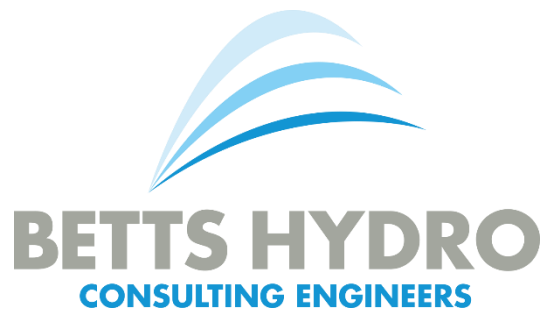




LAND OFF ROSSETT ROAD ROSSETT

DRAINAGE MANAGEMENT STRATEGY



For

Castle Green
Unit 20
St Asaph Business Park
St Asaph
Denbighshire
LL17 0LJ

The logo for Castle Green, featuring the company name in a serif font with a stylized graphic of vertical bars between the words, all contained within a dark green rectangular box.

AUGUST 2021

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LAND OFF ROSSETT ROAD ROSSETT

DRAINAGE MANAGEMENT STRATEGY

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EXECUTIVE SUMMARY

This Drainage Management Strategy was commissioned by Castle Green, referred to hereafter as 'the client'. This report has been prepared to support a planning application for residential development on land to the north and south of Rossett Road in Rossett. In accordance with national and local drainage hierarchies, the principal focus of this assessment is on the effective management of surface water run-off generated by the new development.

Any proposed impermeable areas that can drain to soakaway or an alternative method of infiltration would significantly improve the sustainability of any surface water systems and be in accordance with the Welsh Governments Statutory Standards for Sustainable Drainage Systems. The published online datasets have been reviewed to consider how favourable the underlying strata is to support a potential infiltration-based solution at the site. Based on the online datasets and FEH catchment characteristics, these conditions would support a full/part infiltration-based surface water management regime at the site due to the underlying strata.

This is further supported by BRE 365 Soakaway Testing undertaken by Betts Geo in October 2020 (Ref: 20MCB019/JS/LR1), which identified ground conditions generally consisted of sands and gravels to depth with localised clays and sandy clays, while groundwater was encountered in the majority of holes between depths of 1.20mbgl – 1.90mbgl. The report also identified that infiltration rates onsite indicate that infiltration is potentially a feasible drainage solution subject to detailed design.

Preliminary detailed design has therefore been undertaken and identified key areas which can discharge directly to ground via permeable roads, domestic soakaways and permeable driveways. Areas onsite that are unable to discharge directly to ground due to certain ground conditions will be lined and have a connection into the onsite infiltration/attenuation basin/ponds proposed within the Northern and Southern Development Parcel.

As part of the proposals initial pre-application with the SuDS Approving Body (SAB), Wrexham County Borough Council, have been undertaken and a sustainable drainage strategy has been agreed in principle. Given the scale of development being proposed and evidence of a positive infiltration drainage management solution there is opportunity to incorporate SuDS methods such as an infiltration basin to assist with the proposed surface water drainage regime, as shown within the Proposed Planning Layout.

It is also proposed that permeable paving and bio-filtration (tree pits) are implemented in non-adopted areas where at all feasible. By including measures such as these the surface water run-off is being dealt with at source and this will assist locally with surface water management. Although infiltration is shown to be feasible it will be necessary for further testing at specific locations to obtain infiltration rates. The SAB have agreed that if rate does not permit stormwater storage for runoff beyond the design event, then this could overflow via a piped connection to the adjacent watercourse. This would also prevent uncontrolled failure in the event of an exceedance event as a result of a blockage or system failure.

Preliminary detailed design has been undertaken and confirmed the specific SuDS to be utilised following a more detailed analysis of levels, ground conditions and attenuation requirements. The SAB have statutory responsibility for approving and adopting the proposed

drainage systems on new developments. Detailed Design is required to support the SAB application.

This Drainage Management Strategy is commensurate with the site and in summary, the development can be considered appropriate in accordance with Welsh Governments Statutory Standards for Sustainable Drainage Systems, providing the mitigation measures proposed within are included within the development proposals.

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Specialist Software

-  Flood Estimation Handbook FEH– Determination of Catchment Descriptors and depths of rainfall.
-  MicroDrainage WinDES (v.14.1) – Calculation of Greenfield run-off rates IH124/ICP-SUDS, Greenfield run-off volumes, rates of rainfall and stormwater storage estimates.

Abbreviations & Acronyms

AEP	Annual Exceedance Probability
BGS	British Geological Survey
CC	Climate Change
CFMP	Catchment Flood Management Plan
DAM	Development Advice Map
FCA	Flood Consequence Assessment
FEH	Flood Estimation Handbook
Ha	Hectare

LDP	Local Development Plan
LFRDP	Local Flood Risk Development Plan
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
mAOD	metres Above Ordnance Datum
NGR	National Grid Reference
NRW	National Resources Wales
NSRI	National Soil Resource Institute
OS	Ordnance Survey
PFRA	Preliminary Flood Risk Assessment
PPW	Planning Policy Wales
QSE	Quick Storage Estimate
SFCA	Strategic Flood Consequence Assessment
SuDS	Sustainable Drainage Systems
SWMP	Surface Water Management Plan
TAN15	Technical Advice Note 15
UKCIP	United Kingdom Climate Impacts Programme
WW	Welsh Water
WCBC	Wrexham County Borough Council

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1.0 INTRODUCTION

1.1 Policy Context

Technical Advice Note 15

- 1.1.1 All forms of flooding and their impact on the natural and built environment are material planning considerations. Planning Policy Wales (PPW) sets out the Government's objectives for the planning system, and how planning should facilitate and promote sustainable patterns of development, avoiding flood risk and accommodating the impacts of climate change. TAN15 provides technical guidance to supplement the policy's set out in PPW with regards to 'development and flood risk', a framework is provided to enable new development to be considered appropriately with regards to risks from fluvial and tidal flooding along with risks associated with additional run-off from development in all locations (see **Appendix A**).

SuDS Standards for Wales

- 1.1.2 In order for the development proposals to be justified in line with the guidance set out in TAN15, development must not increase flood risk elsewhere within the catchment and where possible offer improvement on the pre-development situation. Surface water management is therefore a key focus. The Welsh Government: 'Statutory standards for sustainable drainage systems' (2018) are aimed at ensuring that the most effective drainage scheme is delivered for protecting and enhancing both the natural and built environment.
- 1.1.3 Standard S1 comprises 5 Levels with the most preferred level represented by Level 1, and movement from Level 1 to lower levels determined by demonstration that the exception criteria apply. Level 1 should be met to the maximum extent possible, with lower levels used where required and where appropriate justification can be provided. Different levels may be suitable for different parts of a site, and more than one level may be required to effectively drain the site to meet the requirements of the Standards.
- 1.1.4 The Fixed Standards S2 to S6 do not have exception criteria and prioritised levels. They specify all the criteria that need to be met in order to show compliance to the Standards.

Sustainable Drainage Approval Board (SAB)

- 1.1.5 From January 2019, all new developments of at least 2 properties or over 100m² in Wales will be required to have Sustainable Drainage Systems (SuDS) to manage surface water run-off generated by the proposals. These SuDS must be designed and constructed in accordance with the Welsh Government standards for sustainable drainage. Schedule 3 of the Flood and Water Management Act 2010 (FWMA) establishes Wrexham County Borough Council as a SuDS Approval Board (SAB).
- 1.1.6 The SAB have statutory responsibility for approving and where appropriate adopting the proposed drainage systems on new developments. The SAB application is undertaken separately to the planning permissions and developers are required to obtain both planning approval and SAB approval prior to commencement of any proposed construction works.

1.2 Consultation

- 1.2.1 The report has been prepared in consultation with Welsh Water (WW) and Wrexham County Borough Council (WCBC). The consultations responses (where received) have been appended and can be seen in **Appendix B** and **C** respectively.
- 1.2.2 The Local Planning Authority (LPA), Wrexham County Borough Council, will make the final decision with regards to any planning permissions. The LPA should however consult with the SAB who will provide advice and guidance on drainage matters at a strategic level and in relation to planning applications. WCBC also acts as the Lead Local Flood Authority and will be a key statutory consultee on the application in terms of flood risk and drainage.

2.0 EXISTING SITE BACKGROUND

2.1 Location

- 2.1.1 The site is accessed off Rossett Road in Rossett. The Ordnance Survey National Grid Reference (OS NGR) for the site is E: 337284, N: 357242 and the nearest postcode is LL12 0DZ (full location plan in **Appendix E**). The total site covers approximately 6.27ha and is divided into two separate parcels by Rossett Road; the Northern Development Parcel covers 2.83ha and the Southern Development Parcel covers 3.44ha. The parcels are edged in red in **Figure 1**. The site is bounded to the north, east and south by undeveloped agricultural land. To the west of site however is the made village of Rossett.



Figure 1: Aerial Photograph of site (Bing Maps, 2021)

2.2 Existing and Historical Land Use

- 2.2.1 The site is undeveloped agricultural land at present and comprises of low-density vegetation with some taller shrubs along the site boundaries, and no other historical uses have been identified as part of this assessment. Review of the online mapping

identified a land drain to be located within the boundary of the Northern Development Parcel. The land drain flows north into a pond which is understood to be fed by overland run-off from the site in exceedance events and the surrounding agricultural land.

2.3 Topography

- 2.3.1 A full topographical survey has been carried out and is included in **Appendix F**. The survey identified the Northern Development Parcel falls from the south-western boundary at a level of 13.5mAOD, down towards the northern corner of site identified to be at a level of 11.25mAOD. The Southern Development Parcel also falls from the south-west from a level of 14.30mAOD down to a level of 12.85mAOD located adjacent to Rossett Road and Lane Farm (located adjacent to the north-eastern corner of the development parcel). The existing levels are illustrated in **Figure 2** by the contour lines, based on the LiDAR information obtained.

2.4 Nature of the development

- 2.4.1 This DMS has been prepared to support a planning application for residential development, on land to the north and south of Rossett Road in Rossett. Based on the planning layout, the proposals will be complete with access, footpaths, car parking, external works, landscaping, boundary fencing, external services, and drainage (See **Appendix G**).

4.0 SURFACE WATER MANAGEMENT

- 4.0.1 The Welsh Government: 'Statutory standards for sustainable drainage systems' (2018) are aimed at ensuring that the most effective drainage scheme is delivered for protecting and enhancing both the natural and built environment.

4.1 Standard 1 – Surface Water Run-Off Destination

- 4.1.1 Standard S1 comprises of five levels, which are discussed in detail in this assessment subsequently. The Fixed Standards S2 to S6 do not have exception criteria and prioritised levels. They specify all the criteria that need to be met in order to show compliance to the Standards. The five levels for S1 are:

- Priority Level 1: Surface water runoff is collected for use.
- Priority Level 2: Surface water runoff is infiltrated to ground.
- Priority Level 3: Surface water runoff is discharged to a surface water body.
- Priority Level 4: Surface water runoff is discharged to a surface water sewer, highway drain, or another drainage system.
- Priority Level 5: Surface water runoff is discharged to a combined sewer.

Priority Level 1: Surface water runoff is collected for use.

- 4.1.2 Surface water re-use is applicable for residential properties. An external water butt will be provided for each dwelling to collect rainwater from roof tops, to promote domestic external water re-use. Internal rainwater harvesting systems are not proposed. In line with section G1.4 of the 'Statutory standards for sustainable drainage systems', internal rainwater harvesting is not proposed for this site as:

- There is no foreseeable demand for non-potable water on the site throughout its design life.
- There is no foreseeable need to harvest water at the site and Welsh Water have not identified potential stresses on mains water supplies in this area.
- The use of internal rainwater harvesting is not a cost-effective part of the solution for managing surface water runoff on the site, taking account of the potential water supply benefits of such a system.

Priority Level 2: Surface water runoff is infiltrated to ground.

- 4.1.3 Any proposed impermeable areas that can drain to soakaway or an alternative method of infiltration would significantly improve the sustainability of any surface water systems and be justified in line with SuDS Standards for Wales. The published online datasets have initially been reviewed to consider how favourable the underlying strata is to support a potential infiltration-based solution at the site.

- 4.1.4 The British Geology Survey (BGS) mapping data indicates that ground conditions comprise Salop Formation (Mudstone, Sandstone and Conglomerate) with superficial deposits of River Terrace Deposits (Sand and Gravel). Furthermore, the Cranfield Soil and Agrifood Institute Soilscape soil type viewer identifies the soils to be freely draining slightly acid loamy soils. Furthermore, based on the FEH catchment data, the soil factor for the area has been identified to be 0.1, which suggest the soils are very permeable (based on a scale of 0.1 to 0.5, with 0.5 being impermeable). These conditions would not support a full infiltration-based surface water management regime at the site due to the underlying strata.

- 4.1.5 The online datasets and FEH catchment characteristics are further supported by BRE 365 Soakaway Testing undertaken by Betts Geo in October 2020 (Ref: 20MCB019/JS/LR1). The report undertaken by Betts Geo identified that infiltration testing was undertaken on the site by Waterco in 2015 (report reference: w1938-151014 – Infiltration Report) and concluded that soakaway drainage would be a feasible option however the soakaways were only shallow (circa 1m depth).
- 4.1.6 E3P then undertook a Site Investigation in May 2020 (report reference: 14-116-R2-1 June 2020) and encountered groundwater in the majority of holes at depths between 0.50mbgl – 2.50mbgl. The did however, conclude that soakaway drainage would be a feasible option for surface water disposal from the site (except on the area of clay). Betts Geo were then commissioned by MacBryde Homes to undertake additional soakaway tests at the site at a deeper depth than those previously done by Waterco, to identify if deeper soakaways were a viable option and to allow a greater understanding of groundwater conditions on site.
- 4.1.7 The infiltration testing undertaken by Betts Geo identified ground conditions generally consisted of sands and gravels to depth with localised clays and sandy clays, while groundwater was encountered in the majority of holes between depths of 1.20mbgl – 1.90mbgl. The report also identified that infiltration rates onsite indicate that the adoption of soakaways is a potential viable drainage solution across certain areas of the site.
- 4.1.8 A preliminary design been undertaken and included within **Appendix I**. These plans identify key areas which can discharge directly to ground via permeable roads, domestic soakaways and permeable driveways. Areas onsite that are unable to discharge directly to ground due to certain ground conditions will be lined and have a connection into the onsite infiltration basin proposed within the Northern Development Parcel. Surface water run-off will then be able to discharge to ground at these locations (see **Appendix I** for full details).
- 4.1.9 The specific drainage infrastructure to be implemented will be confirmed during the detailed design stage following discussion with all relevant parties and confirmation of the ground conditions. In terms of discharge rates, in accordance with the SuDS Manual (CIRIA 753) and the SuDS Standards for Wales (2018), the proposed discharge rates should not exceed the existing percolation rates on the site, to be confirmed following onsite testing. The surface water drainage system proposed will need to be sized to contain up to and including the 1 in 100yr return period storm event with a 40% allowance for climate change.
- 4.1.10 As part of the proposals initial pre-application SAB discussion have been undertaken with WCBC and a preliminary sustainable drainage strategy has been agreed in principle. This report is to support the proposed planning application and the full SAB approval will need to be sought separately by the developer in due course.

Priority Level 3: Surface water runoff is discharged to a surface water body.

- 4.1.11 Infiltration is able to offer a full surface water management solution for the proposals. It is proposed that two infiltration basins are located within the Northern development

Parcel to cater for surface water flows that cannot be managed directly at the source as infiltration varies onsite.

- 4.1.12 These infiltration basins will be sized to cater for surface water flood events, the SAB (WCBC) have agreed in principle that if rate does not permit stormwater storage for runoff beyond the design event, then this could overflow via a piped connection to the adjacent watercourse (see correspondence in **Appendix D**). This would also prevent uncontrolled failure in the event of an exceedance event as a result of a blockage or system failure.
- 4.1.13 A preliminary design has been undertaken (included within **Appendix I**) and confirms the technical details following a more detailed review of levels, capacity, and attenuation requirements. The Preliminary design has also been identified that the attenuation of surface water never exceeds the required allowance and therefore no flows are shown to enter the land drainage ditch however the high-level overflow has been proposed for when levels exceed extreme scenarios including climate change. This preliminary design was submitted to the SAB as part of pre-application advice, which has since been approved in principle by WCBC.

Priority Level 4: Surface water runoff is discharged to a surface water sewer, highway drain, or another drainage system.

- 4.1.14 As infiltration has been identified to be feasible onsite there are no proposals to discharge surface water run-off from the proposed development site into a public surface water sewer, highway drain or any other drainage system. Furthermore, WW will not accept a surface water connection due to the presence of other primary surface water drainage options available.

Priority Level 5: Surface water runoff is discharged to a combined sewer.

- 4.1.15 As infiltration has been identified to be feasible onsite there are no proposals to discharge surface water run-off from the proposed development site into a combined sewer. Furthermore, WW will not accept a surface water connection due to the presence of other primary surface water drainage options available.

4.2 Standard 2 – Surface Water Run-Off Hydraulic Control

- 4.2.1 This Standard applies to discharges to surface water bodies, surface water sewers or combined sewerage systems. As the proposals are to discharge surface water run-off from the site to the ground via various infiltration methods, mimicking the existing pre-development greenfield regime, this ensures that there is no increased flood risk to others because of the development and through appropriate design will ensure no increased flood risks when climate changes are considered in the future.
- 4.2.2 The specific drainage infrastructure to be implemented will be confirmed during the detailed design stage following discussion with all relevant parties and confirmation of the ground conditions. The proposed onsite infiltration basins will however be sized to contain up to and including the 1 in 100yr return period storm event with a 40% allowance for climate change being contained onsite. The SAB have agreed that if the surface water run-off rate does not permit stormwater storage for runoff beyond the design event, then this could overflow via a piped connection to the adjacent

watercourse. This would also prevent uncontrolled failure in the event of an exceedance event as a result of a blockage or system failure.

- 4.2.3 All surfaces drained to rainwater harvesting systems designed to BS 8515, whether for surface water management or just water supply, provided the RWH system design is based on regular daily demand for non-potable water from surface water runoff. Where areas of site are proposed to be drained via the infiltration basins these systems will be designed in accordance with the SuDS Manual as discussed in further detail in Section 4.6. Furthermore, all permeable surfaces, whether lined or not, will comply to standards set out in the SuDS Manual as discussed further in Section 4.6.

4.3 Standard 3 – Water Quality

- 4.3.1 The proposed drainage regime will look to address the design requirement associated with Water Quality in multiple ways. The key being the incorporation of multiple stages of water treatment prior to discharge from the site. Where feasible permeable roads, domestic soakaways and permeable driveways throughout the site have been considered to provide water quality improvements from filtration.
- 4.3.2 Where infiltration is not feasible at the source, the proposed onsite surface water conveyance network will convey plot and highway drainage to the proposed SuDS infiltration basins. The basins will be designed in accordance with the guidance and practice in the SuDS Manual, to ensure it provides an additional source of water quality treatment prior to flows leaving the site. Planting will also be considered where appropriate to provide additional benefits for any run-off entering these SuDS features.

4.4 Standard 4 – Amenity

- 4.4.1 The developer will consider the use of external rainwater butts in rear gardens of properties to encourage residents to get involved with water and resource control at a domestic level. Rainwater butts would not be suitable to cater for all the run-off generated by the development which is why the wider site will look to include the use of permeable roads/driveways, domestic soakaways and infiltration basins.
- 4.4.2 The proposed drainage regime will look to address the design requirement associated with amenity, through the inclusion of the permeable roads/driveways, domestic soakaways and infiltration basins. The infiltration basins may not be occupied in all storm events as it will be designed with an overflow from the main conveyance drainage, meaning there could also be scope to utilise this space for recreation where design standards comply. The provision of the basins will also promote better wellbeing and health through improved visual aesthetics that would be associated with this proposed bringing blue/green corridor within the residential scheme.

4.5 Standard 5 – Biodiversity

- 4.5.1 The proposed drainage regime will look to address the design requirements associated with biodiversity by ensuring the existing land drainage ditch within the northern corner of the Northern Development Parcel is retained and enhanced to form a blue/green

corridor within the scheme. Furthermore, the proposed permeable roads/driveways, domestic soakaways and infiltration basins will be designed to promote the maximum benefits in terms of biodiversity. Any planting proposed will be native to the area and provide benefits to natural and local ecosystems, the specific design and criteria will be confirmed during detailed design, in conjunction with an appropriate ecologist.

4.6 Standard 6 - Design of Drainage for Construction, Operation and Maintenance

- 4.6.1 From January 2019, all new developments of at least 2 properties or over 100m² in Wales will be required to have Sustainable Drainage Systems (SuDS) to manage surface water run-off generated by the proposals. These SuDS must be designed and constructed in accordance with the Welsh Government SuDS standards for Wales guidance and Schedule 3 of the Flood and Water Management Act 2010 (FWMA), which establishes Wrexham County Borough Council as a SuDS Approval Board (SAB).
- 4.6.2 The SAB have statutory responsibility for approving and where appropriate adopting the proposed drainage systems on new developments. The SAB application is undertaken separately to the planning permissions and developers are required to obtain both planning approval and SAB approval prior to commencement of any proposed construction works.
- 4.6.3 As part of the proposals initial pre-application SAB discussion have been undertaken with WCBC and a preliminary sustainable drainage strategy has been agreed in principle. This report is to support the proposed planning application and the full SAB approval will need to be sought separately by the developer in due course.
- 4.6.4 A preliminary design has been undertaken (see drawing included within **Appendix I**) and confirmed the specific SuDS to be utilised following a more detailed analysis of levels, ground conditions and attenuation requirements, in conjunction with the SAB at Wrexham County Borough Council, as outlined within **Figure 3**. The SuDS methods proposed consist of permeable roads/driveways and domestic soakaways.

Permeable Surfaces

- 4.6.5 Permeable surfaces will therefore be used for all driveways and private roads on site in accordance with Section G1.15 of SuDS standards for Wales. No additional area is drained to the majority of private roads and driveways on site. Areas of permeable paving which do accommodate inflow from other areas of the site have been designed appropriately. The presence of the permeable surfaces will allow the first 5mm of rainfall to be dealt with at source as identified in the SuDS Manual, as illustrated within **Figure 2 (Appendix J)** for full details).
- 4.6.6 An extract from the SuDS Manual has been included within **Appendix J** identifying the design guidance for the different types of permeable surfacing that has been identified as one of the primary options for handling surface water runoff from site.

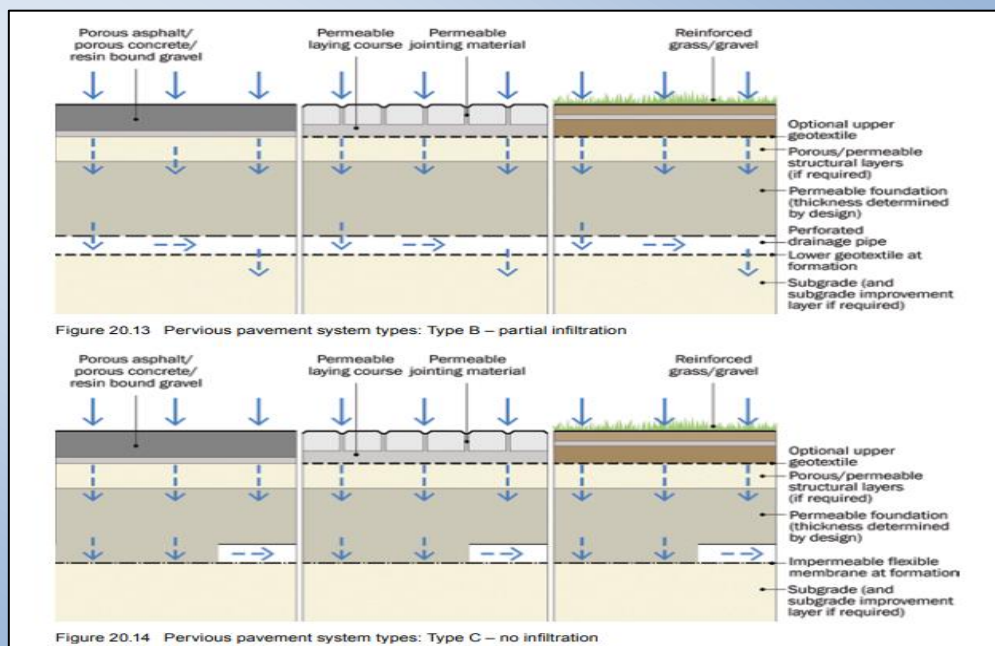


Figure 2: Examples of Permeable Surfaces Extract (SuDS Manual, 2015)

Soakaways

- 4.6.7 Surface water runoff will be disposed of using infiltration techniques. Private individual property soakaways will be used for properties located in areas with suitable infiltration characteristics. Infiltration devices (soakaways and permeable paving) will be sized to accommodate the 1 in 100 year plus 40% CC event, to ensure the proposed drainage system will not increase in flood risk elsewhere. An example of a Soakaway from the SuDS Manual has been included within **Figure 3 (Appendix J)** for full details).

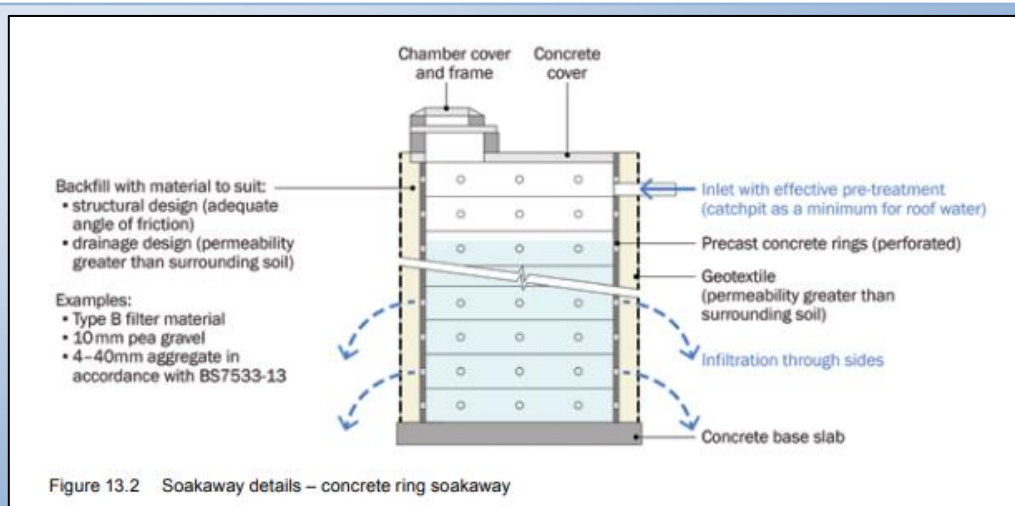


Figure 3: An Example of a Soakaway Extract (SuDS Manual, 2015)

Infiltration Basins

- 4.6.8 As discussed within Section 4.3, The proposals will also be incorporated infiltration basins within the Northern Development Parcel to assist with stormwater storage and for surface water flows that cannot be managed directly at the source as infiltration varies onsite. An example of an infiltration basin from the SuDS Manual has been included within **Figure 4 (Appendix J)** for full details).

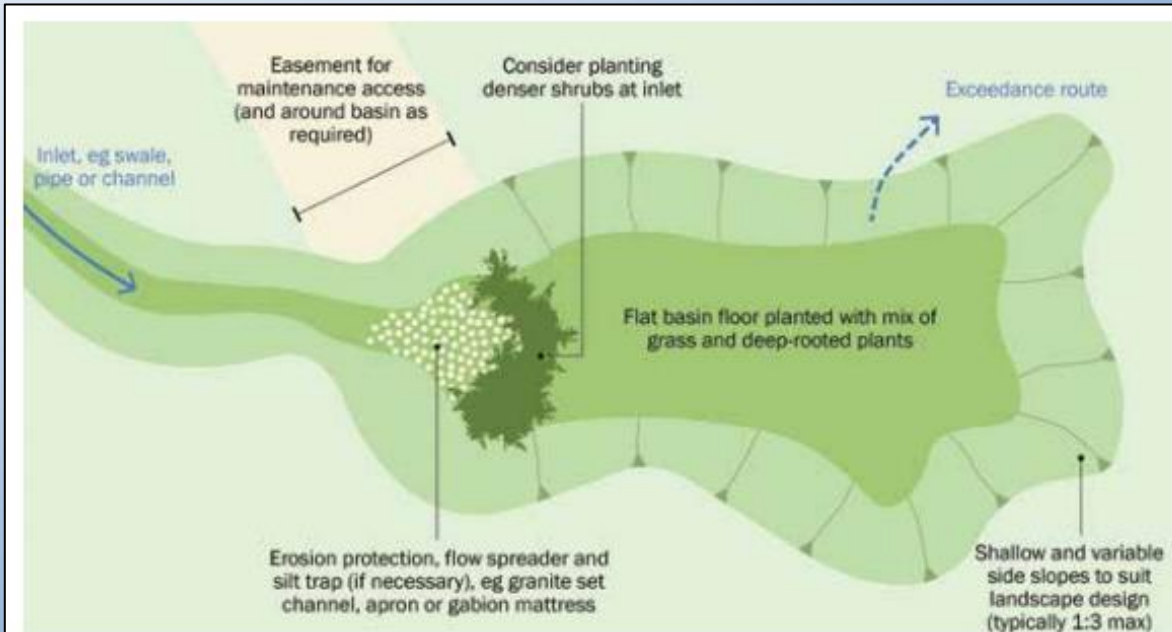


Figure 13.4 Plan view of infiltration basin

Figure 4: An Example of an Infiltration Basin (SuDS Manual, 2015)

Maintenance

- 4.6.9 Regular inspection and maintenance are important for the effective operation of SuDS. Before private driveways, private water butts and individual property soakaways are handed over to the property owners they should be inspected for clogging, litter, weeds and water ponding and all failures rectified. After hand-over the property owners should be inspect these assets regularly, preferably during and after heavy rainfall to check effective operation and to identify areas of ponding.
- 4.6.10 Maintenance activities can be broadly defined as: 1) regular, 2) occasional and 3) remedial maintenance. It is proposed that maintenance regime for permeable paving follows table 20.15 in the CIRIA 753 SuDS Manual guidance (**Appendix J**).
- 4.6.11 The maintenance of communal drainage features such as the infiltration basin will be the responsibility of SAB. Maintenance of shared permeable surfaces (permeable paved access roads and parking areas) however can be arranged through appointment of a site management company.

4.7 Climate Change

- 4.7.1 There are significant indications that the UK climate is changing; the nature of this change will vary based on regional and catchment differences, consensus is that effects will become more pronounced over the coming decades. With reference to TAN15 the most likely effects to be experienced within Wales are:
- Increases in sea levels.
 - Greater inflow into estuaries and the sea
 - Significant changes in rainfall patterns seasonally
 - Increased evapotranspiration
- 4.7.2 Making 'provisions' for these anticipated future changes to flood risk is an important action, ensuring future 'sustainable development' within Wales as identified within TAN15; Section 2.1. Current expert opinion indicates the likelihood of more frequent short duration and high intensity rainfall events and the addition of more frequent periods of long duration rainfall meaning future flooding events will have a greater impact on the environment and society.
- 4.7.3 Furthermore, in accordance with SuDS Standards for Wales; Section G2.5 the proposed SuDS methods will be used to support development resilience to climate change by reducing the risk of localised surface water flooding, mitigating pollution that may arise from surface water runoff and helping to safeguard water supplies. The development proposals also take account of likely future pressures on flood risk, the environment and water resources such as climate change and urban creep.
- 4.7.4 Any increase in the level of flood risk to the potential development from Climate Change is likely to be related to the increase in rainfall intensity and duration and its impact upon the surface water drainage system. Climate Change will therefore be accounted for within the design with an increase in peak rainfall intensity of 40%.

4.8 Foul Water Management

- 4.8.1 At present there are no foul water flows generated by site and no existing foul water connections. There are several public sewer assets within the vicinity of site including those located within Rossett Road to the west of site. The proposals are to discharge foul water flows, via a new connection from site into the nearest public combined sewer (375mm dia) located to the west of the Northern Development Parcel within Trevalyn Hall View, subject to agreement with WW (see Proposed Level and Drainage Plans Included within **Appendix I**).
- 4.8.2 Based on the proposals for the construction of up to 132no. residential units the approximate peak foul water flows generated by the development are 6.1l/s. This is based on 4000 litres per dwelling per 24 hours; the guidance contained within Sewers for Adoption (SfA).
- 4.8.3 Detailed design will be required to confirm feasibility of the strategy based on the topographic levels following further detailed investigations. It is clear based on the existing topographic levels a pumped system will be required in part. The proposals are to drain the foul water flows from the Southern and Northern Development Parcel via

gravity to a pumping station which will then pump flows up to the public combined sewer located within Trevalyn Hall View. Early design review is recommended as Welsh Water will have specific design considerations that will need to be adhered to for any proposed pumping station(s) serving the proposals.

- 4.8.4 Consents and relevant agreements will be required from WW prior to commencement of works. Early consultation with WW is recommended to identify any additional constraints and their preferred point(s) of connection. It is possible that offsite works would be required for a connection to the public sewer network. Any offsite asset routing works will also need to be considered in terms of consents with the relevant landowners (Highways Authority).

5.0 SUMMARY AND CONCLUSIONS

- 5.1 This report has been prepared to support a planning application for residential development on land to the north and south of Rossett Road in Rossett. In accordance with national and local drainage hierarchies, the principal focus of this assessment is on the effective management of surface water run-off generated by the new development.
- 5.2 Any proposed impermeable areas that can drain to soakaway or an alternative method of infiltration would significantly improve the sustainability of any surface water systems and be in accordance with the Welsh Governments Statutory Standards for Sustainable Drainage Systems. The published online datasets have been reviewed to consider how favourable the underlying strata is to support a potential infiltration-based solution at the site. Based on the online datasets and FEH catchment characteristics, these conditions would support a full/part infiltration-based surface water management regime at the site due to the underlying strata.
- 5.3 This is further supported by BRE 365 Soakaway Testing undertaken by Betts Geo in October 2020 (Ref: 20MCB019/JS/LR1), which identified ground conditions generally consisted of sands and gravels to depth with localised clays and sandy clays, while groundwater was encountered in the majority of holes between depths of 1.20mbgl – 1.90mbgl. The report also identified that infiltration rates onsite indicate that infiltration is potentially a feasible drainage solution subject to detailed design.
- 5.4 Preliminary detailed design has therefore been undertaken and identified key areas which can discharge directly to ground via permeable roads, domestic soakaways and permeable driveways. Areas onsite that are unable to discharge directly to ground due to certain ground conditions will be lined and have a connection into the onsite infiltration/attenuation basin/ponds proposed within the Northern and Southern Development Parcel.
- 5.5 As part of the proposals initial pre-application with the SuDS Approving Body (SAB), Wrexham County Borough Council, have been undertaken and a sustainable drainage strategy has been agreed in principle. Given the scale of development being proposed and evidence of a positive infiltration drainage management solution there is opportunity to incorporate SuDS methods such as an infiltration basin to assist with the proposed surface water drainage regime, as shown within the Proposed Planning Layout.
- 5.6 It is also proposed that permeable paving and bio-filtration (tree pits) are implemented in non-adopted areas where at all feasible. By including measures such as these the surface water run-off is being dealt with at source and this will assist locally with surface water management. Although infiltration is shown to be feasible it will be necessary for further testing at specific locations to obtain infiltration rates. The SAB have agreed that if the surface water run-off rate does not permit stormwater storage for runoff beyond the design event, then this could overflow via a piped connection to the adjacent watercourse. This would also prevent uncontrolled failure in the event of an exceedance event as a result of a blockage or system failure.

- 5.7 Preliminary detailed design has been undertaken and confirmed the specific SuDS to be utilised following a more detailed analysis of levels, ground conditions and attenuation requirements. The SAB have statutory responsibility for approving and where appropriate adopting the proposed drainage systems on new developments. Detailed Design is required to support the SAB application.
- 5.8 This Drainage Management Strategy is commensurate with the site and in summary, the development can be considered appropriate in accordance with Welsh Governments Statutory Standards for Sustainable Drainage Systems, providing the mitigation measures proposed within are included within the development proposals.

6.0 RECOMMENDATIONS

- 6.1 Any overland flows generated by the development will be carefully controlled and safe avenues directing overland flows away from any proposed properties will be provided. Any natural conveyance routes will so be maintained through the site, where practical.
- 6.2 To minimise the flood risk to the neighbouring properties and conform to the guidance set out in SuDS Standards for Wales, it is proposed that surface water run-off be managed effectively and sustainably in accordance with best practice and standard guidance.
- 6.3 The SAB have statutory responsibility for approving and where appropriate adopting the proposed drainage systems on new developments. The SAB application is undertaken separately to the planning permissions and developers are required to obtain both planning approval and SAB approval prior to commencement of any proposed construction works. As part of the proposals initial pre-application SAB discussion have been undertaken with WCBC and a sustainable drainage strategy has been agreed in principle. This report is to support the proposed planning application and the full SAB approval will need to be sought separately by the developer in due course.
- 6.4 The proposed onsite infiltration basins will be sized to contain up to and including the 1 in 100yr return period storm event with a 40% allowance for climate change being contained onsite. The basins will also contain a high-level overflow that connects into the land drainage ditch located within the northern corner of the Northern Development Parcel should the basin be exceeded during extreme and prolonged rainfall events that exceed the 1 in 100yr event plus 40% Climate Change.
- 6.5 As with any drainage system blockages within either the foul or surface water system have the potential to cause flooding or disruption. It is important that should any drainage systems not be offered for adoption to either the Water Company or the SAB then an appropriate maintenance regime is proposed to be scheduled with a suitably qualified management company for these private drainage systems.

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Watertight International – <http://www.watertightinternational.com/>

Welsh Water – <http://www.dwrcymru.com/>

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APPENDIX A: SUDS STANDARDS FOR WALES EXTRACTS

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Sustainable Drainage Systems Standards for Wales

Early design thinking to deliver multifunctional spaces and effective drainage for phased development

Drainage systems should be considered at the earliest stages of site design to influence the layout of the roads, buildings and public open spaces. Planning of a new site layout should be informed by the topography and the requirements of surface water management systems to both effectively drain and treat the runoff. Any existing watercourses, ditches, and other drainage features both within and adjoining the site should help inform proposals. By doing so, biodiversity, amenity and cost effectiveness can be maximised through using areas of land for a range of multifunctional purposes in addition to surface water management e.g. landscaping, car parking, recreational areas, rainwater harvesting etc. Early conceptual design will require that infiltration tests are also undertaken early to inform the conceptual design of the drainage system.

Where a development is phased, the design of the SuDS scheme should consider the effects of each stage as well the whole development on the performance of the surface water drainage system.

Development design should take account of existing flood risk policies in the Local Flood Risk Management Strategy, any flood consequence assessments, surface water management plans, the catchment flood management plan and the river basin management plan (see Section 4, Regulatory Framework). It should also take account of any relevant local planning documents.

How the National Standards work

To assist in understanding the basis for the required Standards to be complied with, there is an introductory **Principles** section. There are two types of Standards. Standard S1 is a **Hierarchy Standard** while S2 to S6 are **Fixed Standards**.

- **Principles** for SuDS drainage design explain the objectives for applying the Standards;
- The **Hierarchy Standard** gives criteria for prioritising the choice of runoff destination (Standard S1);
- **Fixed Standards** (Standards S2 to 6) give:
 - Design Standards which state the minimum design criteria that all SuDS should satisfy; and
 - Standards which state how SuDS should be built, maintained and operated.

Sustainable Drainage Systems Standards for Wales

The SuDS Standards are aimed at ensuring that the most effective drainage scheme is delivered for protecting and enhancing both the natural and built environment.

Standard S1 comprises 5 Levels with the most preferred level represented by Level 1, and movement from Level 1 to lower levels determined by demonstration that the exception criteria apply. Level 1 should be met to the maximum extent possible, with lower levels used where required and where appropriate justification can be provided. Different levels may be suitable for different parts of a site, and more than one level may be required to effectively drain the site to meet the requirements of the Standards.

Fixed Standards S2 to S6 do not have exception criteria and prioritised levels. They specify all the criteria that need to be met in order to show compliance to the Standards.

Links with the planning system

Developers should demonstrate compliance with these standards in submitting planning applications. For major developments, where a drainage strategy document may be required as part of a local validation requirement, this should demonstrate how these standards have been met in the site design.

It should be noted that a number of planning authorities in Wales have adopted guidance on sustainable drainage which should be taken into account in any development proposal.

Glossary

Note that Section 5 contains a glossary which aims to explain and clarify any unfamiliar terms or specialist words used in this document.

3. Standards

Standard S1 – Surface water runoff destination

This Standard addresses the use of surface water by the development and where it should be discharged. The aim is to ensure that runoff is treated as a resource and managed in a way that minimises negative impact of the development on flood risk, the morphology and water quality of receiving waters and the associated ecology. This will ensure that early consideration is given to the use of rainwater harvesting systems to both manage runoff and deliver a source of non-potable water for the site where practical. Where it is not, prioritisation should be given to infiltration. Discharges to sewerage systems must be limited where possible.

S1 Surface water runoff destination

Priority Level 1: Surface water runoff is collected for use;

Priority Level 2: Surface water runoff is infiltrated to ground;

Priority Level 3: Surface water runoff is discharged to a surface water body;

Priority Level 4: Surface water runoff is discharged to a surface water sewer, highway drain, or another drainage system;

Priority Level 5: Surface water runoff is discharged to a combined sewer.

Note that Priority Levels 1 is the preferred (highest priority) and that 4 and 5 should only be used in exceptional circumstances.

Guidance on Standard S1 – Surface water runoff destination

G1.1 As much of the runoff as possible (subject to technical or cost constraints) should be discharged to each destination before a lower priority destination (level) is considered.

G1.2 Depending on the site characteristics, drainage from different parts of the site could have different drainage destinations.

Sustainable Drainage Systems Standards for Wales

G1.38 Provision should be made for separation and removal of sediments and oils before connection to a combined sewer.

G1.39 The possibility of the developer funding disconnection of surface water entering the combined sewer at locations either upstream or downstream of the site connection should be investigated with the sewerage undertaker and the local authority to mitigate the impact of the runoff into the sewer from the development.

Standard S2 – Surface water runoff hydraulic control

The aim of Standard S2 is to manage the surface water runoff from and on a site to protect people on the site from flooding from the drainage system for events up to a suitable return period, to mitigate any increased flood risk to people and property downstream of the site as a result of the development, and to protect the receiving water body from morphological damage.

S2 Surface water runoff hydraulic control

- 1) Surface water should be managed to prevent, so far as possible, any discharge from the site for the majority of rainfall events of less than 5mm.
- 2) The surface water runoff rate for the 1 in 1 year return period event (or agreed equivalent) should be controlled to help mitigate the negative impacts of the development runoff on the morphology and associated ecology of the receiving surface water bodies.
- 3) The surface water runoff (rate and volume) for the 1% (1 in 100 year) return period event (or agreed equivalent) should be controlled to help mitigate negative impacts of the development on flood risk in the receiving water body.
- 4) The surface water runoff for events up to the 1% (1 in 100 year) return period (or agreed equivalent) should be managed to protect people and property on and adjacent to the site from flooding from the drainage system.
- 5) The risks (both on site and off site) associated with the surface water runoff for events greater than the 1% (1 in 100 year) return period should be considered. Where the consequences are excessive in terms of social disruption, damage or risk to life, mitigating proposals should be developed to reduce these impacts.
- 6) Drainage design proposals should be examined for the likelihood and consequences of any potential failure scenarios (e.g. structural failure or

Standard S3 - Water Quality

Standard S3 addresses the drainage design requirements to minimise the potential pollution risk posed by the surface water runoff to the receiving water body.

S3 Surface water quality management

Treatment for surface water runoff should be provided to prevent negative impacts on the receiving water quality and/or protect downstream drainage systems, including sewers.

Guidance on Standard S3 - Water Quality

G3.1 Runoff from roads, commercial and other urban environments can, in particular, contain grit, sediments, oils and poly-aromatic hydrocarbons (PAHs), metals, and dissolved salts – each of which has the potential to cause pollution of receiving surface water or groundwater. SuDS can be effective at reducing a wide range of these pollutants through enabling sedimentation, filtration and a range of photolytic, chemical and biological processes.

G3.2 This Section provides guidance on Standard S3, which aims to ensure SuDS effectively manage sediment and other pollutants, ensuring discharges from the systems are of an acceptable quality and will not cause a pollution risk.

G3.3 The effective management of surface water runoff is essential, even if the receiving water body is already polluted. Consideration should be given to supporting current or future quality objectives for the water body over the lifetime of the development.

G3.4 The effectiveness of components in improving water quality is strongly linked to the reduction in the volume of runoff. Well-designed SuDS, designing for water quality management, should maximise volume reduction when designing conveyance and attenuation measures, preferably using vegetated, surface-based systems.

G3.5 This guidance does not supersede the requirements of the Water Framework and Groundwater Directives, but provides options for compliance in line with Natural Resources Wales advice.

Standard S4 - Amenity

Standard S4 addresses the design of SuDS components to ensure that, where possible, they enhance the provision of high quality, attractive public space which can help provide health and wellbeing benefits, they improve liveability for local communities and they contribute to improving the climate resilience of new developments.

S4 - Amenity

The design of the surface water management system should maximise amenity benefits.

Guidance on Standard S4 - Amenity

G4.1 The aim of standard S4 is to ensure that, wherever possible, and having regard to the need to prioritise infiltration drainage and rainwater harvesting (Standard S.1), the SuDS scheme makes the best contribution to development design by maximising benefits for amenity as well as for biodiversity, water quantity and quality.

G4.2 It is likely that multiple components will be required, linked in series across the site, to achieve a SuDS scheme that integrates well with the environment of a new development. Keeping water at or close to the ground surface will help to promote amenity benefits. Managing runoff at source will promote the use of smaller, distributed features, rather than large retention or detention features which are often inappropriate.

G4.3 A key aim for sustainable drainage is to provide an improved local environment which integrates the surface water drainage function with open space, providing amenity and recreation opportunities where possible. Examples of successful schemes in the UK and abroad are available²⁴. This Section (and Section 5 Biodiversity standard) provides guidance on how to ensure that SuDS can work for people and nature. This section shows how SuDS can add amenity value by contributing towards:

- making sites pleasant places to live or work;
- reducing hazards from climate change;
- creation of amenity space - contributing to green space accessibility standards; and
- promoting the well-being of site users.

²⁴ www.susdrain.org

Standard S5 - Biodiversity

Standard S5 addresses the design of SuDS to ensure, where possible, they create ecologically rich green and blue corridors in developments and enrich biodiversity value by linking networks of habitats and ecosystems together. Biodiversity should be considered at the early design stage of a development to ensure the potential benefits are maximised.

S5 - Biodiversity

The design of the surface water management system should maximise biodiversity benefits.

Guidance on Standard S5 - Biodiversity

G5.1 The aim of standard S5 is to ensure that, wherever possible, and having regard to the need to prioritise infiltration drainage and rainwater harvesting, the SuDS scheme makes the best use of a site to maximise benefits for biodiversity, as well as for amenity, water quantity and quality. Biodiversity benefits will usually be best achieved by drainage systems which are on the surface and visible with vegetated components, forming part of the local green infrastructure and local ecosystem structure. It is important to ensure that the SuDS design does not damage existing sensitive habitats. Amenity is addressed by Standard S4.

G5.2 The provision of biodiversity enhancement in developments is a requirement of Planning Policy Wales and Technical Advice Note (TAN) 5²⁸.

G5.3 A key aim for sustainable drainage is to provide an improved local environment which integrates the surface water drainage function with open space providing habitat opportunities where possible. This Standard and Standard 4 (Amenity) provide guidance on how to ensure that SuDS can work for people and nature. SuDS can add biodiversity value by:

- Supporting and promoting natural local habitat and species,
- Contributing to the delivery of local biodiversity objectives,
- Contributing to habitat connectivity, delivering wider biodiversity benefits,
- Creating diverse, self-sustaining, resilient local ecosystems.

²⁸ TAN 5 Nature Conservation and Development
<http://gov.wales/topics/planning/policy/tans/tan5/?lang=en>

Standard S6 – Design of drainage for Construction, Operation and Maintenance and Structural Integrity

Standard S6 deals with designing robust surface water drainage systems so they can be easily and safely constructed, maintained and operated, taking account of the need to minimise negative impacts on the environment and natural resources.

S6 – Design of drainage for Construction, Operation and Maintenance

- 1) All elements of the surface water drainage system should be designed so that they can be constructed easily, safely, cost-effectively, in a timely manner, and with the aim of minimising the use of scarce resources and embedded carbon (energy).
- 2) All elements of the surface water drainage system should be designed to ensure maintenance and operation can be undertaken (by the relevant responsible body) easily, safely, cost-effectively, in a timely manner, and with the aim of minimising the use of scarce resources and embedded carbon (energy).
- 3) The surface water drainage system should be designed to ensure structural integrity of all elements under anticipated loading conditions over the design life of the development site, taking into account the requirement for reasonable levels of maintenance.

Guidance on Standard S6 – Design of drainage for Construction, Operation and Maintenance

Construction

G6. 1 The design should take full account of the method of construction, including any specific programming requirements, to minimise the potential for poor construction of any drainage component. For phased developments, the design should indicate how SuDS features will be managed, protected and commissioned, especially where their use may change through the construction programme. The SuDS Manual includes detailed guidance on planning a SuDS scheme.

G6.2 The Construction (Design and Management) Regulations 2015 include requirements for designers to take account of the health and safety risks

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APPENDIX B: NRW INFORMATION & CORRESPONDENCE

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Megan Berry

From: Megan Berry
Sent: 14 December 2020 09:08
To: 'datadistribution@cyfoethnaturiolcymru.gov.uk'
Subject: Product 5 & 6
Attachments: LOCATION PLAN.pdf

To whom it may concern,

Rossett Rd, Rossett

Please could you confirm whether you have any information that you feel would be valuable to a Flood Risk Assessment and Drainage Management Strategy for the above site (location plan attached), including details of historical flooding and Specific Drainage Requirements; this would be greatly appreciated. If there are any other specific requirements that you require in a scope of works for this site please can you advise at this stage so that it can be fully incorporated into the proposals at an early stage.

Please do not hesitate to contact me on the details below to discuss further should you require additional information or clarification.

Kind Regards

Megan Berry BSc(Hons) MCIWEM
Graduate Flood Risk Analyst

BETTS HYDRO

Consulting Engineers

Old Marsh Farm Barns, Welsh Road, Sealand, Flintshire, CH5 2LY
Chester +44 (0)1244 289041

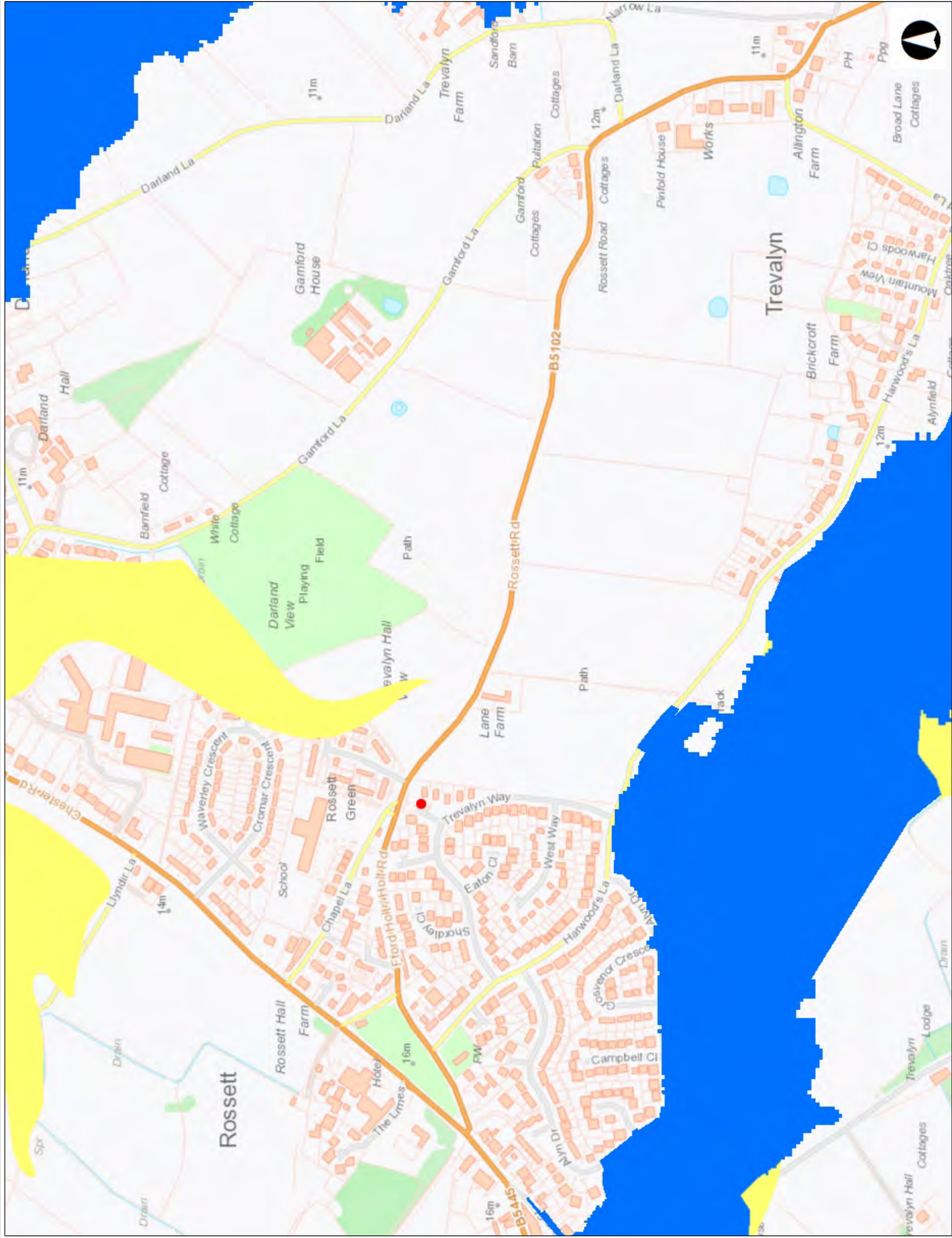
meganberry@betts-associates.co.uk
www.betts-associates.co.uk

CIVIL | STRUCTURAL | GEO-ENVIRONMENTAL | HYDROLOGY | FLOOD RISK MANAGEMENT
SUDS | STRUCTURAL SURVEYS | PARTY WALL DUTIES | INFILTRATION | GEOTECHNICAL

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Flood Risk Map from Rivers

Allwedd / Map Key

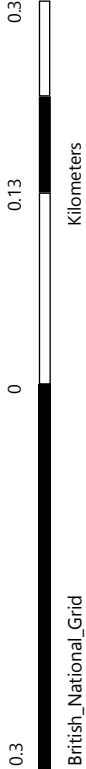
Flood Risk from Rivers - Extent

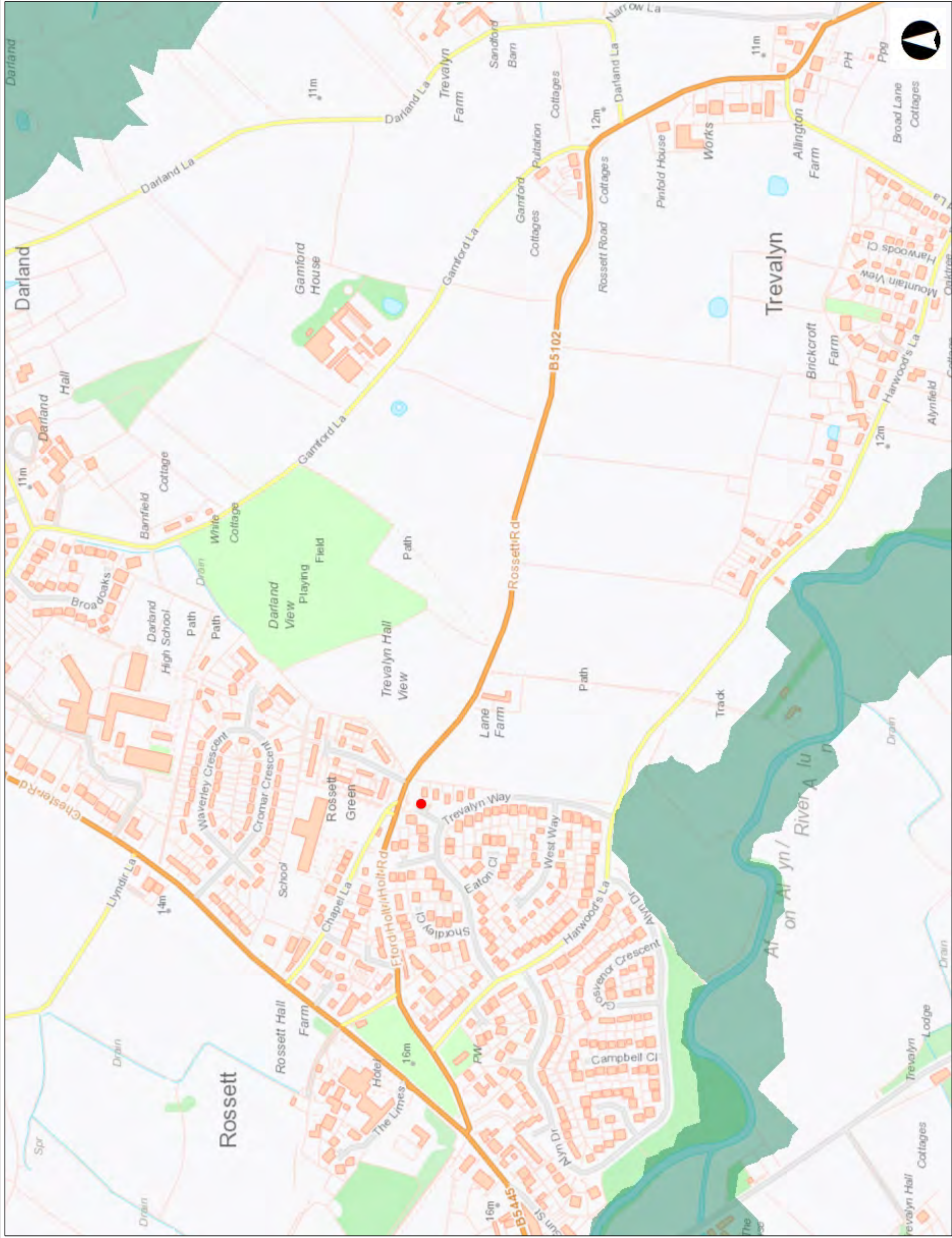
- High
- Medium
- Low

Graddfa / Scale at A3 1: 5,000

Dyddiad / Date
07/01/2021

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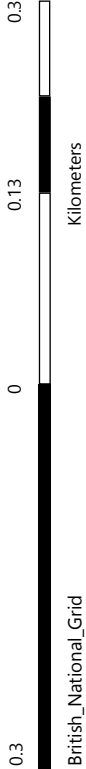
FLOOD RISK FROM RESERVOIR

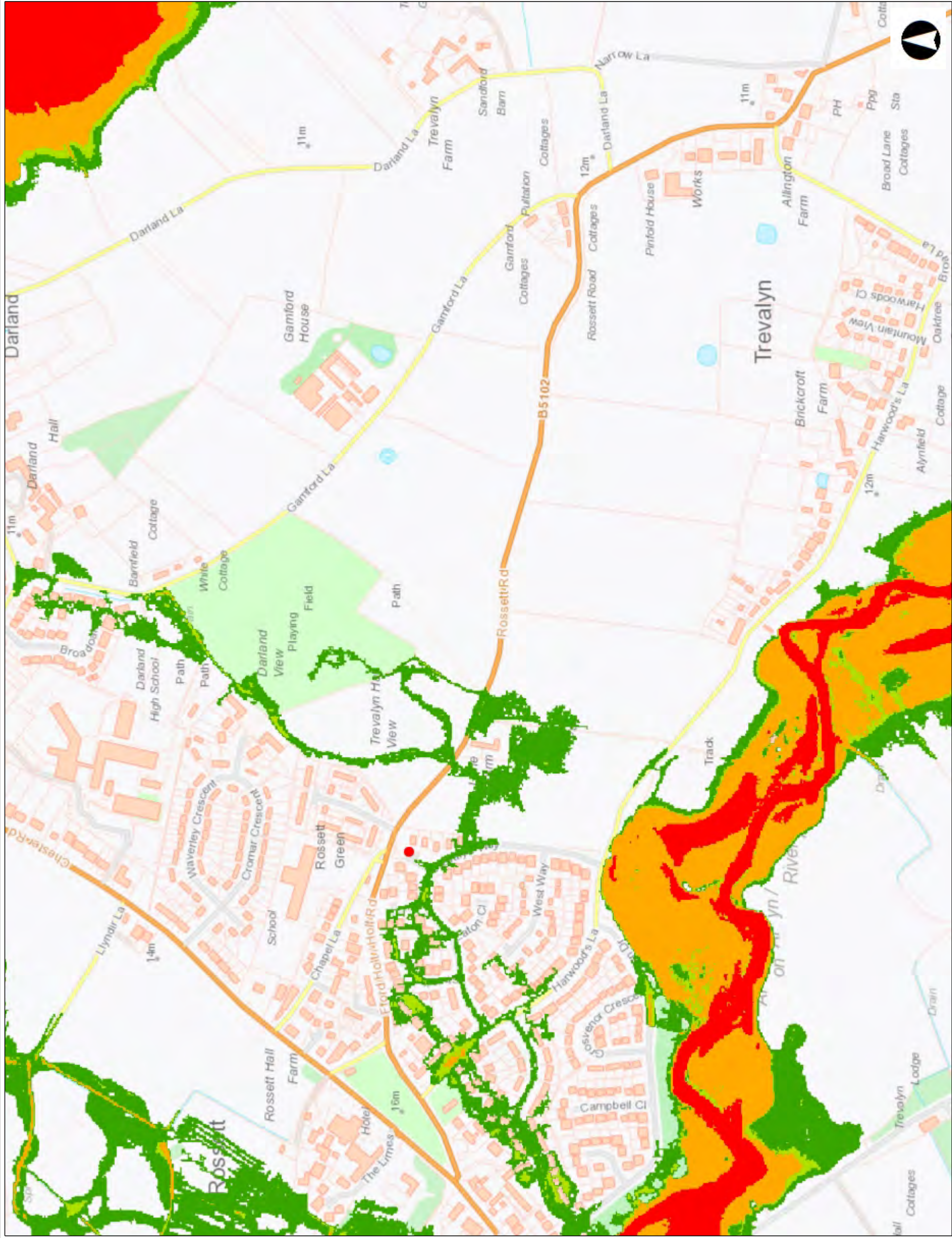
Allwedd / Map Key
Flood Risk from Reservoirs

Graddfa / Scale at A3 1: 5,000

Dyddiad / Date
18/12/2020

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National Flood Risk Map from Rivers - Hazard

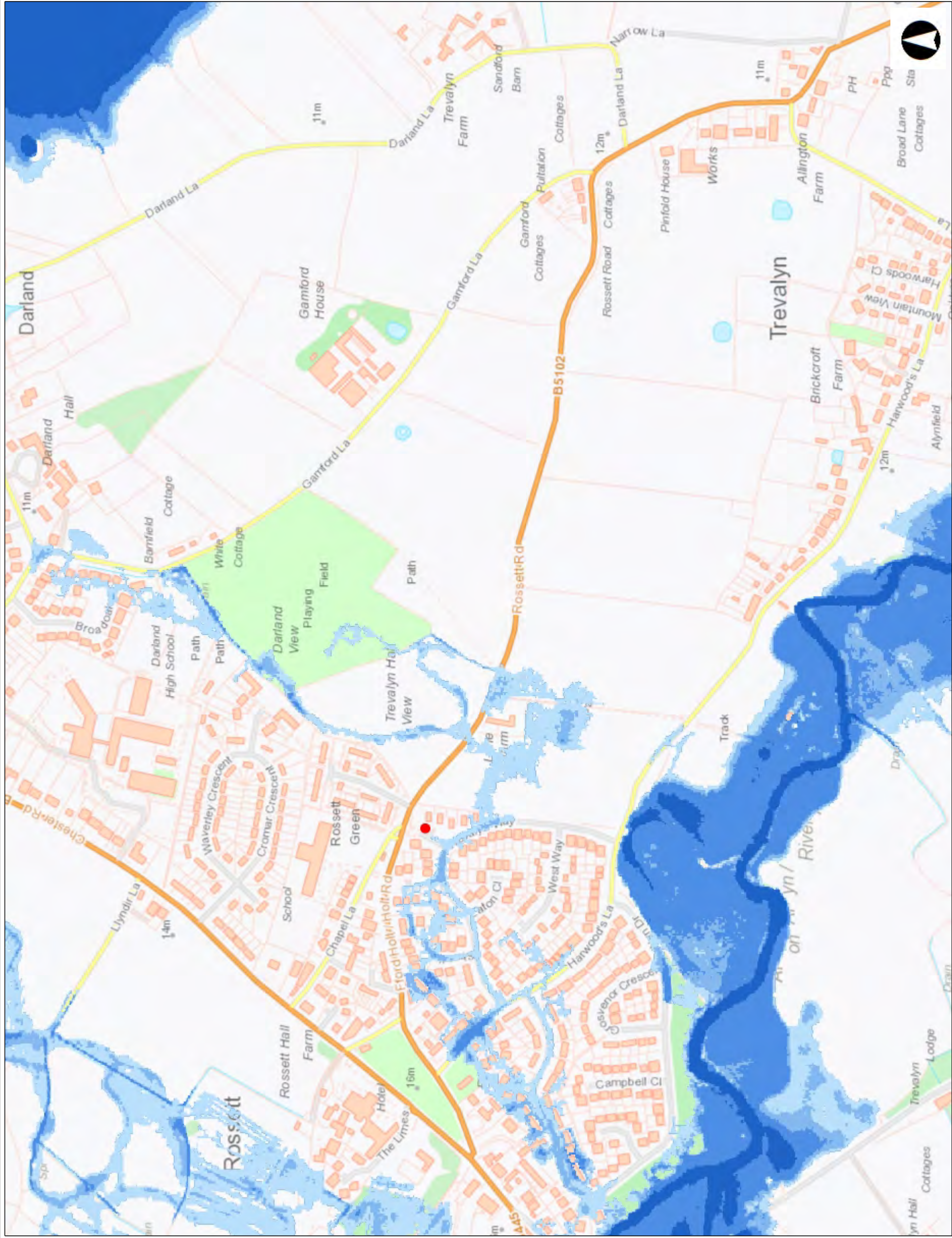
Allwedd / Map Key

Rivers Hazard - Low Risk

- Low
- Danger for Some
- Danger for Most
- Danger for All

Graddfa / Scale at A3 1: 5,000

Dyddiad / Date
07/01/2021

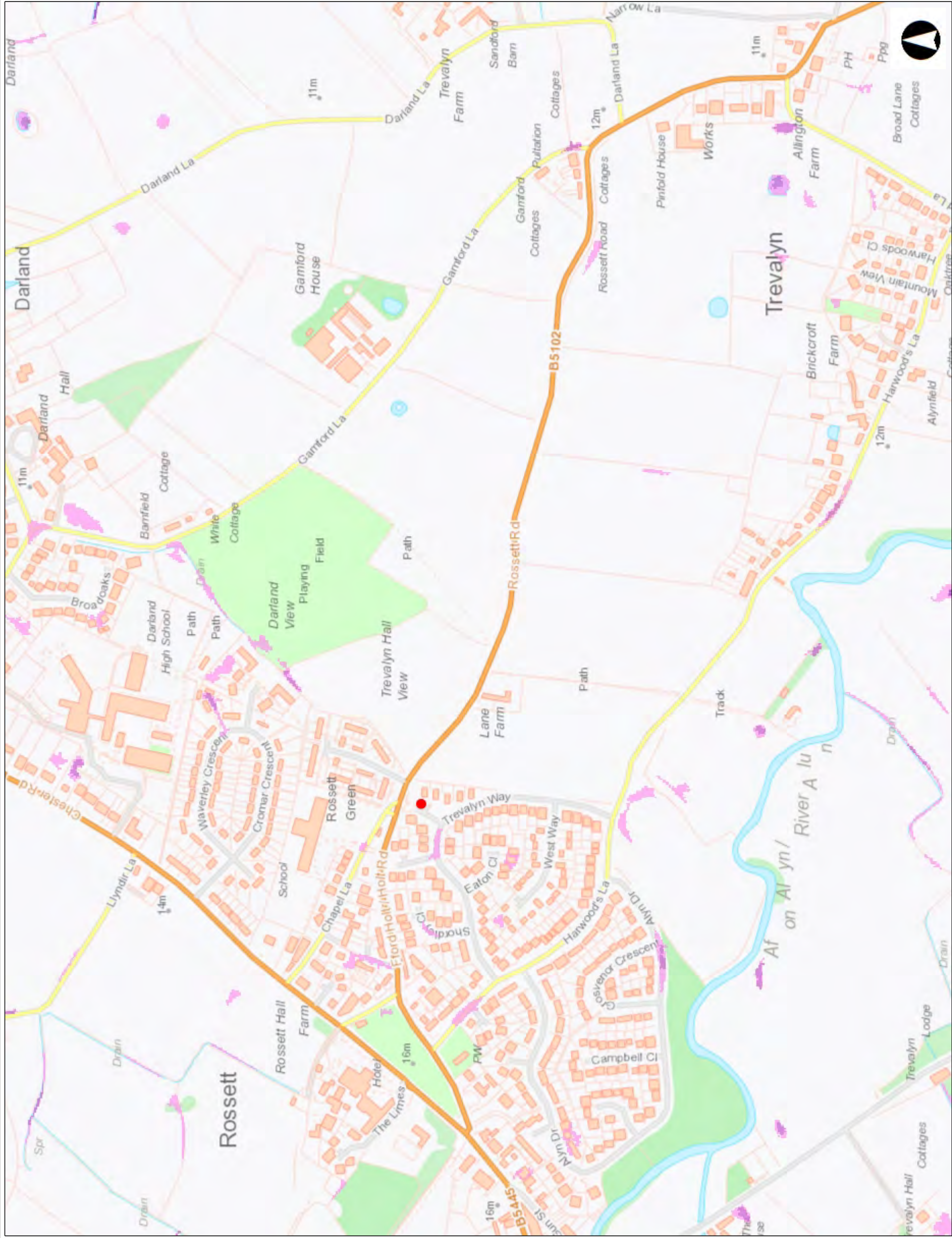


National Flood Risk Map from Rivers - Depth

- Allwedd / Map Key
- Rivers Depth - Low Risk
- Less than 0.15m
 - 0.15 - 0.30m
 - 0.30 - 0.90m
 - Greater than 0.9m

Graddfa / Scale at A3 1: 5,000

Dyddiad / Date
07/01/2021



FLOOD RISK FROM SURFACE WATER

Allwedd / Map Key

Flood Risk from Surface Water & Small Watercourses - Extent

- High
- Medium
- Low

Graddfa / Scale at A3 1: 5,000

Dyddiad / Date
18/12/2020

APPENDIX C: WW SEWER RECORDS & CORRESPONDENCE

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Megan Berry

From: Environmental Information Requests <EnvironmentalInformationRequests@dwrcymru.com>
Sent: 04 January 2021 15:35
To: Megan Berry
Subject: Request for Information - Sewer Flood Risk
Attachments: LOCATION PLAN.pdf

Our Reference: EIR/646/2020

Dear Ms Berry,

Request for information

We write further to your request for information dated 14th December 2020, which we have been considering under the Environmental Information Regulations 2004.

We can confirm that we have reviewed our flooding database and have no flood risks reported to us on our sewerage network in this postcode or in the vicinity of the development site.

Turning to your query on specific drainage requirements, we have a dedicated Planning Team within our Developer Services function that can provide advice on the capacity in our infrastructure to accommodate new development.

Our pre-planning service will review the capacity available in our sewerage network, wastewater treatment works and clean water network to accommodate the flows/demand from a proposed development. It will also raise awareness of any of our assets crossing the site which will need to be factored into the layout of your development and provide general advice on surface water drainage.

An application for pre-planning advice can be submitted online via the following address <https://developers.dwrcymru.com/en/applications/planning/pre-planning>. If you wish to discuss in more detail our Planning Team are contactable on 08009172652 or alternatively by email developer.services@dwrcymru.com.

We hope that this response is clear. Should you have any questions, please contact us by email at EnvironmentalInformationRequests@dwrcymru.com.

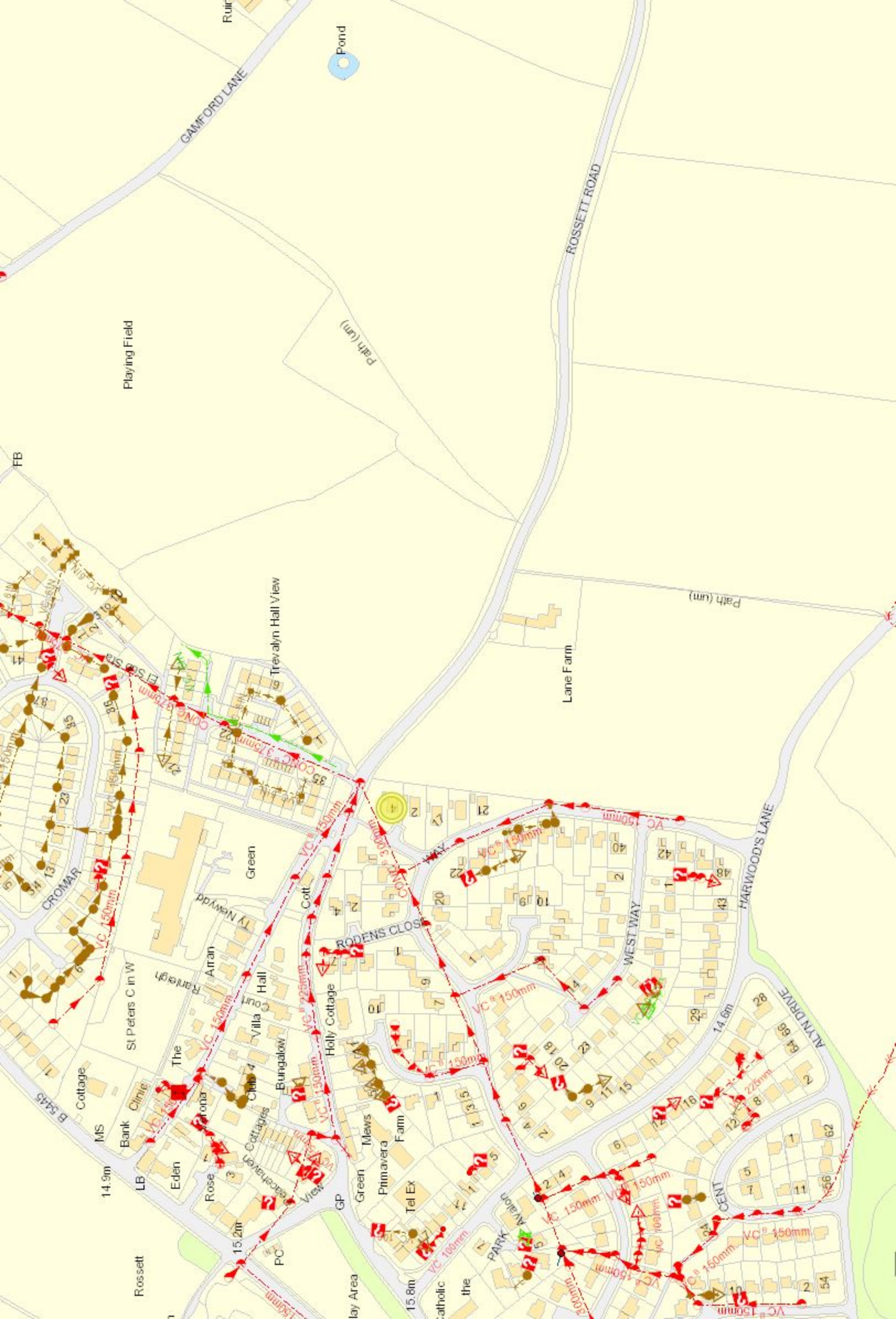
If you are dissatisfied with the handling of your request, you have the right to ask for an internal review. Internal review requests should be submitted within 40 working days of the date of receipt of this response and should be addressed to Company Secretary, Pentwyn Road, Nelson, Treharris, Mid Glamorgan, CF46 6LY.

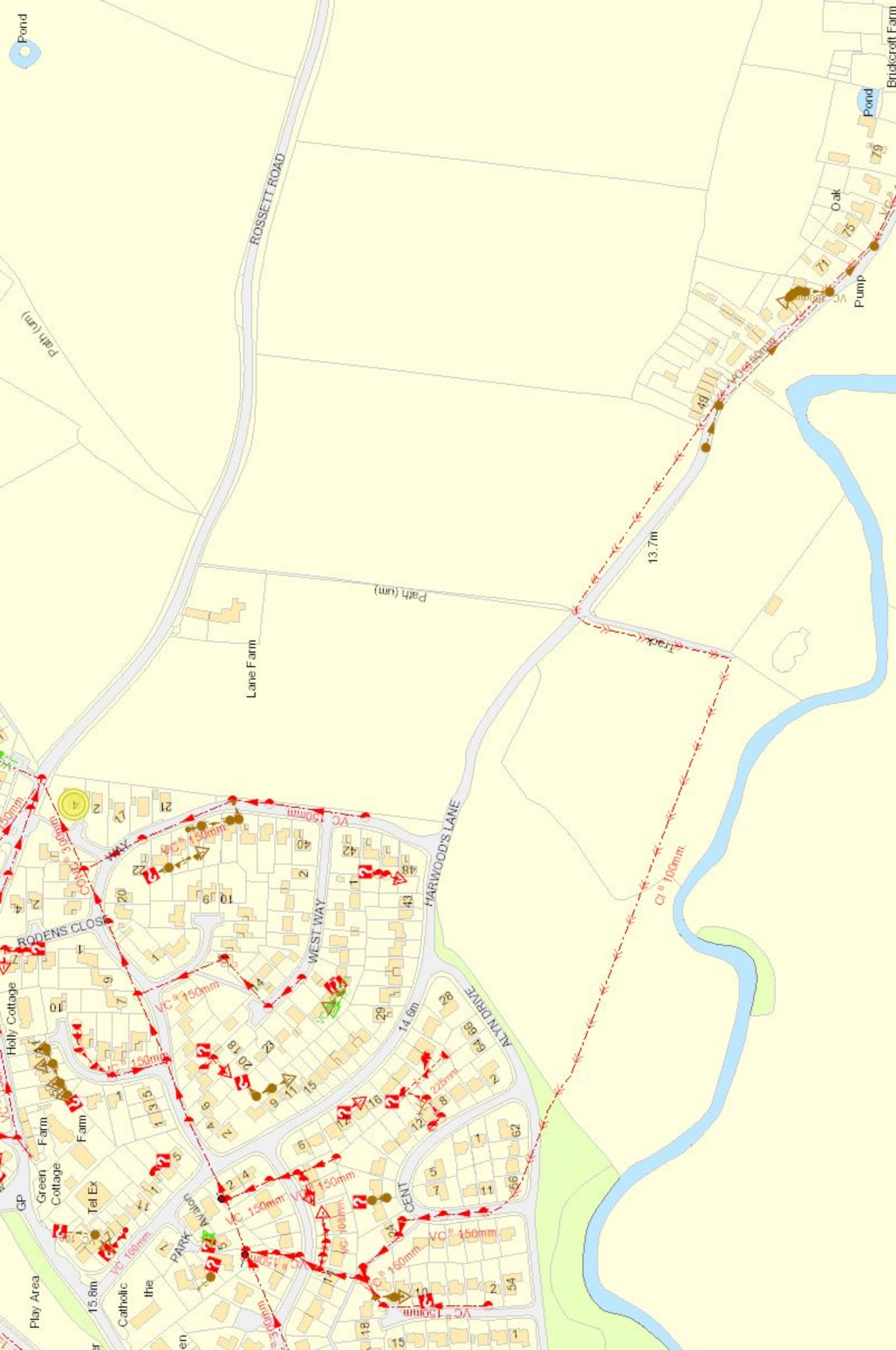
If you are not content with the outcome of the internal review, you have the right to apply directly to the Information Commissioner for a decision.

Yours sincerely,

R.Stevens

Dŵr Cymru Welsh Water





APPENDIX D: LLFA CORRESPONDENCE

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Megan Berry

From: Megan Berry
Sent: 14 December 2020 09:09
To: 'planning@wrexham.gov.uk,'
Subject: Flood Risk and SAB Information
Attachments: LOCATION PLAN.pdf

To whom it may concern,

Rossett Rd, Rossett

Please could you confirm whether you have any information that you feel would be valuable to a Flood Risk Assessment and Drainage Management Strategy for the above site (location plan attached), including details of historical flooding and Specific Drainage Requirements; this would be greatly appreciated. If there are any other specific requirements that you require in a scope of works for this site please can you advise at this stage so that it can be fully incorporated into the proposals at an early stage.

Please do not hesitate to contact me on the details below to discuss further should you require additional information or clarification.

Kind Regards

Megan Berry BSc(Hons) MCIWEM
Graduate Flood Risk Analyst

BETTS HYDRO

Consulting Engineers

Old Marsh Farm Barns, Welsh Road, Sealand, Flintshire, CH5 2LY
Chester +44 (0)1244 289041

meganberry@betts-associates.co.uk
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CIVIL | STRUCTURAL | GEO-ENVIRONMENTAL | HYDROLOGY | FLOOD RISK MANAGEMENT
SUDS | STRUCTURAL SURVEYS | PARTY WALL DUTIES | INFILTRATION | GEOTECHNICAL

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APPENDIX E: LOCATION PLAN

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LOCATION PLAN

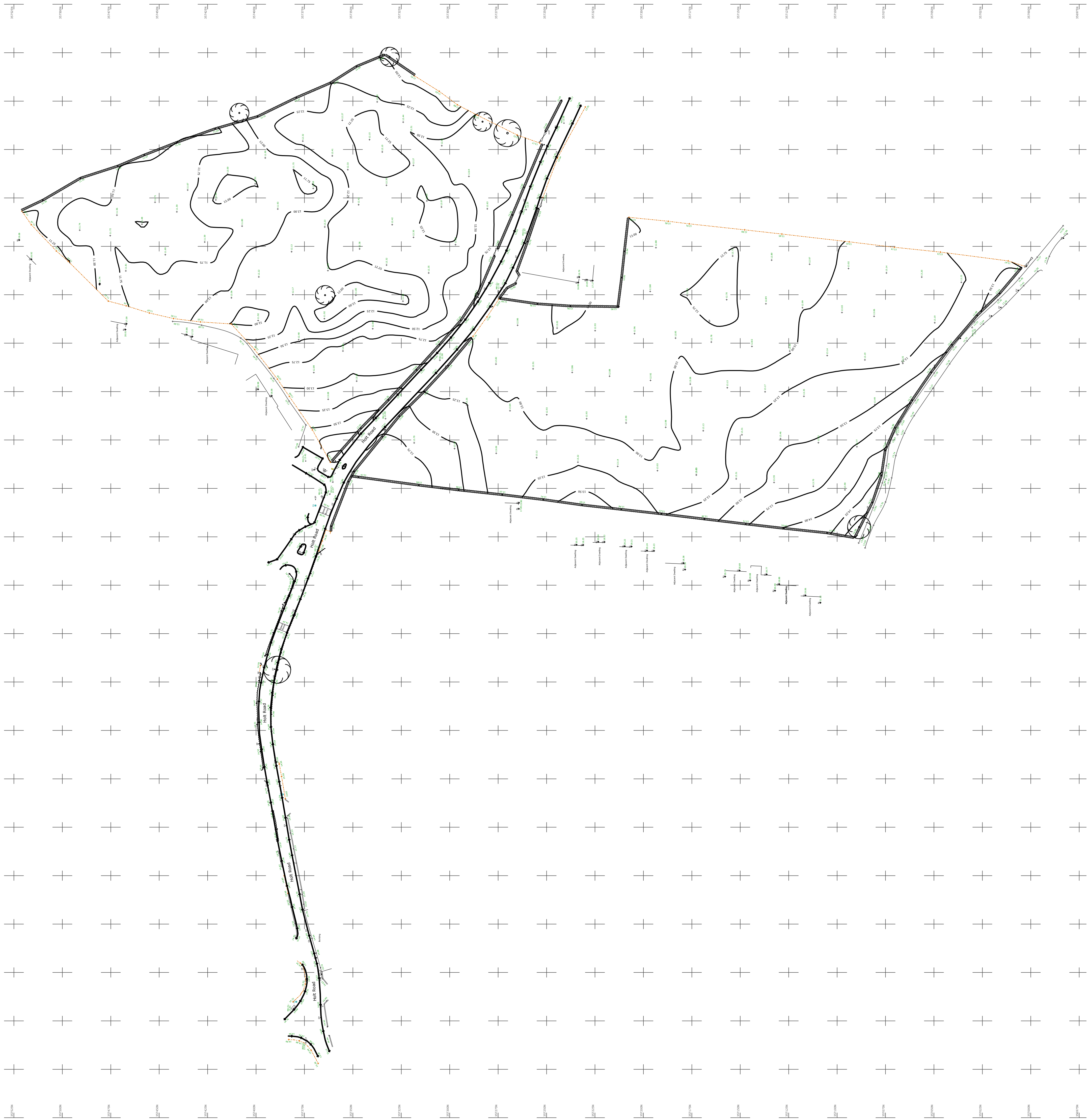
ROSSETT ROAD, WREXHAM



OS X (Eastings)	337284
OS Y (Northings)	357242
Nearest Post Code	LL12 0DZ
Lat (WGS84)	N53:06:31 (53.108663)
Long (WGS84)	W2:56:18 (-2.938311)
Lat, Long	53.108663, -2.938311
Nat Grid	SJ372572 / SJ3728457242
mX	-327091
mY	6968925

APPENDIX F: TOPOGRAPHIC SURVEY

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APPENDIX G: PROPOSED PLANNING LAYOUT

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SCHEDULE OF ACCOMMODATION



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•

•

•



Castle Green,
Unit 20,
St. Asaph Business Park,
Fordd Richard Davies, St Asaph,
Denbighshire. LL17 0LJ.
Tel. 01745 536677

Site: Rossett Road, Rossett

Title: **Site Layout**

Scale: 1:500@A0

APPENDIX H: INFILTRATION REPORTS AND RESULTS

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20MCB019/JS/LR1

28th October 2020

FAO Ryan Dodd
Design Engineer
MacBryde Homes

Dear Ryan,

Holt Road, Rossett – Additional Soakaway Testing Results

Introduction

Client furnished third party information regarding soakaways was provided for review.

Infiltration testing was undertaken on the site by Waterco in 2015 (report reference: w1938-151014 – Infiltration Report) and concluded that soakaway drainage would be a feasible option for surface water disposal. No groundwater was encountered in any of these pits however the soakaways were only shallow (circa 1m depth).

E3P then undertook a Site Investigation in May 2020 (report reference: 14-116-R2-1 June 2020) and encountered groundwater in the majority of holes at depths between 0.50mbgl – 2.50mbgl. The did however, conclude that soakaway drainage would be a feasible option for surface water disposal from the site (except on the area of clay).

During to the groundwater levels encountered during the E3P fieldwork, Betts Geo were commissioned by MacBryde Homes to undertake additional soakaway tests at the site at a deeper depth than those previously done by Waterco. This would allow the client to see if deeper soakaways were a viable option and allow a greater understanding of groundwater conditions on site.

This letter report should be read in conjunction with the reports referenced above.

Fieldwork

The additional soakaway testing was undertaken on the 26th and 27th October 2020 and involved the following:

- Six (6 No) soakaway positions dug to between 1.30mbgl – 1.80mbgl.
- Four (4 No) trial pits taken to depths of between 1.90mbgl – 2.10mbgl to assess the stability of the deeper sands and gravels.

All infiltration tests were undertaken in general accordance with BRE365 and positions were agreed between Betts Geo, MacBryde Homes and Waterco.



Old Marsh Farm Barns
Welsh Road, Sealand
Flintshire CH5 2LY
Telephone: 01244 288 179
Fax: 01244 288 516

www.betts-associates.co.uk

Ground Conditions Encountered

As with the previous ground investigation, ground conditions generally consisted of sands and gravels to depth with localized clays and sandy clays. Groundwater was encountered in the majority of holes between depths of 1.20mbgl – 1.90mbgl. Only SA03 was recorded as dry during the time of the investigation.

Pit stability was often recorded as unstable within the SANDS & GRAVELS and instability increased with depth. As such the tests whilst undertaken in general accordance with BRE365 are not deemed to be fully compliant.

Results of Infiltration Testing

Three out of the six soakaway holes has two re-fills (three fills in total), however SA01, SA05 and SA06 had no re-fills (1 fill in total). The last test within SA02 had to be terminated due to major collapse of the pit. Full details can be found on the attached logs.

Poor infiltration rates were encountered in the following holes due to the following reasons:

- SA01 (1 fill) – Groundwater ingress to 1.18mbgl before test began.
- SA05 (1 fill) – Groundwater ingress to 0.96mbgl before test began.
- SA06 (1 fill) – Groundwater ingress to 0.80mbgl before test began.

The following range of infiltration rates were encountered across the site: 1.2×10^{-4} to 7.3×10^{-5} .

The recorded infiltration rates indicate that the adoption of soakaways is a potential viable drainage solution across certain areas of the site (subject to drainage design and regulatory approval), and as such the additional testing should help progress the drainage design and development layout.

We trust the above meets your requirements and should you or LCC have any questions please do not hesitate to contact us

Yours sincerely



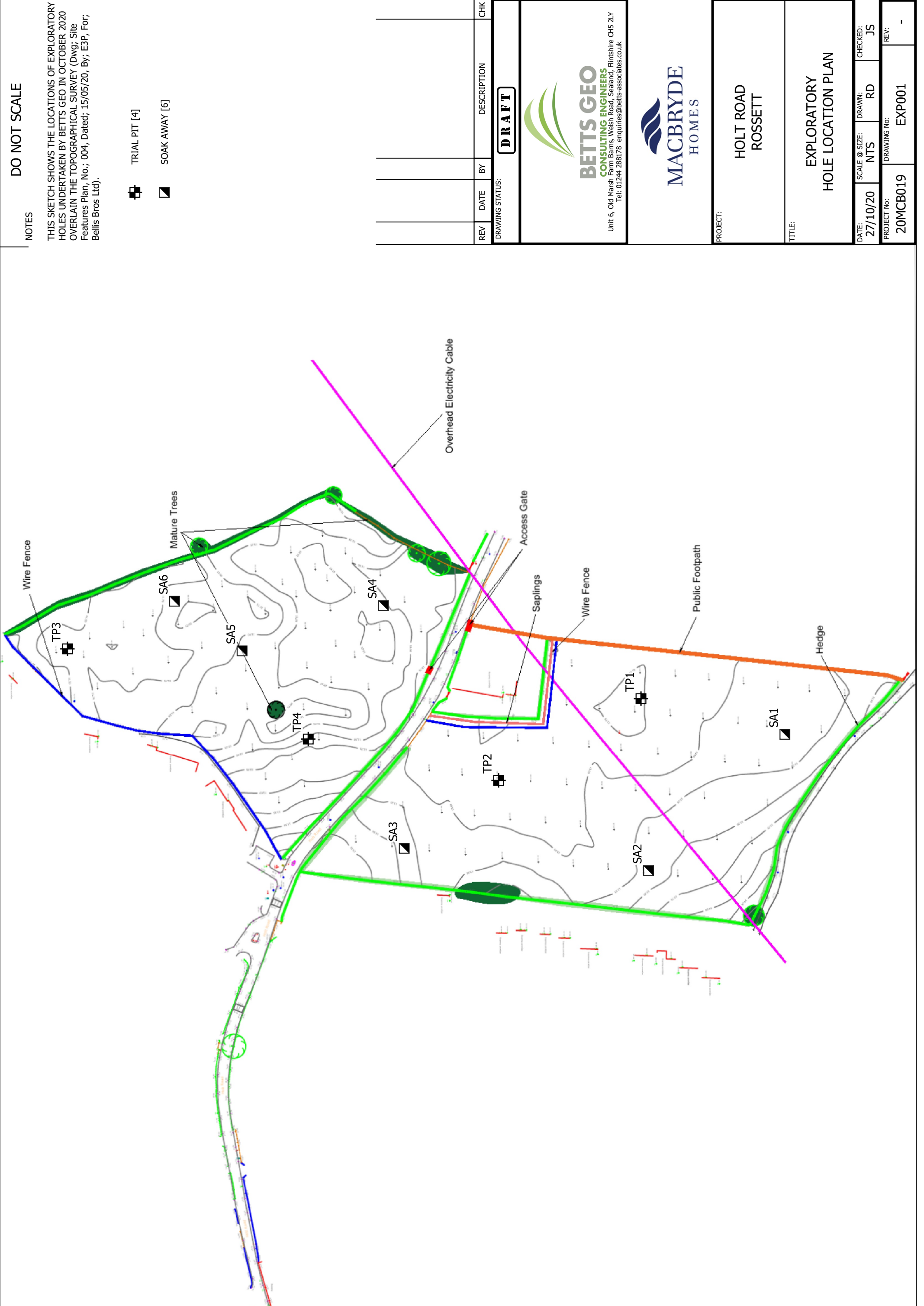
Jenny Skues
Senior Geo-Environmental Engineer
BETTS GEO ENVIRONMENTAL

Encs. Locations of Further Infiltration Tests and results.



Old Marsh Farm Barns
Welsh Road, Sealand
Flintshire CH5 2LY
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Fax: 01244 288 516

www.betts-associates.co.uk



DO NOT SCALE

NOTES

THIS SKETCH SHOWS THE LOCATIONS OF EXPLORATORY HOLES UNDERTAKEN BY BETTS GEO IN OCTOBER 2020 OVERLAIN THE TOPOGRAPHICAL SURVEY (Dwg; Site Features Plan, No.; 004, Dated; 15/05/20, By; E3P, For; Bellis Bros Ltd).

-  TRIAL PIT [4]
-  SOAK AWAY [6]

REV	DATE	BY	DESCRIPTION	CHK
DRAWING STATUS: DRAFT				



BETTS GEO
CONSULTING ENGINEERS
Unit 6, Old Marsh Farm Barns, Welsh Road, Sealand, Flintshire CH5 2LY
Tel: 01244 288178 enquiries@betts-associates.co.uk



MACBRYDE
HOMES

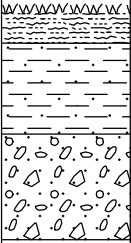
PROJECT: HOLT ROAD
ROSSETT

TITLE: EXPLORATORY
HOLE LOCATION PLAN

DATE: 27/10/20	SCALE @ SIZE: NTS	DRAWN: RD	CHECKED: JS
PROJECT No: 20MCB019		DRAWING No: EXP001	
REV:		-	

TRIAL PIT LOG

Project Holt Road, Rossett				TRIAL PIT No SA1
Job No 20MCB019	Date 26-10-20	Ground Level (m)	Co-Ordinates ()	
Contractor BETTS GEO Ltd				Sheet 1 of 1

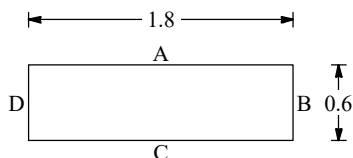
0	A	B	C	D	0	Legend 
1					1	
2					2	
3					3	
4					4	

STRATA

SAMPLES & TESTS

Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.30		Harvested crop over TOPSOIL: Dark brown clayey SAND. Occasional rootlets.			
0.30-0.90		Firm light brown very sandy CLAY. Frequent sand pockets. Becomes orangish brown with depth.			
0.90-1.60		Medium dense grey slightly silty fine to coarse SAND & GRAVEL of various lithologies. Gravel is sub angular to sub rounded.			
		Groundwater ingress.			

Shoring/Support:
Stability: Collapse below 0.90mbgl.



GENERAL REMARKS

Moderate groundwater ingress at 1.40mbgl. Rising to 1.18m before soakaway test was undertaken.

All dimensions in metres
Scale 1:50

Client MacBryde Homes

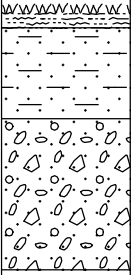
Method/
Plant Used

JCB 3CX

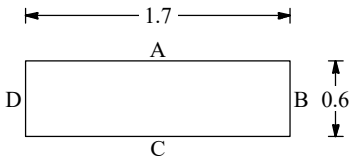
Logged By
JS

TRIAL PIT LOG

Project Holt Road, Rossett				TRIAL PIT No SA2
Job No 20MCB019	Date 26-10-20	Ground Level (m)	Co-Ordinates ()	
Contractor BETTS GEO Ltd				Sheet 1 of 1

A		B		C		D		Legend	
0								0	
1								1	
2								2	
3								3	
4								4	

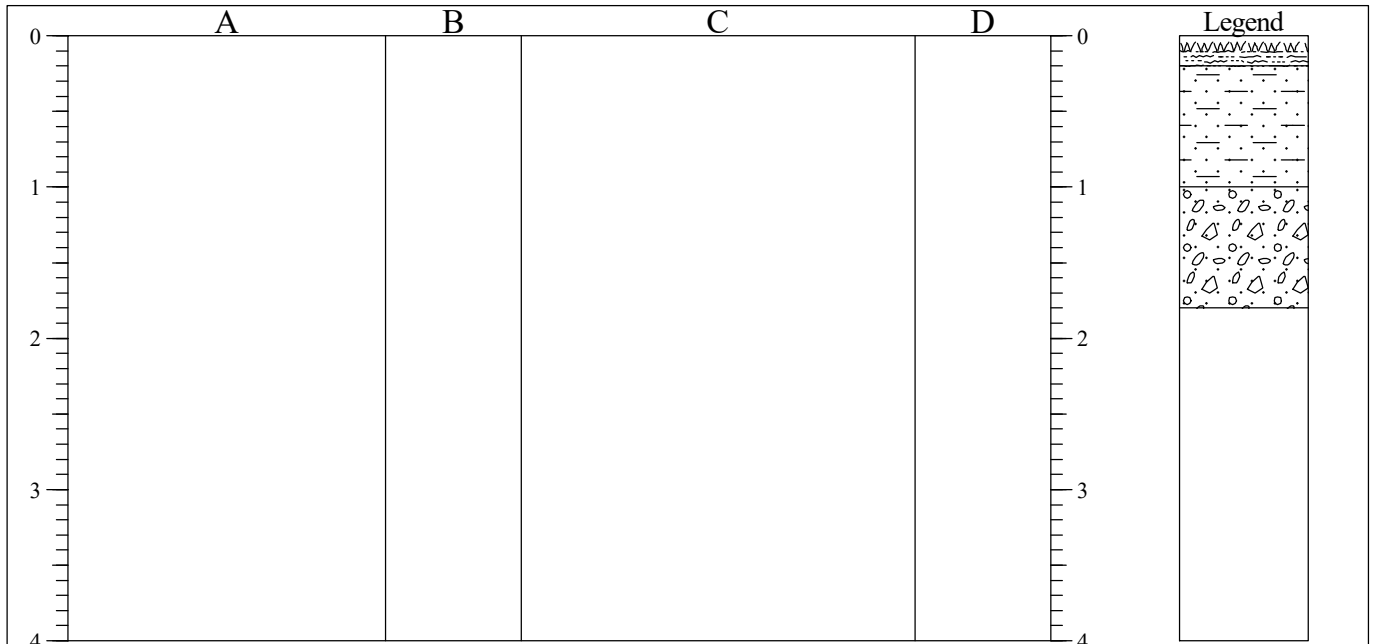
STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.20		Harvested crop over TOPSOIL: Dark brown clayey SAND. Occasional rootlets.			
0.20-0.80		Medium dense brown clayey fine to coarse SAND.			
0.80-1.80		Medium dense brown cobblely fine to coarse SAND & GRAVEL of various lithologies. Gravel is sub angular to sub rounded.			
		Groundwater ingress.			

Shoring/Support: Stability: Collapse below 0.80mbgl. 				GENERAL REMARKS Slow groundwater ingress at 1.80mbgl. Rising to 1.70mbgl before soakaway testing commenced.	
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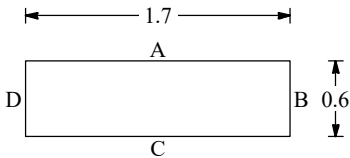
All dimensions in metres Scale 1:50	Client MacBryde Homes	Method/ Plant Used JCB 3CX	Logged By JS
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TRIAL PIT LOG

Project Holt Road, Rossett				TRIAL PIT No SA3
Job No 20MCB019	Date 26-10-20	Ground Level (m)	Co-Ordinates ()	
Contractor BETTS GEO Ltd				Sheet 1 of 1



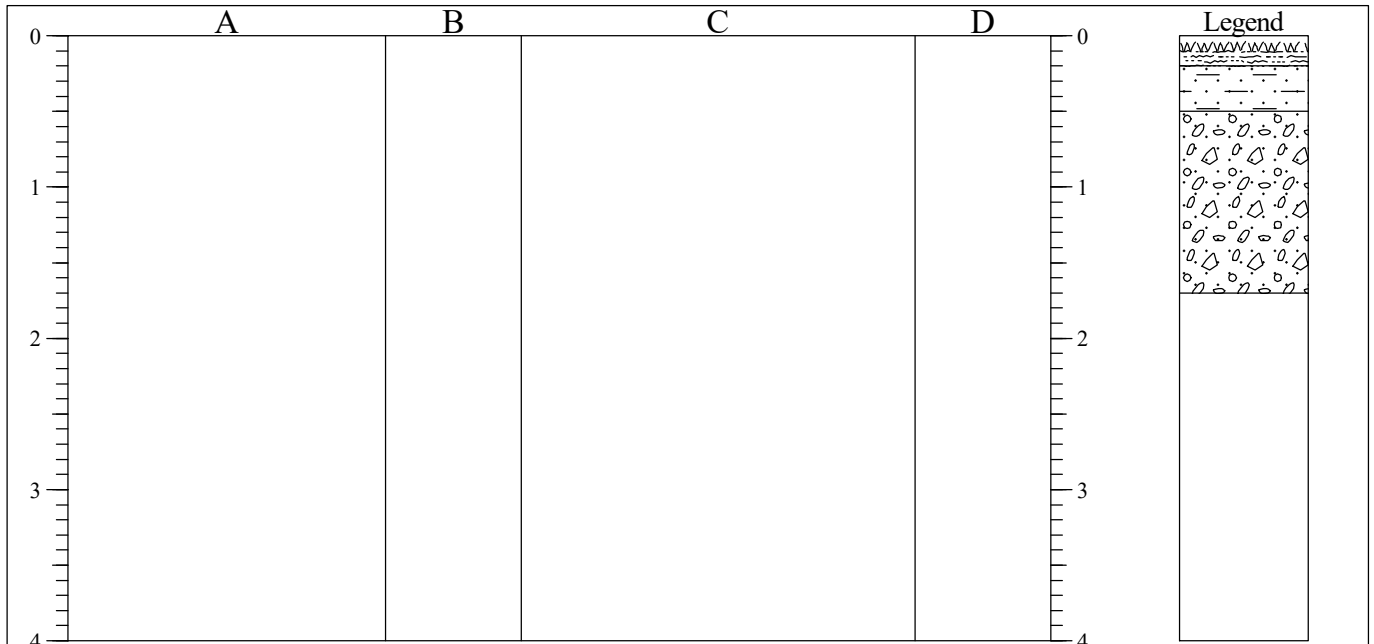
STRATA				SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests	
0.00-0.20		Harvested crop over TOPSOIL: Dark brown clayey SAND. Occasional rootlets.				
0.20-1.00		Firm brown very sandy CLAY. Frequent sand pockets.				
1.00-1.80		Medium dense to dense dark brown cobbly fine to coarse SAND & GRAVEL of various lithologies. Gravel is sub angular to sub rounded.				

Shoring/Support: Stability: Slight collapse in SAND & GRAVELS.  N ↑ ↓	GENERAL REMARKS Dry.
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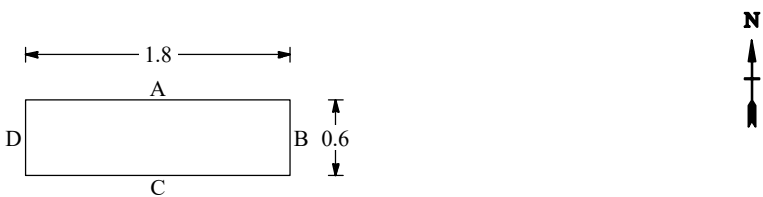
All dimensions in metres Scale 1:50	Client MacBryde Homes	Method/ Plant Used JCB 3CX	Logged By JS
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TRIAL PIT LOG

Project Holt Road, Rossett				TRIAL PIT No SA4
Job No 20MCB019	Date 27-10-20	Ground Level (m)	Co-Ordinates ()	
Contractor BETTS GEO Ltd				Sheet 1 of 1



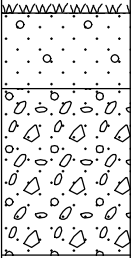
STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.20		Grass over TOPSOIL: Dark brown slightly clayey SAND.			
0.20-0.50		Medium dense brown slightly cobbley very gravelly fine to coarse SAND.			
0.50-1.70		Medium dense brown slightly cobbley SAND & GRAVEL of various lithologies. Gravel is sub angular to sub rounded.			
		Groundwater ingress.			

Shoring/Support: Stability: Slight collapse in SAND & GRAVELS.		GENERAL REMARKS Slow groundwater ingress at very base of pit.
		

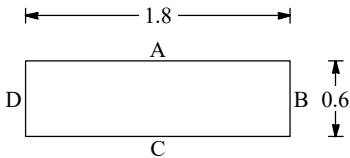
All dimensions in metres Scale 1:50	Client MacBryde Homes	Method/ Plant Used JCB 3CX	Logged By JS
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TRIAL PIT LOG

Project Holt Road, Rossett				TRIAL PIT No SA5
Job No 20MCB019	Date 27-10-20	Ground Level (m)	Co-Ordinates ()	
Contractor BETTS GEO Ltd				Sheet 1 of 1

A		B		C		D		Legend	
0								0	
1								1	
2								2	
3								3	
4								4	

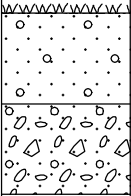
STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.10		Grass over TOPSOIL: Dark brown slightly clayey SAND.			
0.10-0.60		Medium dense brown slightly gravelly fine to coarse SAND.			
0.60-1.70		Medium dense brown/dark brown slightly cobbly slightly silty fine to medium SAND & GRAVEL of various lithologies. Gravel is sub angular to sub rounded. Wet.			
		1.50 Groundwater ingress.			

Shoring/Support: Stability: Major collapse below 0.60mbgl. 				GENERAL REMARKS Fast groundwater ingress at 1.50mbgl. Rising to 0.96mbgl before soakaway testing commenced.	
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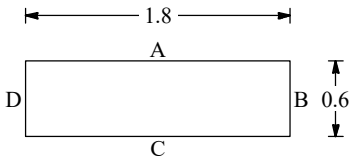
All dimensions in metres Scale 1:50	Client MacBryde Homes	Method/ Plant Used JCB 3CX	Logged By JS
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TRIAL PIT LOG

Project Holt Road, Rossett				TRIAL PIT No SA6
Job No 20MCB019	Date 27-10-20	Ground Level (m)	Co-Ordinates ()	
Contractor BETTS GEO Ltd				Sheet 1 of 1

A		B		C		D		Legend	
0								0	
1								1	
2								2	
3								3	
4								4	

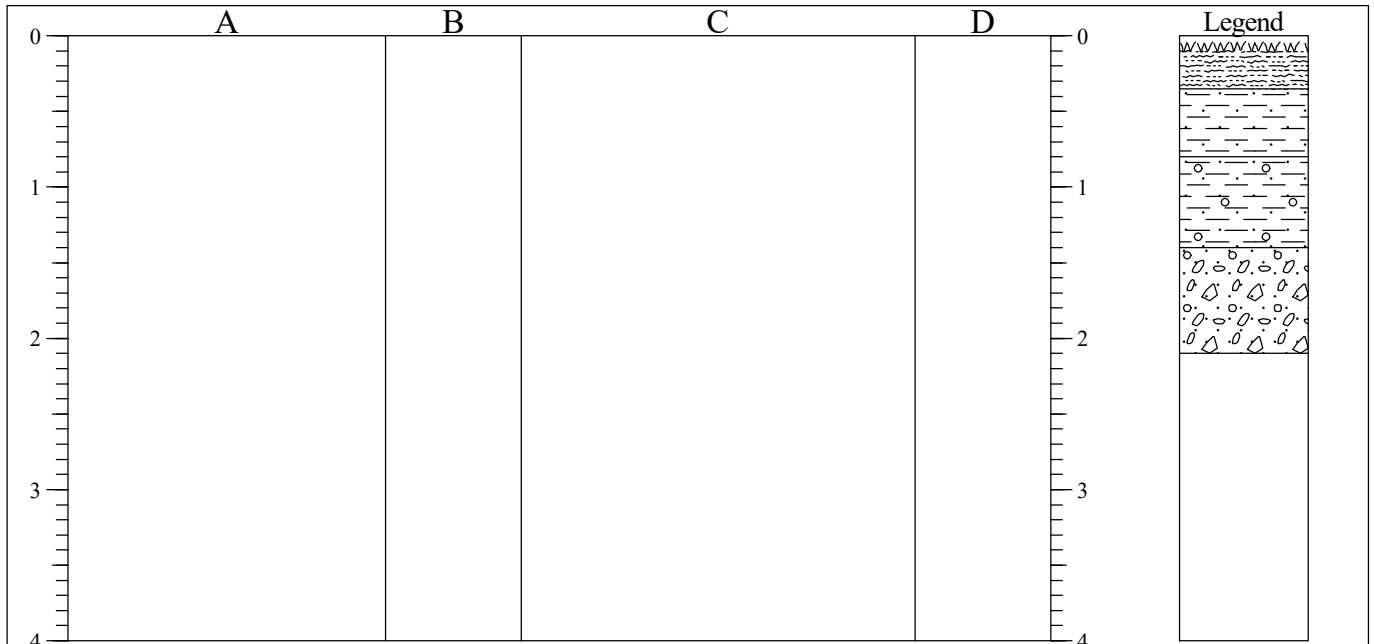
STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.10 0.10-0.70		Grass over TOPSOIL: Dark brown slightly clayey SAND.			
		Medium dense brown slightly gravelly fine to coarse SAND.			
0.70-1.30		Medium dense greyish brown slightly cobbly slightly silty fine to medium SAND & GRAVEL of various lithologies. Gravel is sub angular to sub rounded. Wet.			
		1.20 Groundwater ingress.			

Shoring/Support: Stability: Major collapse below 0.70mbgl. 				GENERAL REMARKS Fast groundwater ingress and running sands at 1.20mbgl. Rising to 0.80mbgl before soakaway testing commenced.	
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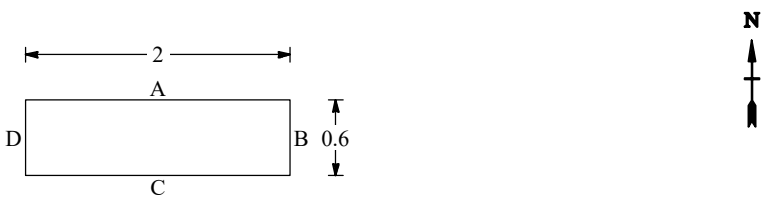
All dimensions in metres Scale 1:50	Client MacBryde Homes	Method/ Plant Used JCB 3CX	Logged By JS
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TRIAL PIT LOG

Project Holt Road, Rossett				TRIAL PIT No TP1
Job No 20MCB019	Date 26-10-20	Ground Level (m)	Co-Ordinates ()	
Contractor BETTS GEO Ltd				Sheet 1 of 1



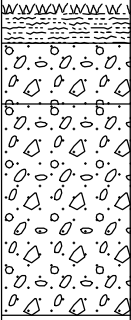
STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.35		Harvested crop over TOPSOIL: Dark brown clayey SAND. Occasional rootlets.			
0.35-0.80		Firm yellowish brown very sandy CLAY.			
0.80-1.40		Stiff greyish brown gravelly sandy CLAY. Occasional grey mottling.			
1.40-2.10		Medium dense greyish brown slightly silty cobblely fine to coarse SAND & GRAVEL of various lithologies. Wet.			
		1.90 Groundwater ingress.			

Shoring/Support: Stability: Major collapse below 1.40mbgl. 				GENERAL REMARKS Moderate groundwater ingress at 1.90mbgl.	
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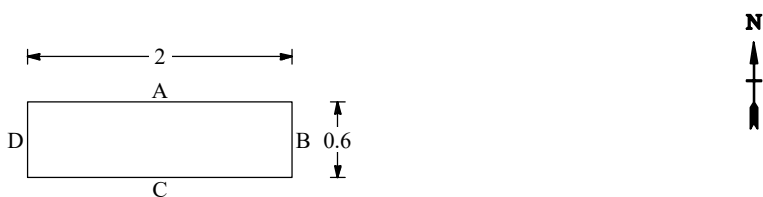
All dimensions in metres Scale 1:50	Client MacBryde Homes	Method/ Plant Used JCB 3CX	Logged By JS
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TRIAL PIT LOG

Project Holt Road, Rossett				TRIAL PIT No TP2
Job No 20MCB019	Date 26-10-20	Ground Level (m)	Co-Ordinates ()	
Contractor BETTS GEO Ltd				Sheet 1 of 1

A		B		C		D		Legend	
0								0	
1								1	
2								2	
3								3	
4								4	

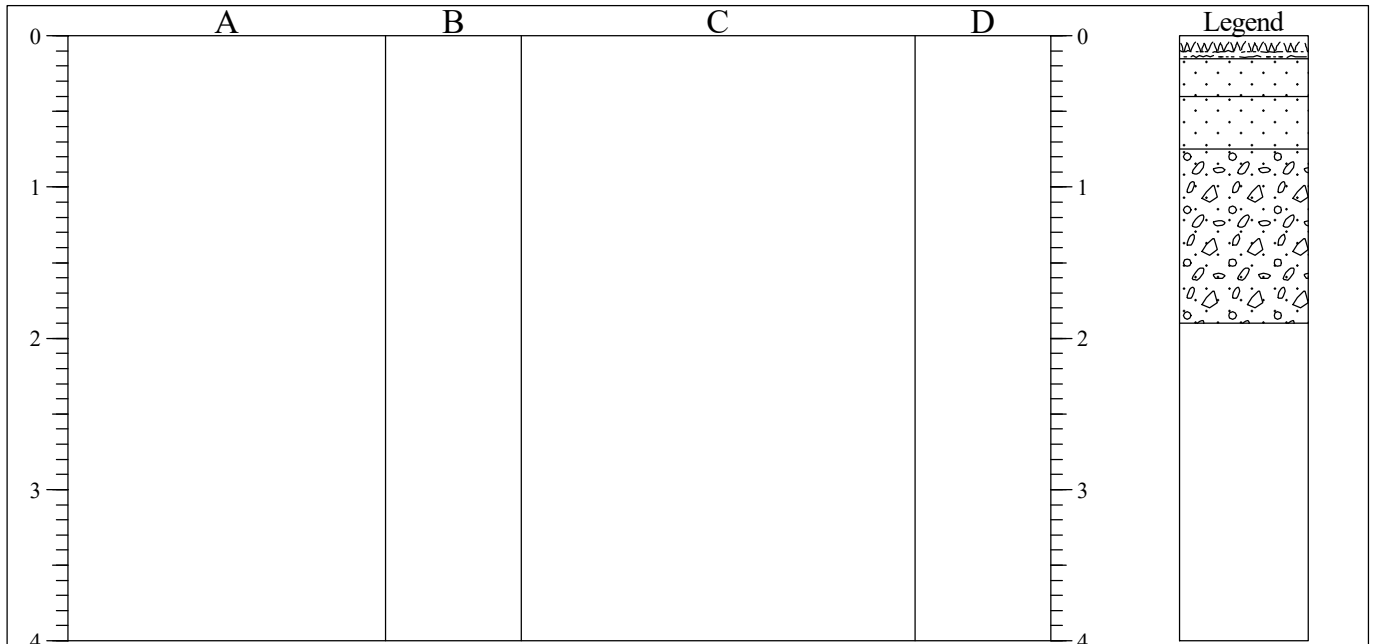
STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.30		Harvested crop over TOPSOIL: Dark brown clayey SAND. Occasional rootlets.			
0.30-0.70		Medium dense brown slightly cobbley fine to coarse SAND & GRAVEL.			
0.70-2.10		Medium dense very cobbley fine to coarse SAND & GRAVEL.			
		1.80 Groundwater ingress.			

Shoring/Support: Stability: Slight collapse between 0.30 - 0.70mbgl. Major collapse below 0.70mbgl.		GENERAL REMARKS Fast groundwater ingress at 1.80mbgl.
		

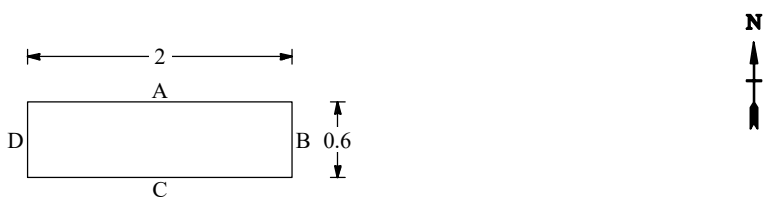
All dimensions in metres Scale 1:50	Client MacBryde Homes	Method/ Plant Used JCB 3CX	Logged By JS
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TRIAL PIT LOG

Project Holt Road, Rossett				TRIAL PIT No TP3
Job No 20MCB019	Date 27-10-20	Ground Level (m)	Co-Ordinates ()	
Contractor BETTS GEO Ltd				Sheet 1 of 1



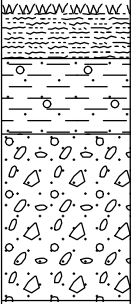
STRATA				SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests	
0.00-0.15		Grass over possible MADE GROUND: Dark brown slightly clayey SAND. Rare gravel of brick.				
0.15-0.40		Medium dense brown fine to coarse SAND.				
0.40-0.75		Medium dense orangish brown fine to medium SAND. Rare black pockets.				
0.75-1.90		Medium dense greyish brown slightly cobbly fine to coarse SAND & GRAVEL of various lithologies. Gravel is sub angular to sub rounded. Wet.				
		1.80 Groundwater ingress.				

Shoring/Support: Stability: Collapse between 0.40 - 0.75mbgl. Major collapse below 0.75mbgl.		GENERAL REMARKS Fast groundwater ingress at 1.80mbgl. Pit terminated due to instability.
		

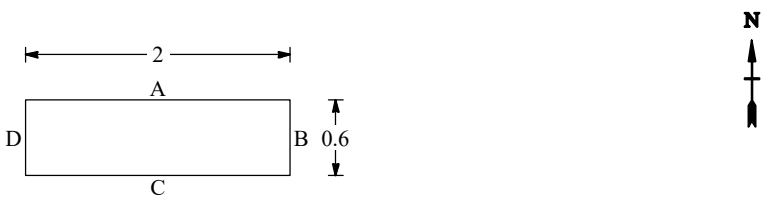
All dimensions in metres Scale 1:50	Client MacBryde Homes	Method/ Plant Used JCB 3CX	Logged By JS
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TRIAL PIT LOG

Project Holt Road, Rossett				TRIAL PIT No TP4
Job No 20MCB019	Date 27-10-20	Ground Level (m)	Co-Ordinates ()	
Contractor BETTS GEO Ltd				Sheet 1 of 1

A		B		C		D		Legend	
0								0	
1								1	
2								2	
3								3	
4								4	

STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.40		Grass over TOPSOIL: Dark brown slightly gravelly slightly clayey SAND.			
0.40-0.90		Firm to stiff brown/orangish brown sandy gravelly CLAY.			
0.90-2.00		Medium dense brown cobblely fine to coarse SAND & GRAVEL of various lithologies. Gravel is sub angular to sub rounded. Wet.			
		1.80 Groundwater ingress.			

Shoring/Support: Stability: Major collapse below 0.90mbgl.				GENERAL REMARKS	
				Moderate groundwater ingress at 1.80mbgl. Pit terminated due to instability.	

All dimensions in metres Scale 1:50	Client MacBryde Homes	Method/ Plant Used JCB 3CX	Logged By JS
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SOAKAWAY TEST RESULTS

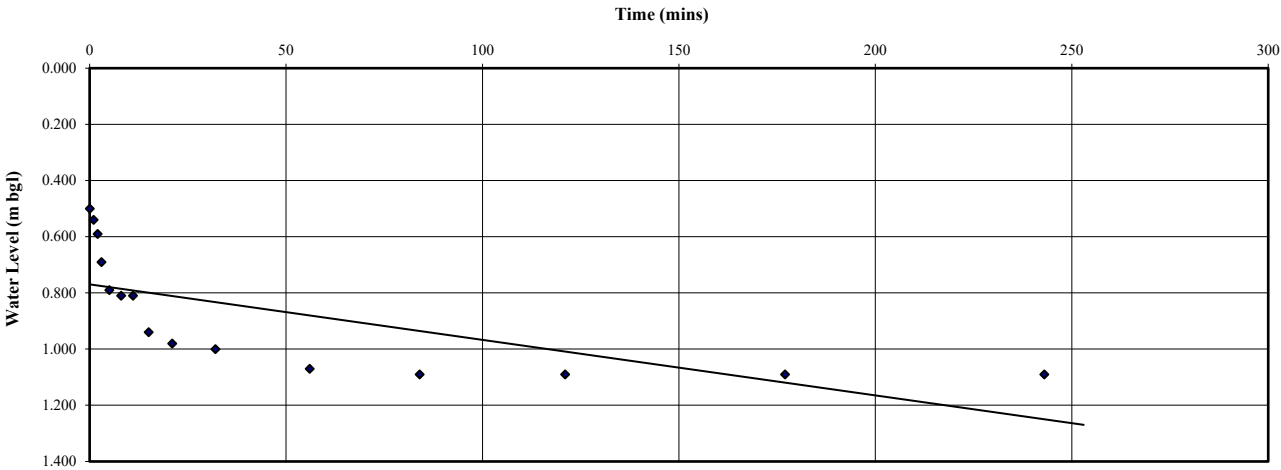
Date of Test: 26/10/20

Hole ID: SA01

Test No 1

Trial Pit Dimensions (m)	Length	Width	Depth	Depth for Analysis
	1.80	0.60	1.60	1.10

Time (mins)	Depth of water (m bgl)	Time (mins)	Depth of water (m bgl)	Effective storage volume in trial pit $V_{(p75-25)}$ = between effective depths 25% to 75%. = 0.59 m ³	
0.0	0.500			Initial surface area of trial pit up to $a_{(p50)}$ = 50% effective depth and including the base area. = 3.72 m ²	
1.0	0.540				
2.0	0.590				
3.0	0.690				
5.0	0.790				
8.0	0.810			$t_{(p75-25)}$ = Time for the water level to fall from 75 % to 25% effective depth. = min	
11.0	0.810				
15.0	0.940				
21.0	0.980				
32.0	1.000				
56.0	1.070			Soil infiltration rate = $\frac{.}{t_{(p75-25)} \times a_{(p50)} \times 60}$	
84.0	1.090				
121.0	1.090				
177.0	1.090				
243.0	1.090				
				Depth _(25%) = 1.325	Depth _(75%) = 0.775 m
				Soil infiltration rate = N/A m/sec	
				Remarks Test aborted due to groundwater sitting at 1.09mbgl. * Extrapolated soil infiltration rate	



Contract: Bloor Homes - Holt Road, Wrexham

Contract No: 18BLH002

SOAKAWAY TEST RESULTS

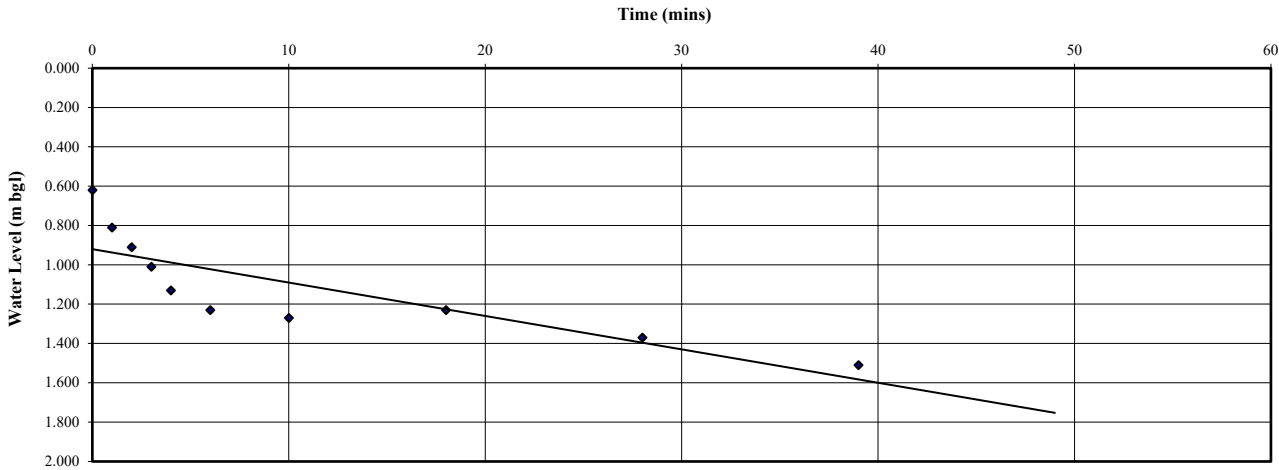
Date of Test: 26/10/20

Hole ID: SA02

Test No 1

Trial Pit Dimensions (m)	Length	Width	Depth	Depth for Analysis
	1.70	0.60	1.80	1.18

Time (mins)	Depth of water (m bgl)	Time (mins)	Depth of water (m bgl)	Effective storage volume in trial pit $V_{(p75-25)}$ = between effective depths 25% to 75%. =0.60m³
0.0	0.620			
1.0	0.810			
2.0	0.910			
3.0	1.010			Initial surface area of trial pit up to $a_{(p50)}$ = 50% effective depth and including the base area. =3.73m²
4.0	1.130			
6.0	1.230			
10.0	1.270			
18.0	1.230			Time for the water level to fall from 75 $t_{(p75-25)}$ = % to 25% effective depth. =37min
28.0	1.370			
39.0	1.510			
				Soil infiltration rate = $t_{(p75-25)} \times a_{(p50)} \times 60$
				Depth_(25%) = 1.505 Depth_(75%) = 0.915 m
				Soil infiltration rate = 7.3E-05 m/sec
				Remarks * Extrapolated soil infiltration rate



Contract: Bloor Homes - Holt Road, Wrexham

Contract No: 18BLH002

SOAKAWAY TEST RESULTS

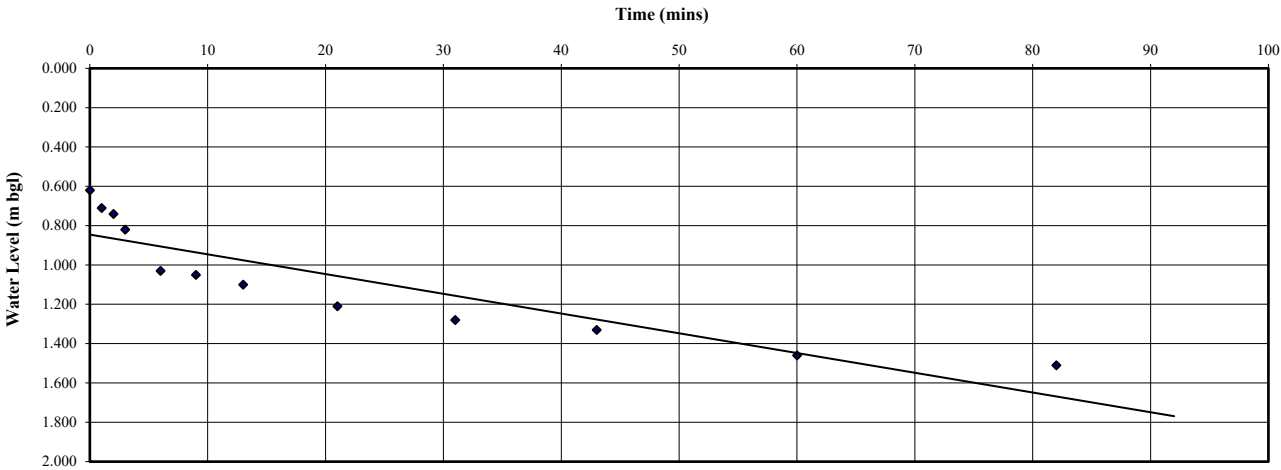
Date of Test: 26/10/20

Hole ID: SA02

Test No 2

Trial Pit Dimensions (m)	Length	Width	Depth	Depth for Analysis
	1.70	0.60	1.80	1.18

Time (mins)	Depth of water (m bgl)	Time (mins)	Depth of water (m bgl)	Effective storage volume in trial pit $V_{(p75-25)}$ = between effective depths 25% to 75%. = 0.60 m ³	
0.0	0.620			Initial surface area of trial pit up to $a_{(p50)}$ = 50% effective depth and including the base area. = 3.73 m ²	
1.0	0.710				
2.0	0.740				
3.0	0.820				
6.0	1.030				
9.0	1.050			$t_{(p75-25)}$ = Time for the water level to fall from 75 % to 25% effective depth. = 78 min	
13.0	1.100			Soil infiltration rate = $\frac{V_{(p75-25)}}{t_{(p75-25)} \times a_{(p50)} \times 60}$	
21.0	1.210				
31.0	1.280			Depth _(25%) = 1.505 Depth _(75%) = 0.915 m	
43.0	1.330				
60.0	1.460			Soil infiltration rate = 3.4E-05 m/sec	
82.0	1.510			Remarks * Extrapolated soil infiltration rate	



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Contract No:
18BLH002

SOAKAWAY TEST RESULTS

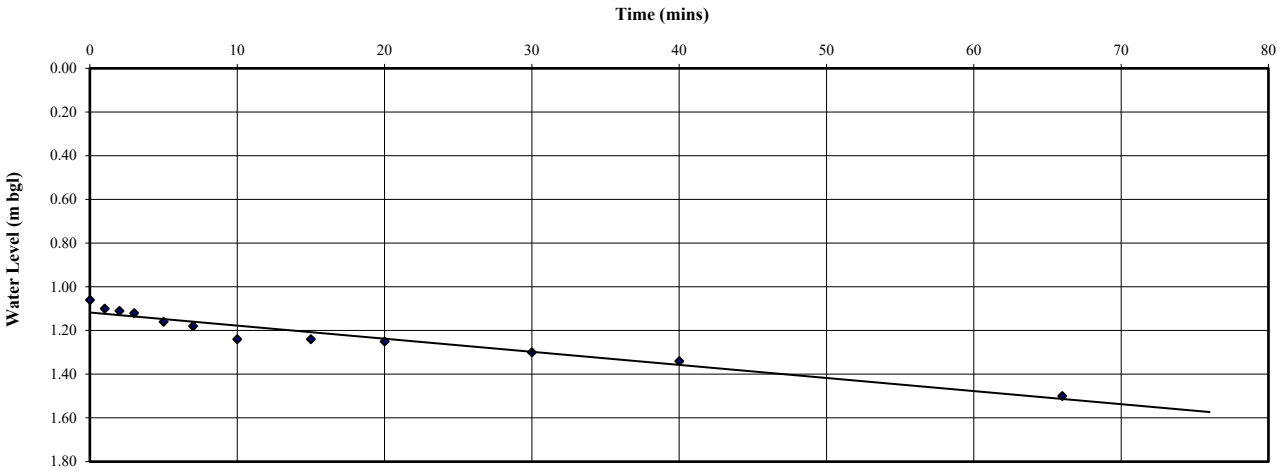
Date of Test: 26/10/20

Hole ID: SA02

Test No 3

Trial Pit Dimensions (m)	Length	Width	Depth	Depth for Analysis
	1.70	0.60	1.80	0.74

Time (mins)	Depth of water (m bgl)	Time (mins)	Depth of water (m bgl)	Effective storage volume in trial pit $V_{(p75-25)}$ = between effective depths 25% to 75%. = 0.38 m³	
0.0	1.060			Initial surface area of trial pit up to $a_{(p50)}$ = 50% effective depth and including the base area. = 2.72 m²	
1.0	1.100				
2.0	1.110				
3.0	1.120				
5.0	1.160				
7.0	1.180			Time for the water level to fall from 75 $t_{(p75-25)}$ = % to 25% effective depth. = min	
10.0	1.240				
15.0	1.240				
20.0	1.250				
30.0	1.300				
40.0	1.340			Soil infiltration rate = $t_{(p75-25)} \times a_{(p50)} \times 60$	
66.0	1.500				
				Depth _(25%) = 1.615	Depth _(75%) = 1.245 m
				Soil infiltration rate = N/A m/sec	
				Remarks Test had to be aborted due to major collapse of pit * Extrapolated soil infiltration rate	



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SOAKAWAY TEST RESULTS

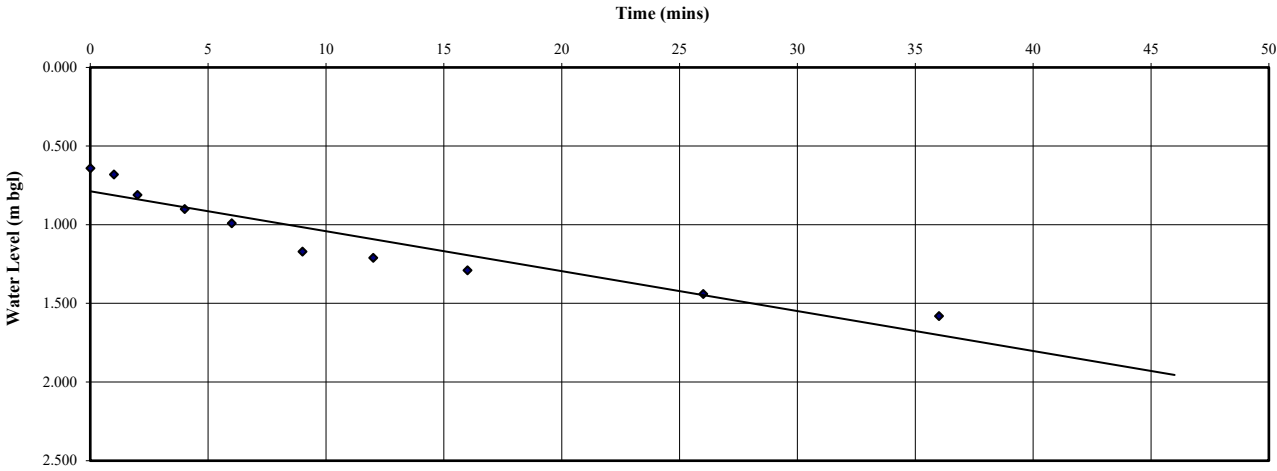
Date of Test: 26/10/20

Hole ID: SA03

Test No 1

Trial Pit Dimensions (m)	Length	Width	Depth	Depth for Analysis
	1.80	0.60	1.70	1.06

Time (mins)	Depth of water (m bgl)	Time (mins)	Depth of water (m bgl)	Effective storage volume in trial pit $V_{(p75-25)}$ = between effective depths 25% to 75%. = 0.57 m³	
0.0	0.640			Initial surface area of trial pit up to $a_{(p50)}$ = 50% effective depth and including the base area. = 3.62 m²	
1.0	0.680				
2.0	0.810				
4.0	0.900				
6.0	0.990				
9.0	1.170			$t_{(p75-25)}$ = Time for the water level to fall from 75 % to 25% effective depth. = 22 min	
12.0	1.210				
16.0	1.290				
26.0	1.440				
36.0	1.580				
				Soil infiltration rate = $\frac{V_{(p75-25)}}{t_{(p75-25)} \times a_{(p50)} \times 60}$	
				Depth _(25%) = 1.435	Depth _(75%) = 0.905 m
				Soil infiltration rate = 1.2E-04 m/sec	
				Remarks * Extrapolated soil infiltration rate	



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SOAKAWAY TEST RESULTS

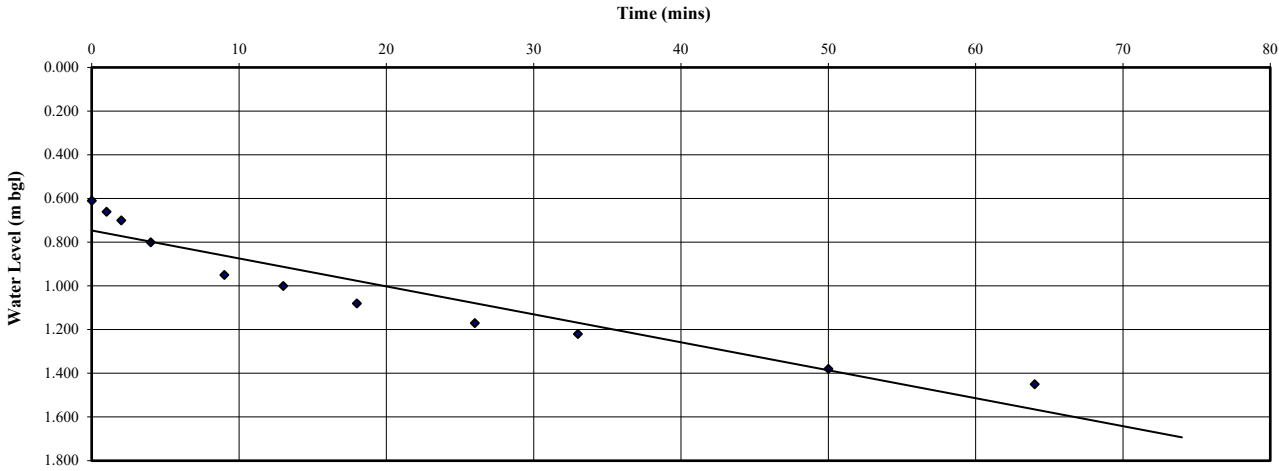
Date of Test: 26/10/20

Hole ID: SA03

Test No 2

Trial Pit Dimensions (m)	Length	Width	Depth	Depth for Analysis
	1.80	0.60	1.70	1.09

Time (mins)	Depth of water (m bgl)	Time (mins)	Depth of water (m bgl)	Effective storage volume in trial pit $V_{(p75-25)}$ = between effective depths 25% to 75%. =0.59m³
0.0	0.610			
1.0	0.660			
2.0	0.700			
4.0	0.800			Initial surface area of trial pit up to $a_{(p50)}$ = 50% effective depth and including the base area. =3.70m²
9.0	0.950			
13.0	1.000			
18.0	1.080			
26.0	1.170			Time for the water level to fall from 75 $t_{(p75-25)}$ = % to 25% effective depth. =58min
33.0	1.220			
50.0	1.380			
64.0	1.450			
				Soil infiltration rate = $t_{(p75-25)} \times a_{(p50)} \times 60$
				Depth_(25%) = 1.4275 Depth_(75%) = 0.883m
				Soil infiltration rate = 4.6E-05 m/sec
				Remarks * Extrapolated soil infiltration rate



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SOAKAWAY TEST RESULTS

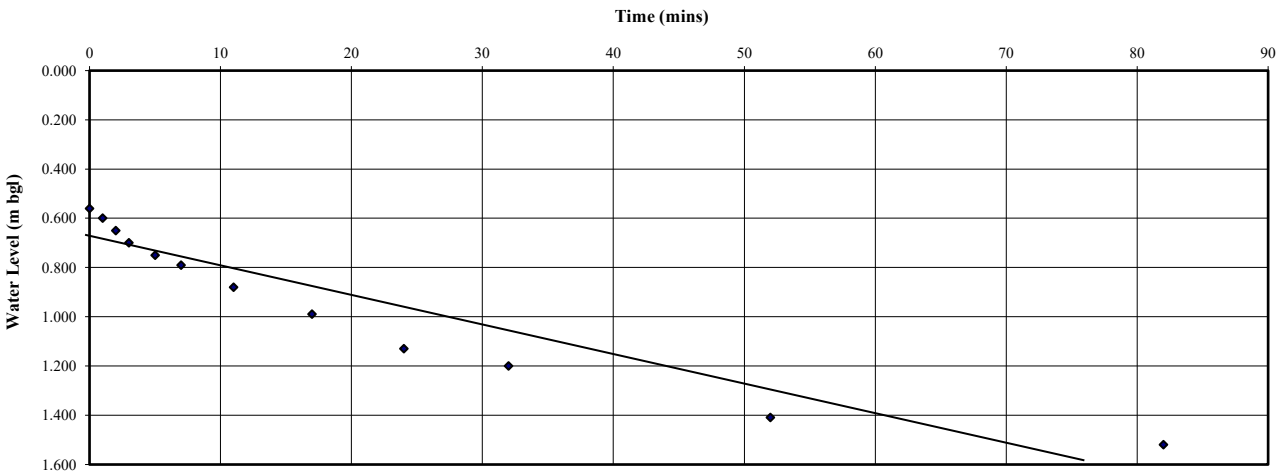
Date of Test: 26/10/20

Hole ID: SA03

Test No 3

Trial Pit Dimensions (m)	Length	Width	Depth	Depth for Analysis
	1.70	0.60	1.70	1.18

Time (mins)	Depth of water (m bgl)	Time (mins)	Depth of water (m bgl)	Effective storage volume in trial pit $V_{(p75-25)}$ = between effective depths 25% to 75%. = 0.60 m ³	
0.0	0.560			Initial surface area of trial pit up to $a_{(p50)}$ = 50% effective depth and including the base area. = 3.73 m ²	
1.0	0.600				
2.0	0.650				
3.0	0.700				
5.0	0.750				
7.0	0.790				
11.0	0.880			$t_{(p75-25)}$ = Time for the water level to fall from 75 % to 25% effective depth. = 41 min	
17.0	0.990				
24.0	1.130				
32.0	1.200				
52.0	1.410			Soil infiltration rate = $\frac{\cdot}{t_{(p75-25)} \times a_{(p50)} \times 60}$	
82.0	1.520				
				Depth _(25%) = 1.405	Depth _(75%) = 0.815 m
				Soil infiltration rate = 6.6E-05 m/sec	
				Remarks * Extrapolated soil infiltration rate	



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Contract No: 18BLH002

SOAKAWAY TEST RESULTS

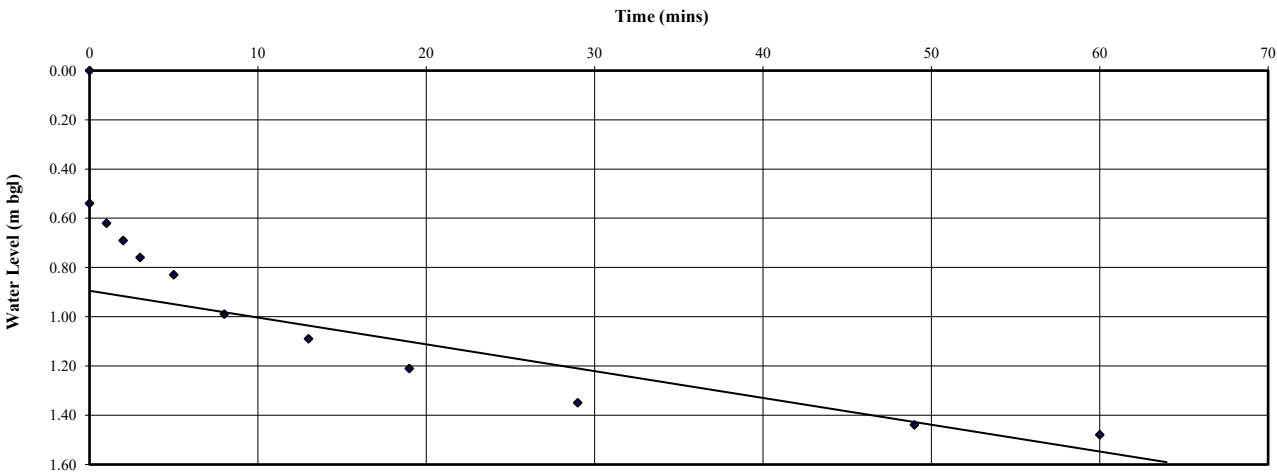
Date of Test: 27/10/20

Hole ID: SA04

Test No 1

Trial Pit Dimensions (m)	Length	Width	Depth	Depth for Analysis
	1.80	0.60	1.70	1.16

Time (mins)	Depth of water (m bgl)	Time (mins)	Depth of water (m bgl)	Effective storage volume in trial pit $V_{(p75-25)}$ = between effective depths 25% to 75%. = 0.63 m ³	
0.0	0.540			Initial surface area of trial pit up to $a_{(p50)}$ = 50% effective depth and including the base area. = 3.86 m ²	
1.0	0.620				
2.0	0.690				
3.0	0.760				
5.0	0.830				
8.0	0.990			$t_{(p75-25)}$ = Time for the water level to fall from 75 % to 25% effective depth. = 42 min	
13.0	1.090				
19.0	1.210				
29.0	1.350				
49.0	1.440				
60.0	1.480			Soil infiltration rate = $\frac{.}{t_{(p75-25)} \times a_{(p50)} \times 60}$	
				Depth _(25%) = 1.41	Depth _(75%) = 0.830 m
				Soil infiltration rate = 6.4E-05 m/sec	
				Remarks * Extrapolated soil infiltration rate	



Contract: Bloor Homes - Holt Road, Wrexham

Contract No: 18BLH002

SOAKAWAY TEST RESULTS

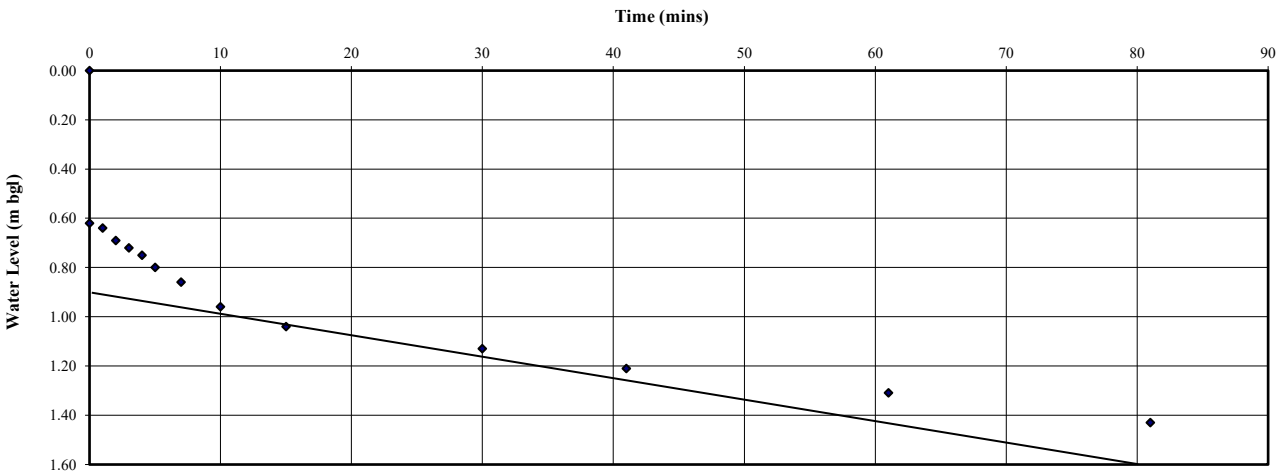
Date of Test: 27/10/20

Hole ID: SA04

Test No 2

Trial Pit Dimensions (m)	Length	Width	Depth	Depth for Analysis
	1.80	0.60	1.70	1.08

Time (mins)	Depth of water (m bgl)	Time (mins)	Depth of water (m bgl)	Effective storage volume in trial pit $V_{(p75-25)}$ = between effective depths 25% to 75%. = 0.58 m ³	
0.0	0.620			Initial surface area of trial pit up to $a_{(p50)}$ = 50% effective depth and including the base area. = 3.67 m ²	
1.0	0.640				
2.0	0.690				
3.0	0.720				
4.0	0.750				
5.0	0.800			$t_{(p75-25)}$ = Time for the water level to fall from 75 % to 25% effective depth. = 73 min	
7.0	0.860				
10.0	0.960				
15.0	1.040				
30.0	1.130				
41.0	1.210			Soil infiltration rate = $\frac{\cdot}{t_{(p75-25)} \times a_{(p50)} \times 60}$	
61.0	1.310				
81.0	1.430				
				Depth _(25%) = 1.43	Depth _(75%) = 0.890 m
				Soil infiltration rate = 3.6E-05 m/sec	
				Remarks * Extrapolated soil infiltration rate	



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SOAKAWAY TEST RESULTS

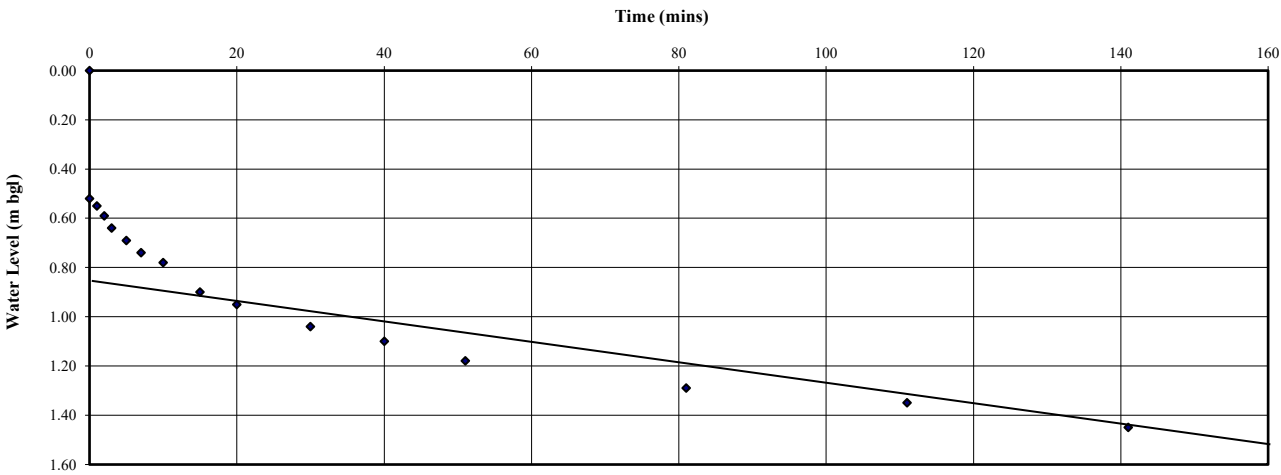
Date of Test: 27/10/20

Hole ID: SA04

Test No 4

Trial Pit Dimensions (m)	Length	Width	Depth	Depth for Analysis
	1.80	0.60	1.70	1.18

Time (mins)	Depth of water (m bgl)	Time (mins)	Depth of water (m bgl)	Effective storage volume in trial pit $V_{(p75-25)}$ = between effective depths 25% to 75%. = 0.64 m ³	
0.0	0.520			Initial surface area of trial pit up to $a_{(p50)}$ = 50% effective depth and including the base area. = 3.91 m ²	
1.0	0.550				
2.0	0.590				
3.0	0.640				
5.0	0.690				
7.0	0.740			$t_{(p75-25)}$ = Time for the water level to fall from 75 % to 25% effective depth. = 118 min	
10.0	0.780				
15.0	0.900				
20.0	0.950				
30.0	1.040				
40.0	1.100			Soil infiltration rate = $\frac{\cdot}{t_{(p75-25)} \times a_{(p50)} \times 60}$	
51.0	1.180				
81.0	1.290				
111.0	1.350				
141.0	1.450				
				Depth _(25%) = 1.405	Depth _(75%) = 0.815 m
				Soil infiltration rate = 2.3E-05 m/sec	
				Remarks * Extrapolated soil infiltration rate	



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Contract No: 18BLH002

SOAKAWAY TEST RESULTS

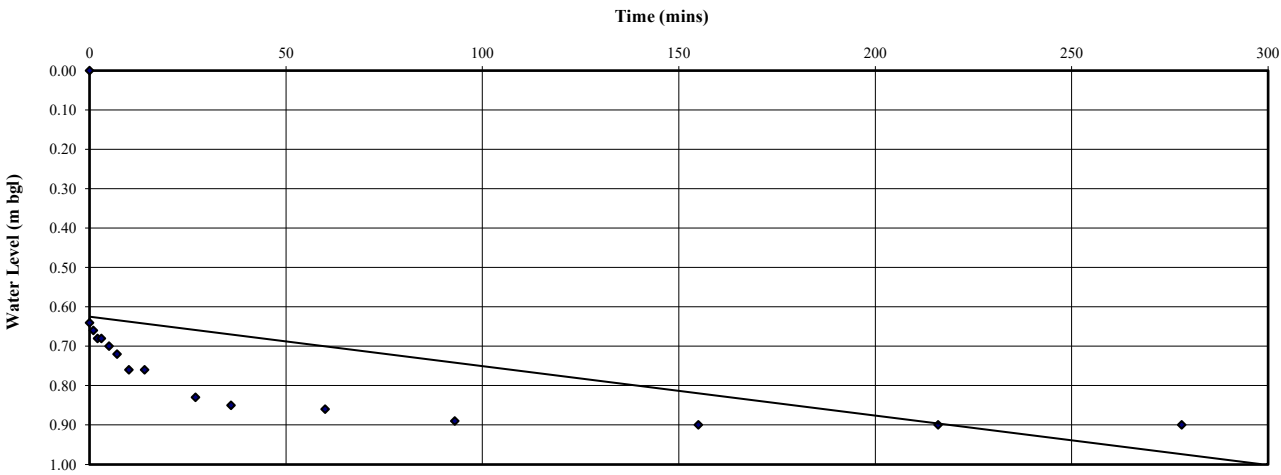
Date of Test: 27/10/20

Hole ID: SA05

Test No 1

Trial Pit Dimensions (m)	Length	Width	Depth	Depth for Analysis
	1.80	0.60	1.70	1.06

Time (mins)	Depth of water (m bgl)	Time (mins)	Depth of water (m bgl)	Effective storage volume in trial pit $V_{(p75-25)}$ = between effective depths 25% to 75%. = 0.57 m ³	
0.0	0.640			Initial surface area of trial pit up to $a_{(p50)}$ = 50% effective depth and including the base area. = 3.62 m ²	
1.0	0.660				
2.0	0.680				
3.0	0.680				
5.0	0.700				
7.0	0.720			$t_{(p75-25)}$ = Time for the water level to fall from 75 % to 25% effective depth. = min	
10.0	0.760				
14.0	0.760				
27.0	0.830			Soil infiltration rate = $\frac{\cdot}{t_{(p75-25)} \times a_{(p50)} \times 60}$	
36.0	0.850				
60.0	0.860				
93.0	0.890				
155.0	0.900			Depth _(25%) = 1.435 Depth _(75%) = 0.905 m	
216.0	0.900				
278.0	0.900			Soil infiltration rate = N/A m/sec	
				Remarks Test aborted due to groundwater sitting at 0.90mbgl. * Extrapolated soil infiltration rate	



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Contract No: 18BLH002

SOAKAWAY TEST RESULTS

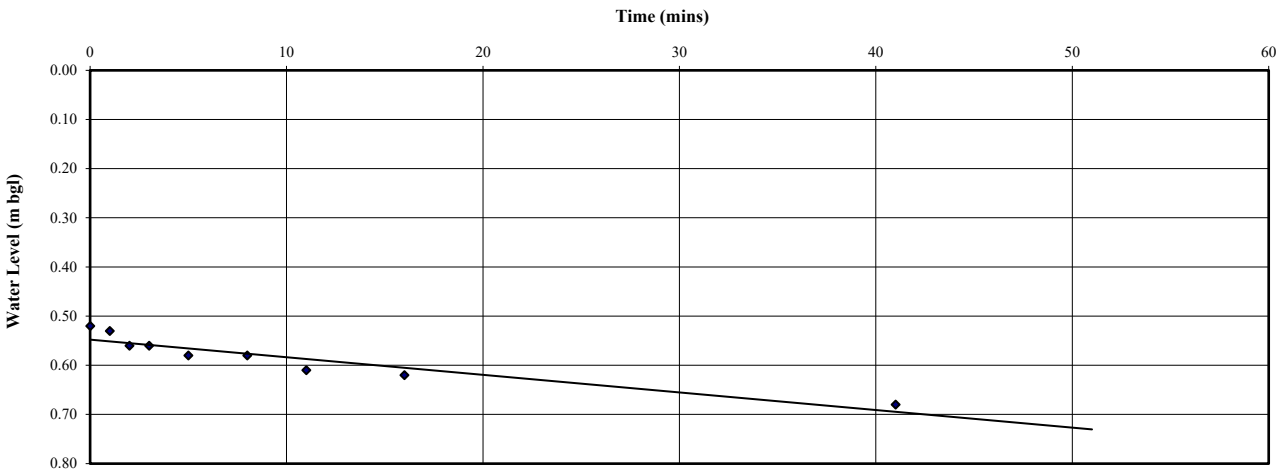
Date of Test: 27/10/20

Hole ID: SA06

Test No 1

Trial Pit Dimensions (m)	Length	Width	Depth	Depth for Analysis
	1.80	0.60	1.30	0.78

Time (mins)	Depth of water (m bgl)	Time (mins)	Depth of water (m bgl)	Effective storage volume in trial pit $V_{(p75-25)}$ = between effective depths 25% to 75%. =0.42m³
0.0	0.520			
1.0	0.530			
2.0	0.560			
3.0	0.560			Initial surface area of trial pit up to $a_{(p50)}$ = 50% effective depth and including the base area. =2.95m²
5.0	0.580			
8.0	0.580			
11.0	0.610			
16.0	0.620			Time for the water level to fall from 75 $t_{(p75-25)}$ = % to 25% effective depth. =min
41.0	0.680			
74.0	0.690			
136.0	0.690			
197.0	0.690			Soil infiltration rate = $t_{(p75-25)} \times a_{(p50)} \times 60$
259.0	0.690			
				Depth_(25%) = 1.105 Depth_(75%) = 0.715 m
				Soil infiltration rate = N/A m/sec
				Remarks Test aborted due to groundwater sitting at 0.69mbgl. * Extrapolated soil infiltration rate

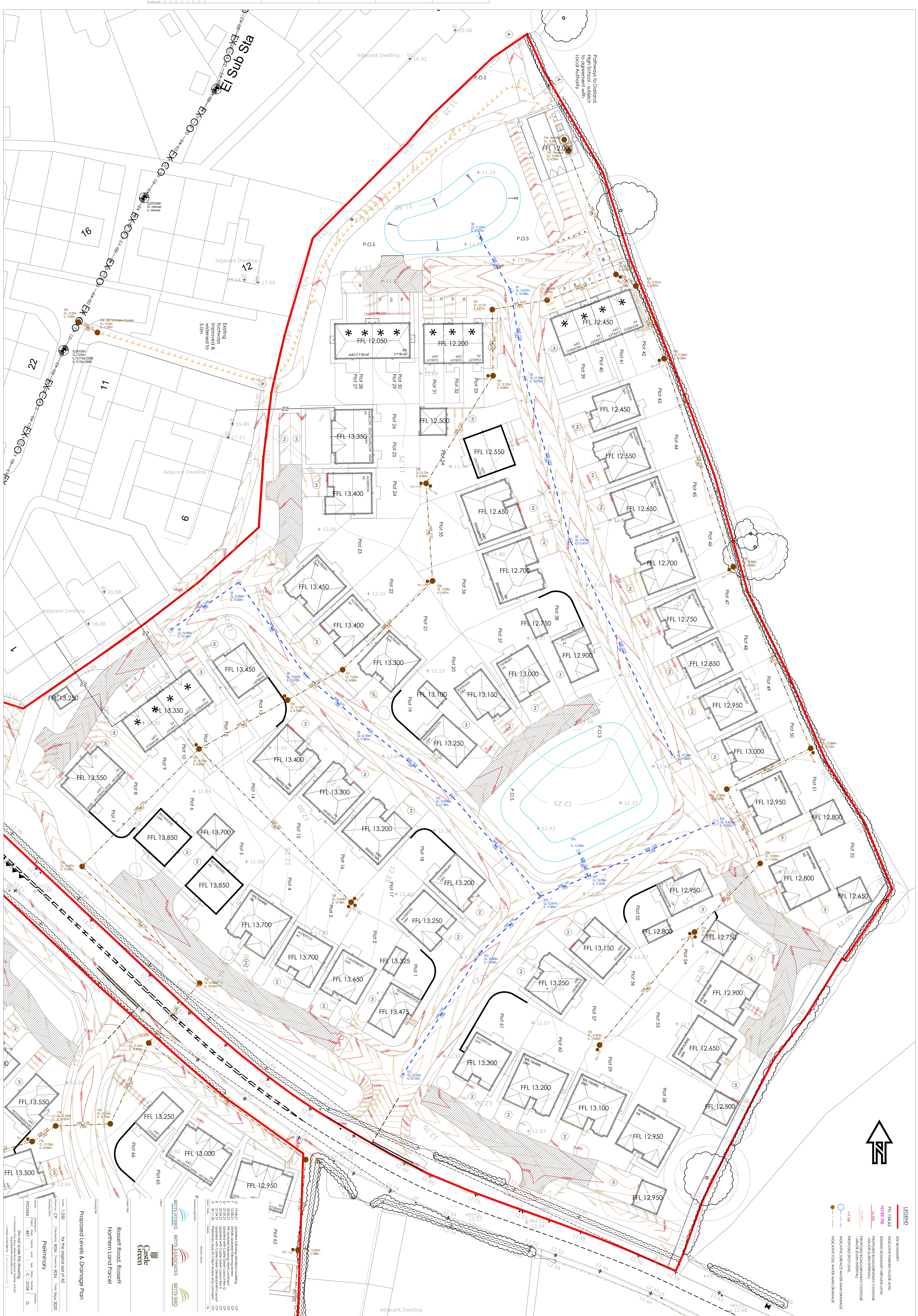


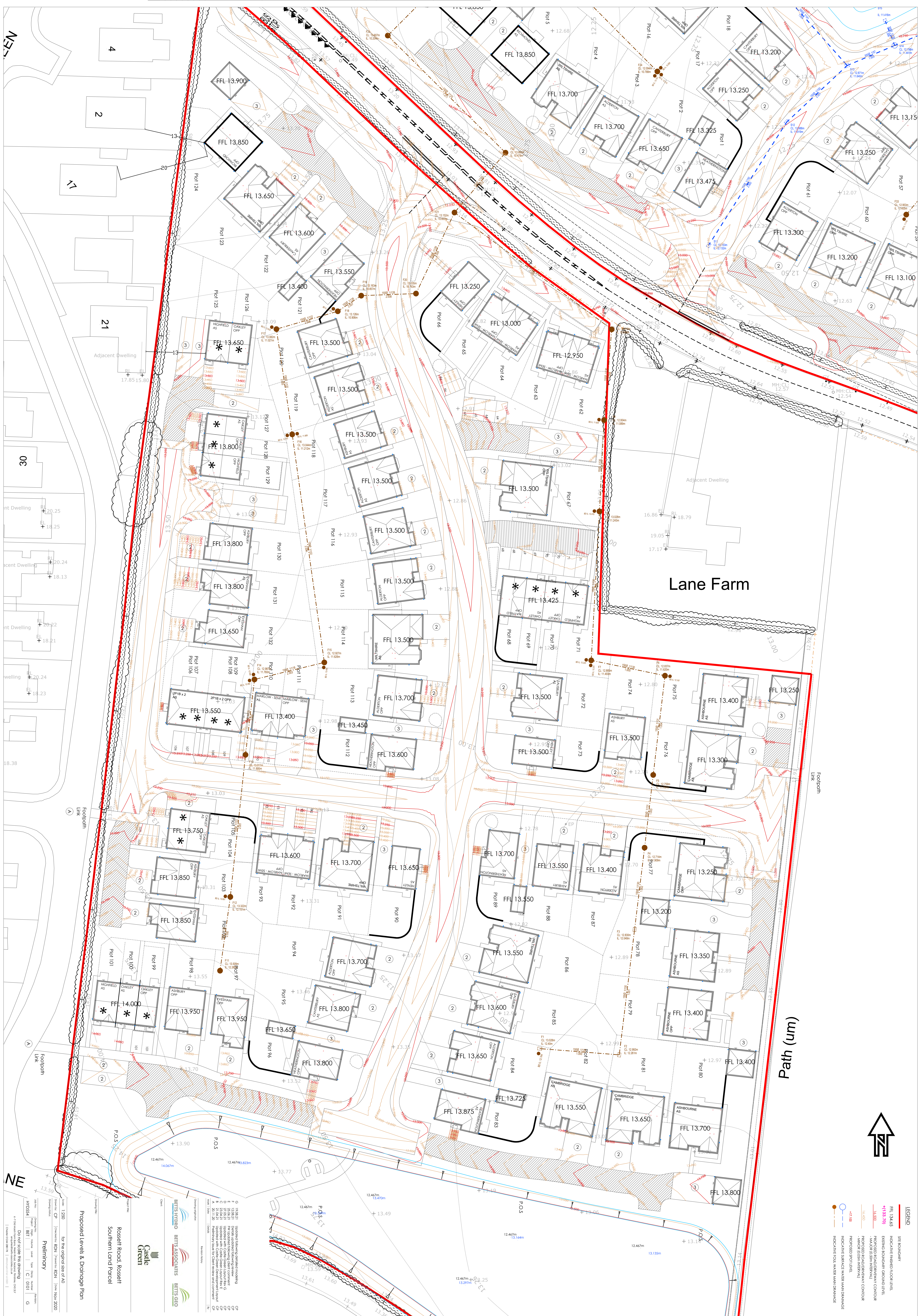
Contract: Bloor Homes - Holt Road, Wrexham

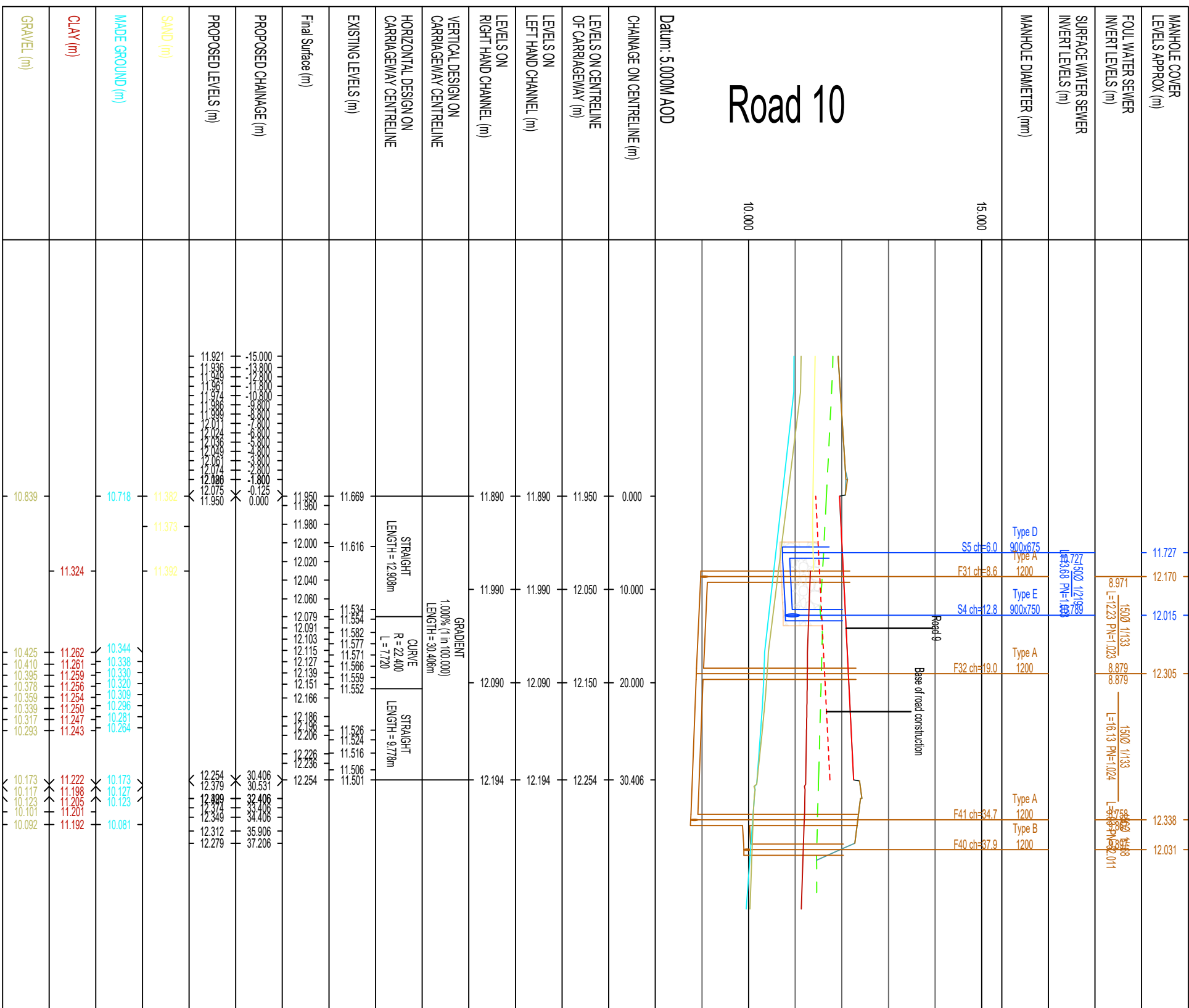
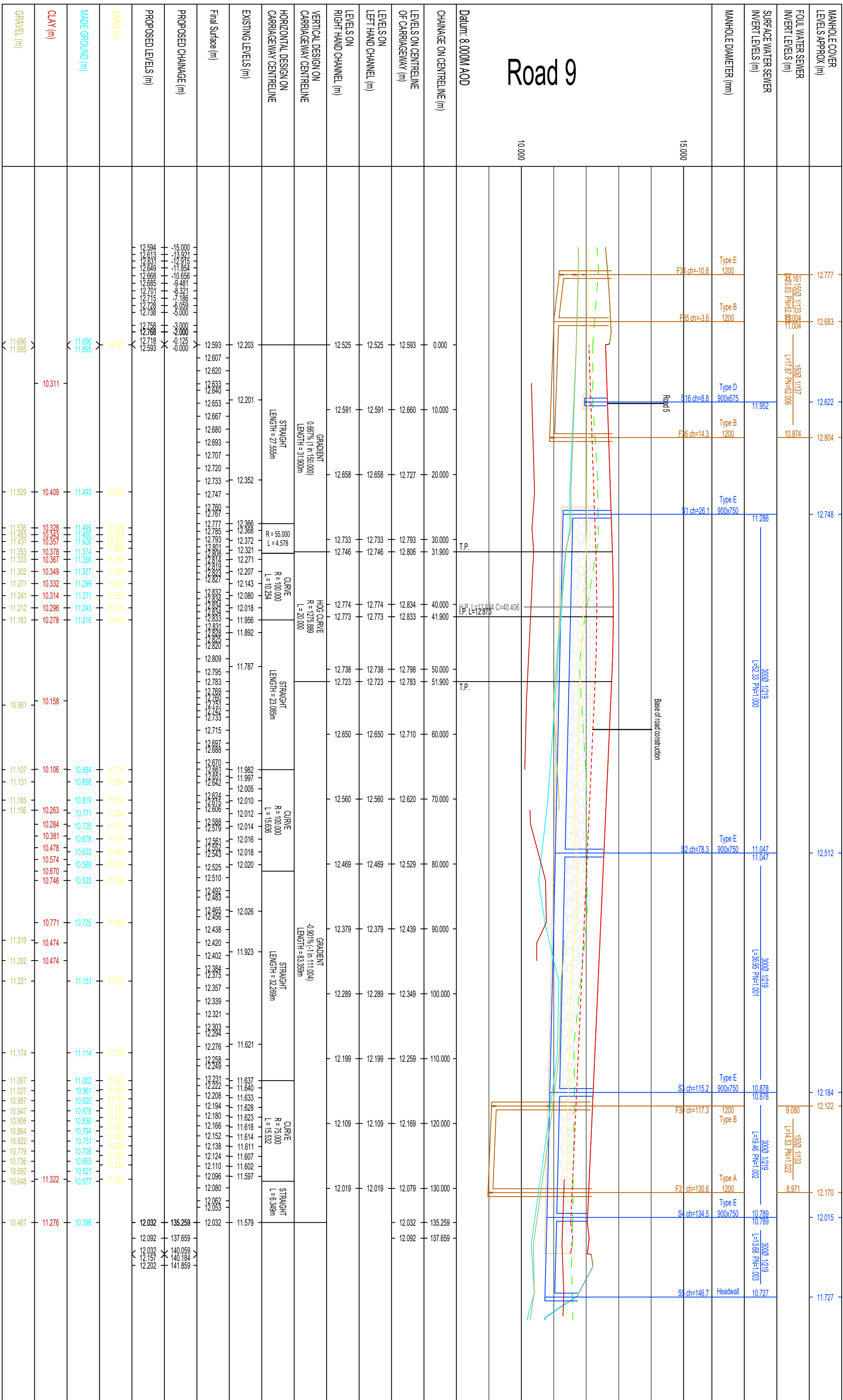
Contract No: 18BLH002

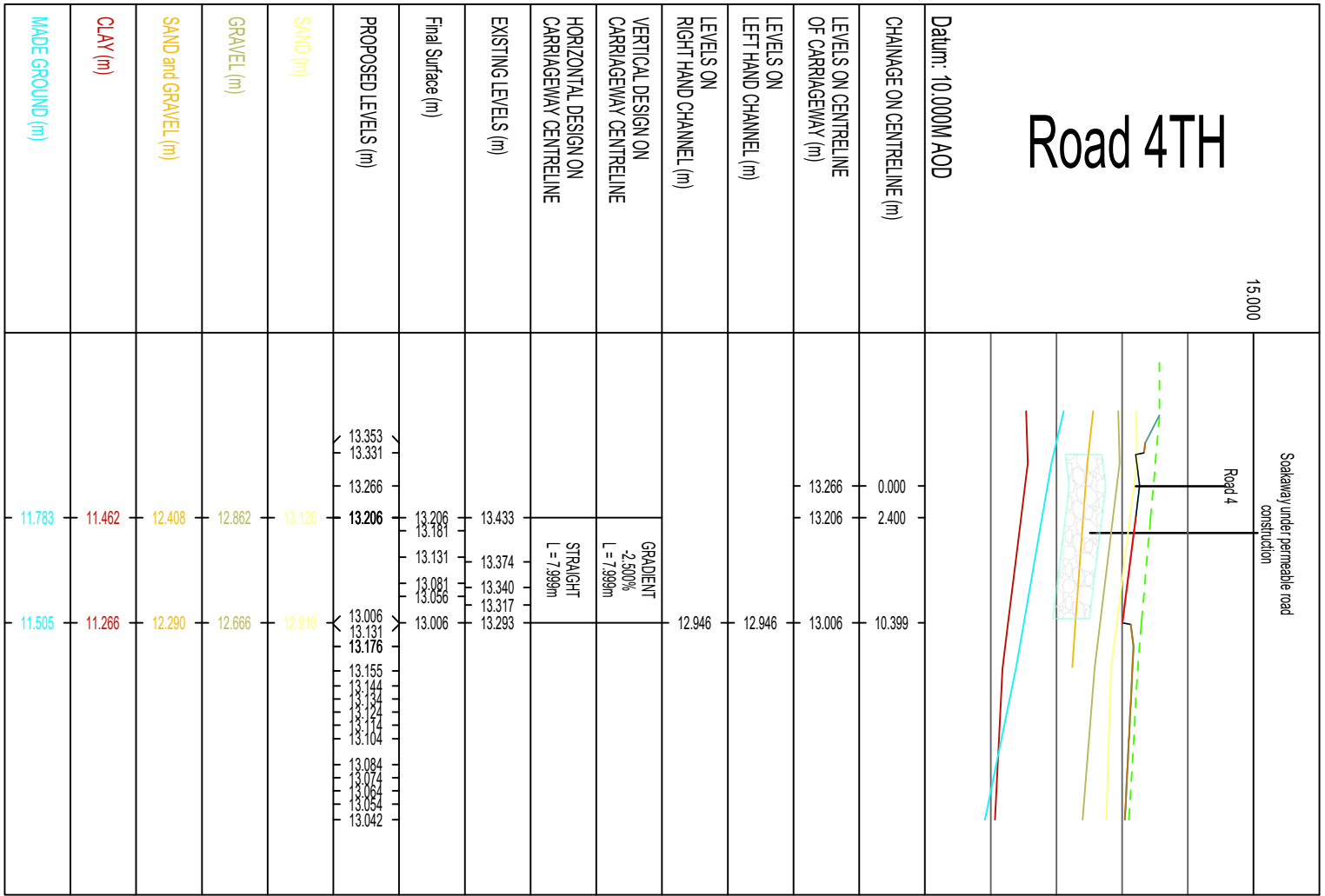
APPENDIX I: PROPOSED LEVELS AND DRAINAGE STRATEGY PLANS

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APPENDIX J: TYPICAL SUDS DETAILS

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Figure 17.1 Typical conveyance/attenuation swale

17.1.2 Dry swale (or “enhanced” swale)

The dry swale is a vegetated conveyance channel, designed to include a filter bed of prepared soil that overlays an underdrain system (Figure 17.2). This underdrain provides additional treatment and conveyance capacity beneath the base of the swale, and prevents waterlogging. To prevent infiltration, or where groundwater levels are high, a liner could be introduced at the base.

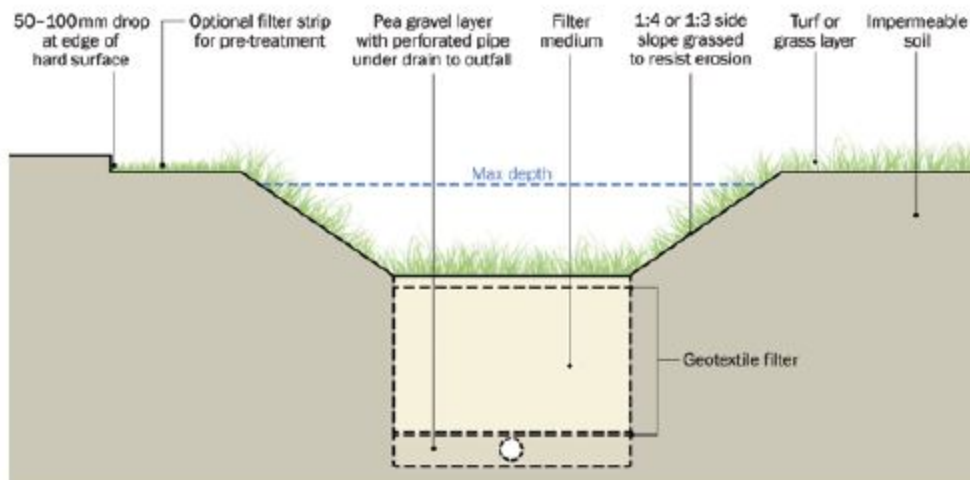


Figure 17.2 Typical dry swale

17.1.3 Wet swale

This system is equivalent to the conveyance swale, but is designed specifically to deliver wet and/or marshy conditions in the base (Figure 17.3). They can be used where sites are very flat and soils are poorly drained and/or to deliver the functionality or amenity or biodiversity requirements of a longitudinal pond/wetland component. Specific wetland planting will be required for the swale base.

A typical swale plan view is given in Figure 17.5.

20.1.8 Block porous paving

Concrete (or other recycled materials such as glass) block porous paving relies on water permeating through the porous paving unit material rather than through widened joints. Experience in the UK indicates that they are much more prone to clogging than any of the other types of system, due to very small size of the voids in the surface of the paving unit. Therefore, their potential use is limited due to this risk of clogging.

20.1.9 Systems of water management

There are three principal systems of water management below the surface of pervious pavements that are described in Figures 20.12 to 20.14.

Type A (Figure 20.12) reflects a system where all the rainfall passes into the substructure (where it may be stored temporarily) from where it infiltrates into the soil beneath. Normally, there will be no discharge from the system to a sewer or watercourse. However, an emergency overflow may be required to cater for events in excess of the design event or to allow for the system becoming less efficient (ie infiltration rates reducing) over its design life.

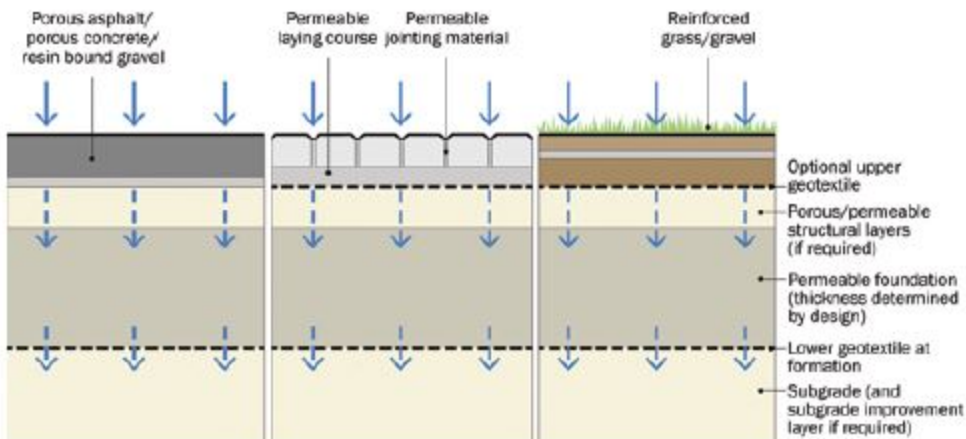


Figure 20.12 Pervious pavement system types: Type A – total infiltration

In a Type B system (Figure 20.13), the proportion of the rainfall that exceeds the infiltration capacity of the subsoils flows to the receiving drainage system. This can occur by direct drainage through the sub-base or by conveyance via perforated pipes within or below it. Geocomposite blankets can also be used to collect and convey water below the sub-base layer or can be placed vertically at the edges of the construction to allow connection to a pipe. By preventing the build-up of water above the subgrade, the risks to soil stability are reduced.

There is no infiltration with a Type C system (Figure 20.14). The system is generally wrapped in an impermeable, flexible membrane placed above the subgrade (formation level). Once the water has filtered through the sub-base, it is conveyed to the outfall via perforated pipes or fin drains. This can be used for situations where:

- soils have low permeability or low strength (and could therefore be damaged by the introduction of infiltrating water)
- the water is to be harvested and used
- the underlying groundwater is sensitive and requires protection
- the water table is within 1 m of the sub-base
- the site is contaminated and the risks of mobilising contaminants must be minimised.

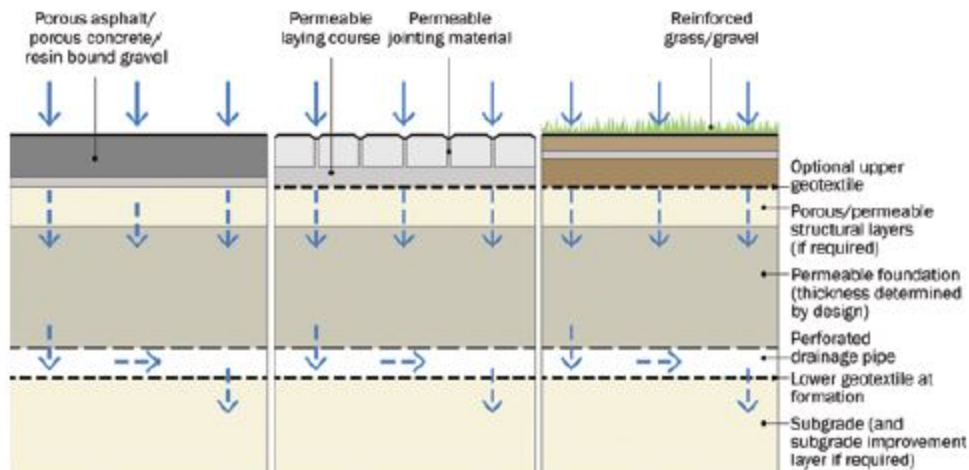


Figure 20.13 Pervious pavement system types: Type B – partial infiltration

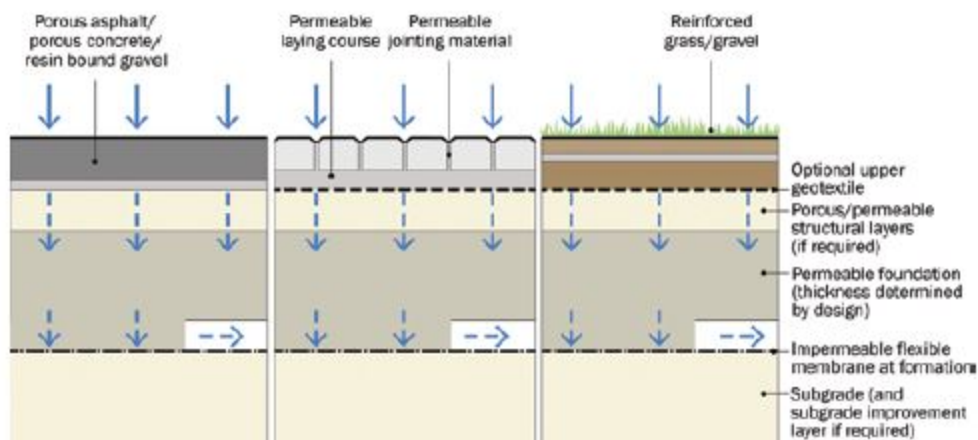


Figure 20.14 Pervious pavement system types: Type C – no infiltration

Variations of these three basic types of pervious pavement construction include the following:

- Grass reinforcement systems can be used over standard pavement materials (eg Type 1 sub-base). These systems will provide interception, but attenuation and treatment of the residual runoff from the surface will still be required, as they do not provide for any storage of water in the sub-base.
- Impermeable asphalt or concrete surfacing used over permeable sub-base (known as macro pervious surfaces [MPPS], or reservoir pavements) where the water is introduced into the storage in the sub-base via a series of distinct entry points – fast enough to prevent flooding during the design storm but without allowing silt and debris to enter the sub-base. The system offers the opportunity to accrue the benefits of a pervious pavement when the use of traditional paving surfaces is the preferred option due to traffic considerations. The performance of the silt trapping devices is crucial in this application as it is impossible to subsequently remove silt from the sub-base without complete system reinstatement. Simple catch pits or normal channels are not suitable.

required) and also usually acts as a maintenance route). Access for maintenance to smaller features may often just be an easement with sufficient space and gradients to allow access by mini excavators.

Larger ponds should, preferably, be divided into zones – providing the water quality and quantity volume storage in a number of independent cells. These can create increased attenuation, longer pollutant removal pathways (and therefore enhanced pollution removal), an easier maintenance regime and more varied ecology. They also allow:

- enhanced biodiversity – with lower zones tending to comprise cleaner water
- a more environmentally effective maintenance programme – through staggered programmes for each of the zones.



Figure 23.3 Wetland, Banner Country Park, Upton, Northamptonshire

Figure 23.4 provides a typical design of a pond in plan view and profile. Figure 23.5 shows typical planted pond edge details and Figure 23.6 shows equivalent details for a typical non-planted pond.

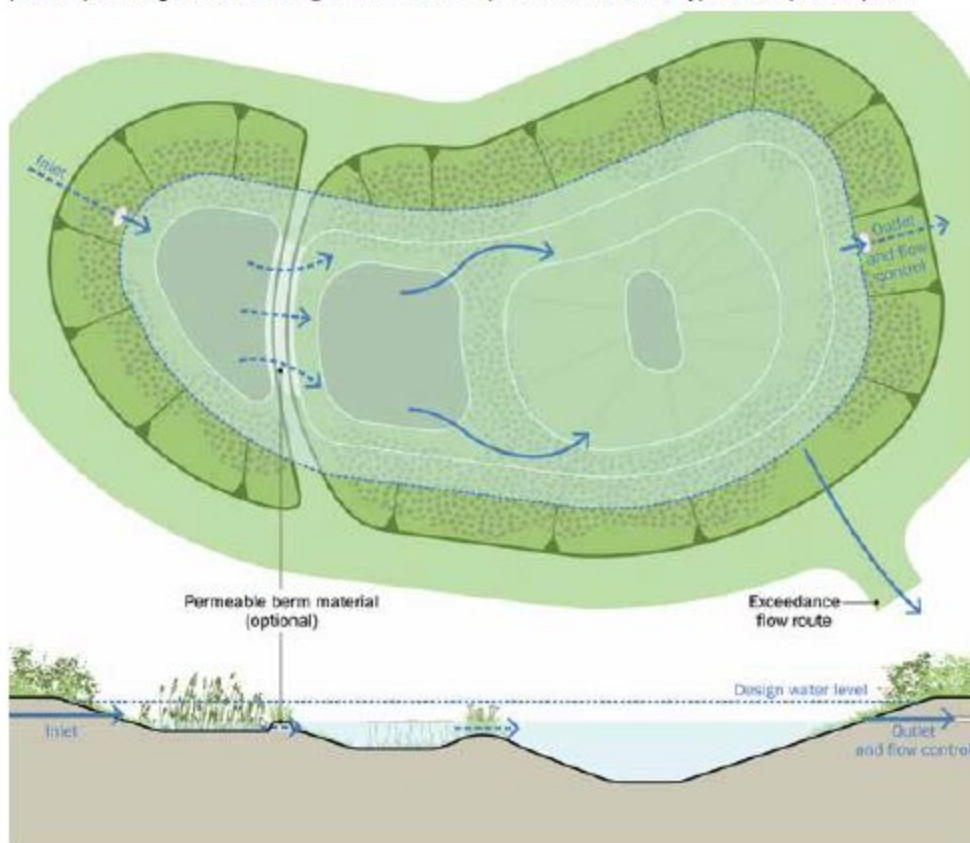
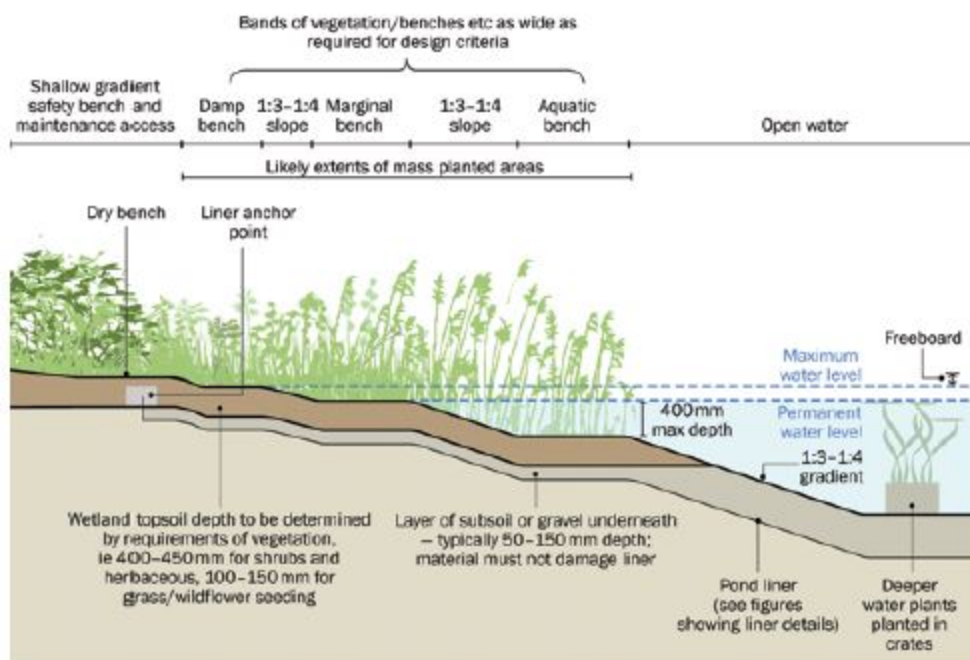
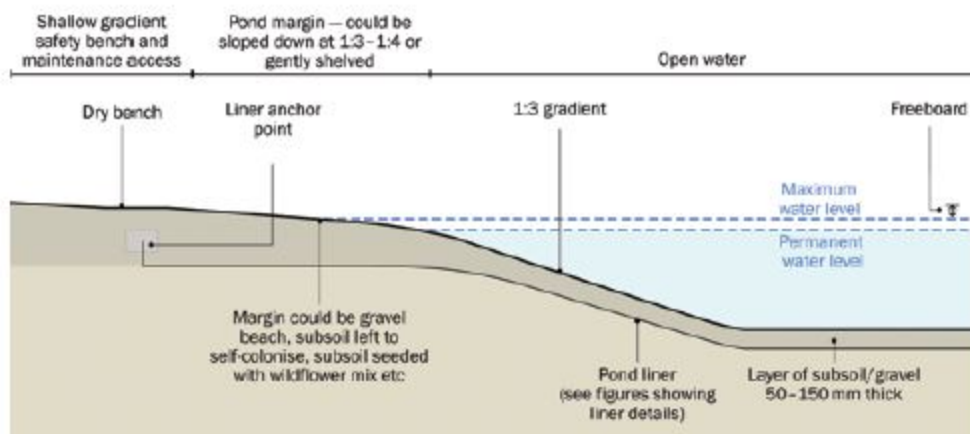


Figure 23.4 Plan view and profile of pond details



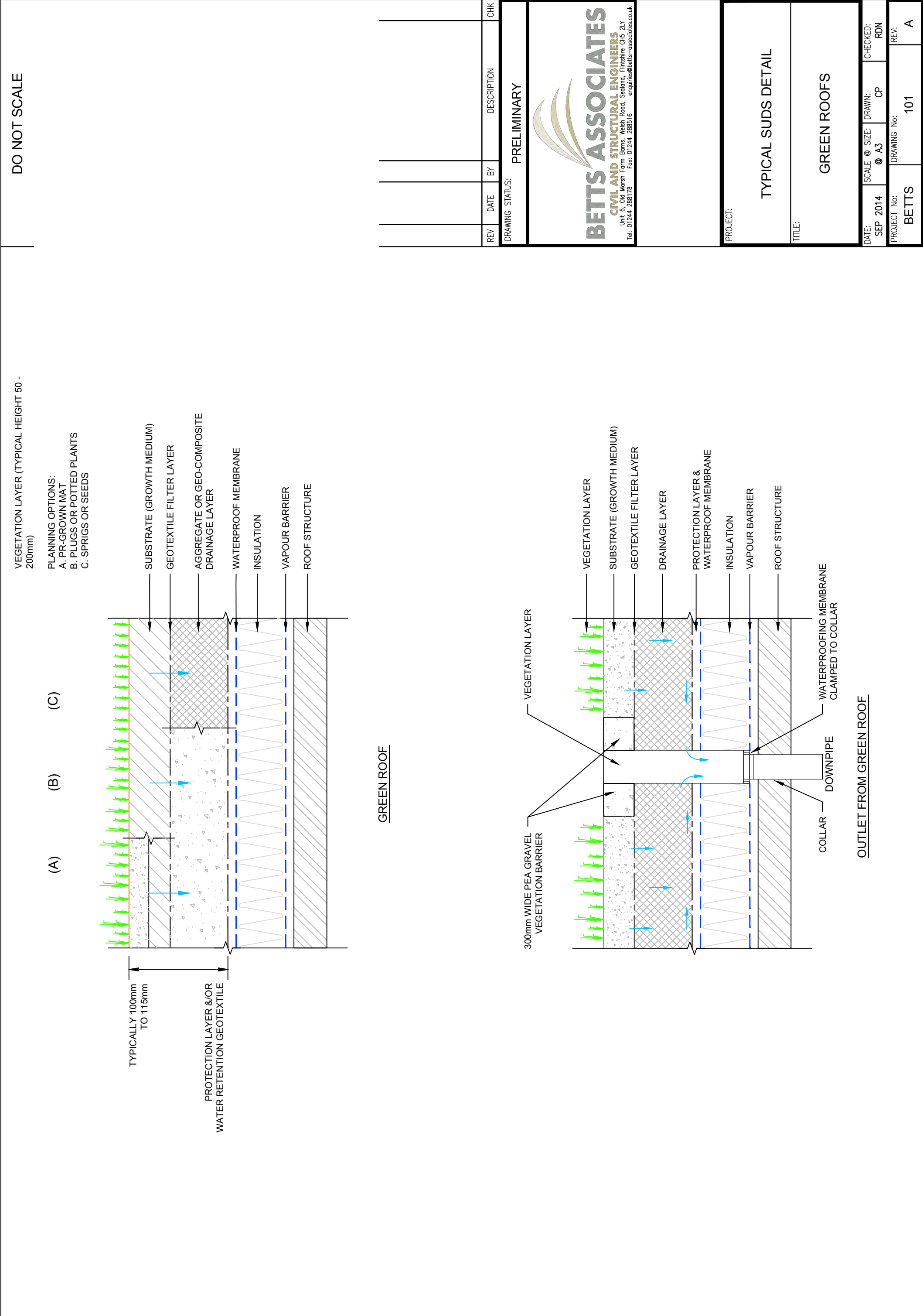
Notes: Width, surfacing and extent etc of safety bench and maintenance access all dependent on site, size of pond, maintenance requirements etc

Figure 23.5 Typical planted pond edge details

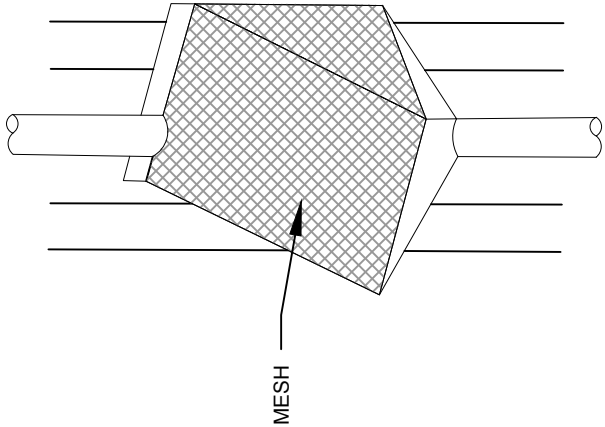


Notes: Width, surfacing and extent etc of safety bench and maintenance access all dependent on site, size of pond, maintenance requirements etc

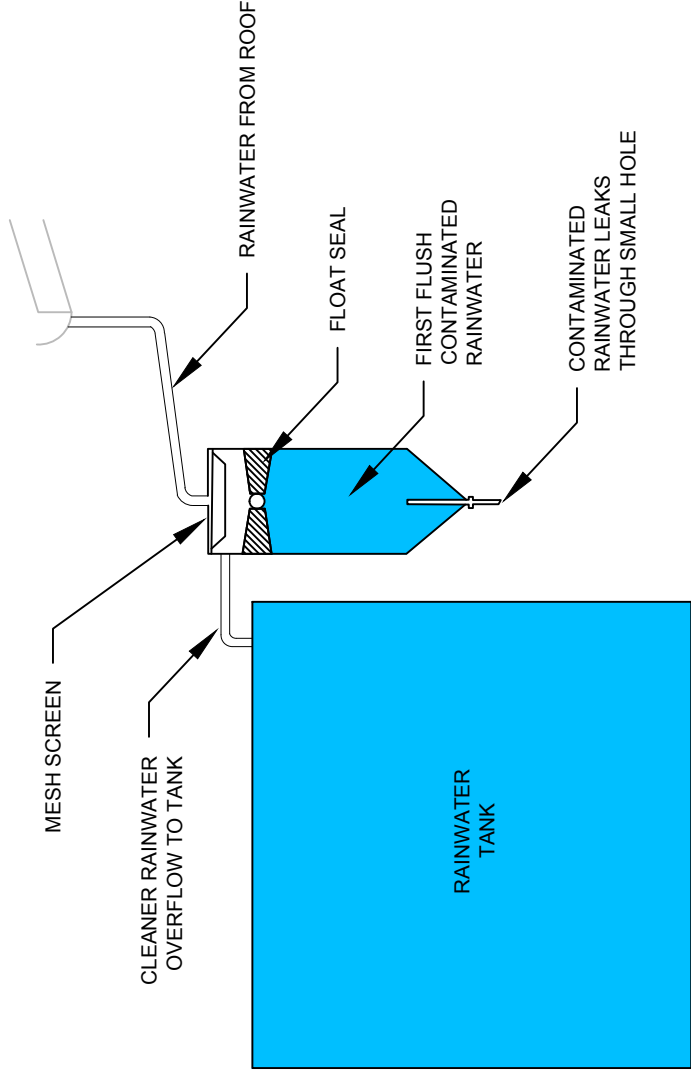
Figure 23.6 Typical non-planted pond edge details



DO NOT SCALE



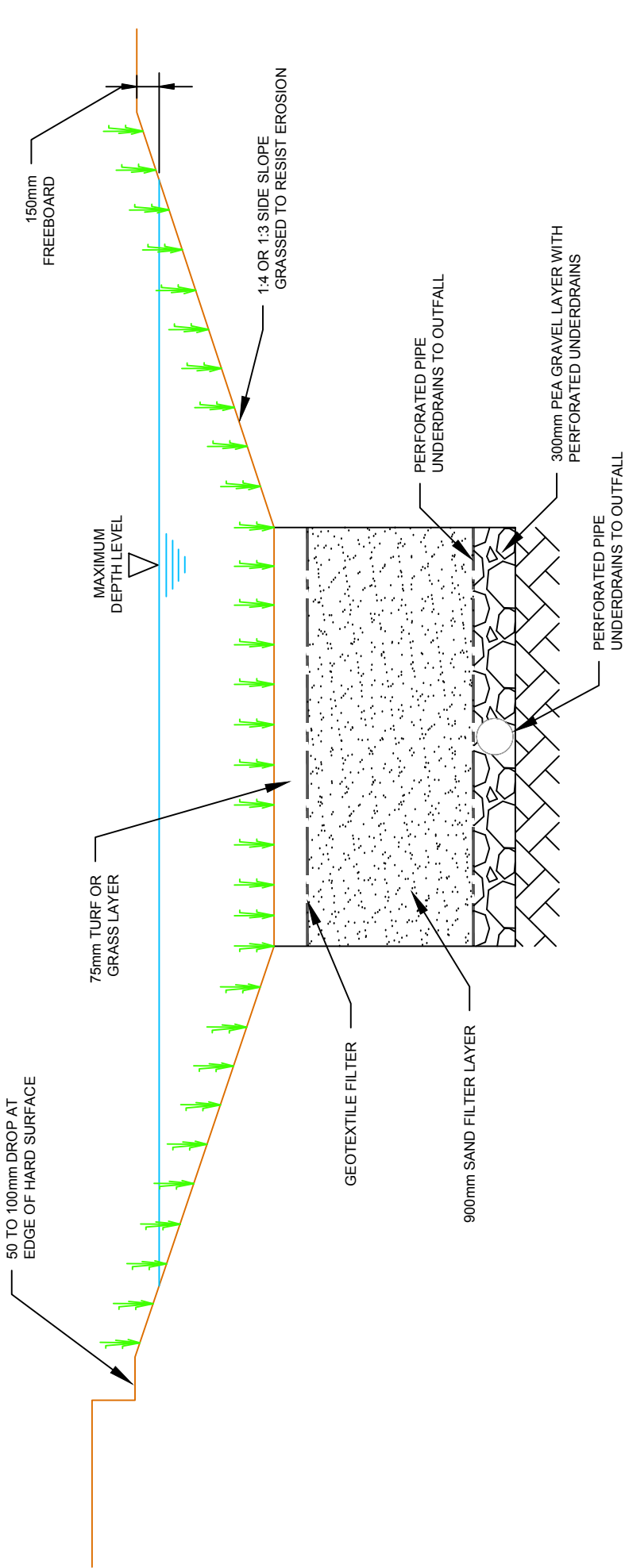
RAINWATER HARVESTING



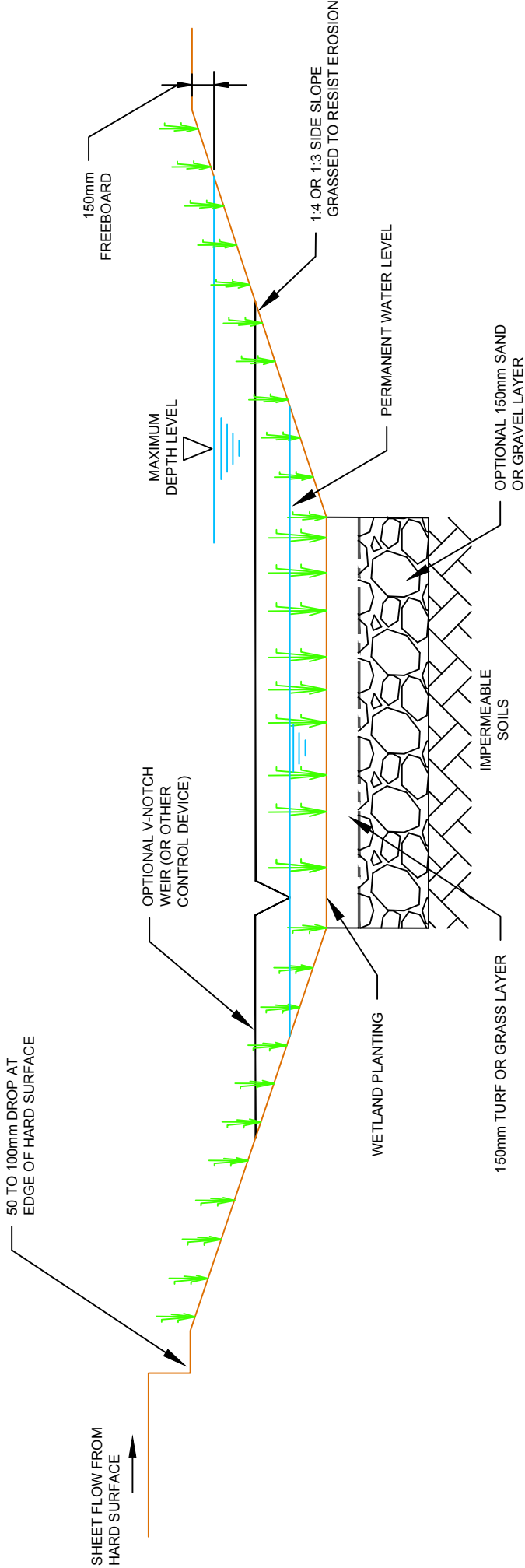
RAINWATER HARVESTING

[illegible]

DO NOT SCALE



DRY SWALE



WET SWALE

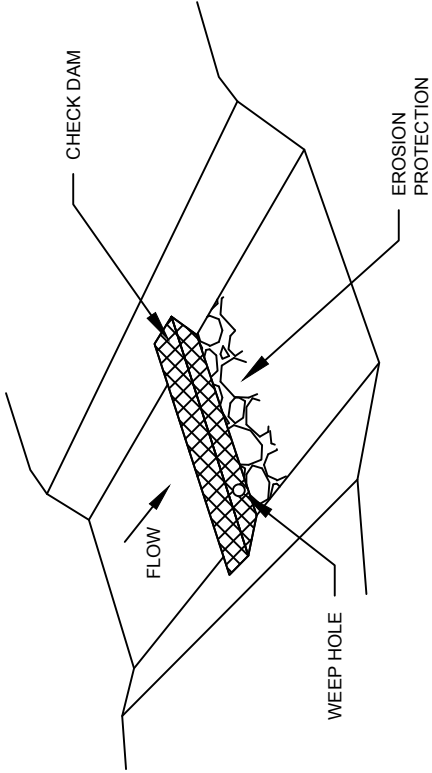
REV	DATE	BY	DESCRIPTION	CHK
DRAWING STATUS: PRELIMINARY				



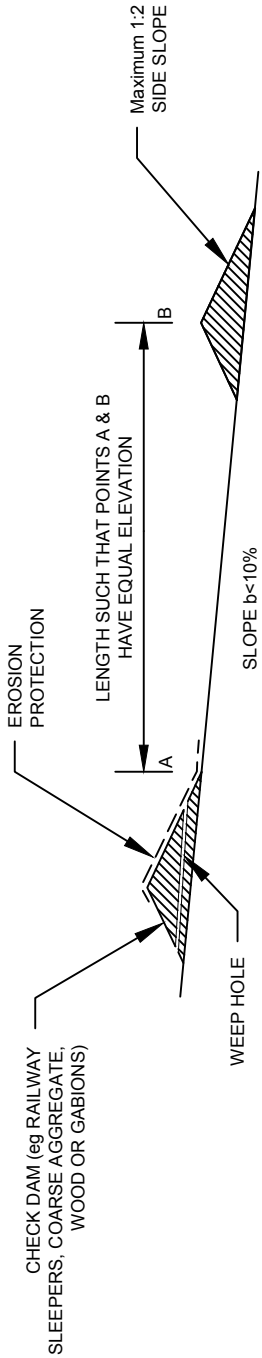
BETTS ASSOCIATES
CIVIL AND STRUCTURAL ENGINEERS
Unit 6, Old Marsh Farm Barns, Welsh Road, Sealand, Flintshire CH5 2LY
Tel: 01244 288178 Fax: 01244 288516 enquiries@betts-associates.co.uk

PROJECT: TYPICAL SUDS DETAIL				
TITLE: SWALES (1 of 2)				
DATE: SEP 2014	SCALE @ SIZE: @ A3	DRAWN: CP	CHECKED: RDN	REV: A
PROJECT No: BETTS		DRAWING No: 103		REV: A

DO NOT SCALE

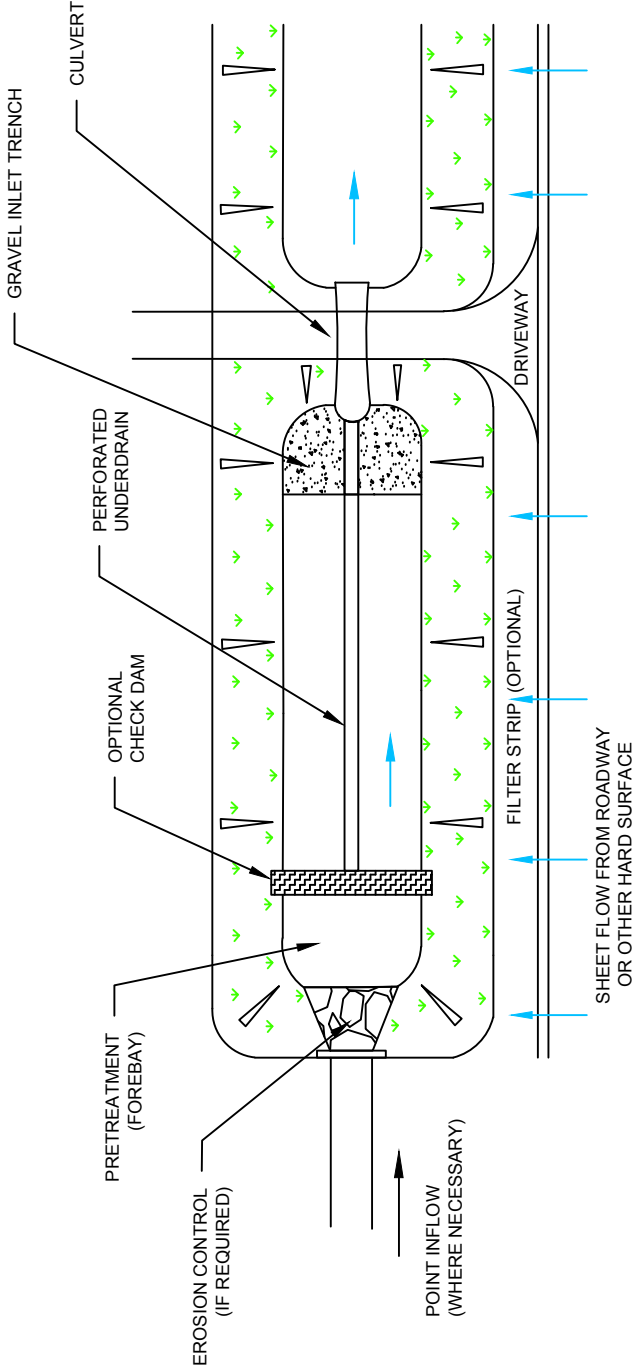


SCHEMATIC



ELEVATION

CHECK DAM



ENHANCED DRY SWALE

REV	DATE	BY	DESCRIPTION	CHK

DRAWING STATUS: PRELIMINARY



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PROJECT:

TYPICAL SUDS DETAIL

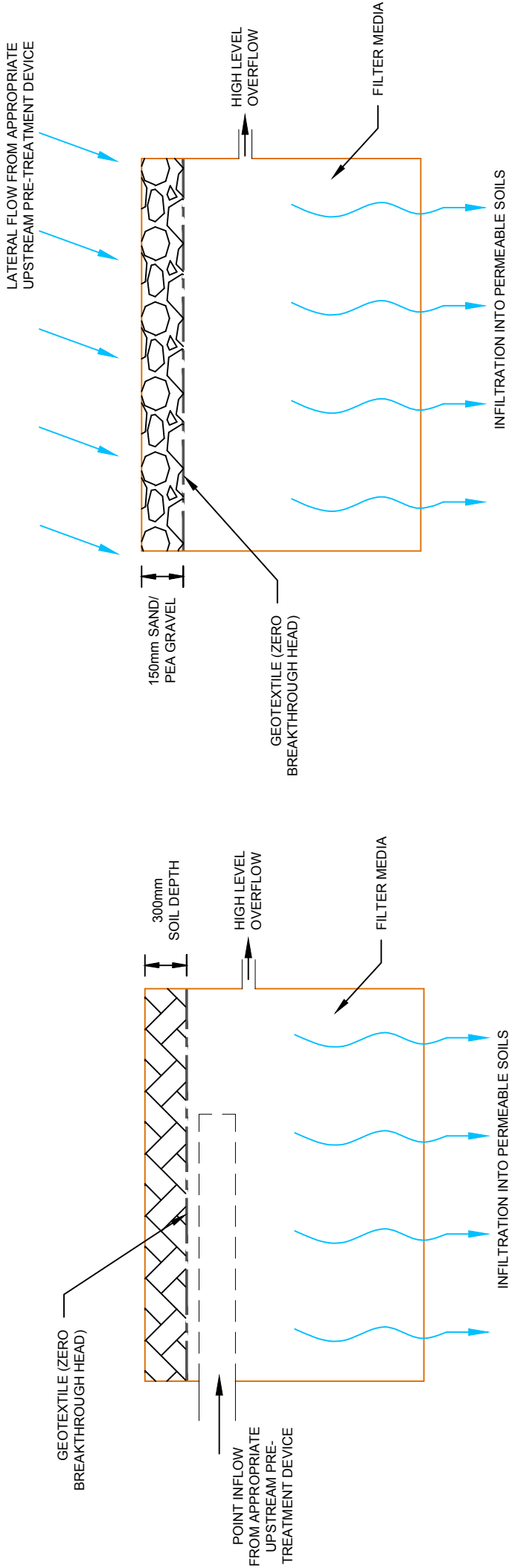
TITLE:

SWALES
(2 of 2)

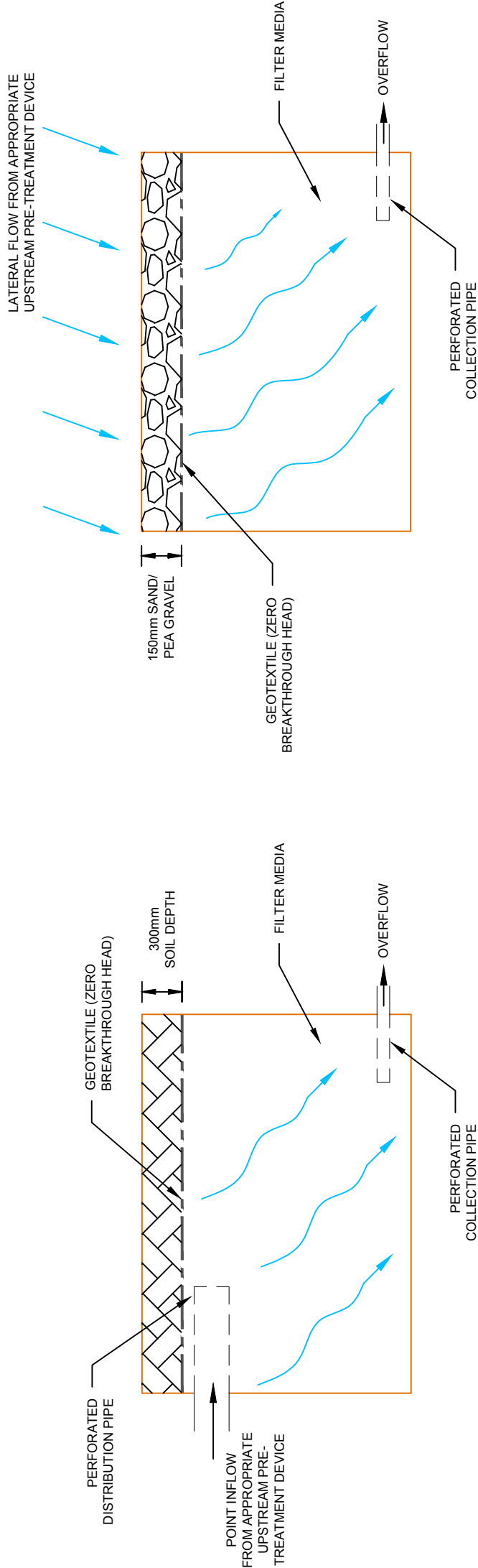
DATE: SEP 2014	SCALE @ SIZE: @ A3	DRAWN: CP	CHECKED: RDN
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PROJECT No: BETTS	DRAWING No: 104	REV: A
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DO NOT SCALE



INFILTRATION TRENCH SCHEMATICS



FILTER TRENCH SCHEMATICS

REV	DATE	BY	DESCRIPTION	CHK

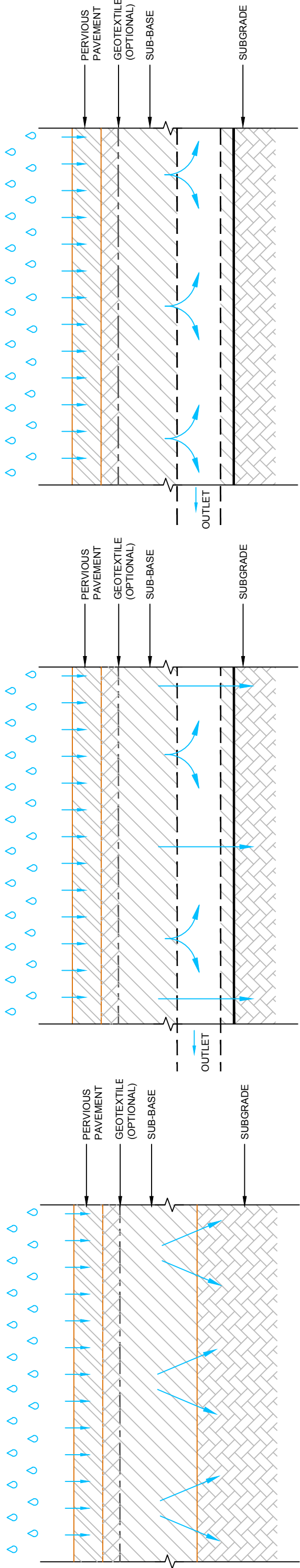
DRAWING STATUS: PRELIMINARY



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PROJECT:	TYPICAL SUDS DETAIL			
TITLE:	TRENCHES			
DATE: SEP 2014	SCALE @ A3	SIZE: CP	DRAWN: RDN	CHECKED: RDN
PROJECT No: BETTS	DRAWING No: 105		REV: A	

DO NOT SCALE

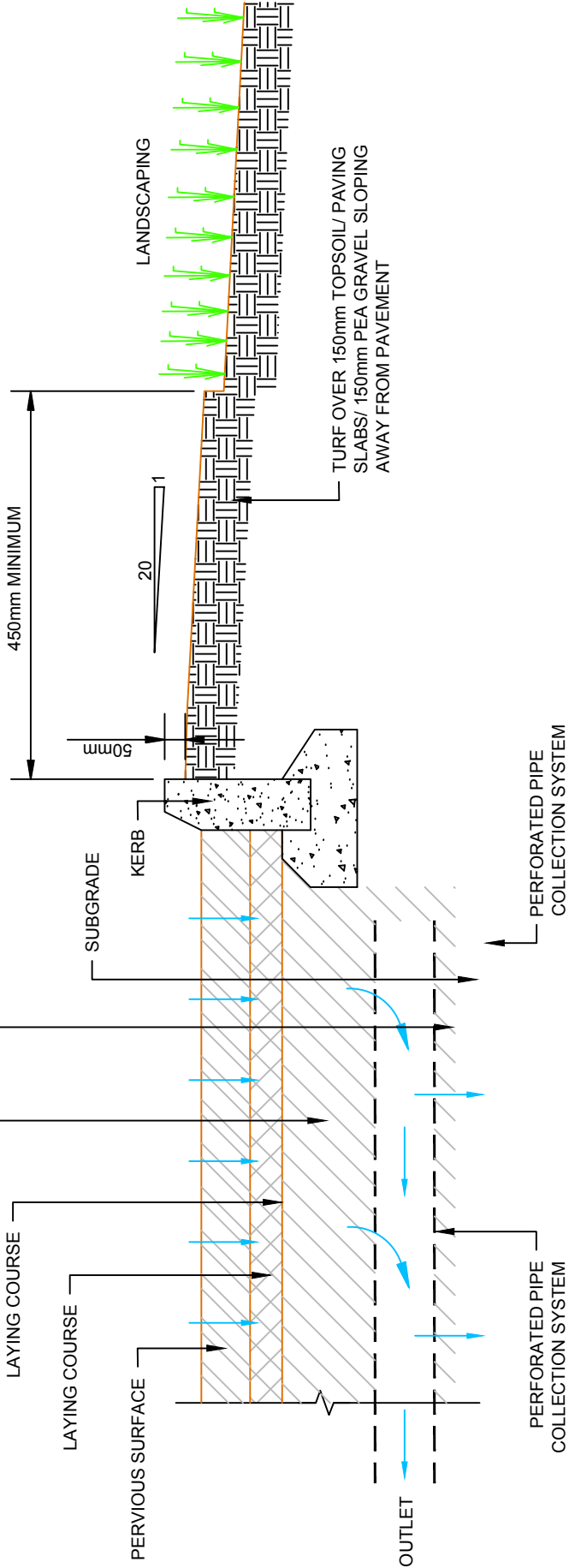


TYPE A: TOTAL INFILTRATION

TYPE B: PARTIAL INFILTRATION

TYPE C: NO INFILTRATION

AGGREGATE SUB-BASE (MAY BE REPLACED WITH GEOCELLULAR BLOCKS)



LANDSCAPING DETAIL

REV	DATE	BY	DESCRIPTION	CHK
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DRAWING STATUS: PRELIMINARY



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PROJECT:

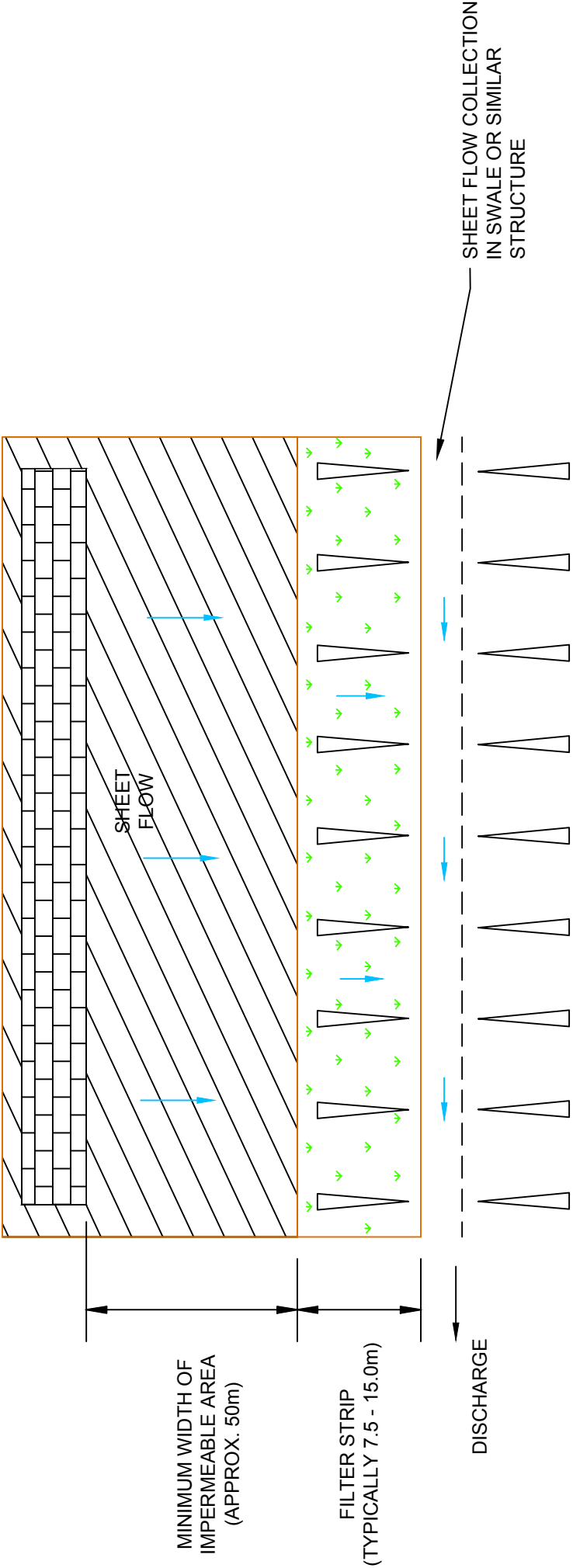
TYPICAL SUDS DETAIL

TITLE:

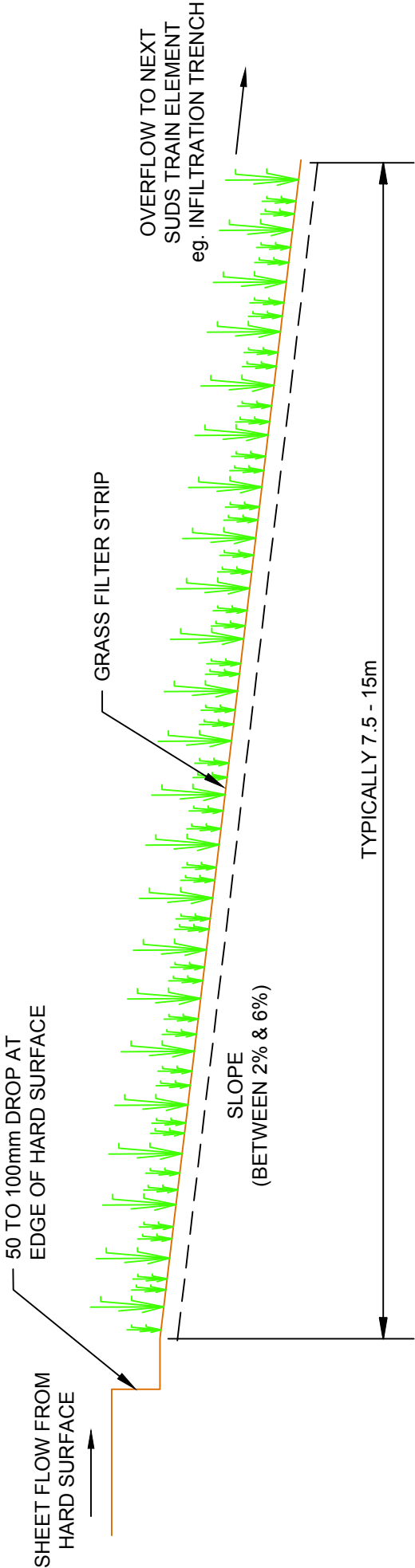
PERVIOUS PAVEMENTS

DATE: SEP 2014	SCALE @ SIZE: @ A3	DRAWN: CP	CHECKED: RDN
PROJECT No: BETTS	DRAWING No: 105	REV: A	

DO NOT SCALE



PLAN



ELEVATION

REV	DATE	BY	DESCRIPTION	CHK

DRAWING STATUS: PRELIMINARY



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PROJECT:

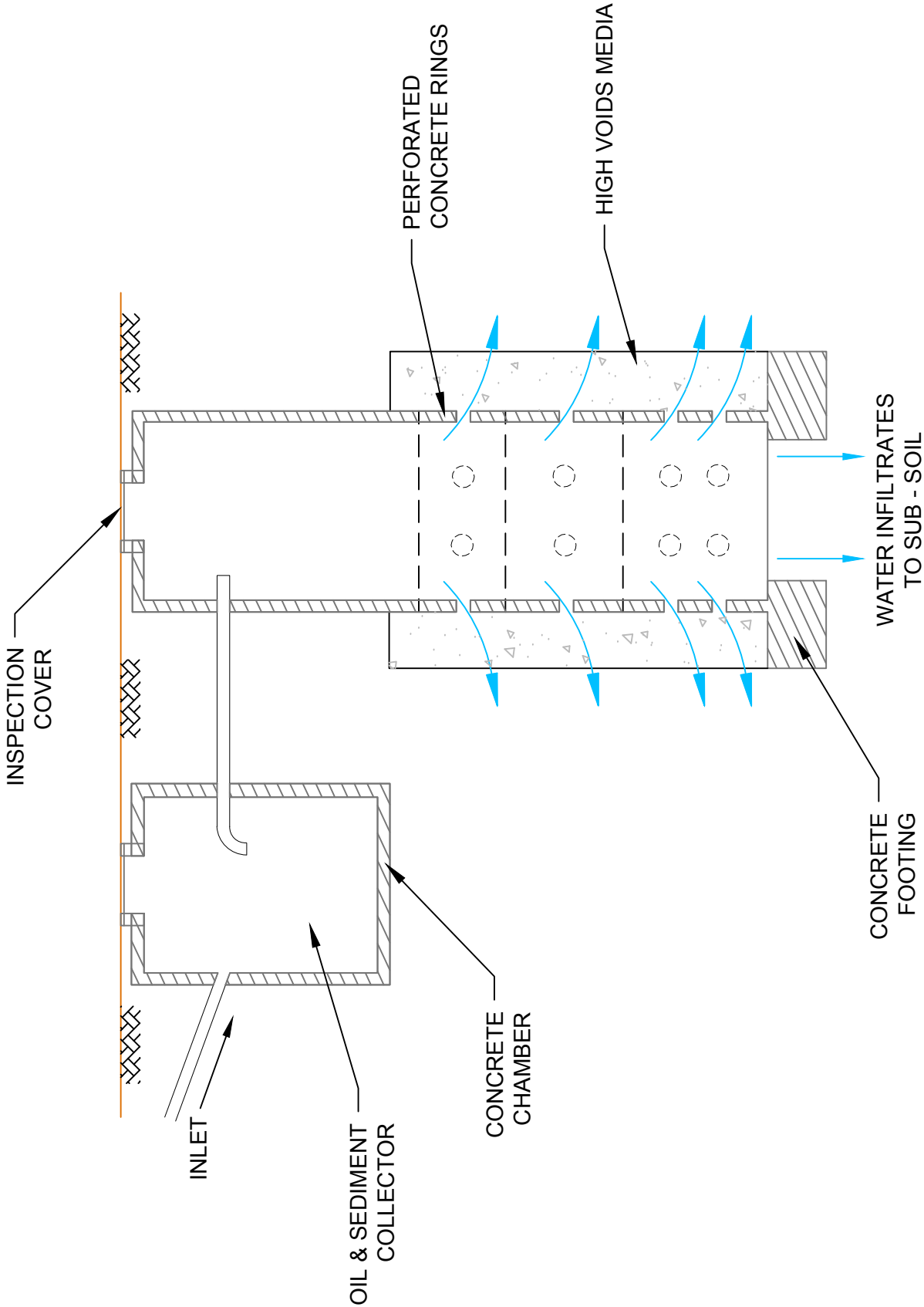
TYPICAL SUDS DETAIL

FILTER STRIPS

DATE:	SCALE @ SIZE:	DRAWN:	CHECKED:
SEP 2014	@ A3	CP	RDN

PROJECT No:	DRAWING No:	REV:
BETTS	107	A

DO NOT SCALE



SOAKAWAY DETAILS
(INCLUDING PRE-TREATMENT DEVICE)

REV	DATE	BY	DESCRIPTION	CHK

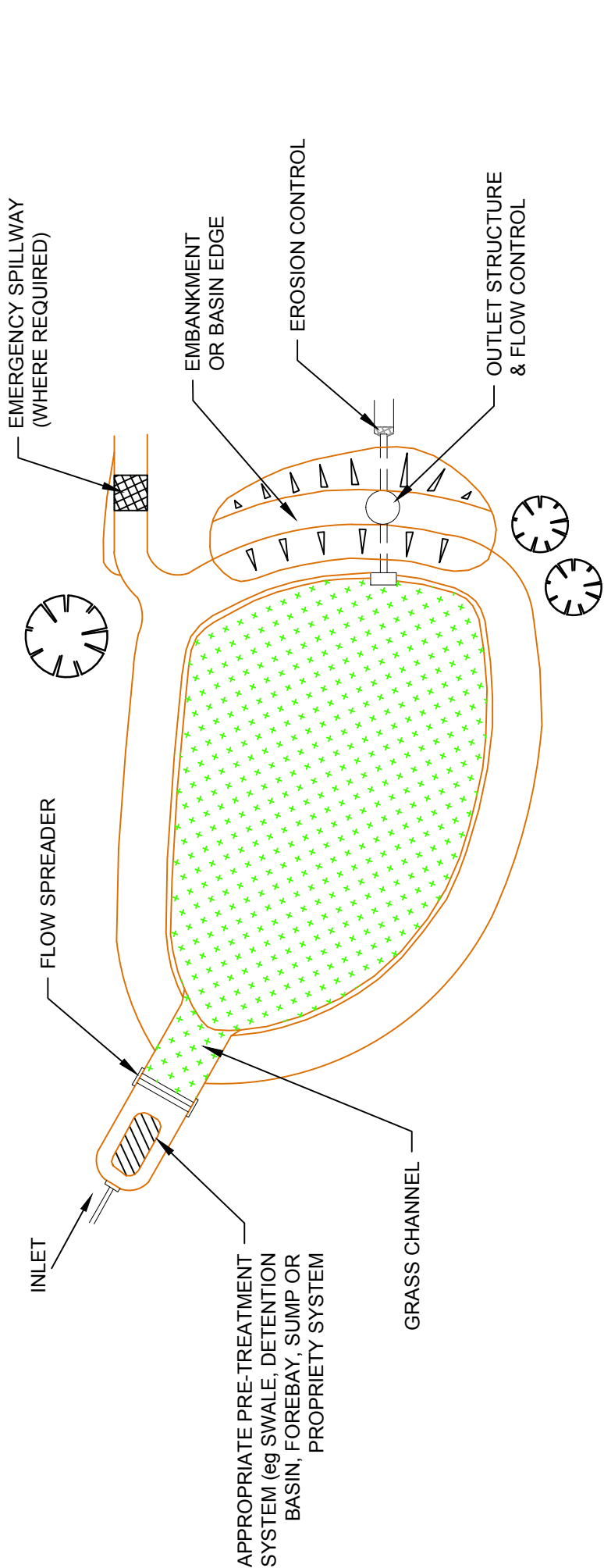
DRAWING STATUS: PRELIMINARY



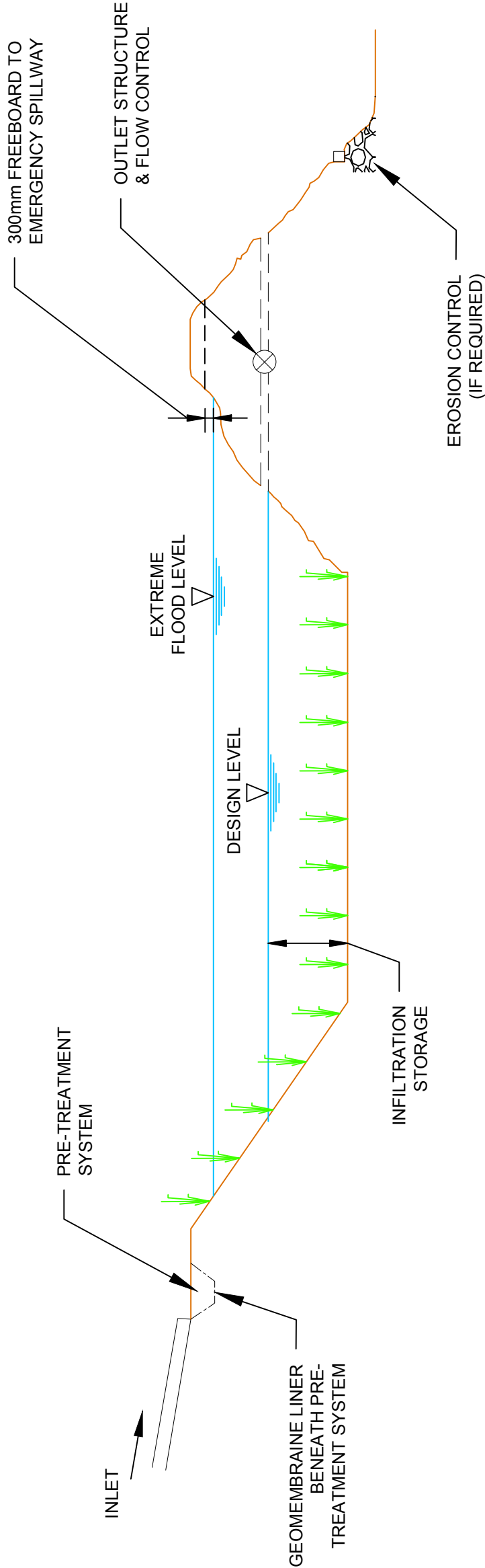
BETTS ASSOCIATES
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Unit 6, Old Marsh Farm Barns, Welsh Road, Sealand, Flintshire CH5 2LY
Tel: 01244 288178 Fax: 01244 288516 enquiries@betts-associates.co.uk

PROJECT:				
TYPICAL SUDS DETAIL				
TITLE:				
SOAKAWAYS				
DATE: SEP 2014	SCALE @ A3	SIZE: A3	DRAWN: CP	CHECKED: RDN
PROJECT No: BETTS		DRAWING No: 108		REV: A

DO NOT SCALE



PLAN VIEW



ELEVATION

REV	DATE	BY	DESCRIPTION	CHK

DRAWING STATUS: PRELIMINARY



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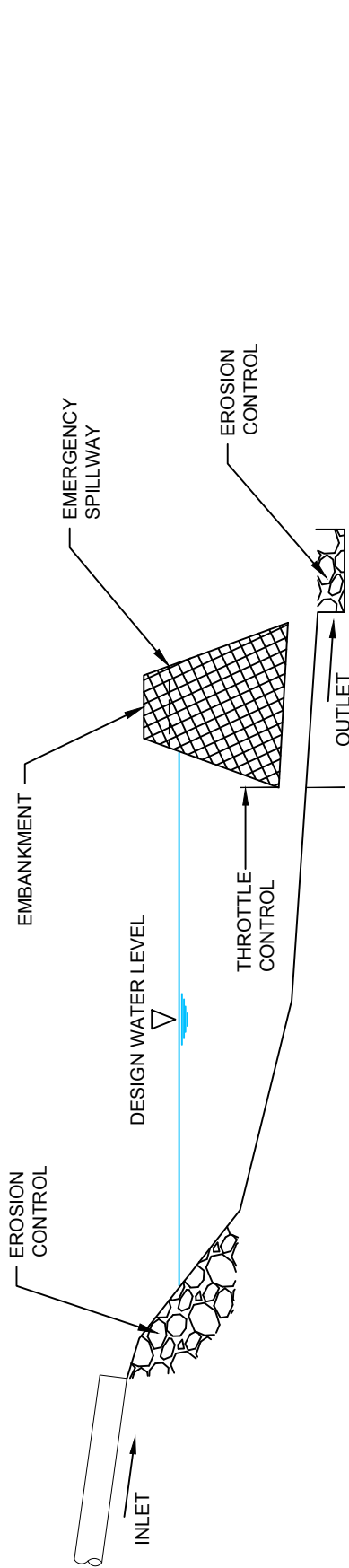
PROJECT: TYPICAL SUDS DETAIL

TITLE: INFILTRATION BASINS

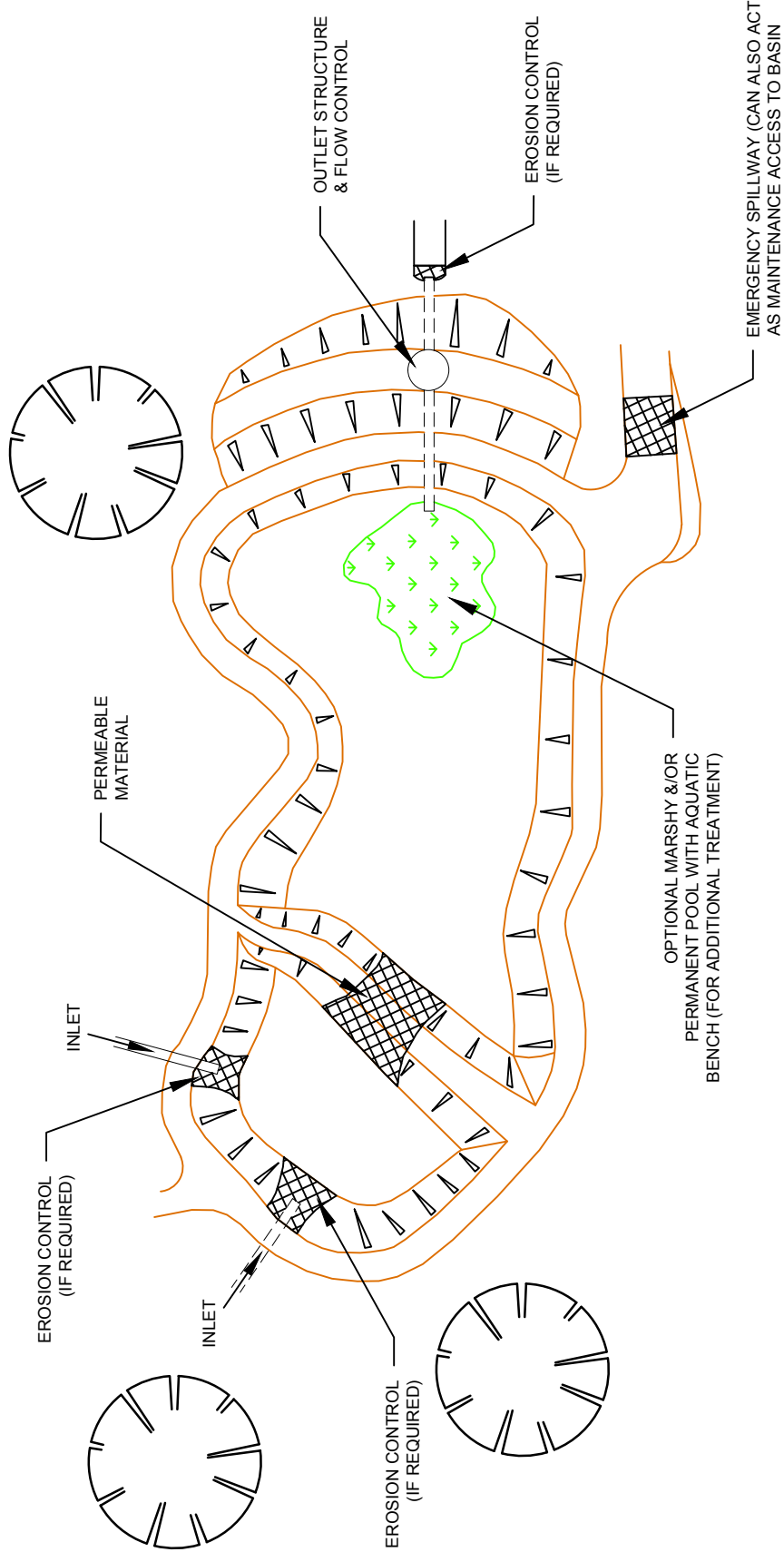
DATE:	SCALE @	SIZE:	DRAWN:	CHECKED:
SEP 2014	@ A3		CP	RDN

PROJECT No:	DRAWING No:	REV:
BETTS	109	A

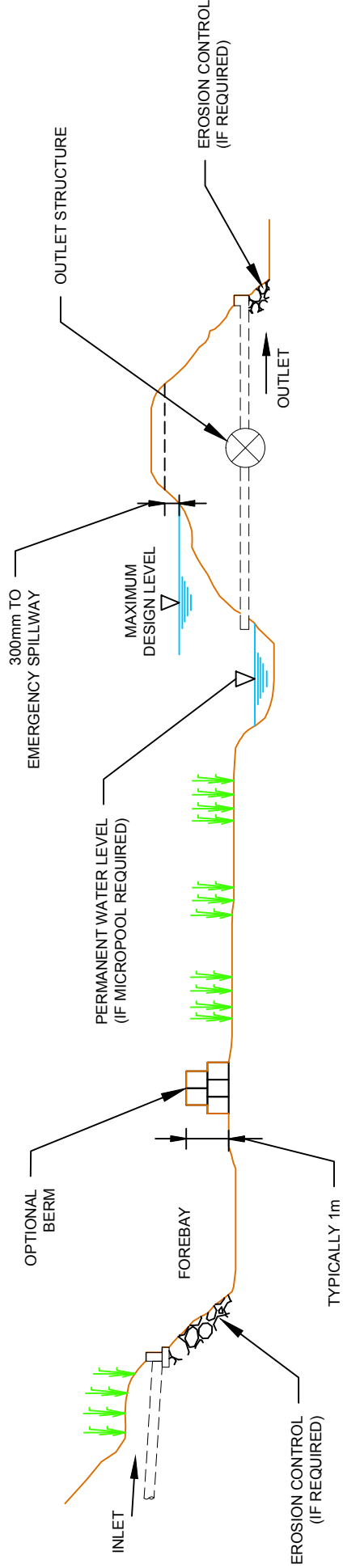
DO NOT SCALE



SCHEMATIC OF DETENTION
BASIN PROFILE



PLAN VIEW



ELEVATION

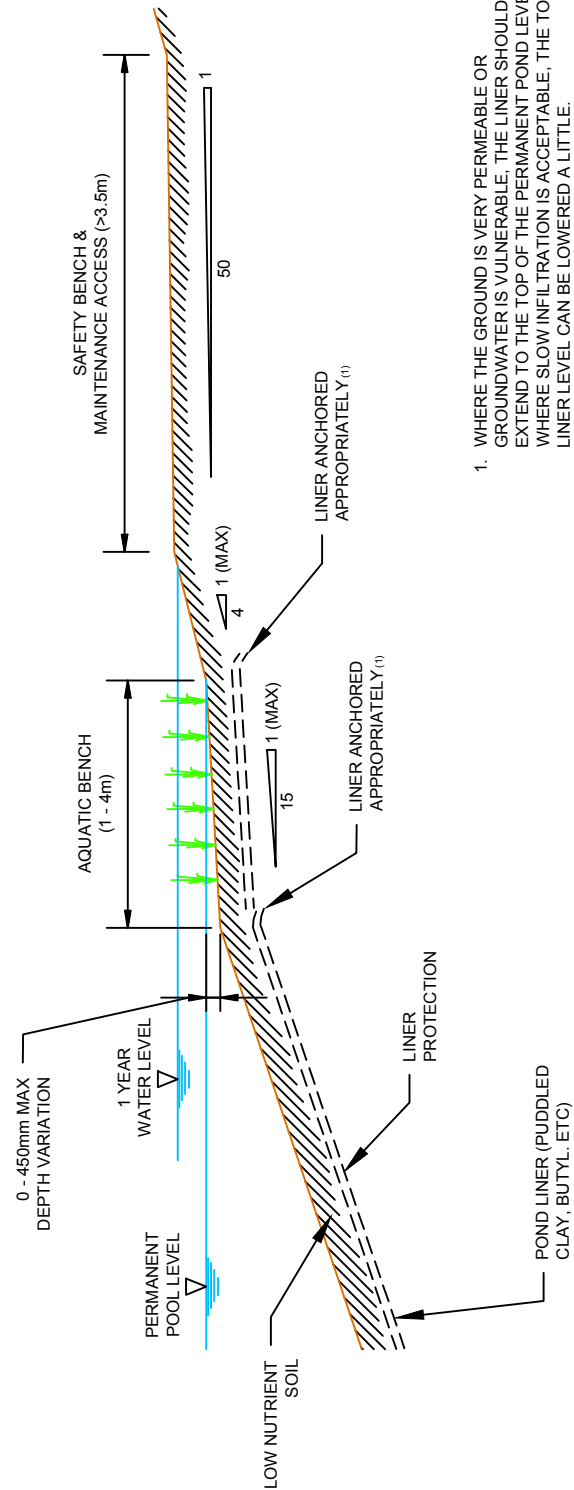
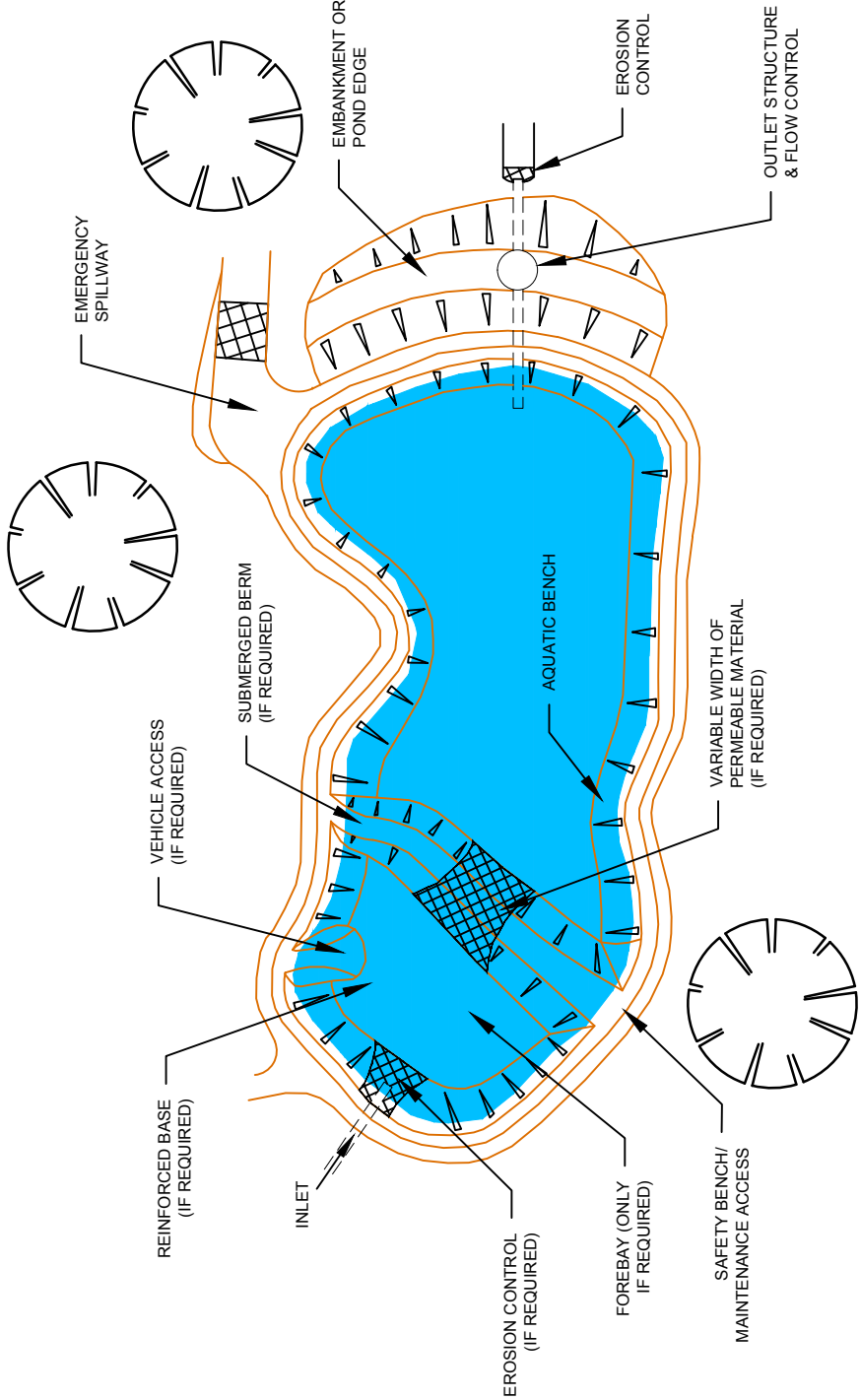
REV	DATE	BY	DESCRIPTION	CHK
DRAWING STATUS: PRELIMINARY				



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PROJECT:	TYPICAL SUDS DETAIL			
TITLE:	DETENTION BASINS			
DATE: SEP 2014	SCALE @ A3	SIZE: CP	DRAWN: RDN	CHECKED: RDN
PROJECT No: BETTS	DRAWING No: 110	REV: A		

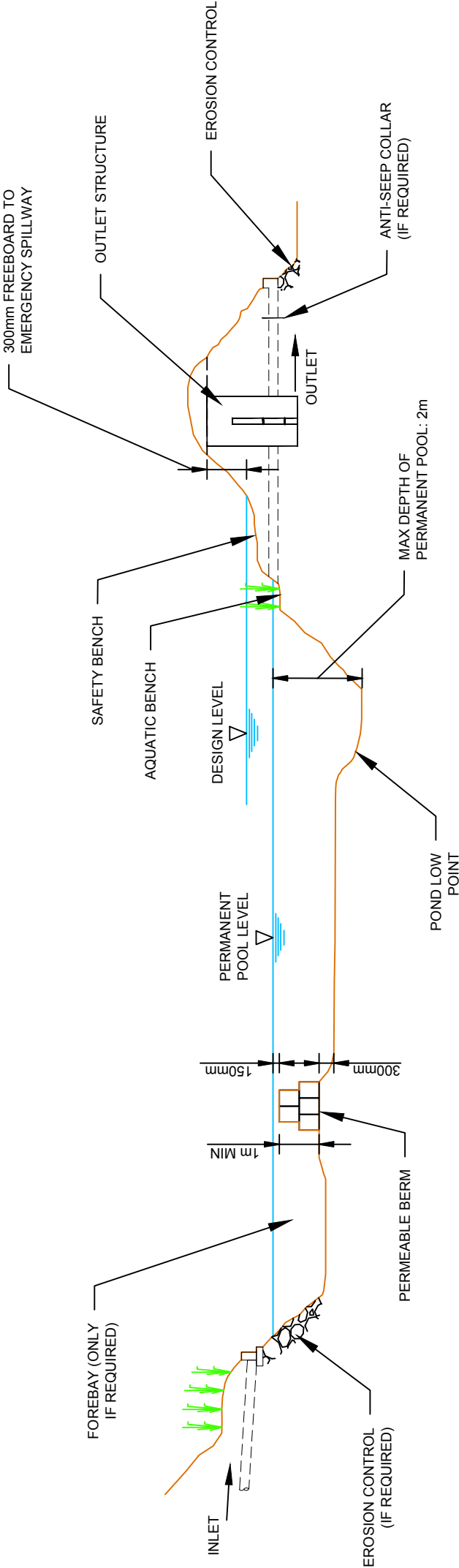
DO NOT SCALE



1. WHERE THE GROUND IS VERY PERMEABLE OR GROUNDWATER IS VULNERABLE, THE LINER SHOULD EXTEND TO THE TOP OF THE PERMANENT POND LEVEL. WHERE SLOW INFILTRATION IS ACCEPTABLE, THE TOP LINER LEVEL CAN BE LOWERED A LITTLE.

TYPICAL POND EDGE GEOMETRY

PLAN VIEW



PROFILE

REV	DATE	BY	DESCRIPTION	CHK
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DRAWING STATUS: PRELIMINARY



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enquiries@betts-associates.co.uk

PROJECT:

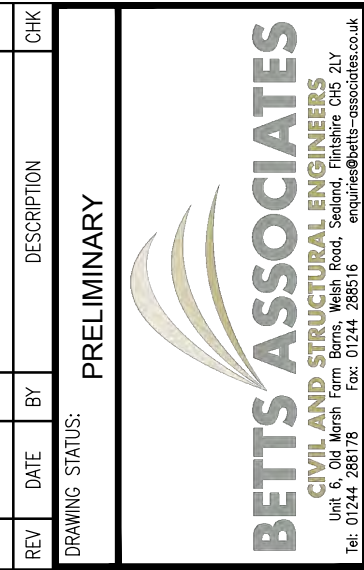
TYPICAL SUDS DETAIL

TITLE:

WET PONDS

DATE: SEP 2014	SCALE @ SIZE: @ A3	DRAWN: CP	CHECKED: RDN
PROJECT No: BETTS	DRAWING No: 111	REV: A	

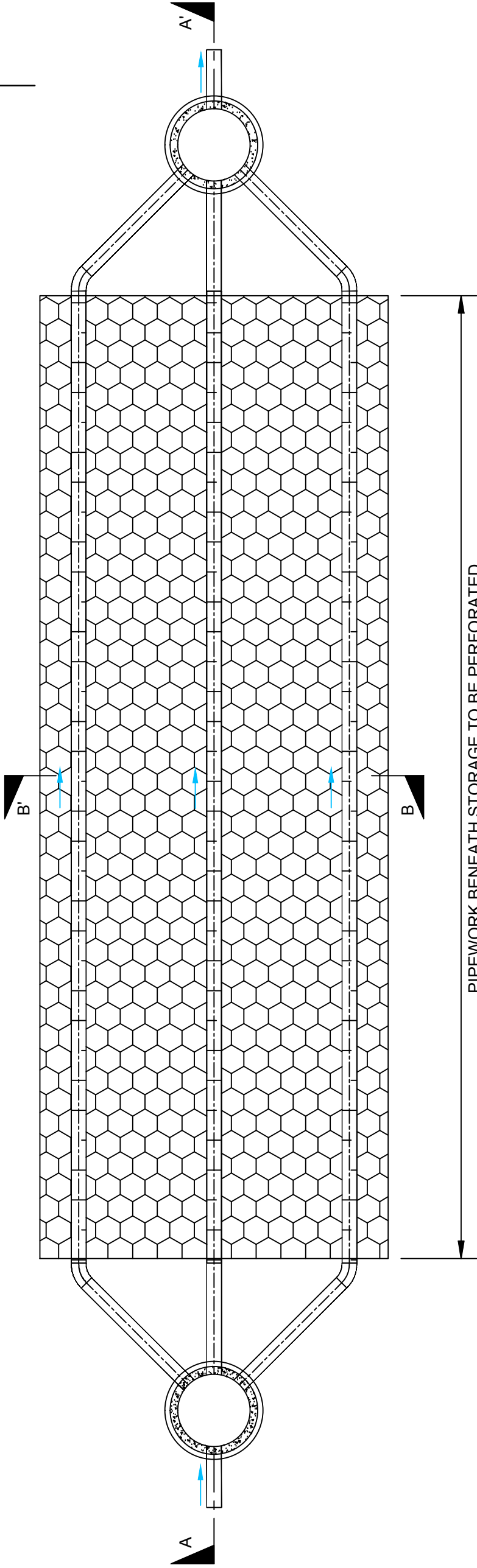
DO NOT SCALE



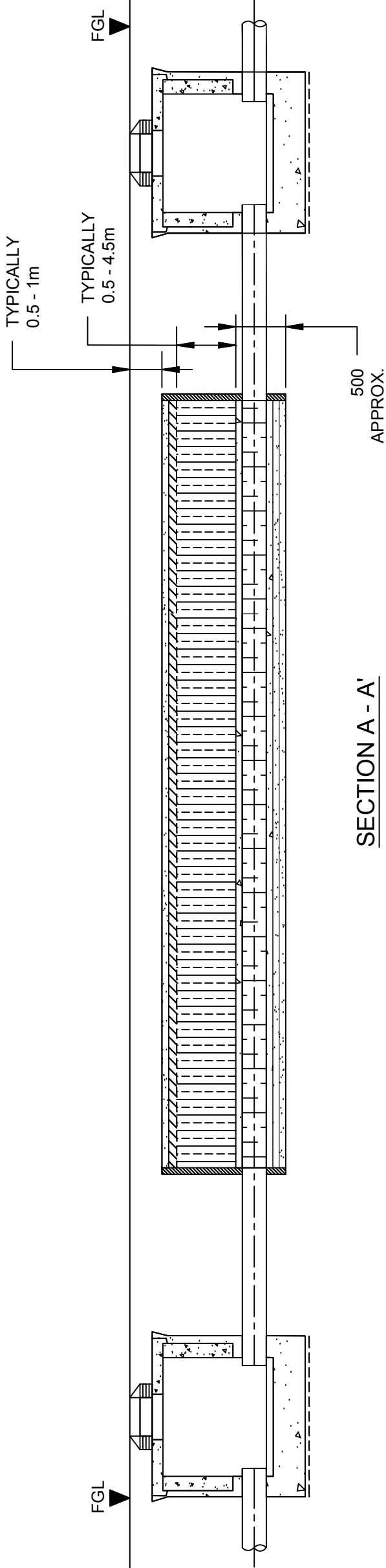
PROJECT:	TYPICAL SUDS DETAIL
TITLE:	BIORETENTION APPLICATIONS

DATE: SEP 2014	SCALE @ SIZE: @ A3	DRAWN: CP	CHECKED: RDN
PROJECT No: BETTS		DRAWING No: 112	
		REV: A	

DO NOT SCALE

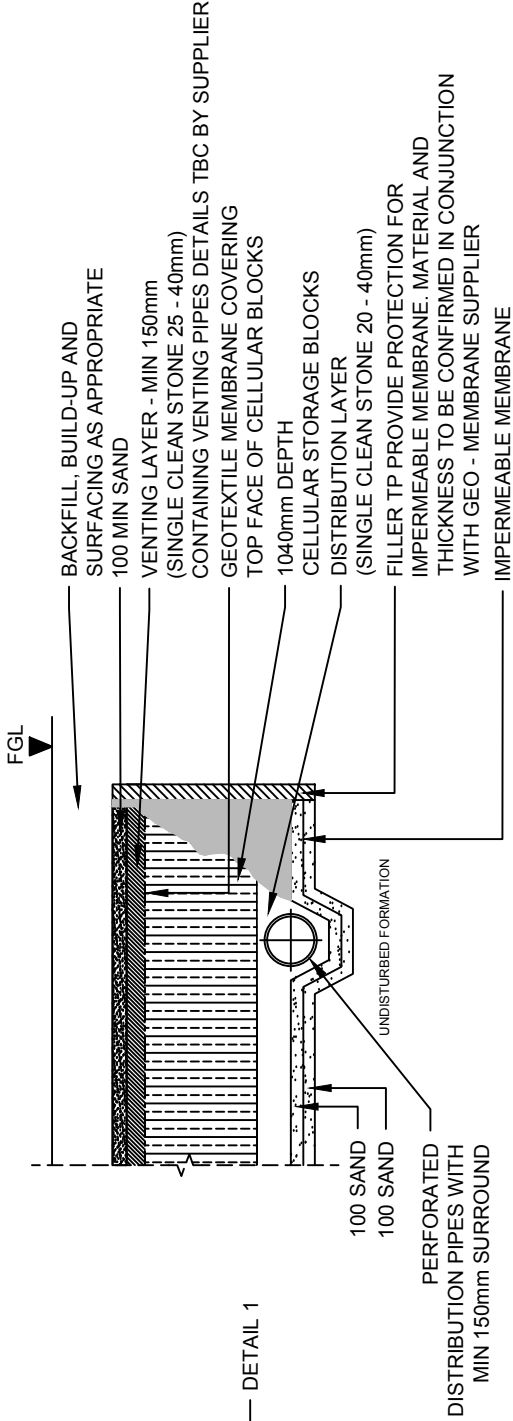
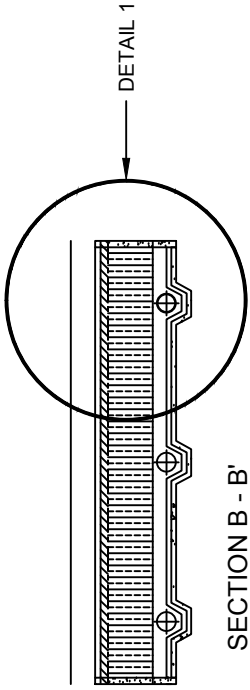


PLAN



SECTION A - A'

ALL DIMENSIONS AND DEPTHS DEPENDENT ON REQUIRED VOLUME AND LOCAL GROUND CONDITIONS



DETAIL 1

REV	DATE	BY	DESCRIPTION	CHK
DRAWING STATUS: PRELIMINARY				



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PROJECT: TYPICAL SUDS DETAIL				
TITLE: CELLULAR STORAGE				
DATE: SEP 2014	SCALE @ SIZE: @ A3	DRAWN: CP	CHECKED: RDN	REV: A
PROJECT No: BETTS		DRAWING No: 113		REV: A

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APPENDIX K: NOTES OF LIMITATIONS

The data essentially comprised a study of available documented information from various sources together with discussions with relevant authorities and other interested parties. There may also be circumstances at the site that are not documented. The information reviewed is not exhaustive and has been accepted in good faith as providing representative and true data pertaining to site conditions. If additional information becomes available which might impact our conclusions, we request the opportunity to review the information, reassess the potential concerns and modify our opinion if warranted.

It should be noted that any risks identified in this report are perceived risks based on the available information.

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