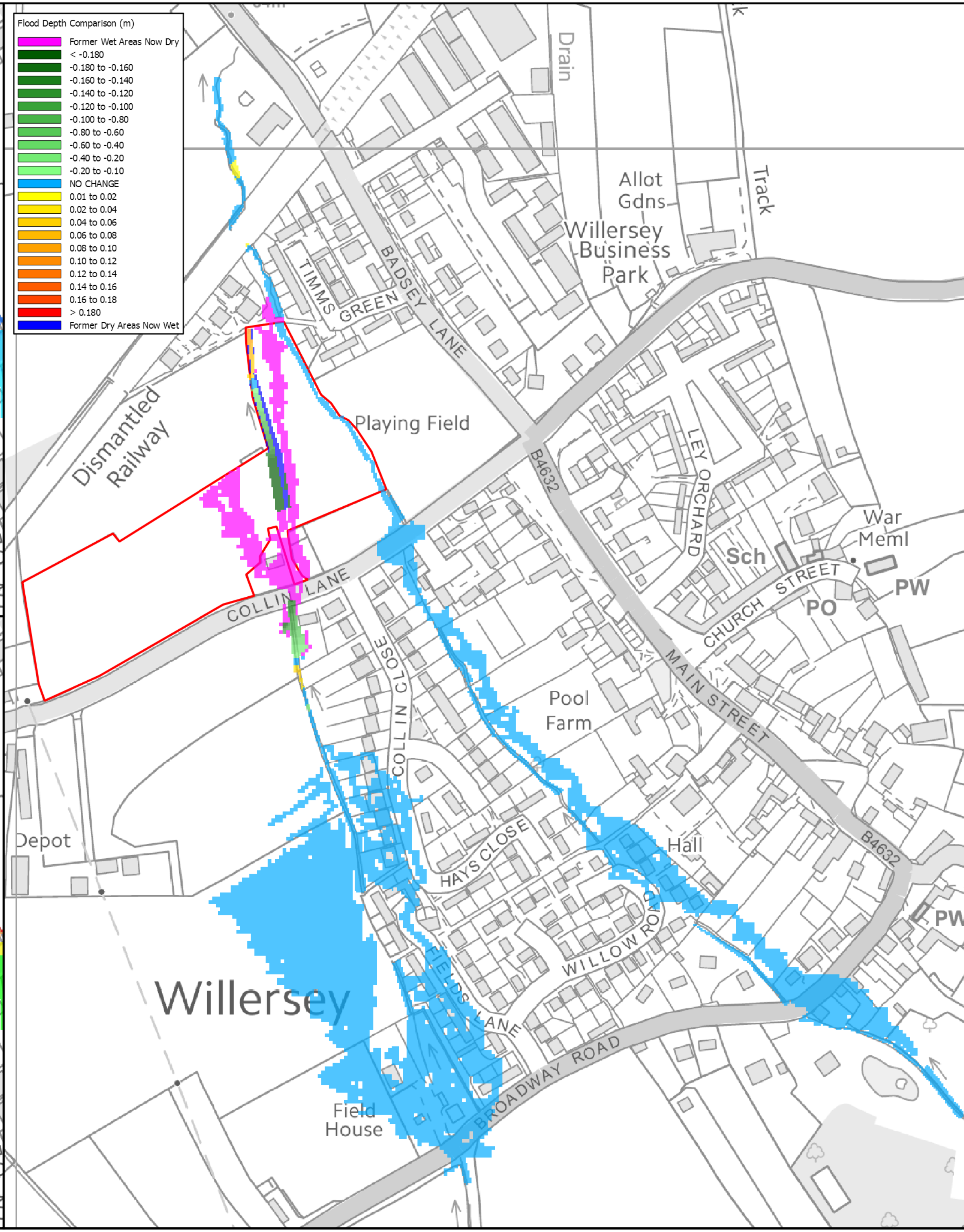

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KEY

Approximate Site Boundary

Rev	Date	Details of issues/ revision	Drw	Rev
P2	01.10.14	UPDATE OF MITIGATION MEASURES	JO'N	RG
P1	24.09.14	PRELIMINARY ISSUE	JO'N	RG

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Client
NEWLAND HOMES

Project Title
COLLIN LANE WILLERSEY

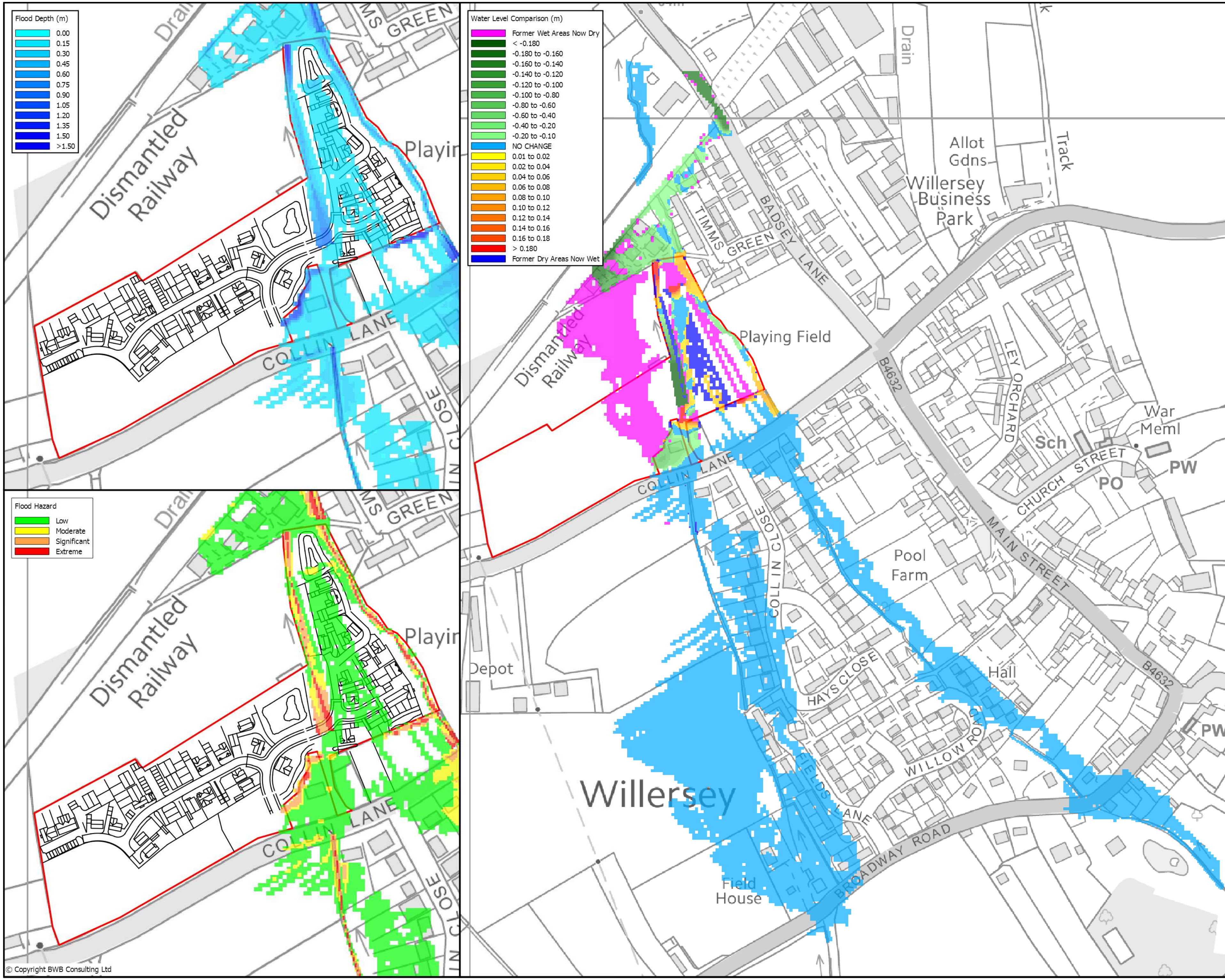
Drawing Title
1 IN 20 YEAR
FLOOD DEPTHS
PROPOSED CONDITIONS
INCLUDING MITIGATION

Scale	NTS	Drawn	J O'Neill
Size	A3	Reviewed	R Green

Drawing Status
PRELIMINARY

Drawing No.
BMW/2315/WSK07

Revision
P2



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KEY

Site Boundary

P2	01.10.14	MITIGATION MEASURES UPDATED	JO'N	RG
P1	24.09.14	PRELIMINARY ISSUE	JO'N	RG
Rev	Date	Details of issues/ revision	Drw	Rev

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NEWLAND HOMES

Project Title
COLLIN LANE WILLERSEY

Drawing Title
1 IN 1000 YEAR FLOOD DEPTHS PROPOSED CONDITIONS INCLUDING MITIGATION

Scale	NTS	Drawn	J O'Neill
Size	A3	Reviewed	R Green

Drawing Status
PRELIMINARY

Drawing No.	Revision
BMW/2315/WSK15	P2

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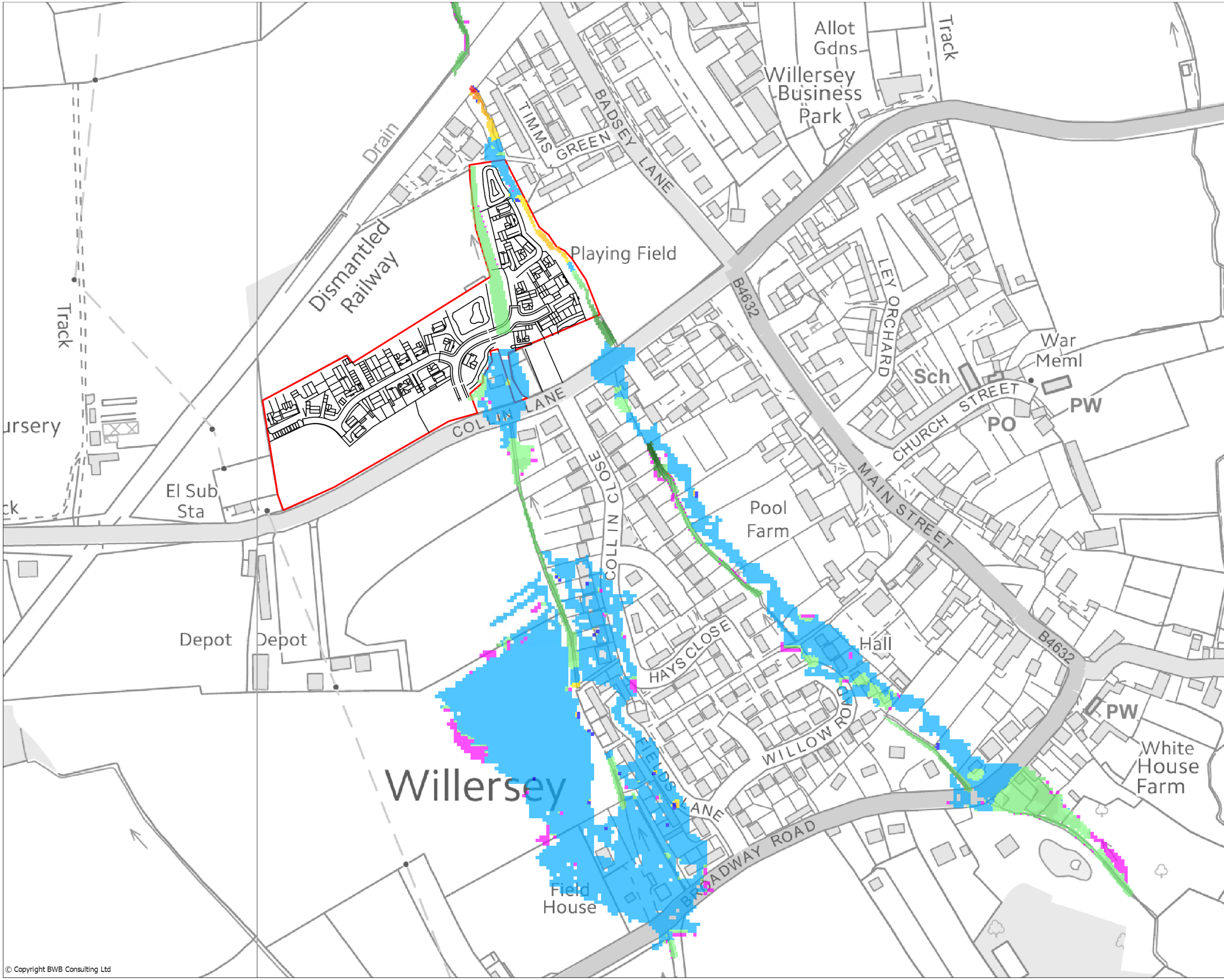
APPENDIX 7

Sensitivity Testing - Hydraulic Modelling Results



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KEY

Site Boundary

Water Level Comparison (m)

- < -0.180
- -0.180 to -0.160
- -0.160 to -0.140
- -0.140 to -0.120
- -0.120 to -0.100
- -0.100 to -0.80
- -0.80 to -0.60
- -0.60 to -0.40
- -0.40 to -0.20
- -0.20 to -0.10
- NO CHANGE
- 0.01 to 0.02
- 0.02 to 0.04
- 0.04 to 0.06
- 0.06 to 0.08
- 0.08 to 0.10
- 0.10 to 0.12
- 0.12 to 0.14
- 0.14 to 0.16
- 0.16 to 0.18
- > 0.180
- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

P1	01.10.14	PRELIMINARY ISSUE	JO'N	RG
Rev	Date	Details of issues/ revision	Drw	Rev

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Client

NEWLAND HOMES

Project Title

COLLIN LANE WILLERSEY

Drawing Title

1 IN 100 YEAR SENSITIVITY TESTING ROUGHNESS COEFFICIENT -20%

Scale	NTS	Drawn	J O'Neill
Size	A3	Reviewed	R Green

Drawing Status

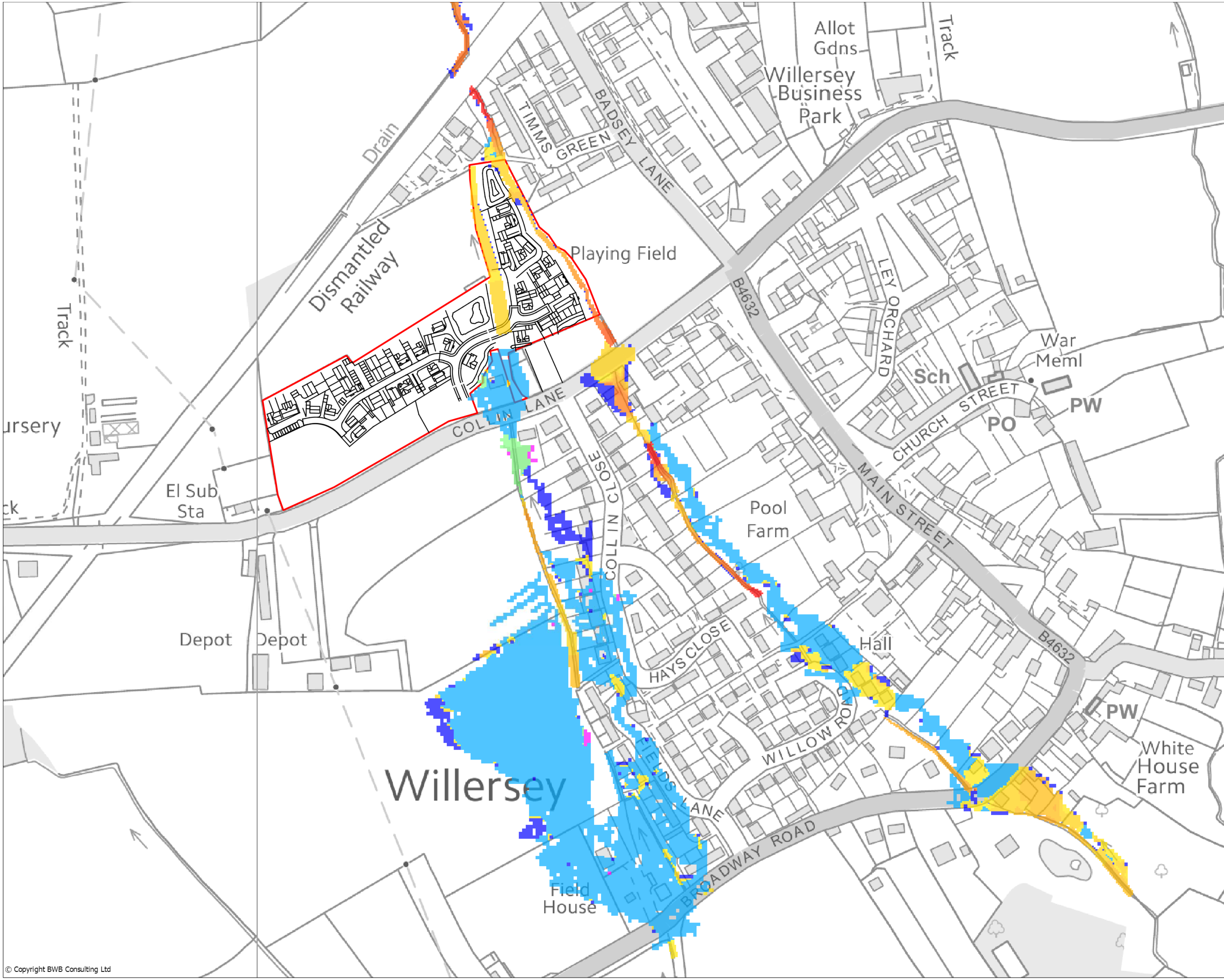
PRELIMINARY

Drawing No.

BMW/2315/WSK21

Revision

P1



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6. MODEL RESULTS NOT YET PEER REVIEWED THEREFORE SUBJECT TO CHANGE

KEY

- Site Boundary

Water Level Comparison (m)

- < -0.180
- -0.180 to -0.160
- -0.160 to -0.140
- -0.140 to -0.120
- -0.120 to -0.100
- -0.100 to -0.80
- -0.80 to -0.60
- -0.60 to -0.40
- -0.40 to -0.20
- -0.20 to -0.10
- NO CHANGE
- 0.01 to 0.02
- 0.02 to 0.04
- 0.04 to 0.06
- 0.06 to 0.08
- 0.08 to 0.10
- 0.10 to 0.12
- 0.12 to 0.14
- 0.14 to 0.16
- 0.16 to 0.18
- > 0.180
- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

Rev	Date	Details of issues/ revision	Drw	Rev
P1	01.10.14	PRELIMINARY ISSUE	JO'N	RG

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Client

NEWLAND HOMES

Project Title

COLLIN LANE WILLERSEY

Drawing Title

1 IN 100 YEAR SENSITIVITY TESTING ROUGHNESS COEFFICIENT +20%

Scale	NTS	Drawn	J O'Neill
Size	A3	Reviewed	R Green

Drawing Status

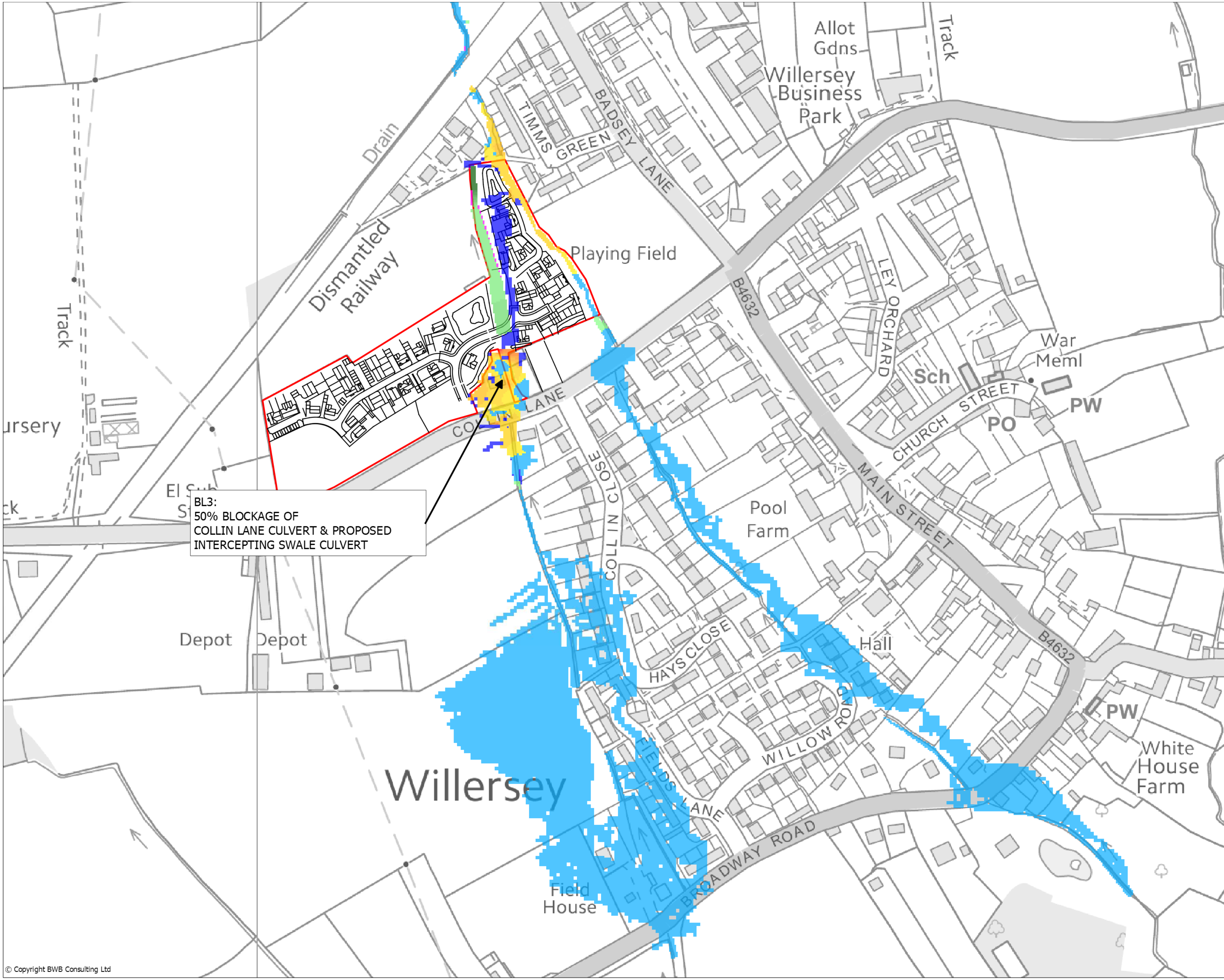
PRELIMINARY

Drawing No.

BMW/2315/WSK20

Revision

P1



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KEY

Site Boundary

Water Level Comparison (m)

- < -0.180
- -0.180 to -0.160
- -0.160 to -0.140
- -0.140 to -0.120
- -0.120 to -0.100
- -0.100 to -0.80
- -0.80 to -0.60
- -0.60 to -0.40
- -0.40 to -0.20
- -0.20 to -0.10
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- 0.02 to 0.04
- 0.04 to 0.06
- 0.06 to 0.08
- 0.08 to 0.10
- 0.10 to 0.12
- 0.12 to 0.14
- 0.14 to 0.16
- 0.16 to 0.18
- > 0.180
- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

Rev	Date	Details of issues/ revision	Drw	Rev
P1	01.10.14	PRELIMINARY ISSUE	JO'N	RG

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Client

NEWLAND HOMES

Project Title

COLLIN LANE WILLERSEY

Drawing Title

1 IN 100 YEAR SENSITIVITY TESTING BL3: 50% BLOCKAGE OF 2 WESTERN CULVERTS

Scale	NTS	Drawn	J O'Neill
Size	A3	Reviewed	R Green

Drawing Status

PRELIMINARY

Drawing No.	Revision
BMW/2315/WSK19	P1

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KEY

Site Boundary

Water Level Comparison (m)

- < -0.180
- -0.180 to -0.160
- -0.160 to -0.140
- -0.140 to -0.120
- -0.120 to -0.100
- -0.100 to -0.80
- -0.80 to -0.60
- -0.60 to -0.40
- -0.40 to -0.20
- -0.20 to -0.10
- NO CHANGE
- 0.01 to 0.02
- 0.02 to 0.04
- 0.04 to 0.06
- 0.06 to 0.08
- 0.08 to 0.10
- 0.10 to 0.12
- 0.12 to 0.14
- 0.14 to 0.16
- 0.16 to 0.18
- > 0.180
- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

Rev	Date	Details of issues/ revision	Drw	Rev
P1	01.10.14	PRELIMINARY ISSUE	JO'N	RG

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Client

NEWLAND HOMES

Project Title

COLLIN LANE WILLERSEY

Drawing Title

1 IN 100 YEAR SENSITIVITY TESTING BL2: 50% BLOCKAGE OF COLLIN LANE CULVERT

Scale	NTS	Drawn	J O'Neill
Size	A3	Reviewed	R Green

Drawing Status

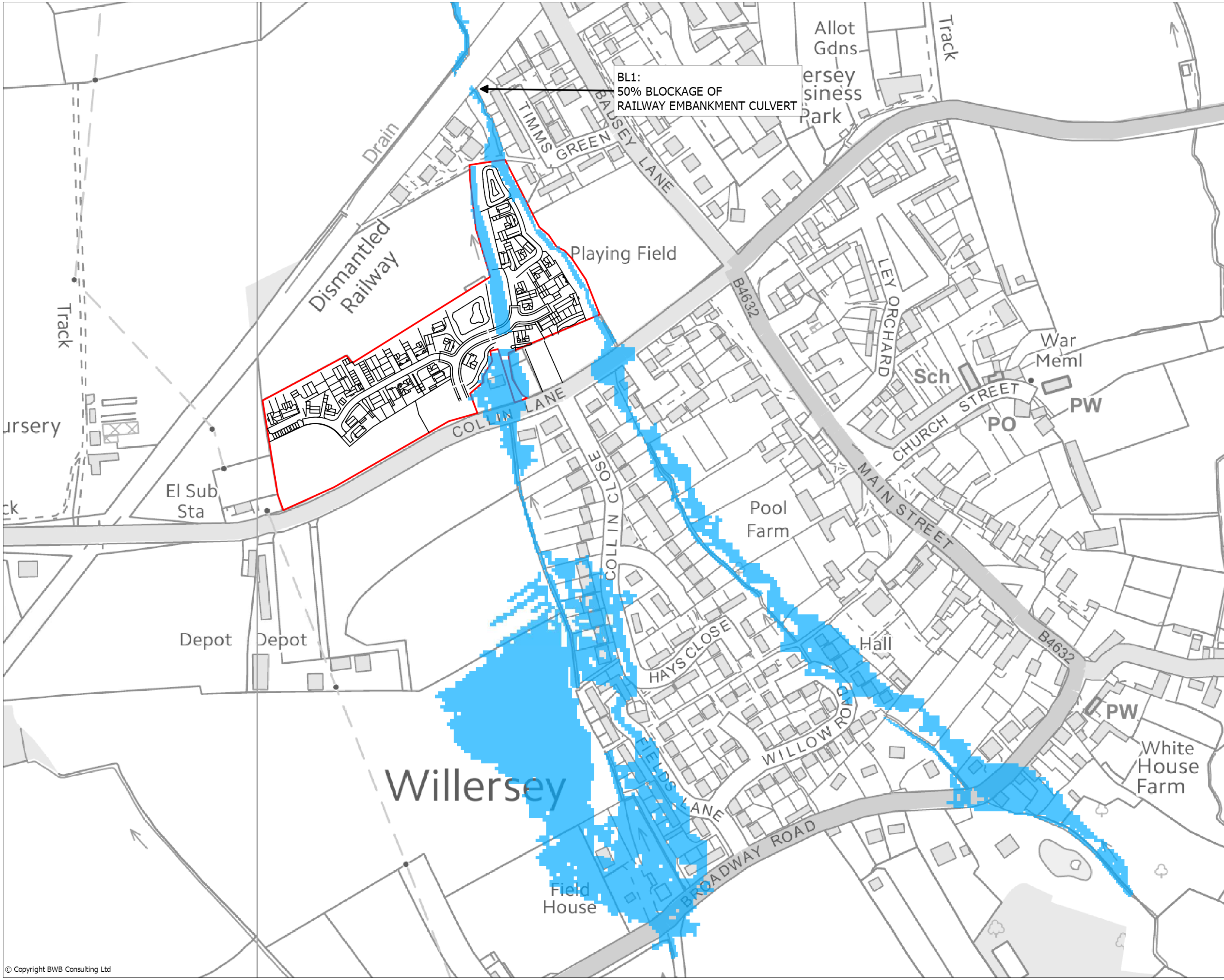
PRELIMINARY

Drawing No.

BMW/2315/WSK18

Revision

P1



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KEY

Site Boundary

Water Level Comparison (m)

- < -0.180
- -0.180 to -0.160
- -0.160 to -0.140
- -0.140 to -0.120
- -0.120 to -0.100
- -0.100 to -0.80
- -0.80 to -0.60
- -0.60 to -0.40
- -0.40 to -0.20
- -0.20 to -0.10
- NO CHANGE
- 0.01 to 0.02
- 0.02 to 0.04
- 0.04 to 0.06
- 0.06 to 0.08
- 0.08 to 0.10
- 0.10 to 0.12
- 0.12 to 0.14
- 0.14 to 0.16
- 0.16 to 0.18
- > 0.180
- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

Rev	Date	Details of issues/ revision	Drw	Rev
P1	01.10.14	PRELIMINARY ISSUE	JO'N	RG

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Client

NEWLAND HOMES

Project Title

COLLIN LANE WILLERSEY

Drawing Title

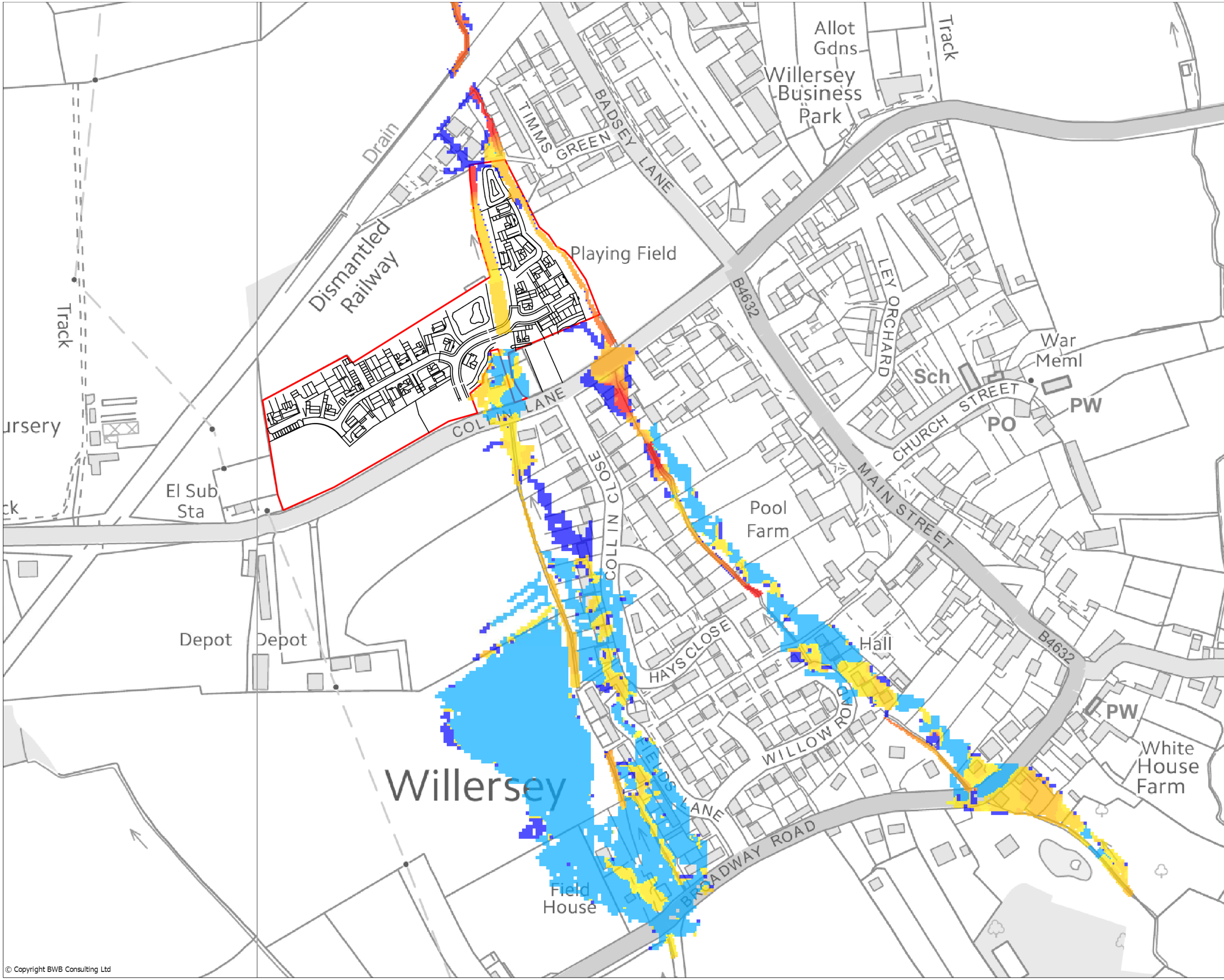
1 IN 100 YEAR SENSITIVITY TESTING BL1: 50% BLOCKAGE OF RAILWAY EMBANK. CUL.

Scale	NTS	Drawn	J O'Neill
Size	A3	Reviewed	R Green

Drawing Status

PRELIMINARY

Drawing No.	Revision
BMW/2315/WSK17	P1



NOTES

1. DO NOT SCALE THIS DRAWING. ALL DIMENSIONS MUST BE CHECKED/ VERIFIED ON SITE. IF IN DOUBT ASK.

2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS, ENGINEERS AND SPECIALISTS DRAWINGS AND SPECIFICATIONS.

3. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE. ALL LEVELS IN METRES UNLESS NOTED OTHERWISE.

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5. ORDNANCE SURVEY MAP REPRODUCED BY PERMISSION OF ORDNANCE SURVEY © CROWN COPYRIGHT. ALL RIGHTS RESERVED.

6. MODEL RESULTS NOT YET PEER REVIEWED THEREFORE SUBJECT TO CHANGE

KEY

Site Boundary

Water Level Comparison (m)

- < -0.180
- -0.180 to -0.160
- -0.160 to -0.140
- -0.140 to -0.120
- -0.120 to -0.100
- -0.100 to -0.80
- -0.80 to -0.60
- -0.60 to -0.40
- -0.40 to -0.20
- -0.20 to -0.10
- NO CHANGE
- 0.01 to 0.02
- 0.02 to 0.04
- 0.04 to 0.06
- 0.06 to 0.08
- 0.08 to 0.10
- 0.10 to 0.12
- 0.12 to 0.14
- 0.14 to 0.16
- 0.16 to 0.18
- > 0.180
- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

Rev	Date	Details of issues/ revision	Drw	Rev
P1	01.10.14	PRELIMINARY ISSUE	JO'N	RG

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Client

NEWLAND HOMES

Project Title

COLLIN LANE WILLERSEY

Drawing Title

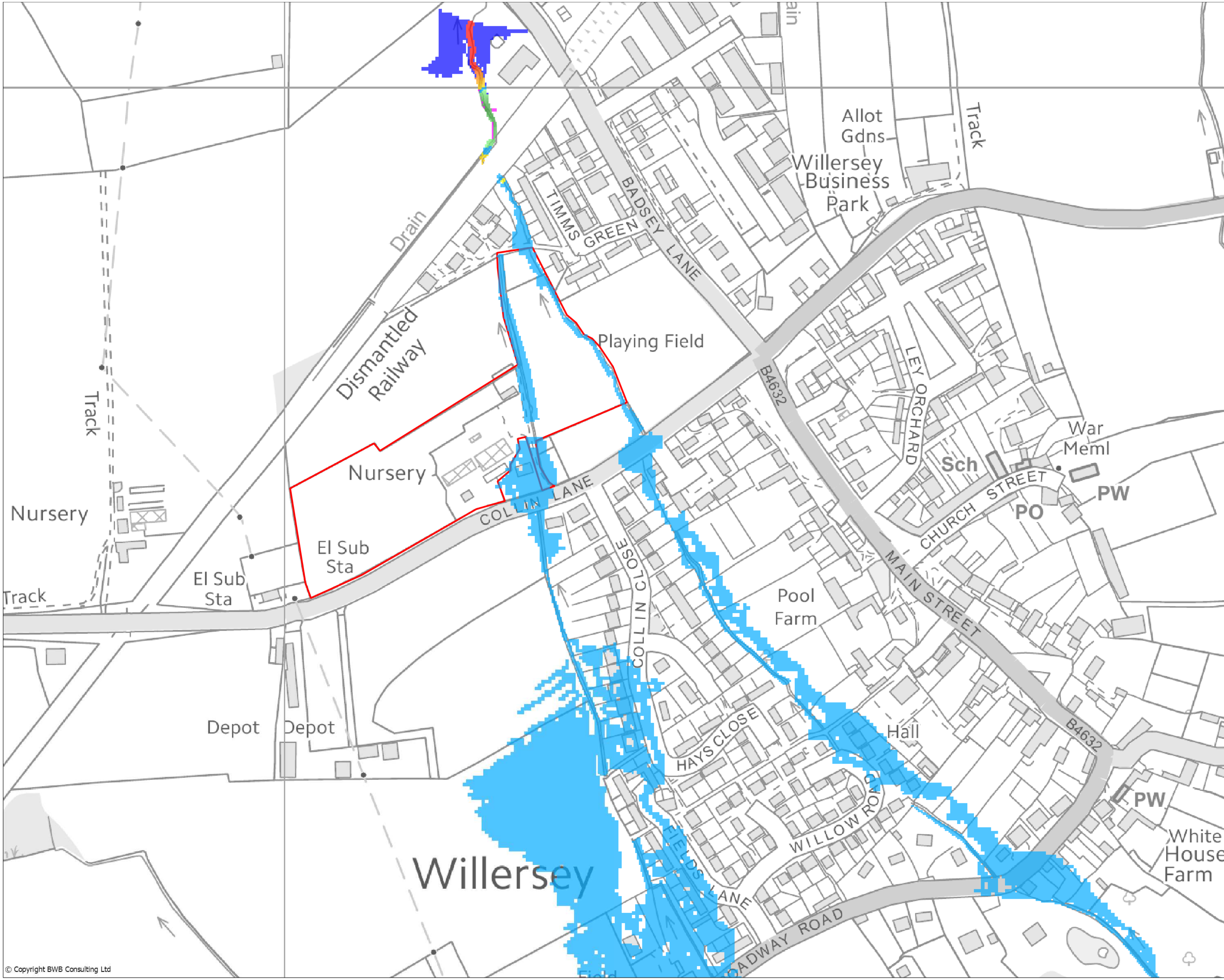
1 IN 100 YEAR SENSITIVITY TESTING +20% FLOWS

Scale	NTS	Drawn	J O'Neill
Size	A3	Reviewed	R Green

Drawing Status

PRELIMINARY

Drawing No.	Revision
BMW/2315/WSK16	P1



NOTES

1. DO NOT SCALE THIS DRAWING. ALL DIMENSIONS MUST BE CHECKED/ VERIFIED ON SITE. IF IN DOUBT ASK.

2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS, ENGINEERS AND SPECIALISTS DRAWINGS AND SPECIFICATIONS.

3. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE. ALL LEVELS IN METRES UNLESS NOTED OTHERWISE.

4. ANY DISCREPANCIES NOTED ON SITE ARE TO BE REPORTED TO THE ENGINEER IMMEDIATELY.

5. ORDNANCE SURVEY MAP REPRODUCED BY PERMISSION OF ORDNANCE SURVEY © CROWN COPYRIGHT. ALL RIGHTS RESERVED.

6. MODEL RESULTS NOT YET PEER REVIEWED THEREFORE SUBJECT TO CHANGE

KEY

Site Boundary

Water Level Comparison (m)

- < -0.180
- -0.180 to -0.160
- -0.160 to -0.140
- -0.140 to -0.120
- -0.120 to -0.100
- -0.100 to -0.80
- -0.80 to -0.60
- -0.60 to -0.40
- -0.40 to -0.20
- -0.20 to -0.10
- NO CHANGE
- 0.01 to 0.02
- 0.02 to 0.04
- 0.04 to 0.06
- 0.06 to 0.08
- 0.08 to 0.10
- 0.10 to 0.12
- 0.12 to 0.14
- 0.14 to 0.16
- 0.16 to 0.18
- > 0.180
- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

Rev	Date	Details of issues/ revision	Drw	Rev
P1	01.10.14	PRELIMINARY ISSUE	JO'N	RG

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Client

NEWLAND HOMES

Project Title

COLLIN LANE WILLERSEY

Drawing Title

1 IN 100 YEAR SENSITIVITY TESTING ROUGHNESS COEFFICIENT DSB +500mm

Scale	NTS	Drawn	J O'Neill
Size	A3	Reviewed	R Green

Drawing Status

PRELIMINARY

Drawing No.	Revision
BMW/2315/WSK22	P1

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APPENDIX D

SEWER RECORDS

SEVERN TRENT WATER

SEVERN TRENT WATER Ltd
Asset Data Management
GISmapping Team
PO Box 5344
Coventry
CV3 9FT
Tel 0845 601 6616 (OPT 5)
Fax 02477 715862

Our Ref 80342

03 July 2014

Apparatus Location Enquiry

Further to your enquiry re: Harvest Piece, Collin Lane, Willersey, Broadway WR12 7PE
(Your ref: BMW2315)

Enclosed is a copy of the plans showing the approximate positions of the **nearest public sewers** situated within the vicinity of the land/property which is the subject of your enquiry.

Asset Data Management can only provide plans of the location of the Company's underground assets. Therefore service pipes and drains are the responsibility of the property owner and should be anticipated during any excavation.

However, we wish to inform you that although most private lateral drains and sewers were transferred to Severn Trent Water's ownership on 1st October 2011, the Company does not possess complete records of these assets and therefore they may not be shown on these maps.

Please also find enclosed a copy of Severn Trent Water's General Conditions and Precautions for your information.

Please forward VAT receipt to your finance department.

Kind Regards
GISmapping Team

BWB CONSULTING LTD

RECD 04 JUL 2014

TO SEE	SEEN
JG	

Enquiry received
GISmapping:
03 July 2014

Sewer Node / Sewer Pipe Data

REFERENCE	COVER LEVEL	INV LEVEL UPSTR	INV LEVEL DOWNSTR	PURP	MATL	SHAPE	MAX SIZE	MIN SIZE	GRADIENT	YEAR LAID
SP10392604	71.74	70.63	70.23	F	VC	C	150	nil	129.03	nill
SP10392606	71.74	70.63	70.23	F	VC	C	150	nil	129.03	nill
SP10392901	66.32	64.82	64.56	F	VC	C	225	nil	111.00	nill
SP10392902	66.53	64.97	64.82	F	VC	C	225	nil	126.38	nill
SP10392903	66.32	64.82	64.56	F	VC	C	225	nil	111.00	nill
SP10392904	66.53	64.97	64.82	F	VC	C	225	nil	126.38	nill
SP10393301	78.71	77.05	76.61	F	VC	C	150	nil	133.70	nill
SP10393302	77.63	76.60	76.47	F	VC	C	150	nil	162.31	nill
SP10393303	77.91	76.45	76.45	F	VC	C	150	nil	0.00	nill
SP10393304	77.24	76.25	76.02	F	VC	C	150	nil	173.74	nill
SP10393305	78.13	76.41	76.21	F	VC	C	150	nil	206.70	nill
SP10393306	78.71	77.05	76.61	F	VC	C	150	nil	133.70	nill
SP10393307	77.63	76.60	76.47	F	VC	C	150	nil	162.31	nill
SP10393308	77.91	76.45	76.45	F	VC	C	150	nil	0.00	nill
SP10393309	77.24	76.25	76.02	F	VC	C	150	nil	173.74	nill
SP10393310	78.13	76.41	76.21	F	VC	C	150	nil	206.70	nill
SP10393401	76.62	75.52	74.36	F	VC	C	150	nil	48.19	nill
SP10393402	76.33	75.35	74.12	F	VC	C	150	nil	54.42	nill
SP10393403	75.15	74.10	73.16	F	VC	C	150	nil	76.71	nill
SP10393404	77.15	75.99	75.75	F	VC	C	150	nil	165.08	nill
SP10393405	76.92	75.73	75.55	F	VC	C	150	nil	176.44	nill
SP10393406	76.77	75.71	75.37	F	VC	C	150	nil	40.97	nill
SP10393407	76.62	75.52	74.36	F	VC	C	150	nil	48.19	nill
SP10393408	76.33	75.35	74.12	F	VC	C	150	nil	54.42	nill
SP10393409	75.15	74.10	73.16	F	VC	C	150	nil	76.71	nill
SP10393410	77.15	75.99	75.75	F	VC	C	150	nil	165.08	nill
SP10393411	76.92	75.73	75.55	F	VC	C	150	nil	176.44	nill
SP10393412	76.77	75.71	75.37	F	VC	C	150	nil	40.97	nill
SP10393501	74.02	73.08	71.84	F	VC	C	150	nil	34.27	nill
SP10393502	75.32	74.36	73.10	F	VC	C	150	nil	50.90	nill
SP10393503	74.02	73.08	71.84	F	VC	C	150	nil	34.27	nill
SP10393504	75.32	74.36	73.10	F	VC	C	150	nil	50.90	nill
SP10393601	71.25	70.15	69.89	F	VC	C	150	nil	148.46	nill
SP10393602	72.45	71.33	71.29	F	VC	C	150	nil	794.50	nill
SP10393603	73.55	72.04	72.03	F	VC	C	150	nil	640.00	nill
SP10393604	72.56	71.21	70.15	F	VC	C	150	nil	40.13	nill
SP10393605	73.48	72.02	71.72	F	VC	C	150	nil	48.07	nill
SP10393606	73.35	71.71	71.42	F	VC	C	150	nil	46.90	nill
SP10393607	72.86	71.42	71.28	F	VC	C	150	nil	83.29	nill
SP10393608	71.25	70.15	69.89	F	VC	C	150	nil	148.46	nill
SP10393609	72.45	71.33	71.29	F	VC	C	150	nil	794.50	nill
SP10393610	73.55	72.04	72.03	F	VC	C	150	nil	640.00	nill
SP10393611	72.56	71.21	70.15	F	VC	C	150	nil	40.13	nill
SP10393612	73.48	72.02	71.72	F	VC	C	150	nil	48.07	nill
SP10393613	73.35	71.71	71.42	F	VC	C	150	nil	46.90	nill
SP10393614	72.86	71.42	71.28	F	VC	C	150	nil	83.29	nill

MATERIALS

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

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

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

SEWER RECORD DATA TABLE

O/S Map scale:	1:3500	**This map is centred upon: O / S Grid reference:**	
Date of issue:	03.07.14	**x:**	410090
Sheet No.	2 of 3	**y:**	239654

Sewer Node

Sewer Pipe Data

REFERENCE	COVER LEVEL	INV LEVEL UPSTR	INV LEVEL DOWNSTR	PURP	MATL	SHAPE	MAX SIZE	MIN SIZE	GRADIENT	YEAR LAID
SP10393701	72.35	69.89	69.41	F	VC	C	150	nil	132.50	nill
SP10393702	72.35	69.89	69.41	F	VC	C	150	nil	132.50	nill
SP10393801	68.38	66.36	64.97	F	VC	C	225	nil	57.50	nill
SP10393802	71.30	69.18	66.36	F	VC	C	150	nil	33.56	nill
SP10393803	68.38	66.36	64.97	F	VC	C	225	nil	57.50	nill
SP10393804	71.30	69.18	66.36	F	VC	C	150	nil	33.56	nill
SP10393901	68.26	66.32	64.90	F	VC	C	150	nil	19.93	nill
SP10393902	68.26	66.32	64.90	F	VC	C	150	nil	19.93	nill
SP10394303	78.94	77.05	76.41	F	VC	C	150	nil	59.39	nill
SP10394306	78.94	77.05	76.41	F	VC	C	150	nil	59.39	nill
SP10394403	76.78	75.84	75.74	F	VC	C	150	nil	191.82	nill
SP10394409	76.78	75.84	75.74	F	VC	C	150	nil	191.82	nill
SP10394501	75.43	73.98	72.05	F	VC	C	150	nil	44.79	nill
SP10394502	75.43	73.98	72.05	F	VC	C	150	nil	44.79	nill
SP10394701	72.35	69.41	69.19	L	VC	C	150	nil	283.59	nill
SP10394704	72.35	69.41	69.19	F	VC	C	150	nil	283.59	nill
SP10402001	66.92	64.52	nil	F	VC	C	225	nil	0.00	nill
SP10402004	66.92	64.52	nil	F	VC	C	225	nil	0.00	nill

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
RP	- 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

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

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

SEWER RECORD DATA TABLE

O/S Map scale: 1:3500		This map is centred upon: O / S Grid reference:
Date of Issue: 03.07.14		x: 410090
Sheet No. 3 of 3		y: 239654

- Abandoned 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)

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

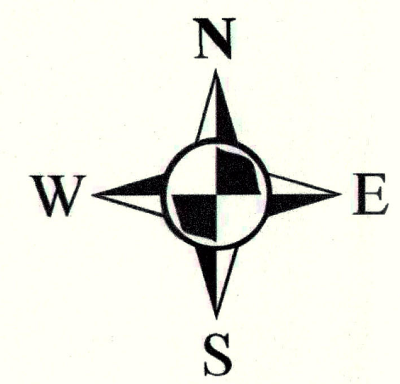
- Blind Shaft
- Combined Use Manhole
- Flushing Chamber
- Foul Use Manhole
- Grease Trap
- Head Node
- Hydrobrake
- Lamphole
- Outfall
- Overflow
- Penstock
- Petrol Interceptor

- 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
- Culverted Watercourse
- Pre-1937 Properties

CATEGORIES

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

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



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: 03.07.14

This map is centred upon:
O / S Grid reference:
x : 410090
y : 239654

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.

APPENDIX E

WINDES DRAINAGE METHODS AND RESULTS

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.400
Area (ha)	1.000	Urban	0.000
SAAR (mm)	736	Region Number	Region 4

Results	**l/s**
QBAR Rural	3.6
QBAR Urban	3.6
Q100 years	9.3
Q1 year	3.0
Q30 years	7.1
Q100 years	9.3

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.400
Area (ha)	2.000	Urban	0.000
SAAR (mm)	736	Region Number	Region 4

Results	**l/s**
QBAR Rural	7.2
QBAR Urban	7.2
Q100 years	18.5
Q1 year	6.0
Q30 years	14.1
Q100 years	18.5

Consultancy | Environment | Infrastructure | Buildings

BWB

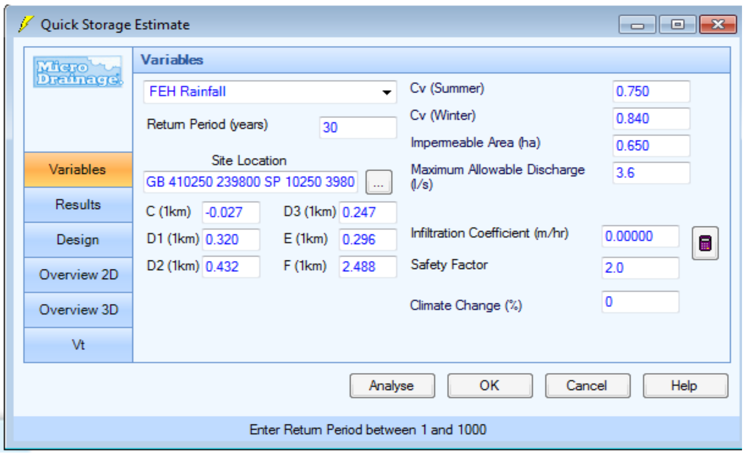
Job No.	Calc. No./Sketch No.		Rev.
BMW2315			A
Project		Date Prepared	Prepared by JC
COLLIN LANE, WILLERSEY		26/09/2014	Checked by JON

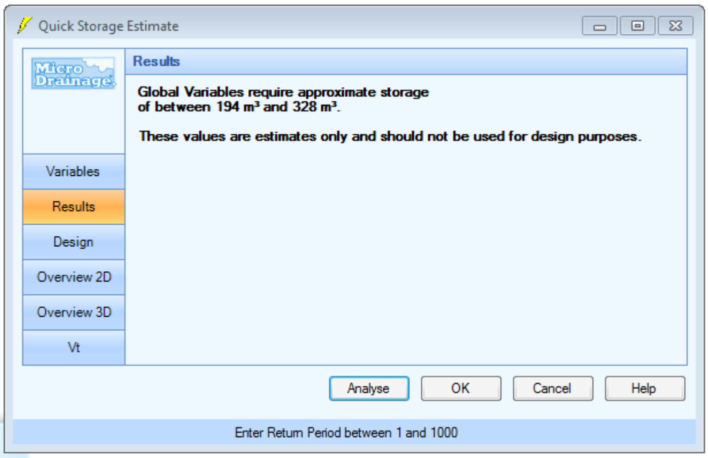
Title

Potential Attenuation Storage Volumes

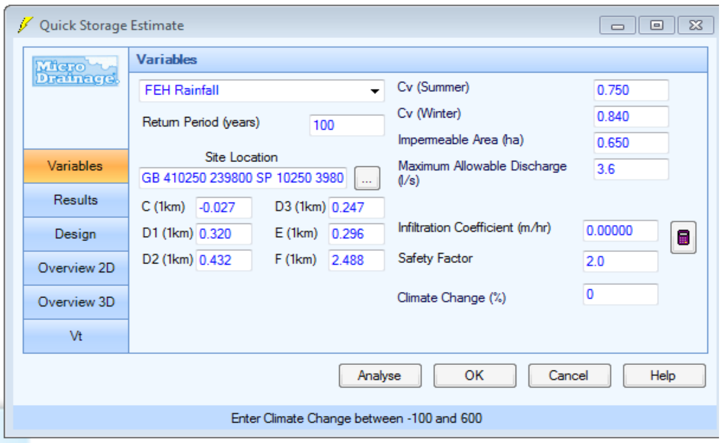
In accordance with the SFRA, it is proposed to restrict run-off from the development to existing QBAR rate. An existing rate of 3.6 l/s has been estimated for eastern catchment of the site and an existing rate of 7.2 l/s has been estimated for the western catchment of the site.
Based on risk of blockage to small orifices, the proposed limit to run-off from development is 5.0 l/s in the eastern catchment and 7.2 l/s in the western catchment. This allowable run-off rate has been used to estimate potential attenuation storage volumes on site.
The potential attenuation storage volumes has been estimated using WinDes Source Control Module for range of return periods, including 30% allowance for climate change on 100-year event.

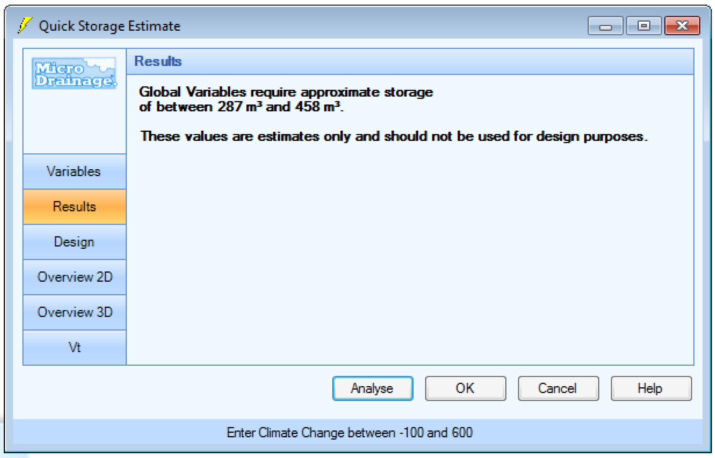
East 30-Year Return Period





100-Year Return Period





Continued on Sheet 2

Consultancy | Environment | Infrastructure | Buildings

BWB

Job No.	Calc. No./Sketch No.	Rev.
BMW2315		A

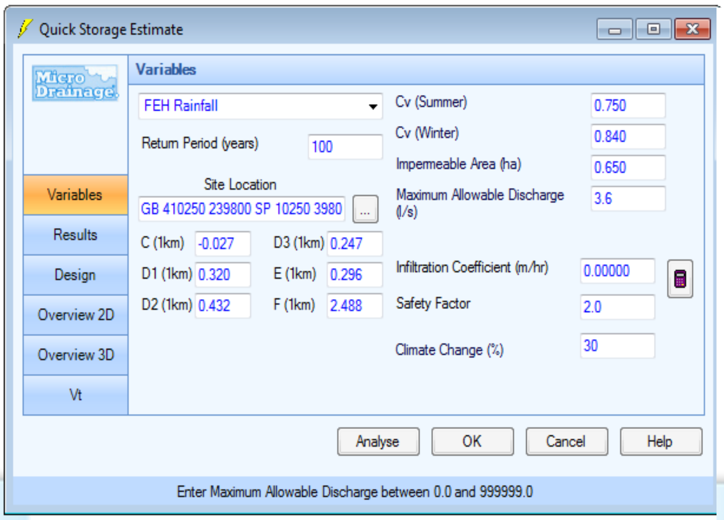
Project	Date Prepared	Prepared by / Checked by
COLLIN LANE, WILLERSEY	26/09/2014	Prepared by: JC Checked by: JON

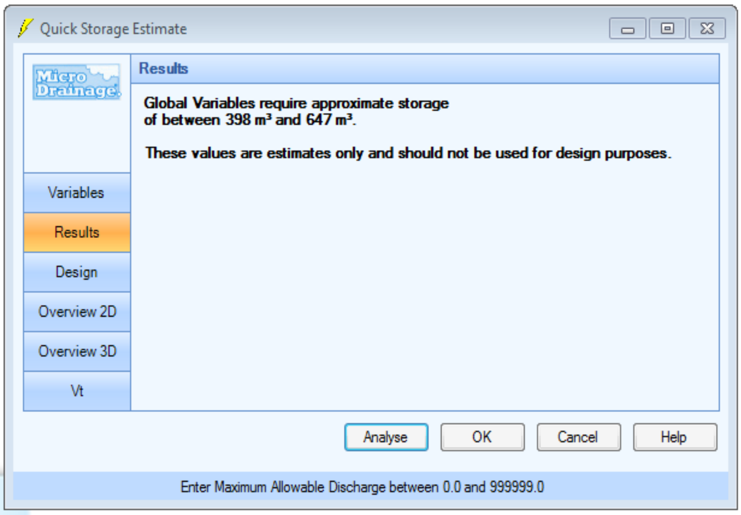
Title

Potential Attenuation Storage Volumes

Continuation from Sheet 1

100-Year Return Period Plus Climate Change





Allowable Run-Off Rate	Contributing Area	Return Period	Storage Volume
5.0 l/s	0.65	30-Year 100-Year 100-YearCC	11 - 18 m^3 20 - 29 m^3 28 - 40m^3

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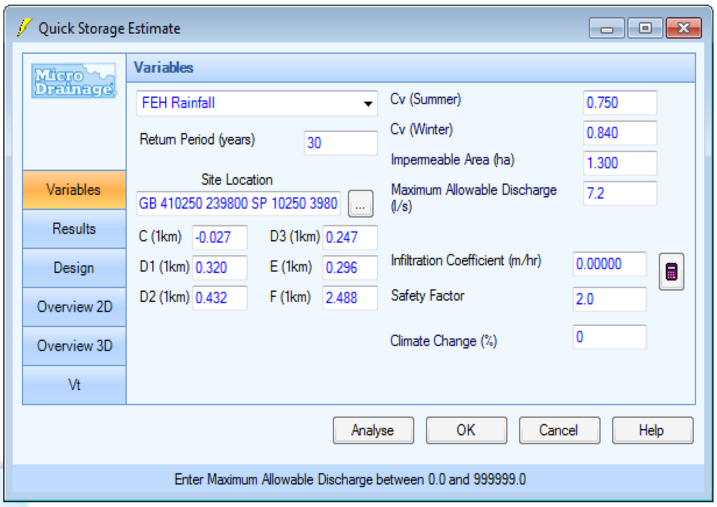
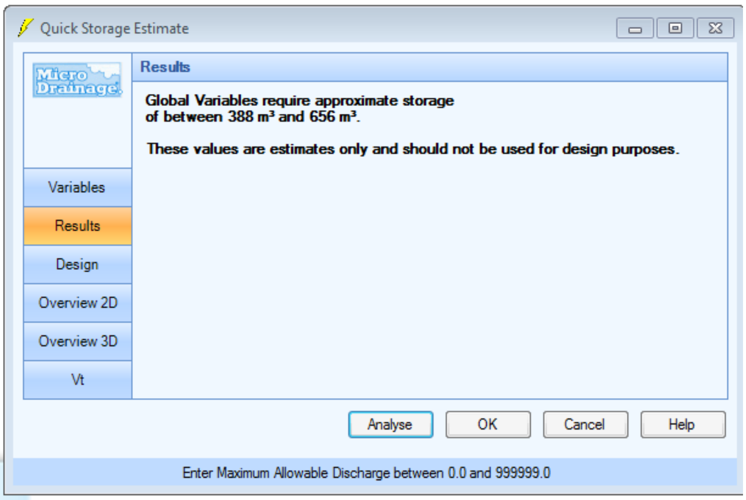
BWB

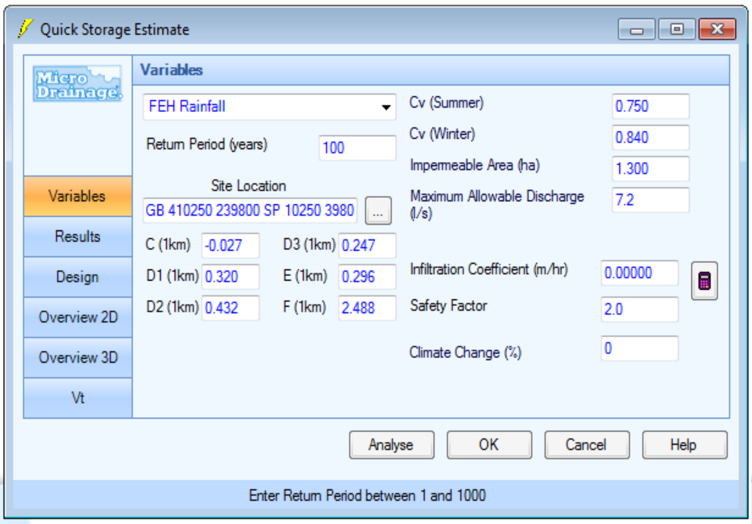
Job No.	Calc. No./Sketch No.		Rev.
BMW2315	3 of 4		A
Project		Date Prepared	Prepared by JC
COLLIN LANE, WILLERSEY		26/09/2014	Checked by JON
Title			
Potential Attenuation Storage Volumes			

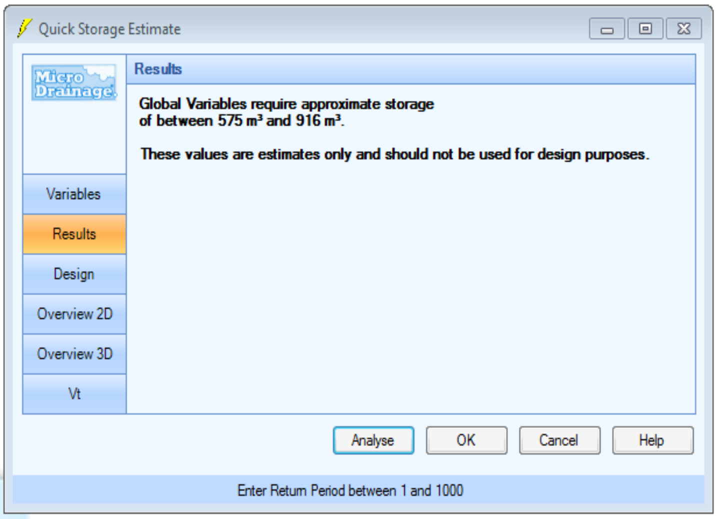
West 30-Year Return Period





100-Year Return Period





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BWB

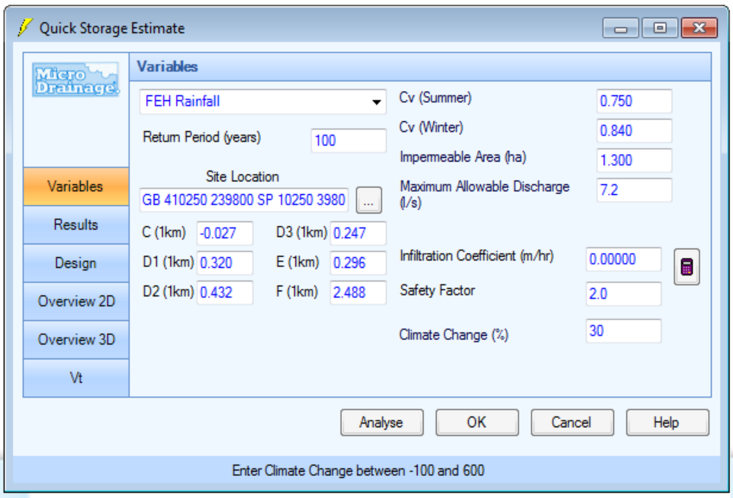
Job No.	Calc. No./Sketch No.		Rev.
BMW2315	4 of 4		A
Project		Date Prepared	Prepared by: JC
COLLIN LANE, WILLERSEY		26/09/2014	Checked by: JON

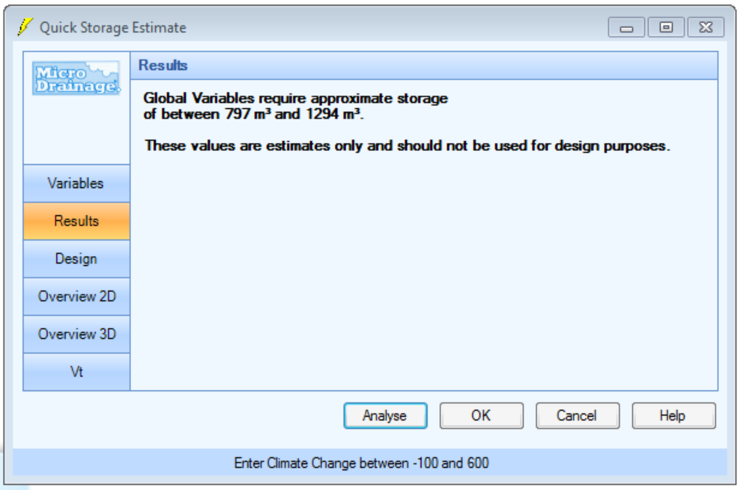
Title

Potential Attenuation Storage Volumes

Continuation from Sheet 1

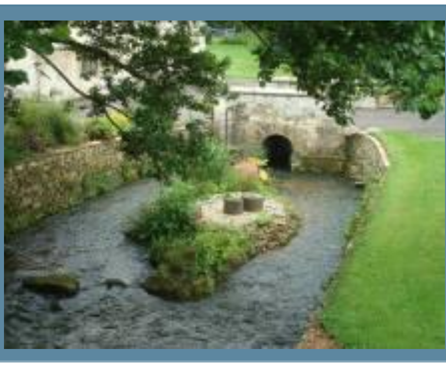
100-Year Return Period Plus Climate Change





Summary

Allowable Run-Off Rate	Contributing Area	Return Period	Storage Volume
7.2	1.3ha	30-Year 100-Year 100-YearCC	388 - 656 m^3 575 - 916 m^3 797 - 1294m^3



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