AMBIENTAL

ENVIRONMENTAL ASSESSMENT

Surface Water Drainage Strategy (SWDS)

Towsbourne, Winkfield Lane,
Winkfield, SL4 4QU

Ref: : 5649_Bussey_Towsbourne

Document Issue Record

Project:	Surface Water Drainage Strategy (SWDS)
Prepared for:	Alan Bussey
Reference:	5649_Bussey_Towsbourne
Site Location:	Land Adj to Towsbourne, Winkfield Lane, Winkfield, SL4 4QU
Proposed Development:	It is understood that the development is for the drainage strategy for new residential dwelling and associate external works in land adjacent to Towsbourne.

Consultant		**Date**	**Signature**
Author	Ryan Hofman	12/10/2020	[redacted]
Document Check	Thea Powell		
Authorisation	Mark Naumann		

Please Note:

Contact Us:

Ambiental Environmental Assessment
Science Park Square
Brighton, BN1 9SB
www.ambiental.co.uk
UK Office: +44 (0) 20 3857 8530 or +44 (0) 20 3857 8540

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1. Introduction

1.1 Ambiental Environmental Assessment has been appointed by Alan Bussey to undertake a Surface Water Drainage Strategy for the proposed development at Land Adj to Towsbourne, Winkfield Lane, Winkfield, SL4 4QU.

1.2 The site is currently a rural residential plot with a single dwelling and associated paddock. A brook runs alongside the site forming the west boundary and Winkfield Lane runs along the south boundary. To the north and east are open fields and gardens respectively.

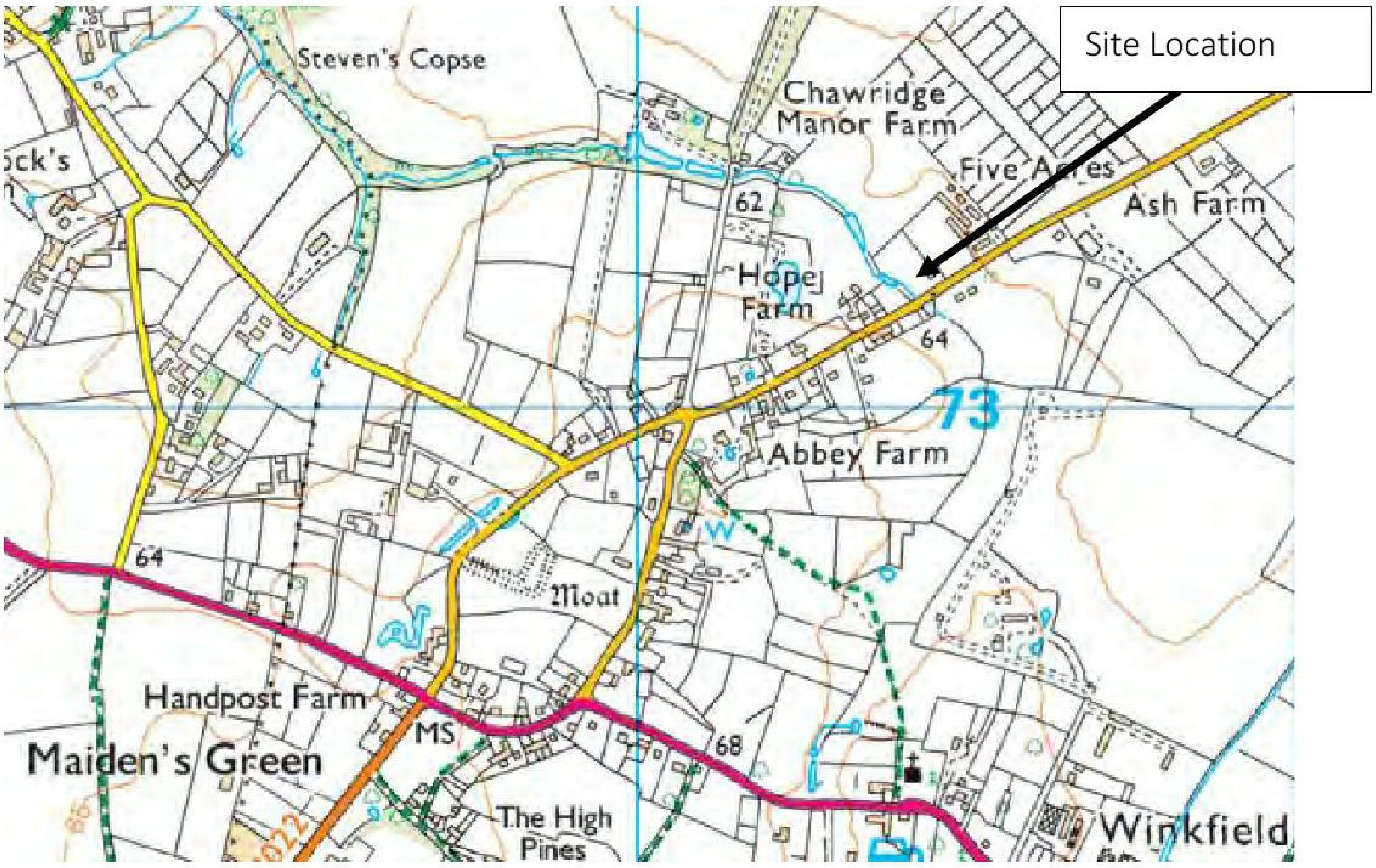


Figure 1: Site Location

1.3 Proposals are to construct an additional detached residential property on site with associated garage and driveway. As per the drawings included in Appendix 1. The redline boundary as provided on the proposed layout has a plan area of approximately 3680m2. The proposed roof development is approximately 265m2 and driveway/patio 491m2. The remaining site is to remain greenfield/garden areas. The proposals also include for construction of a new pond within the garden area to offer both improved habitat for Newts and other ecology but also offers increased flood plain storage should an extreme rainfall event occur to reduce risk to others downstream.

1.4 An ecological survey has been commissioned by the client (Preliminary Ecological Appraisal by John Wenman Ecological Consultancy LLP, Ref R2232/a) and this includes an assessment of the stream and wider site and the impact of the proposed development and includes site photographs.

1.5 A topographic survey has been commissioned at the site and levels on site vary between approximately 64.80mAOD near the existing Towsbourne property, towards the east, to a minimum elevation of approximately 62.80mAOD based on the survey levels. Analysis of topographic levels indicates that the site generally slopes to the south-west. The topographic survey is included in Appendix 1.

1.6 The purpose of this assessment is to demonstrate that the development proposal outlined above can be satisfactorily accommodated without worsening flood risk for the area and without placing the development itself at risk of flooding, as per National guidance provided within the National Planning Policy Framework (NPPF) the National Planning Practice Guidance (NPPG), Defra's National Standards for Sustainable Drainage and Bracknell Forest Council SuDS Guidance.

2. Site Overview

2.1 In order to mitigate flood risk posed by the proposed development, adequate control measures are required to be considered. This will ensure that surface water runoff is dealt with at source and the flood risk off site is not increased.

2.2 All proposed on-site drainage should be designed to accommodate a 1 in 100yr rainfall event including the appropriate allowance for climate change as set out within the NPPF at 40%.

2.3 An ecological survey has been commissioned by the client (Preliminary Ecological Appraisal by John Wenman Ecological Consultancy LLP, Ref R2232/a) and this includes an assessment of the stream and wider site and the impact of the proposed development and includes site photographs.

Existing Drainage Infrastructure and Nearby Watercourses

2.4 An existing watercourse, the Chawridge Bourne borders the site on the west boundary and flows from south to north. And is culverted under Winkfield Lane to the south of the site.

2.5 A comparison of the surveyed channel and the LiDAR data (on which the pluvial flood map is based) shows that the surveyed channel appears to have been omitted from the lidar and for all section the cross section area in the channel is greater that depicted on the LiDAR section See drawing 4460 DR06 in Appendix 2. This is expected due to the post processing that occurs as part of LiDAR surface creation. Therefore, potentially, the flood extent depicted on the Pluvial flood maps may be reduced given the cross section area is greater than modelled. As no better data is available the LiDAR based flood extents have been utilised as a conservative basis for the recommendations in this report.

2.6 There is an existing residential property (Towsbourne) and it is assumed some existing surface and foul drainage is associated with this dwelling although no records of any existing drainage on site have been provided by the Client to inform this report.

2.7 A Preliminary Ecology Appraisal has been undertaken by John Wenman Ecological Consultancy (report Ref: R2232/a) which includes a detailed assessment of the site and associated site photographs. It show the main site to be open grassed paddock/garden with the stream and pond area to be tree lined.

Geology and Infiltration Potential

2.8 No specific site investigation has been carried out to date, as such infiltration potential is based on the British Geological Survey (BGS) Geology of Britain Viewer indicates that the bedrock underlying the site is London Clay Formation - Clay, Silt And Sand Sedimentary Bedrock .

2.9 The British Geological Survey (BGS) Geology of Britain Viewer indicates that there are no superficial deposits underlying the site.

2.10 Based on the BGS, infiltration is unlikely to be feasible due to the clay nature of the soil underlay the site

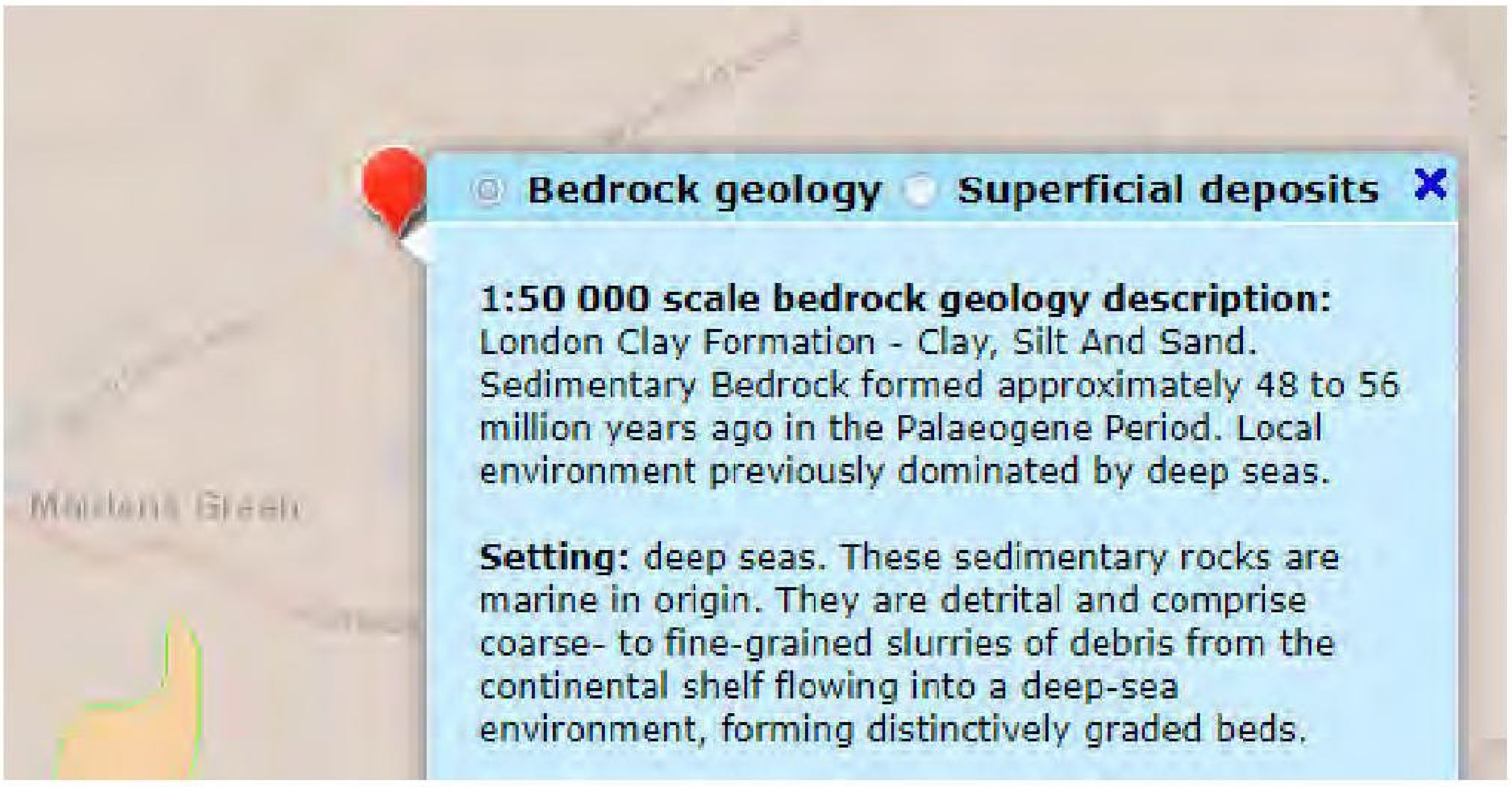


Figure 2 BGS Geology Viewer showing bedrock geology

Flood Zone and Vulnerability

2.11 With reference to the Environment Agency (EA) Flood Map for Planning, the proposed development is located within Flood Zone 1 (see Figure 3). The proposed new residential development is considered "More vulnerable" under the NPPF vulnerability guidance.

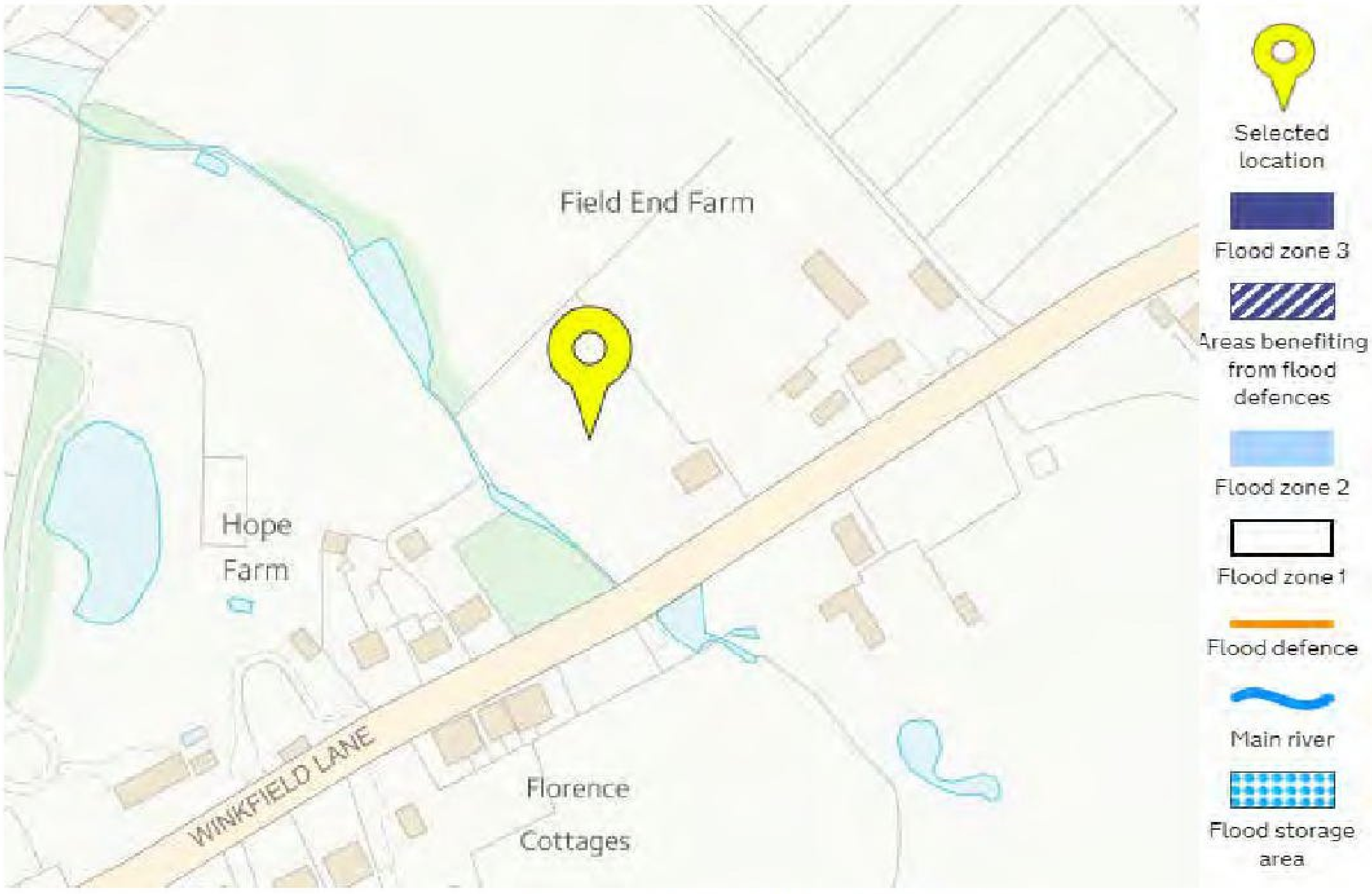


Figure 3 EA Flood Map for Planning

3. Flood Risk Assessment

Sequential Test/Exception Test

3.1 Under the NPPF, all new planning applications should undergo a *Sequential Test*. This test should be implemented by local planning authorities with a view to locating particularly vulnerable new developments (e.g. residential, hospitals, mobile homes etc.) outside of the floodplain.

3.2 The NPPF *Sequential Test: Flood Risk Vulnerability and Flood Zone 'Compatibility' Table* is reproduced below;

Flood Risk Vulnerability Classification		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	**Zone 1**	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test Required	✓	✓
	Zone 3a	Exception Test Required	✓	×	Exception Test Required	✓
	Zone 3b ***Functional Floodplain***	Exception Test Required	✓	×	×	×

Table 1 The Sequential Test: Flood Risk Vulnerability and Flood Zone 'Compatibility' Table as specified by NPPF.
Please note: ✓ means development is appropriate; × means the development should not be permitted.

3.3 Using the principles of the Sequential Test outlined above the proposed development is 'More Vulnerable' and located within Flood Zone 1 (as defined by the EA) and therefore, under the NPPF, is appropriate development for this flood zone and does not require the application of the Exception Test.

Sources of Flooding

3.4 The proposed development is shown located within Flood Zone 1 (low risk of flooding) and can be considered to be 'Highly Vulnerable' according to NPPF guidelines. Table 22 summarises the potential sources of flooding to the site:

Source	Description
Fluvial/Tidal	Flood Zone 1 – Low risk
Surface	Low Risk at development location. Medium to high in locality
Groundwater	Low Risk
Sewer	Low risk

Table 2 Summary of flood sources.

Fluvial/Tidal

3.5 A main river, The Cut, is located approximately 1500m to the south of the development site. The EA Flood Map for Planning shows the proposed development to be located within Flood Zone 1 (low risk of flooding) from this source.

Surface Water (Pluvial)

3.6 The Environment Agency Flood Risk from Surface Water Map shows the proposed development and its immediate vicinity to be within an area of 'Low', 'Medium' and 'High' risk of flooding from surface water. The High and Medium Risk areas are associated with the immediate vicinity of the adjacent Chawridge Bourne and proposed development has been sequentially located outside of these risk areas.

3.7 Areas identified to be at 'Low' risk have between a 0.1% to 1% (1in1000-1in100) annual risk of flooding from this source. A 'Medium' Risk Scenario has a 1% to 3.3% (1in100-1in30) annual risk of occurring. A 'High' risk means that each year this area has a chance of flooding of greater than 3.3% (>1in30). The EA`s Risk of Flooding from Surface Water map is extracted in Figure 4.

Figure 4: EA Risk of Flooding from Surface Water (RoFSW) Map Extract

3.8 It can be seen from the extract above that flood risk is associated with the adjacent Chawridge Bourne and flooding could potentially affect the western areas of the site.

Figure 5: EA RoFSW High Risk Extract

3.9 The EA Surface Water Flood Depth Map for the High Risk Scenario (Figure 5) indicates that the proposed development located on site would not be affected as water is retained largely within the existing Chawridge Bourne. A 'High' risk means that each year this area has a chance of flooding of greater than 3.3% (greater than 1in30).

Figure 6: EA RoFSW Medium Risk Extract

3.10 The EA Surface Water Flood Depth Map for the Medium Risk Scenario (Figure 6) indicates that the proposed development located on site would not be affected as water is retained largely within the existing Chawridge Bourne but with some localised overtopping along the west boundary of the site. A Medium Risk Scenario has a 1% to 3.3% (1in30-1in100yr) annual risk of occurring. The council have provided surface water flood extents for this scenario (see plan in Appendix 1) and this has been used to sequentially locate the proposed development on site outside of the high and medium surface water risk areas.

Figure 7: EA RoFSW Low Risk Extract

3.11 The EA Surface Water Flood Depth Map for the Low Risk Scenario (Figure 7) indicates that the site adjacent to the stream may experience flood levels of up to 900mm in this event adjacent to the watercourse. The proposed development is away from the watercourse but may be potentially effected by the Low Risk surface flooding by depths up to 300mm. The proposed FFL would be raised above this modelled flood extent to mitigate this risk.

3.12 A Low Risk Scenario has a 0.1% to 1% annual risk of occurring (1in100 to 1in1000yr). The greatest depths are located towards the western boundary with flood depths decreasing as the ground levels rise into the site.

3.13 A comparison of the Topographically surveyed channel and the LiDAR data (on which the pluvial flood map is based) shows that the surveyed channel has been largely omitted from the lidar and for all sections taken the cross section area in the channel is greater that depicted on the LiDAR section. This would be expected due to the post processing that occurs as part of LiDAR surface creation. Therefore potentially the flood extent depicted on the Pluvial flood maps may be reduced given the cross section area of the channel appears greater than modelled. As no better data is available the LiDAR based flood extents have been utilised as a conservative basis for the recommendations in this report.

3.14 Proposed Finished floor levels would be sited at a level above any potential flood level associated with the Low risk Flood event, as the building main entrance would be within an area outside of the modelled flood extent. It is recommended that building finished floor levels (FFL's) are located a minimum of 600mm above the 1in100yr flood extent level.

3.15 Based on the topographic survey levels the predicted 1in100yr equates to approximately 63.740mAOD at the proposed building southern extent closest to the modelled water extent. Based on the topographic survey level and the 1in1000yr flood extent reaches a level of level of 64.300mAOD a minimum FFL of 64.500m AOD should be adopted to bring the FFL 200mm above the 1in1000yr flood level extent and greater than 600mm above the approximate 1in100yr level of 63.740m AOD. This ensures the development is safe from the modelled pluvial risk for events up to and including the 1in1000yr event.

3.16 In addition to raising building levels above the 1in1000yr modelled pluvial flood levels and to offer betterment to ecology and flood risk as part of the proposals the client is proposing a pond on the north west extent of the garden. This offers additional breeding area for the Great Crested Newts found in the adjacent watercourse (it should be noted that the pond has not been designed to provide volume mitigation of flood waters). Mitigation of displaced flood water from the proposed development is shown to be provided by locally lowering ground levels to the rear of the dwelling. The flood mitigation modelling has followed the recommended methodology outline by the EA by ensuring there is no flood storage loss at a 'level for level, volume for volume' post development. The mitigation volumes and 3d model assessment is included in Appendix 2 and shown on drawings 4460 DR04 and 4460 DR05.

Groundwater

3.17 No specific site investigation has been carried out to date, as such infiltration potential is based on the British Geological Survey (BGS) Geology of Britain Viewer indicates that the bedrock underlying the site is London Clay Formation - Clay, Silt And Sand Sedimentary Bedrock .

3.18 The British Geological Survey (BGS) Geology of Britain Viewer indicates that there are no superficial deposits underlying the site.

3.19 The site is not shown to be within an EA groundwater Source Protection Zone according to the DEFRA MagicMAP database.

3.20 The Bracknell Forest Level 1 SFRA 2017 contains a map indicating potential ground water risk in the study area. It can be seen from the extract in Figure 8 below that the site is not considered to be in an area at risk from Groundwater flooding. Therefore risk from this source can be considered low.

Figure 8 Groundwater Susceptibility. (Source: BGS)

<u>Sewer</u>

3.21 The Bracknell Forest Level 1 SFRA 2017 contains a map indicating sewer flooding risk in the study area. The site is shown located in an area with 0-1 recorded sewer flooding events. Given the rural nature of the site the risk from sewer flooding can be considered low.

Records of Historical Flooding

3.22 The Bracknell Forest Preliminary Flood Risk Assessment shows the site to be located in an area with no recorded flood records. The 2017 Bracknell Forest Borough Council addendum to the PFRA states '*There have been no significant flood events since the publication of the original PFRA report in December 2011'.* The Bracknell Forest Level 1 SFRA 2017 contains a map showing recorded flood events and none are shown int eh vicinity of the site.

Flood Zones

3.23 According to the EA Flood Map for Planning, the site is shown located within Flood Zone 1 (low risk of flooding).

3.24 The EA Flood Map for Planning has been produced in part using a relatively coarse, national scale flood modelling strategy, and in part by detailed modelling. It is important to note that only the potential floodplain is modelled; **the mitigating effects of any flood defences currently in place are not considered**. For reference, the definition of the NPPF flood risk zones is included below.

Zone	Description
1	**Low Probability.** This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).
2	**Medium Probability.** This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% – 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% – 0.1%) in any year.
3a	**High Probability.** This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.
3b	**The Functional Floodplain.** This zone comprises land where water has to flow or be stored in times of flood. SFRA's should identify this Flood Zone (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1%) flood, or at another probability to be agreed between the LPA and the EA, including water conveyance routes).

Table 3 Definition of the NPPF Flood Zones. (Source: EA)

Climate Change on Site

3.25 The design lifetime of a residential site is 100 years and an allowance for climate change should be considered in accordance with published guidance within the NPPF 2018. The climate change criteria are reproduced below, and it is likely that the 'upper end' allowance for 2070 to 2115 is deemed suitable for the proposed development. To provide a worst-case scenario, the 'upper end' 40% climate change allowance will be used (Table 4).

PEAK RAINFALL INTENSITY ALLOWANCE IN SMALL AND URBAN CATCHMENTS			
Applies across all of England	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper End	10%	20%	40%
Central	5%	10%	20%

Table 4: Peak rainfall intensity allowance in small and urban catchments

Residual Risks

3.26 Residual risks are those remaining after applying the sequential approach to the location of development and taking mitigating actions. Examples of residual flood risk include:

- the failure of flood management infrastructure such as a breach of a raised flood defence, blockage of a surface water conveyance system, overtopping of an upstream storage area, or failure of a pumped drainage system;
- failure of a reservoir, or;
- a severe flood event that exceeds a flood management design standard, such as a flood that overtops a raised flood defence, or an intense rainfall event which the drainage system cannot cope with.

<u>Defence Breach</u>

3.27 The site has been identified by EA Flood Map for Planning to be located outside all extreme modelled flood extents (Flood Zone 1) and as such there is no residual risk of defence failure or overtopping to the site.

<u>Reservoir Failure</u>

3.28 The EA Risk from Reservoir Map demonstrates that the site is outside flood extents in the event of reservoir flooding.

<u>Drainage Exceedance</u>

3.29 In the event of drainage system failure under extreme rainfall events or blockage, overland flow may occur within the site. In the event of the development's drainage system failure, the runoff flow will be dictated by topography on site. Design of external ground levels should be completed at detailed design stage to finalise these overland routes, but some indicative flow paths have been indicated on the outline strategy drawings. External levels should be designed to direct overland flow away from buildings and threshold as depicted on the proposed surface water drainage layout (Appendix 2)

3.30 A comparison of the surveyed channel and the LiDAR data (on which the pluvial flood map is based) shows that the surveyed channel is omitted from the lidar and for all section the cross section area in the channel is greater that depicted on the LiDAR section. This is expected due to the post processing that occurs as part of LiDAR surface creation. Therefore potentially the flood extent depicted on the Pluvial flood maps may be reduced given the cross section area is greater than modelled. As no better data is available the LiDAR based flood extents have been utilised as a conservative basis for the recommendations in this report.

3.31 In addition to raising building levels above the 1in1000yr modelled pluvial flood levels and to offer betterment to ecology and flood risk as part of the proposals the client is proposing a pond on the north west extent of the garden. This offers additional breeding area for the Great Crested Newts found in the adjacent watercourse (it should be noted that the pond has not been designed to provide volume mitigation of flood waters). Mitigation of displaced flood water from the proposed development is shown to be provided by locally lowering ground levels to the rear of the dwelling. The flood mitigation modelling has followed the recommended methodology outline by the EA by ensuring there is no flood storage loss at a 'level for level, volume for volume' post development.. The mitigation volumes and 3d model assessment is included in Appendix 2 and shown on drawings 5649 DR04 and 5649 DR05.

Flood Risk Management Measures

3.32 It is understood that the development is for the construction of new residential dwelling and associated car garage. The development is proposed to have finished floor levels sited above the predicted 1in1000yr pluvial flood level.

3.33 Based on the topographic survey levels the predicted 1in100yr equates to approximately 63.740mAOD at the proposed building southern extent closest to the modelled water extent. Based on the topographic survey level and the 1in1000yr flood extent reaches a level of level of 64.300mAOD a minimum FFL of 64.500m AOD should be adopted to bring the FFL 200mm above the 1in1000yr flood level extent and greater than 600mm above the approximate 1in100yr level of 63.740. This ensures the development is safe from the modelled pluvial risk for events up to and including the 1in1000yr event.

3.34 In event of a pluvial flood event access from the site onto Winkfield Lane may be restricted with potential flood depths shown less than 300mm on the EA`s RoFSW map on line (extracted in Figure 6). Ambiental have downloaded the detailed ROFSW 100yr return period dataset and this is shown on drawing 4460 DR01 in Appendix 2. It can be seen that the modelled flood depths are largely shown to be in the region of 0-150mm deepening to 300-600mm where the stream crosses Winkfield Lane. and in the road outside the access to the site. The verge at the site entrance is shown in the 150-300mm depth range.

3.35 Given potential flood risks increase towards the brook it is recommended that residents stay within the property, where there is safe refuge from all events up the 1in1000yr rainfall event, until flood water recede especially for extreme flood event greater than the 1in100yr rainfall event.

3.36 For rainfall events less than the 1in100yr event flood depths to the east are likely to be less than 250mm. Therefore site users access egress the site to the east where flood depths are acceptable for access under the definitions within FD2320. Access/egress from the west over the adjacent stream should be avoided unless water depths are low.

3.37 The remaining risk is that of surface water generated by the development itself. Flood risk to others can be mitigated by managing water on site, which is to be discharged at a reduced rate for rainfall events up to and including the 1in100yr+cc rainfall event in accordance with Local SuDS policy and the Ciria SuDS manual.

3.38 In addition to raising building levels above the 1in1000yr modelled pluvial flood levels and to offer betterment to ecology and flood risk as part of the proposals the client is proposing a pond on the north west extent of the garden. This offers additional breeding area for the Great Crested Newts found in the adjacent watercourse and also provide volume mitigation to any displacement of pluvial flood water that could occur as a result of the raised FFL of the proposed dwelling. The mitigation volumes and 3d model assessment is included in Appendix 2 and shown on drawings 5649 DR04 and 5649 DR05.

<u>Flood Warning Service</u>

3.39 The EA operates a 24-hour telephone service on 0345 988 1188 that provides frequently updated flood warnings and associated floodplain information. Further information can be found on www.environment-agency.gov.uk/floodline. Floodline Warnings Direct is a free service operated by the EA that provides flood warnings direct to occupants by telephone, mobile phone, fax or pager.

3.40 The development is not currently located with a flood warning area.

<u>Flood Evacuation Plan</u>

3.41 The EA Flood Map for Planning demonstrates that the proposed development lies within Fluvial Flood Zone 1 with a low probability of less than 1 in 1,000 (0.1%) of river flooding in any year.

3.42 In the event of a pluvial flood event, site users are advised to remain within the proposed development providing safe refuge within Flood Zone 1 and outside of the pluvial flood risk area. Should evacuation be required a proposed evacuation route is shown in Figure 9 below. Should flood depths exceed 250mm residents should not attempt to leave the property until flood waters recede.

Figure 9: Proposed Evacuation route

Off Site Impacts

Flood Plain displacement

3.43 The EA Flood Map for Planning demonstrates that the proposed development lies within Fluvial Flood Zone 1 with a low probability of less than 1 in 1,000 (0.1%) of river flooding in any year.

3.44 A comparison of the Topographically surveyed channel and the LiDAR data (on which the pluvial flood map is based) shows that the surveyed channel has been largely omitted from the lidar and for all sections taken the cross section area in the channel is greater that depicted on the LiDAR section. This would be expected due to the post processing that occurs as part of LiDAR surface creation. Therefore potentially the flood extent depicted on the Pluvial flood maps may be reduced given the cross section area of the channel appears greater than modelled. As no better data is available the LiDAR based flood extents have been utilised as a conservative basis for the recommendations in this report.

3.45 As part of the proposals the client is proposing a pond on the north west extent of the garden. This offers additional breeding area for the Great Crested Newts found in the adjacent watercourse. This offers additional breeding area for the Great Crested Newts found in the adjacent watercourse (it should be noted that the pond has not been designed to provide volume mitigation of flood waters). Mitigation of displaced flood water from the proposed development is shown to be provided by locally lowering ground levels to the rear of the dwelling. The flood mitigation modelling has followed the recommended methodology outline by the EA by ensuring there is no flood storage loss at a 'level for level, volume for volume' post development. The mitigation volumes and 3d model assessment is included in Appendix 2 and shown on drawings 5649 DR04 and 5649 DR05.

Generation of Runoff

3.46 The remaining risk is that of surface water generated by the development itself. Flood risk to others can be mitigated by managing water on site to be discharged at a reduced rate for rainfall events up to and including the 1in100yr+cc rainfall event in accordance with Local SuDS policy and the Ciria SuDS manual.

3.47 The following SuDS surface water drainage strategy outlines how surface water can be managed and accommodated on site to mitigate risk to others as a result of development.

4. SUDS Assessment

4.1 In accordance with the SuDS management train approach, the use of various SuDS measures to reduce and control surface water flows have been considered in detail for the development.

4.2 Paragraph 80 of the Planning Practice Guidance of the National Planning Policy Framework (NPPF) states that: Generally, the aim should be to discharge surface run off as high up the following hierarchy of drainage options as reasonably practicable:

1. into the ground (infiltration);
2. to a surface water body;
3. to a surface water sewer, highway drain, or another drainage system;
4. to a combined sewer.

4.3 The management of surface water has been considered in respect to the SuDS hierarchy (below) (as detailed in Building Regulations Part H and within the the *CIRIA 753 'The SUDS Manual', Section 3.2.3)*:

SuDS Drainage Hierarchy		Suitability	Comment
1.	Infiltration	-	Due to the geology at the site, infiltration is unlikely to be suitable for total infiltration.
2.	Discharge to Surface Water	✓	There is a watercourse forming the west boundary of the site.
3.	Discharge to Surface Water Sewer, Highway Drain or another Drainage System	-	
4.	Discharge to Combined Sewer	-	
5.	Discharge to a foul sewer (should not be considered as a possible option)	-	

Table 1: SuDS Hierarchy

4.4 Full infiltration has not been deemed possible given the underlying clay geology. Discharge to a surface water is the next preferred option. It is proposed to utilise this as the discharge mechanism and to utilise the Chawridge Bourne as the discharge point

4.5 However, in order to ensure that flood risk is not increased as part of the development proposals, it is proposed to reduce runoff rates (in line with Bracknell Forest Council SuDS Guidance) to 1 l/s demonstrated to provide a practical minimum flow rate off site without causing long term maintenance issues.

4.6 To achieve the reduction in site run off rates, the use of various SuDS have been considered for the development as follows:

Suitability of SuDS Components		
SuDS Component	Description	Suitability
Infiltrating SuDS	Infiltration can contribute to reducing runoff rates and volumes while supporting baseflow and groundwater recharge processes. The suitability and infiltration rate depends on the permeability of the surrounding soils	x
Permeable Pavement	Pervious surfaces can be used in combination with aggregate sub-base and/or geocellular/modular storage to attenuate and/or infiltrate runoff from surrounding surfaces and roofs. Liners can be used where ground conditions are not suitable for infiltration	✓
Green Roofs	Green Roofs provide areas of visual benefit, ecological value, enhanced building performance and the reduction of surface water runoff. They are generally more costly to install and maintain than conventional roofs but can provide many long-term benefits and reduce the on-site storage volumes	x

Rainwater Harvesting	Rainwater Harvesting is the collection of rainwater runoff for use. It can be collected form roofs or other impermeable area, stored, treated (where required) and then used as a supply of water for domestic, commercial and industrial properties	✓
Swales	Swales are designed to convey, treat and attenuate surface water runoff and provide aesthetic and biodiversity benefits. They can replace conventional pipework as a means of conveying runoff, however space constraints of some sites can make it difficult incorporating them into the design	x
Rills and Channels	Rills and Channels keep runoff on the surface and convey runoff along the surface to downstream SuDS components. They can be incorporated into the design to provide a visually appealing method of conveyance, they also provide effectiveness in pre-treatment removal of silts	x
Bioretention Systems	Bioretention systems can reduce runoff rates and volumes and treat pollution through the use of engineer soils and vegetation. They are particularly effective in delivering interception, but can also be an attractive landscape feature whilst providing habitat and biodiversity	x
Retention Ponds and Wetlands	Ponds and Wetlands are features with a permanent pool of water that provide both attenuation and treatment of surface water runoff. They enhance treatment processes and have great amenity and biodiversity benefits. Often a flow control system at the outfall controls the rates of discharge for a range of water levels during storm events	x
Detention Basins	Detention Basins are landscaped depressions that are usually dry except during and immediately following storm events, and can be used as a recreational or other amenity facility. They generally appropriate to manage high volumes of surface water from larger sites such as a neighbourhoods	x
Geocellular Systems	Attenuation storage tanks are used to create a below-ground void space for the temporary storage of surface water before infiltration, controlled release or use. The inherent flexibility in size and shape means they can be tailored to suit the specific characteristics and requirements of any site	✓
Proprietary Treatment Systems	Proprietary treatment systems are manufactured products that remove specific pollutants from surface water runoff. They are especially useful where site constraints preclude the use of other methods and can be useful in reducing the maintenance requirements of downstream SuDS	✓
Filter Drains and Filter Strips	Filter drains are shallow trenches filled with stone, gravel that cerate temporary subsurface storage for the attenuation, conveyance and filtration of surface water runoff. Filter strips are uniformly graded and gently sloping strips of grass or dense vegetation, designed to treat runoff from adjacent impermeable areas by promoting sedimentation, filtration and infiltration	x

Table 2 - Suitability of SuDS Components

4.7 It has been indicated in Table 2 above, that several SuDS components are deemed appropriate to be used in the following SuDS management train.

4.8 Based on the BGS, the infiltration could not be feasible due to the soil underlay the site. Partial infiltration may be feasible to deal with low return period events therefore unlined permeable surfacing (either gravel or a paved option) has been proposed for the driveway. Supplemental geocellular storage may be required subject to the volumes generated and final site levels.

4.9 Greenroofs have not been considered feasible for this development given the architectural proposals aim to tie in with the pitched style roofs of the local area.

Rainwater harvesting

4.10 Rainwater harvesting (RWH) Systems should be considered for rainwater re-use. Rainwater harvesting can take various forms including simple water butts to utilise runoff for watering and irrigation, to more complex pumped RWH systems to be used in grey water uses. It is strongly recommended that rainwater harvesting is considered, however, the viability and suitability of an RWH system should be reviewed by a specialist to determine the suitability in context to the rest of the site proposals. As a minimum water butts should be provided.

Geocellular System

4.11 Geocellular Systems are generally built by placing together (e.g. stacking) cuboid plastic structures with very high void ratios (90-95%). The formed volume is then surrounded by an impermeable geomembrane and backfilled with the excavated soil to form the attenuation tank. Within the proposed SuDS scheme the Geocellular tanks are used to provide the storage volume requirement. They are to be located within the car parking area, however, the exact layout to be determined at the detailed design stage.

Permeable Paving

4.12 Permeable paving is proposed in any new external hardstanding areas (within the redline boundary excluding bin store area to avoid the risk of contamination). The permeable paving will primarily be designed to be self draining (to mimic an equivalent area of soft landscaping). The paving could be formed by the following make up:

- Permeable surfacing (gravel or paved).
- Laying Course Material.
- Geotextile filter.
- Sub-Base: 6-20mm clean crushed stone storage medium (depth varies).
- Geotextile filter.

4.13 All non-trafficked areas should be of a permeable construction, falling away from buildings.

4.14 SuDS components should be designed to accommodate and dispose of runoff from storms up to and including the 1:100 year +40% climate change event without flooding.

5. Surface Water Drainage Strategy

5.1 In order to mitigate flood risk posed by the proposed development, adequate control measures are required to be considered. This will ensure that surface water runoff is dealt with at source and the flood risk on/off site is not increased over the lifetime of the development.

5.2 Proposals are to route all surface water drainage from roofs and access road/parking to a geocellular crate located to the rear of the proposed property. Outflow from the permeable access road sub base would be directed to the geocellular crate with the permeable surface offering treatment of runoff.

5.3 Drainage is proposed to outfall to the adjacent Chawridge Bourne from the attenuation crate at a reduced runoff rate of 1l/s – considered the lowest feasible runoff rate without causing undue maintenance issues.

5.4 A new connection to the Chawridge Bourne is shown required for the new development and therefore watercourse consents may be required to facilitate the connection.

5.5 A new pond is also proposed on the outlet from the tank/hydrobrake to offer betterment to the local ecology and offer additional flood storage in extreme rainfall events.

5.6 The permeable paving is shown located outside to the 1in100yr pluvial flood extent. The permeable paving is shown to be unlined to promote infiltration where feasible into the clay subgrade. The existing driveway access to the existing Towsbourne property would remain unchanged from existing.

Runoff rates

5.7 Greenfield runoff rates have been calculated using Micro Drainage Software and applying the *Institute of Hydrology Report 124* (Marshall and Bayliss, 1994), as recommended in the *CIRIA 753 'The SUDS Manual'* (See *Table 3 and calculations in Appendix 3)* for calculating the greenfield runoff rates. *Calculations are included in Appendix 3.*

5.8 Proposed runoff rates have been generated using a 10% urban creep factor as advised in the Ciria C753 The SuDS Manual. The results are shown in Table 3 and Appendix 3.

5.9 At this time the driveway is assumed as a permeable pavement and has been used for treatment of the driveway runoff. Supplemental crate storage has been shown to the rear of the proposed property.

SURFACE WATER DISCHARGE RATES SUMMARY.					
Impermeable Area (m^2)			Discharge Rates (l/s)		
		Q_{BAR}	1 year	30 year	100 year
Greenfield (development extent only)	800	0.4	0.3	0.8	1.1
Proposed runoff rates	800		1.0	1.0	1.0
Calculated Post-Development	800		0.9	0.9	1.1

Table 3 – Surface Water Discharge Rates Summary, Site 1.

5.10 As *DEFRA* Report *'Rainfall runoff management for Developments'* recommends, the design principle is to limit the runoff for events of similar frequency of occurrence to the same peak rate of run as that which takes place from greenfield sites. However, there are two situations where the greenfield flow rate is not actually applied to define the limiting discharge rates:

a) The limit of discharges based on QBAR that are less than 1 l/s/ha for permeable sites as this is seen as being an unreasonable requirement (producing very large storage volumes). QBAR is then set to 1 l/s/ha;

b) Small sites would require impractically small controls to achieve the required flow rates where these are calculated to be less than 5 l/s. In this case a minimum flow of 1 l/s is used as a practical minimum for flow control devices without causing blockage risks.

5.11 Therefore, a maximum limiting discharge of 1 l/s (as close to greenfield as practical) has been adopted for the purposes of this assessment.

5.12 The above runoff rates have been based on the FSR Rainfall Profiles for rainfall events up to and including the 1 in 100 year plus 40% climate change allowance.

Climate Change

5.13 The design lifetime of a residential site is typically 100 years and an allowance for climate change should be considered in accordance with published guidance within the NPPF. Given the design life would place the developments end of life cycle at 2118, in line with section 9.5.4.6 of the LBE SuDS guidance, the 'upper end' allowance 40% climate change allowance has been applied to the drainage and storage calculations (*Table 4*).

PEAK RAINFALL INTENSITY ALLOWANCE IN SMALL AND URBAN CATCHMENTS			
Applies across all of England	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper End	10%	20%	40%
Central	5%	10%	20%

Table 4 - Peak rainfall intensity allowance in small and urban catchments

Long Term Storage

5.14 As *DEFRA* Report *'Rainfall runoff management for Developments'* recommends, the design principle is to limit the runoff for events of similar frequency of occurrence to the same peak rate of run as that which takes place from greenfield sites. However, there are two situations where the greenfield flow rate is not actually applied to define the limiting discharge rates:

a) The limit of discharges based on QBAR that are less than 1 l/s/ha for permeable sites as this is seen as being an unreasonable requirement (producing very large storage volumes). QBAR is then set to 1 l/s/ha;

b) Small sites would require impractically small controls to achieve the required flow rates where these are calculated to be less than 5 l/s. In this case a minimum flow of 1 l/s is used as a practical minimum for flow control devices without causing blockage risks.

5.15 Therefore, a maximum limiting discharge of 1 l/s (as close to greenfield as practical) has been adopted for the purposes of this assessment. *It should be noted that infiltration within the permeable pavement has not been included within the calculations but would occur to some degree and reduce runoff in low return period events.*

Urban Creep

5.16 Urban Creep has been applied to the proposed runoff calculations by increasing the drained area by 10% in accordance with guidance within the Ciria SuDS Manual.

Attenuation Storage

5.17 Attenuation storage is needed to temporarily store water during periods when the runoff rates from the development site exceed the allowable discharge rates from the site.

5.18 Rainfall depths for the 1 in 100 years return period plus 40% of CC were produced using Micro Drainage software to estimate the largest volume, critical storm, for typical storm durations. For the proposed site all runoff generated from hard standing area should be attenuated discharge rate at 1l/s.

5.19 In terms of storage, for a 100 years storm event with an allowance for 40% climate change, the critical duration is 180 minutes. Therefore, the **Geocellular Attenuation Storage Volume required for the site is 41.8m^3.** Half drain time is 240 mins and the proposed crate size is 5.5x10.0x0.8m. See Appendix 3, calculations. This storage volume assumes the rear patio is laid in a impermeable pavement and drain to attenuation.

5.20 The permeable paving is also located outside to the 1in100yr pluvial flood extent. The permeable paving is shown to be unlined to promote infiltration where feasible into the clay subgrade.

Design Exceedance

5.21 In the event of drainage system failure under extreme rainfall events or blockage, flooding may occur within the site. In the event of the development's drainage system failure, the runoff flow will be dictated by topography on site. This will not impact on the site or nearby dwellings as runoff would drain to the Chawridge Bourne to the west of the development.

Water Quality

5.22 Adequate treatment must be delivered to the water runoff to remove pollutants through SuDS devices, which are able to provide pollution mitigation. Pollution Hazards and the SuDS Mitigation have been indexed in the *CIRIA 753 'The SUDS Manual'*.

5.23 The Pollution Hazard Indices are summarized in Table 5 – Summary of Pollution Hazard Indices for different Land Use below (*reference: Table 26.3.CIRIA SuDS Manual 2015*)

POLLUTION HAZARD INDICES FOR DIFFERENT LAND USE CLASSIFICATIONS				
LAND USE	Pollution Hazard Level	Total suspended Solids (TSS)	Metals	Hydro-carbons
Residential Roofs	Very Low	0.2	0.2	0. 05
Individual property driveways	Low	0.5	0.4	0.4

Table 5 – Summary of Pollution hazard Indices for different Land Use.

5.24 Runoff from roof areas is considered to generally be uncontaminated. However, to prevent any potential sediment from impacting on the storage structure, S*ediments Traps* should be provided on the outlet to the storage structure to prevent sedimentation, with rodding access provided either side for cleaning and maintenance.

INDICATIVE SuDS MITIGATION INDICES FOR DISCHARGES TO SURFACE WATER			
SuDS Component	Total suspended Solids (TSS)	Metals	Hydrocarbons
Permeable Pavement	0.7	0.6	0.7

Table 6 – Indicative SuDS Mitigation Indices

5.25 The contamination risk associated with this site is considered to be very low, with sediment traps and permeable pavement deemed suitable to mitigate against the potential contamination risk.

Adoption and Maintenance

5.26 All onsite SuDS and drainage systems will be privately maintained by the property owners. A long-term maintenance regime should be agreed with the site owners before commissioning. In addition to a long-term maintenance regime it is recommended that all drainage elements implemented on site should be inspected following the first rainfall event post construction and monthly for the first quarter following construction, see Appendix 4.

6. Conclusion

6.1 This study has been undertaken in accordance with the principles set out in the NPPF. We can conclude that, providing the development adheres to the conditions advised in the conclusions of this report, the said development proposals can be accommodated without increasing flood risk within the locality in accordance with objectives set within the NPPF and published guidance.

6.2 Proposals are to construct an additional detached residential property on site with associated garage and driveway. As per the drawings included in Appendix 1. The redline boundary as provided on the proposed layout has a plan area of approximately 3680m^2. The proposed roof development is approximately 265m^2 and driveway/patio 491m^2. The remaining site is to remain greenfield/garden areas. A new pond is also proposed on the outlet from the tank/hydrobrake to offer betterment to the local ecology and offer additional flood storage in extreme rainfall events.

6.3 An existing watercourse, the Chawridge Bourne borders the site on the west boundary and flows from south to north, and is culverted under Winkfield Road to the south of the site.

6.4 An ecological survey has been commissioned by the client (Preliminary Ecological Appraisal by John Wenman Ecological Consultancy LLP, Ref R2232/a) and this includes an assessment of the stream and wider site and the impact of the proposed development and includes site photographs.

6.5 A topographic survey has been commissioned at the site and levels on site vary between approximately 64.80mAOD near the existing Towsbourne property, towards the east, to a minimum elevation of approximately 62.80mAOD based on the survey levels. Analysis of topographic levels indicates that the site generally slopes to the south-west. The topographic survey is included in Appendix 1.

6.6 The EA Flood Map for Planning shows the proposed development to be located within Flood Zone 1 (low risk of flooding) from fluvial flooding. The site is also shown at low risk from Groundwater and sewer flooding.

6.7 The development is also set at a level that would not be affected by surface water flood events up to the 1in1000yr rainfall event and is located outside the extents of rainfall events up to the 1in100yr rainfall event.

6.8 The proposed dwelling location is shown within an area defined as low risk of pluvial flooding based on the EAs RoFSW mapping. Low risk is defined as between the 1in100 and 1in1000yr return period. West of the proposed dwelling areas of High and Medium risk are within the site redline boundary.

6.9 In the event of a pluvial flood event, site users are advised to remain within the proposed development providing safe refuge within Flood Zone 1 and outside of the pluvial flood risk area. Should evacuation be required a proposed evacuation route is east away from the brook. Should flood depths exceed 250mm residents should not attempt to leave the property until flood waters recede.

6.10 The use of infiltration on site is limited given the clay subgrade shown on the published British Geological Survey Mapping.

6.11 In terms of storage, for a 100 years storm event with an allowance for 40% climate change, the critical duration is 180 minutes. Therefore, the Geocellular Attenuation Storage Volume required for the site is 27.8m3. Half drain time is 255 mins and the proposed crate size is 5.5x7.0x0.8m. See Appendix 3, calculations. This storage volume assumes the rear patio is laid in a permeable pavement and drain itself. If impermeable patio paving is used then the attenuation volume would need to be increased accordingly.

6.12 Runoff rates are shown to be limited to 1 l/s (as close to greenfield runoff rate as practicable). It is proposed to utilise a Hydrobrake (or similar) flow control with a limiting discharge rate of 1l/s prior to discharging to the Chawridge Bourne.

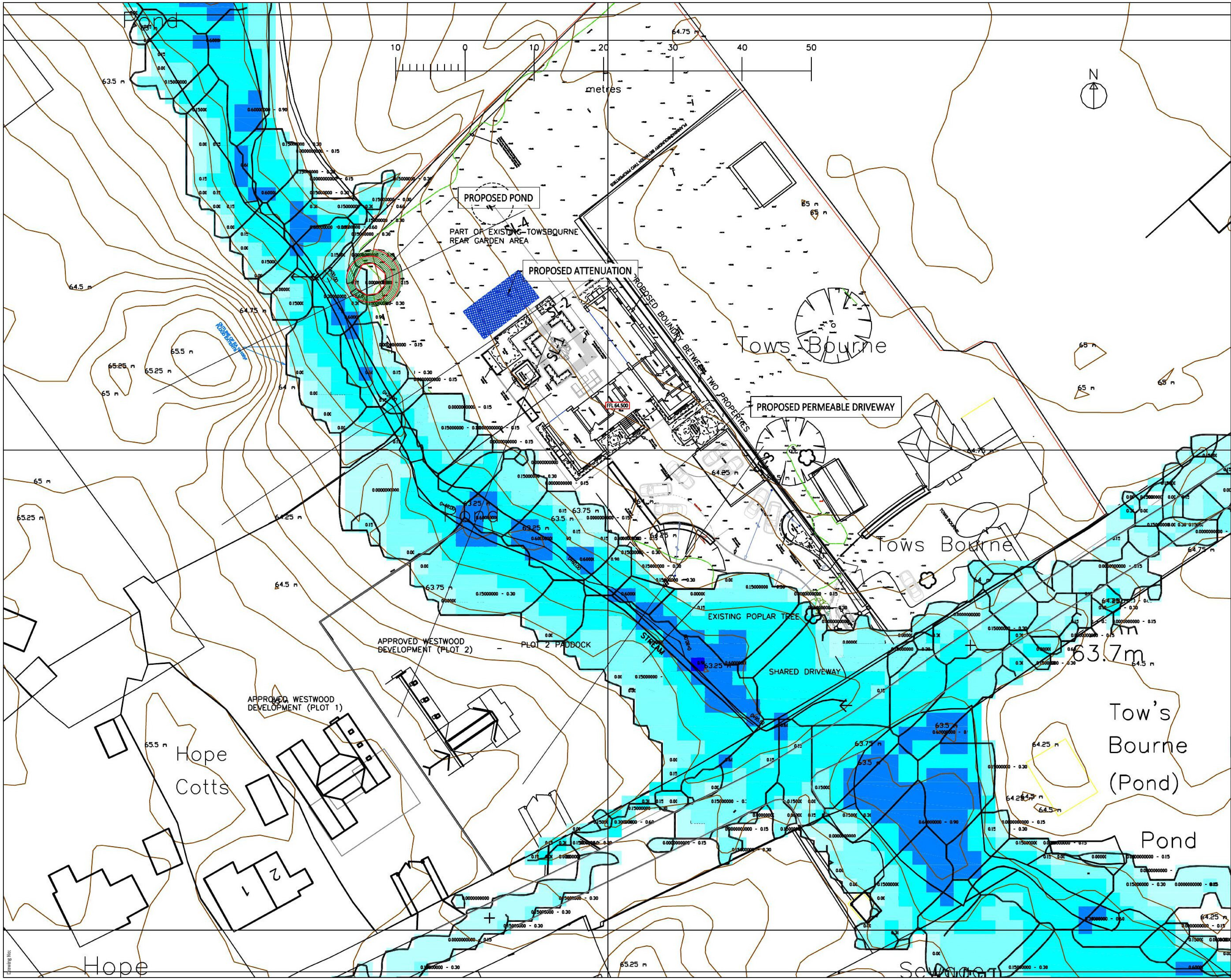
6.13 This study has been undertaken in accordance with the principles set out in NPPF and the HCC SuDS guidance. It can be seen that, providing the development adheres to the conditions advised in the conclusions of this report, the development can be accommodated without increasing flood risk within the locality in accordance with objectives set within the NPPF and published guidance.

6.14 The findings and recommendations of this report are for the use of the client who commissioned the assessment, and no responsibility or liability can be accepted for the use of the report or its findings by any other person or for any other purpose.

Appendix 1 – Supporting Information

Architect Drawings

Appendix 2 – Drainage Strategy Plans



EA 1in100yr fluvial flood depths

0.0 - 0.15
0.15 - 0.30
0.30 - 0.60
0.60 - 0.90
0.90 - 1.20
> 1.20

EA 1in100yr fluvial flood extent

FOR DRAINAGE LAYOUT SEE DRAWING 5649_DR02
FOR SITE CROSS SECTIONS SEE DRAWING 5649_DR06

REV DATE CKD APPD BY DESCRIPTION

PRELIMINARY DRAWING
FOR INFORMATION ONLY. NOT FOR CONSTRUCTION.

Client: Alan Bussey

AMBIENTAL
ENVIRONMENTAL ASSESSMENT

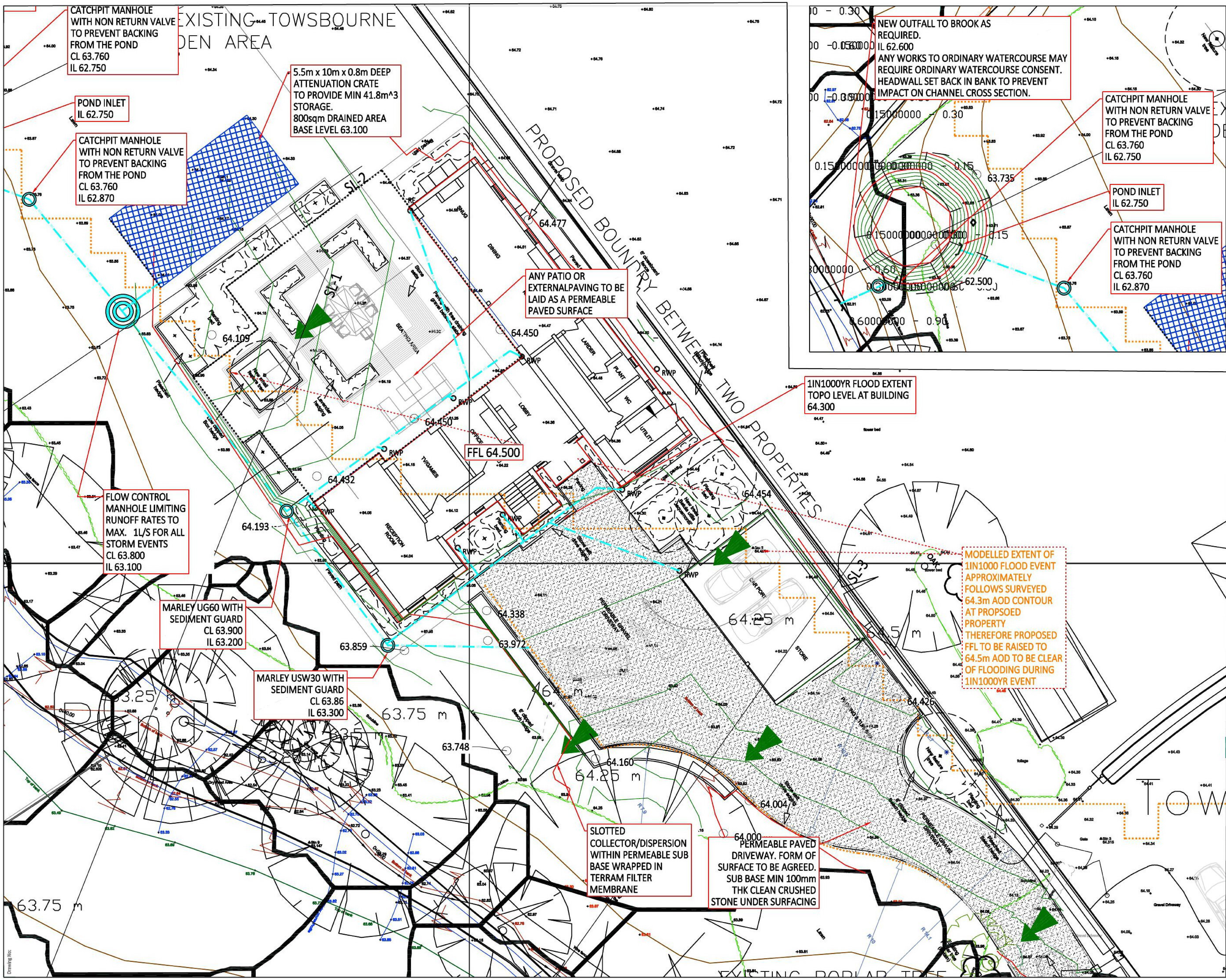
Project: Land Adj to Towsbourne, Winkfield Lane, Winkfield, SL4 4QU

Drawing: Site Layout — EA Flood depths and extents

Drawn by: mn | Date: Jan 21

Drawing No.: 5649_DR01 | Revision: -

Drawing Scale: 1:500



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LEGEND

PRIVATE SURFACE WATER DRAIN
PERFORATED SURFACE WATER DRAIN
TYPE 2 MANHOLE
TYPE 3 INSPECTION CHAMBER
TYPE 4 INSPECTION CHAMBER
RODDING EYE
RAIN WATER PIPE
PERMEABLE PAVING
GEOCELLULAR STORAGE
OVERLAND FLOW ARROW

REV	DATE	CKD	APPD	BY	DESCRIPTION

PRELIMINARY DRAWING
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Client
Alan Bussey

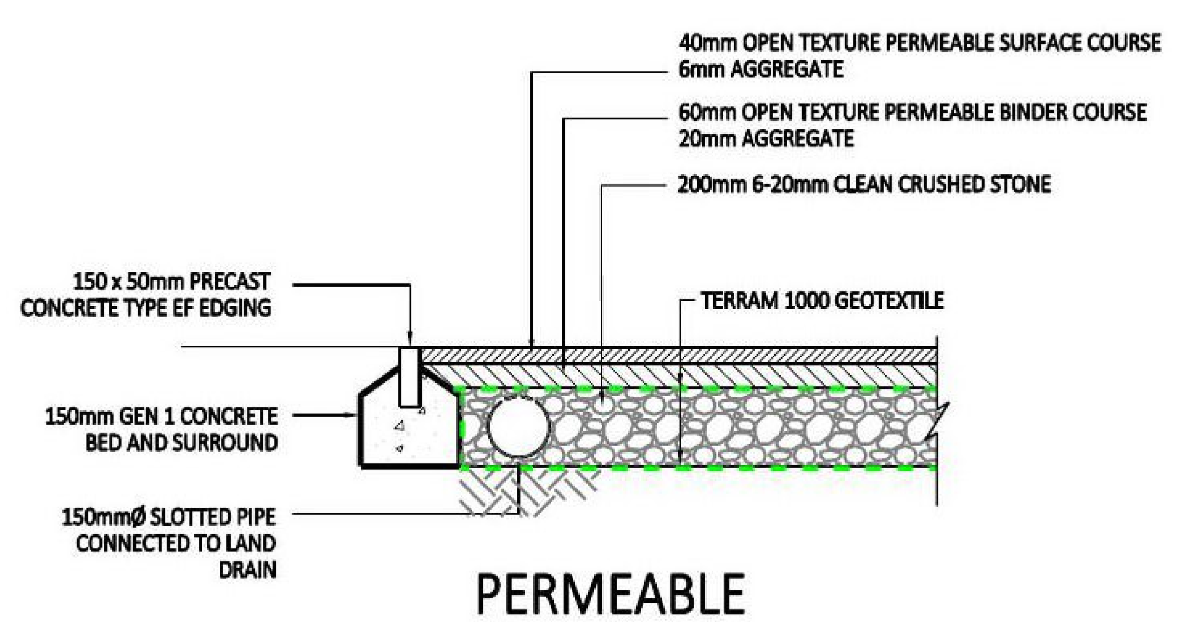
AMBIENTAL
ENVIRONMENTAL ASSESSMENT
The Sussex Innovation Centre | Science Park Square | Falmer | Brighton | BN1 9SB
Tel +44 (0) 203 857 8530 | www.ambiental.co.uk | drainage@ambiental.co.uk

Project
Land Adj to Towsbourne
Winkfield Lane, Winkfield, SL4 4QU

Drawing
Site Layout
EA Flood depths and extents

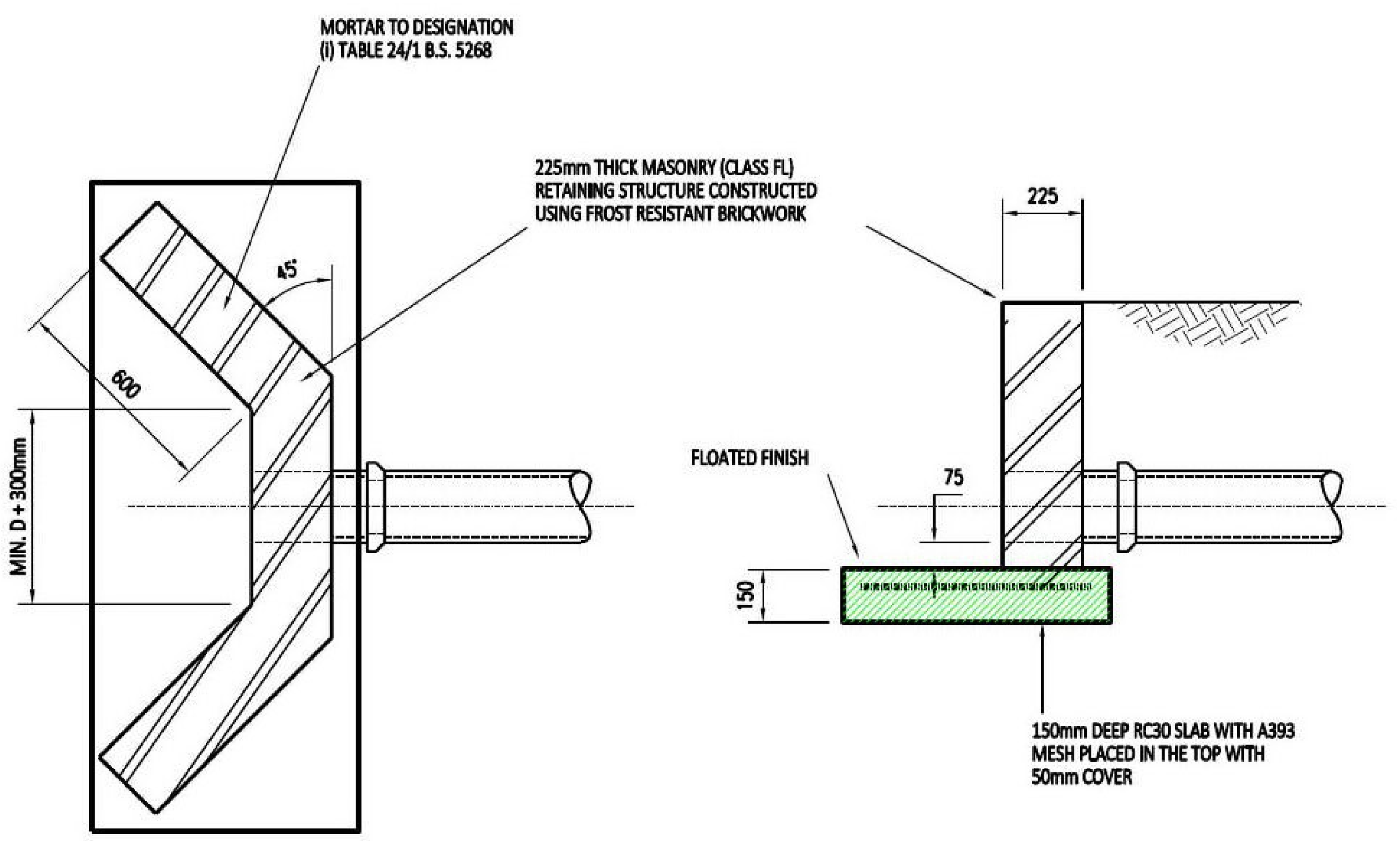
Drawn by: mn
Date: 04/19
Drawing No. 5649_DR02
Revision -
Drawing Scale: 1:200

Drawing No:



PERMEABLE DRIVE SURFACING.

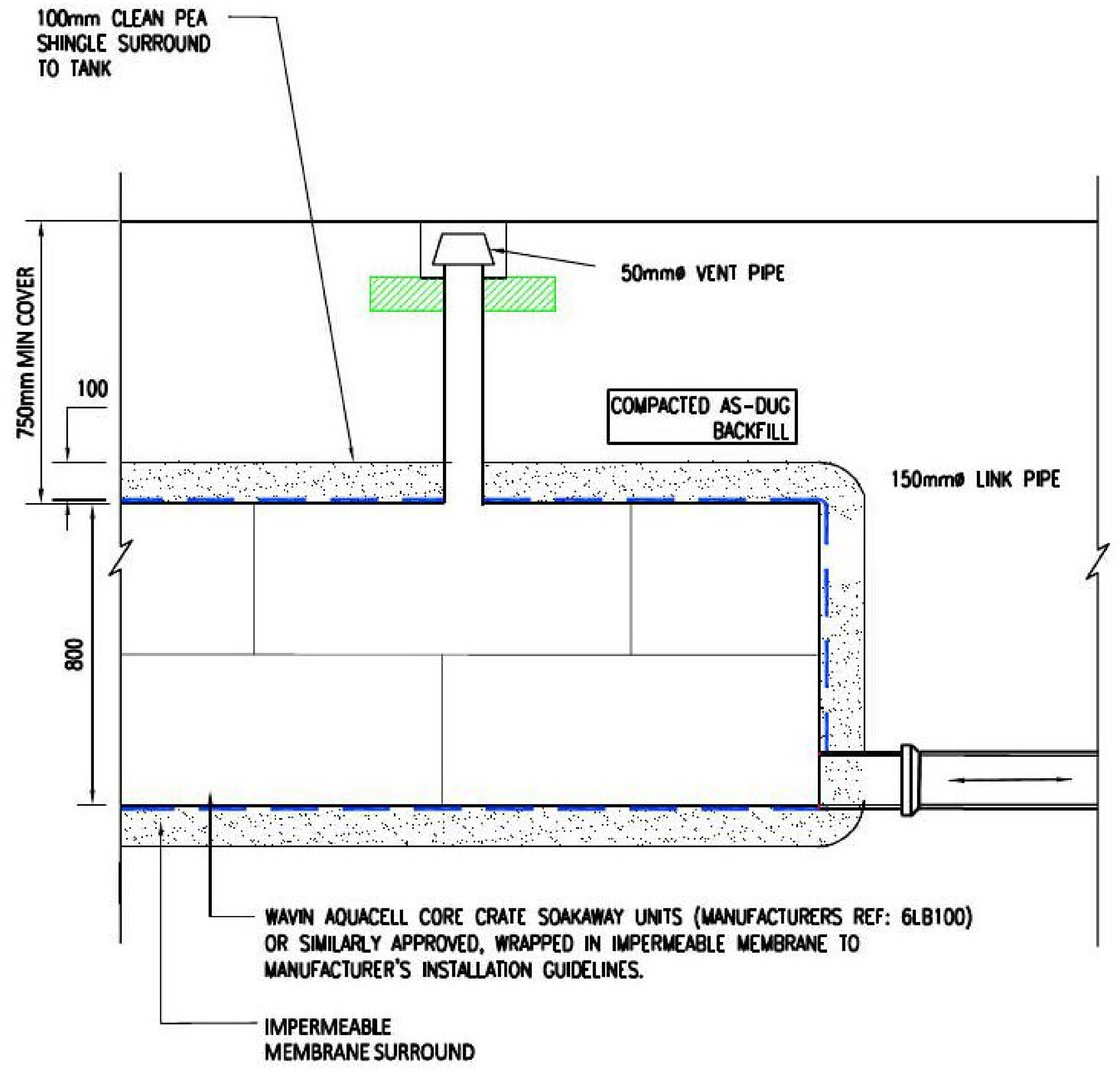
(1:20)



TYPICAL HEADWALL DETAIL.

(DRESSING DETAILS TO BE CONFIRMED)

(1:20)



TYPICAL TANK SECTION

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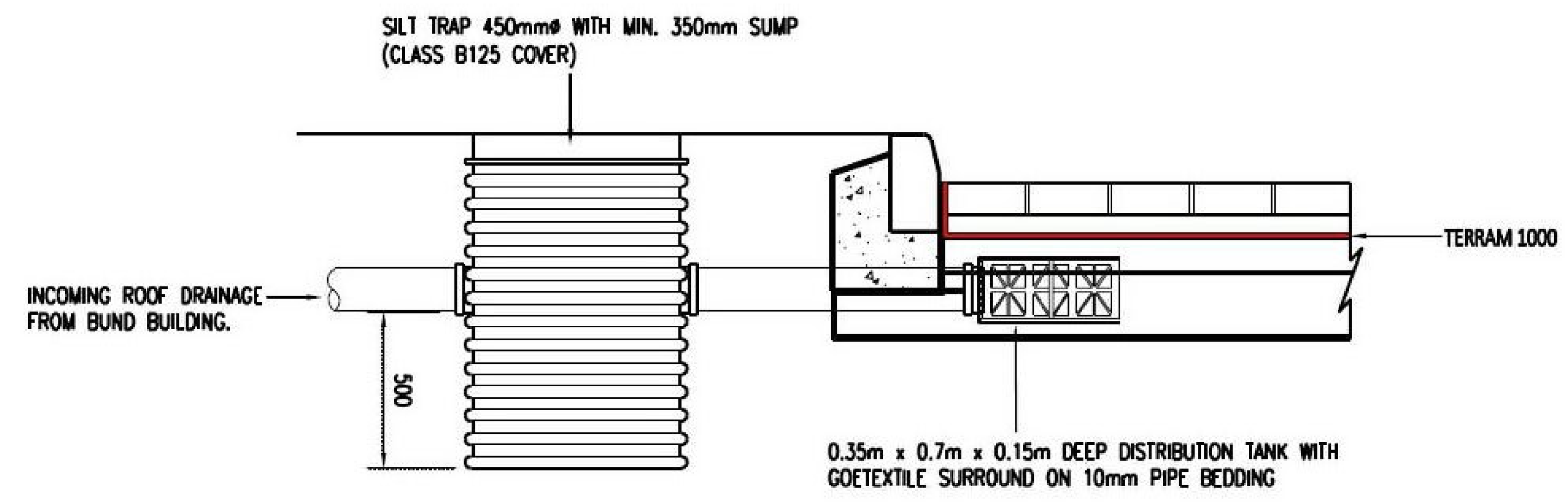
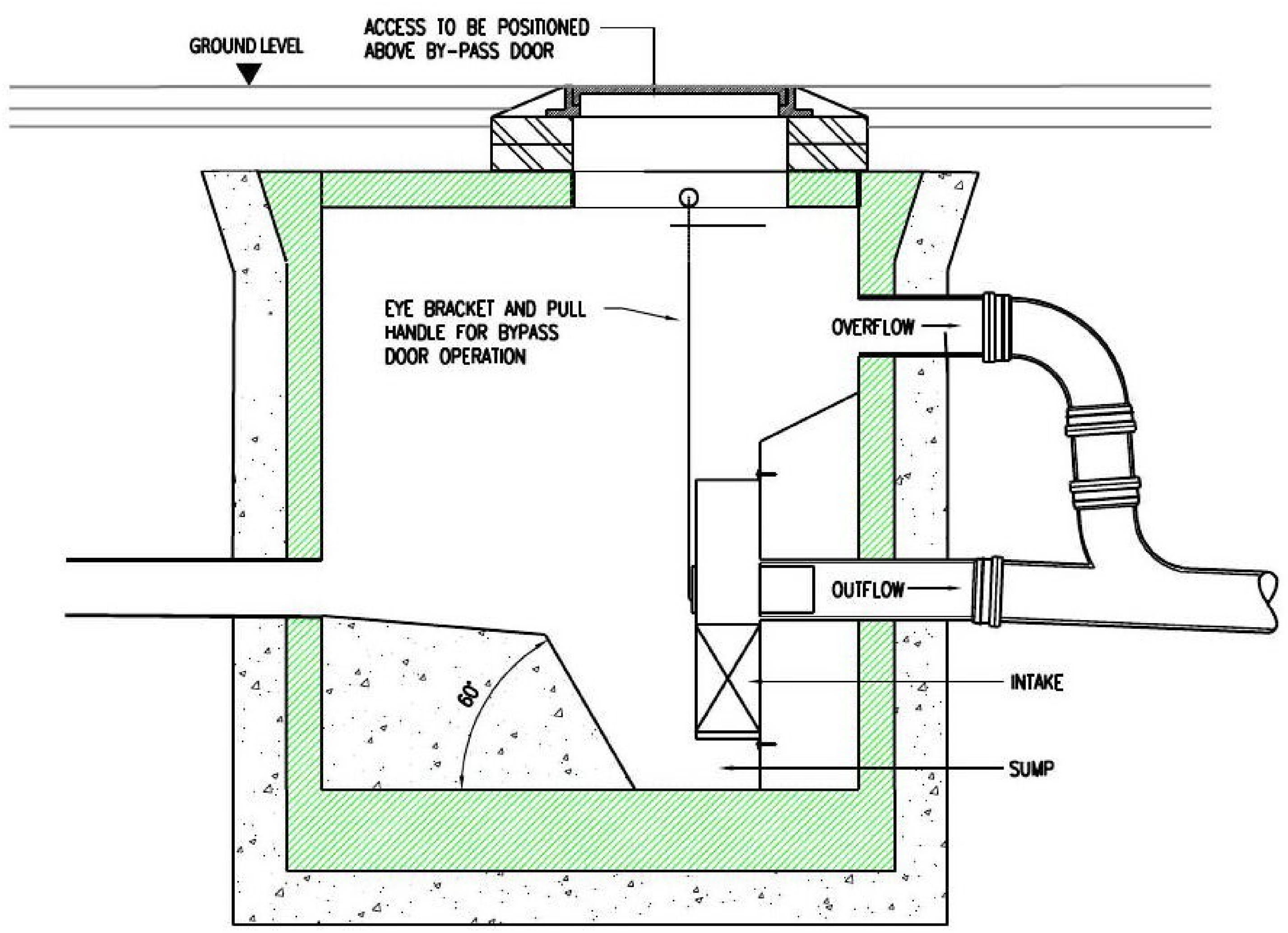


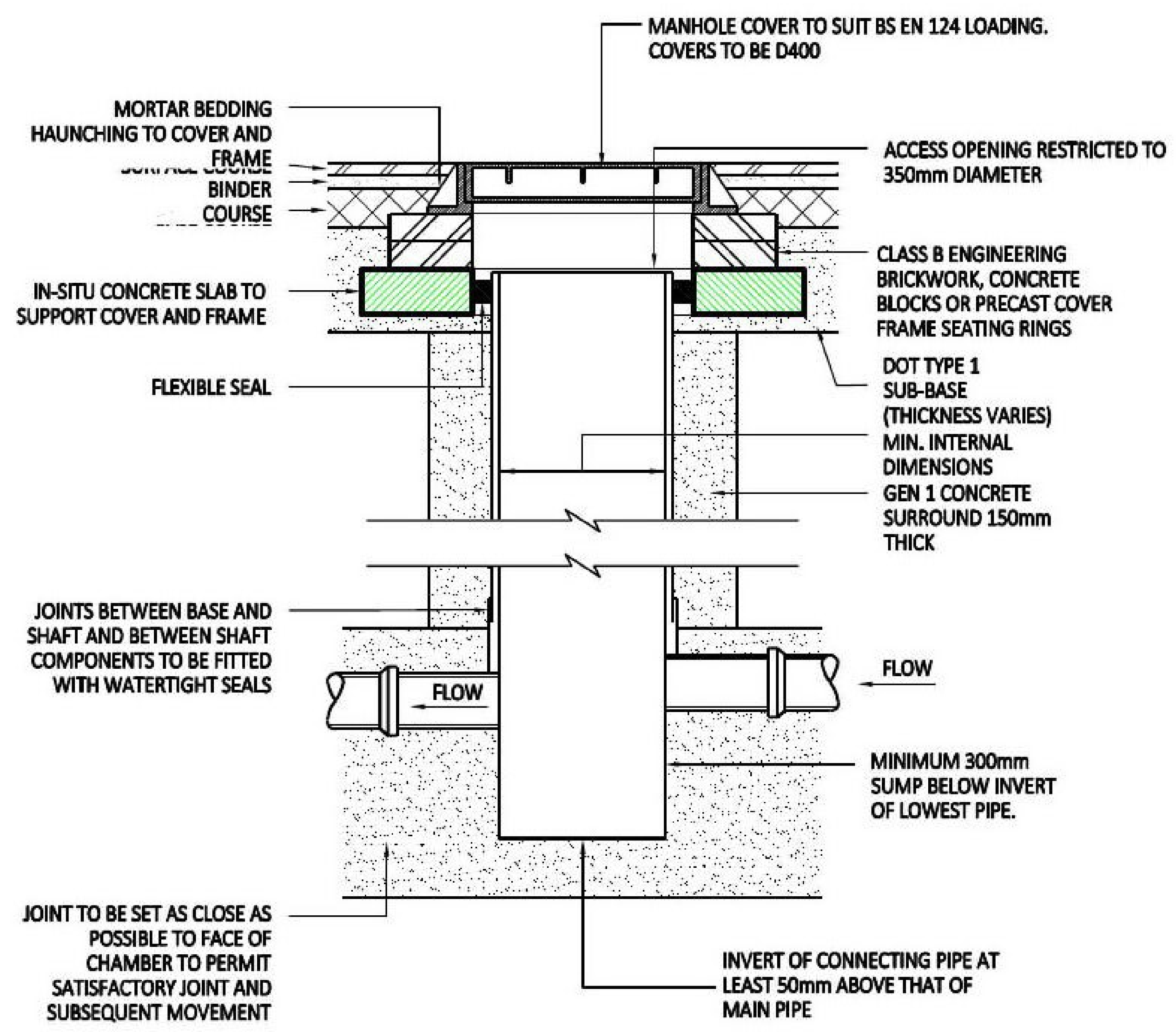
CAR PARK DRAIN CONNECTION

(1:20)



HYDROBRAKE MANHOLE.

(1:20)



TYPE 3 CATCHPIT MANHOLE.

(PREFORMED POLYPIPE RIGIDRAIN 600Ø CATCHPIT MANHOLE OR SIMILAR),
MAX. DEPTH 3m, NON-ENTRY)

(1:20)

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AMBIENTAL
ENVIRONMENTAL ASSESSMENT

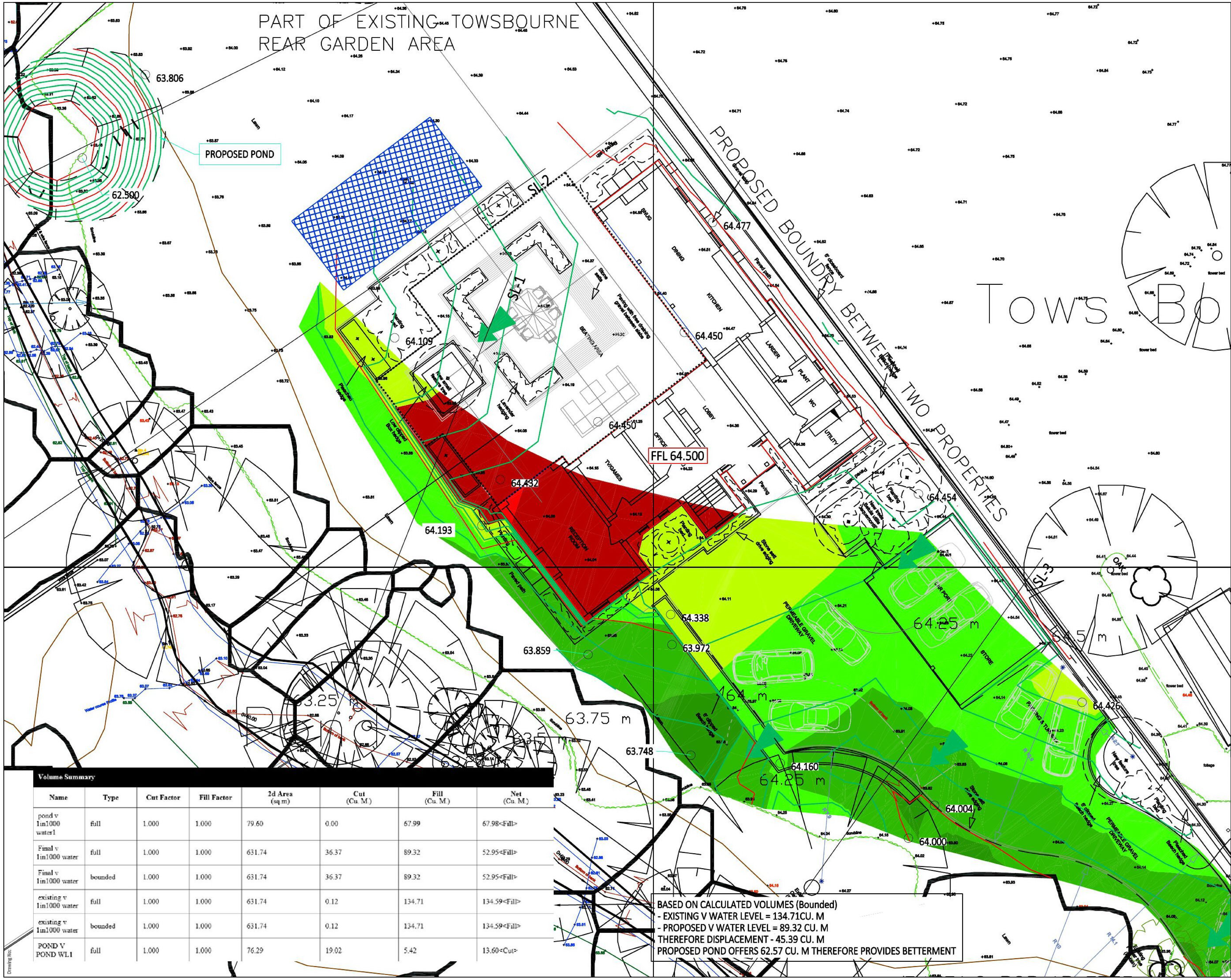
Project: Land Adj to Towsbourne
Winkfield Lane, Winkfield, SL4 4QU

Drawing: CONSTRUCTION DETAILS
SURFACE WATER

Drawn by: mn
Date: 04/19

Drawing No.: 5649_DR03
Revision: -

Drawing Scale: 1:20



Volume Summary							
Name	Type	Cut Factor	Fill Factor	2d Area (sq.m)	Cut (Cu. M)	Fill (Cu. M)	Net (Cu. M)
pond v 1in1000 water1	full	1.000	1.000	79.60	0.00	67.99	67.98<Fill>
Final v 1in1000 water	full	1.000	1.000	631.74	36.37	89.32	52.95<Fill>
Final v 1in1000 water	bounded	1.000	1.000	631.74	36.37	89.32	52.95<Fill>
existing v 1in1000 water	full	1.000	1.000	631.74	0.12	134.71	134.59<Fill>
existing v 1in1000 water	bounded	1.000	1.000	631.74	0.12	134.71	134.59<Fill>
POND V POND WL1	full	1.000	1.000	76.29	19.02	5.42	13.60<Cut>

BASED ON CALCULATED VOLUMES (Bounded)
- EXISTING V WATER LEVEL = 134.71CU. M
- PROPOSED V WATER LEVEL = 89.32 CU. M
THEREFORE DISPLACEMENT - 45.39 CU. M
PROPOSED POND OFFERS 62.57 CU. M THEREFORE PROVIDES BETTERMENT

Elevations Table			
Number	Minimum Elevation	Maximum Elevation	Color
1	-0.600	-0.400	
2	-0.400	-0.200	
3	-0.200	0.000	
4	0.000	0.200	
5	0.200	0.400	
6	0.400	0.600	

1. GENERAL
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b. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTURAL DRAWINGS, DETAILED SPECIFICATIONS WHERE APPLICABLE AND ALL ASSOCIATED DRAWINGS IN THIS SERIES.
c. ANY DISCREPANCY ON THIS DRAWING IS TO BE REPORTED IMMEDIATELY TO THE PARTNERSHIP FOR CLARIFICATION.
d. THE CONTRACTOR IS RESPONSIBLE FOR ALL TEMPORARY WORKS AND FOR THE STABILITY OF THE WORKS IN PROGRESS.
e. CDM REGULATIONS 2015. ALL CURRENT DRAWINGS AND SPECIFICATIONS MUST BE READ IN CONJUNCTION WITH THE DESIGNER'S HAZARD RISK AND ENVIRONMENT ASSESSMENT RECORD. DESIGN HAS BEEN PRODUCED BASED ON INFORMATION PROVIDED BY THE CLIENT/PRINCIPLE DESIGNER AVAILABLE AT TIME OF ISSUE. CONTRACTOR TO REVIEW DRAWING AND SPECIFICATION IN CONTEXT WITH THE WIDER SITE AND SPECIFIC SITE INVESTIGATION, CONTAMINATION ASSESSMENT, ASBESTOS SURVEY, ENVIRONMENTAL SURVEY, UXO SURVEY AND ANY OTHER RELEVANT INFORMATION AND MANAGE RISKS RELATING TO THE WORKS OUTLINED IN THE DRAWINGS AND SPECIFICATION. PRINCIPLE CONTRACTOR TO MAKE DESIGNER AND CLIENT AWARE OF SITE SPECIFIC RISKS THAT MAY AFFECT THE DRAWING AND SPECIFICATION.
f. CDM REGULATIONS 2015. FOR GENERIC MAINTENANCE AND MANAGEMENT RISKS REFER TO CHAPTER 36 OF CIRIA 752 SUDS MANUAL. FOR PROPRIETARY SYSTEMS SEE MANUFACTURER'S MANAGEMENT AND MAINTENANCE DETAILS AND RISK ASSESSMENT WITH REGARDS TO MAINTENANCE OF PROPRIETARY SYSTEMS.

REV DATE CKD APPD BY DESCRIPTION

PRELIMINARY DRAWING
FOR INFORMATION ONLY. NOT FOR CONSTRUCTION.

Client
Alan Bussey

AMBIENTAL
ENVIRONMENTAL ASSESSMENT

The Sussex Innovation Centre | Science Park Square | Falmer | Brighton | BN1 9SB
Tel +44 (0) 203 857 8530 | www.ambiental.co.uk | drainage@ambiental.co.uk

Project
Land Adj to Towsbourne
Winkfield Lane, Winkfield, SL4 4QU

Drawing
Site Layout- VOLUMES AND BANDING
PROPOSED V 1000YR WATER LEVEL

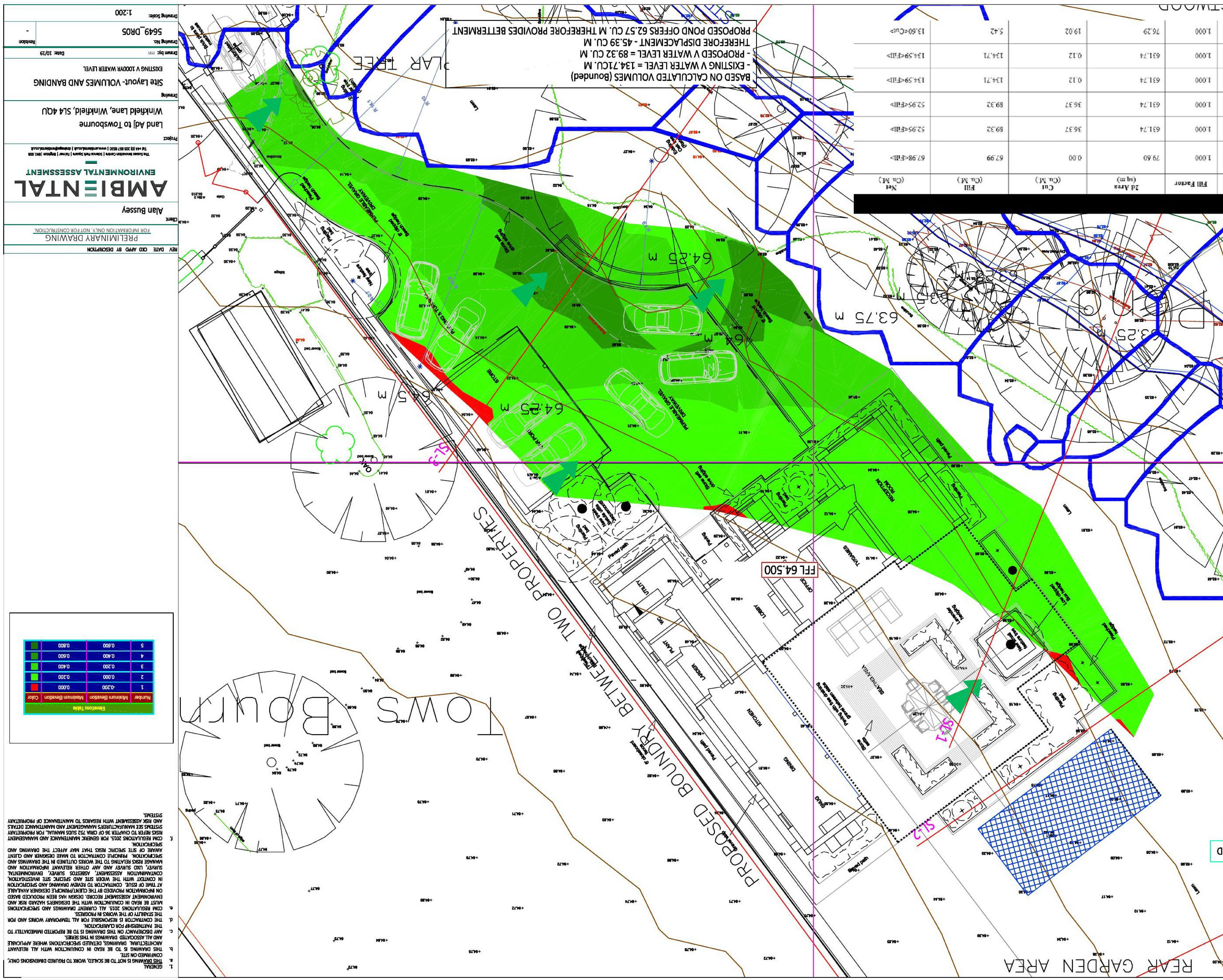
Drawn by: mn
Date: 10/19

Drawing No.
5649_DR04

Revision
-

Drawing Scale:
1:200

Drawing No.:



BASED ON CALCULATED VOLUMES (Bounded)
- EXISTING V WATER LEVEL = 134.71CU. M
- PROPOSED V WATER LEVEL = 89.32 CU. M
THEREFORE DISPLACEMENT - 45.39 CU. M
PROPOSED POND OFFERS 62.57 CU. M THEREFORE PROVIDES BETTERMENT

Volume Summary

Name	Type	Cut Factor	Fill Factor	2d Area (sq.m)	Cut (Cu. M)	Fill (Cu. M)	Net (Cu. M)
pond v 1in1000 water1	full	1.000	1.000	79.60	0.00	67.99	67.98<Fill>
Final v 1in1000 water	full	1.000	1.000	631.74	36.37	89.32	52.95<Fill>
Final v 1in1000 water	bounded	1.000	1.000	631.74	36.37	89.32	52.95<Fill>
existing v 1in1000 water	full	1.000	1.000	631.74	0.12	134.71	134.59<Fill>
existing v 1in1000 water	bounded	1.000	1.000	631.74	0.12	134.71	134.59<Fill>
POND V POND WL1	full	1.000	1.000	76.29	19.02	5.42	13.60<Cut>

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Elevations Table

Number	Minimum Elevation	Maximum Elevation	Color
1	-0.200	0.000	
2	0.000	0.200	
3	0.200	0.400	
4	0.400	0.600	
5	0.600	0.800	

REV DATE CKD APPD BY DESCRIPTION

PRELIMINARY DRAWING
FOR INFORMATION ONLY. NOT FOR CONSTRUCTION.

Client: Alan Bussey

AMBIENTAL
ENVIRONMENTAL ASSESSMENT

The Sussex Innovation Centre | Science Park Square | Falmer | Brighton | BN1 9SB
Tel +44 (0) 203 857 8530 | www.ambiental.co.uk | drainage@ambiental.co.uk

Project: Land Adj to Towsbourne, Winkfield Lane, Winkfield, SL4 4QU

Drawing: Site Layout- VOLUMES AND BANDING
EXISTING V 1000YR WATER LEVEL

Drawn by: mn
Date: 10/19
Drawing No. 5649_DR05
Revision -
Drawing Scale: 1:200

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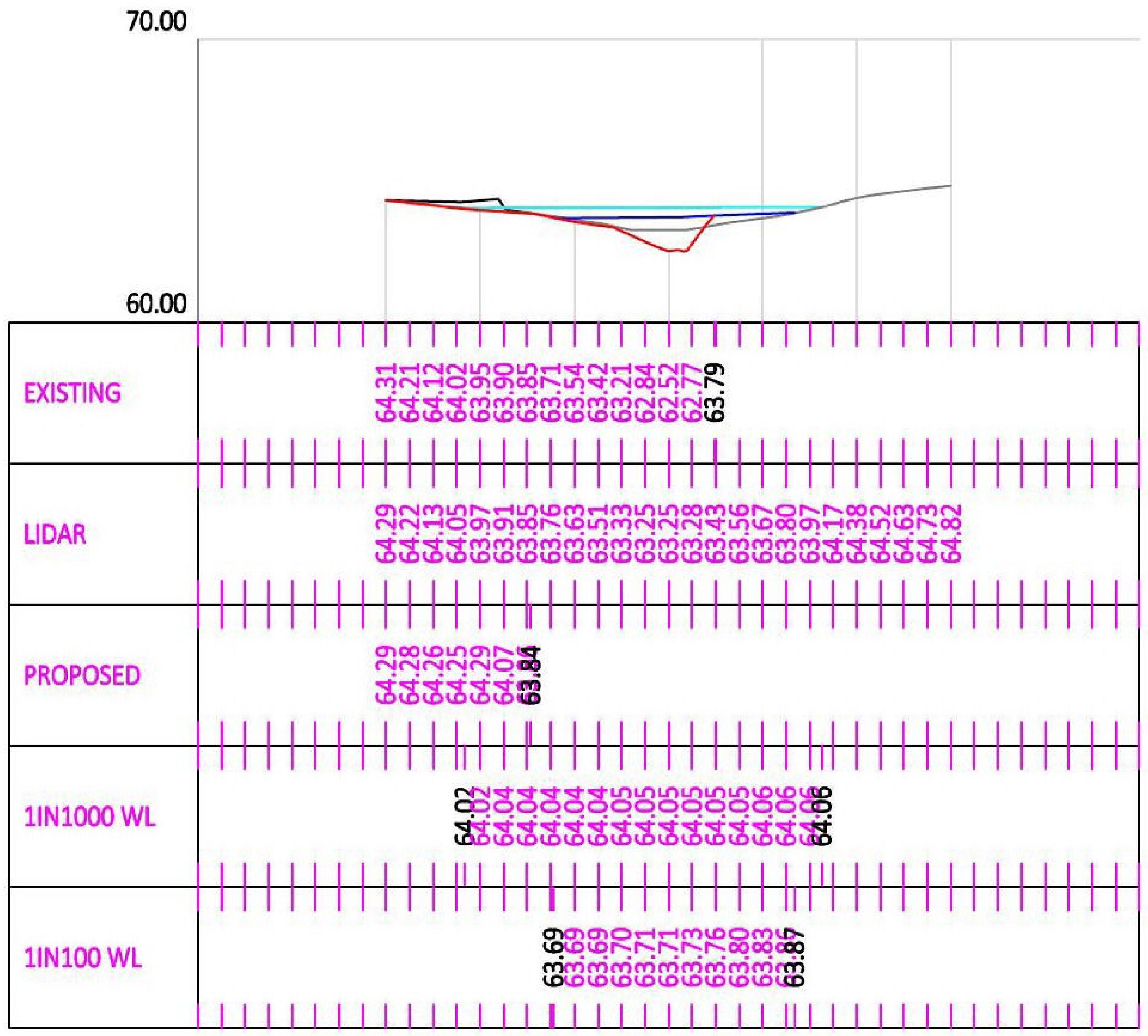
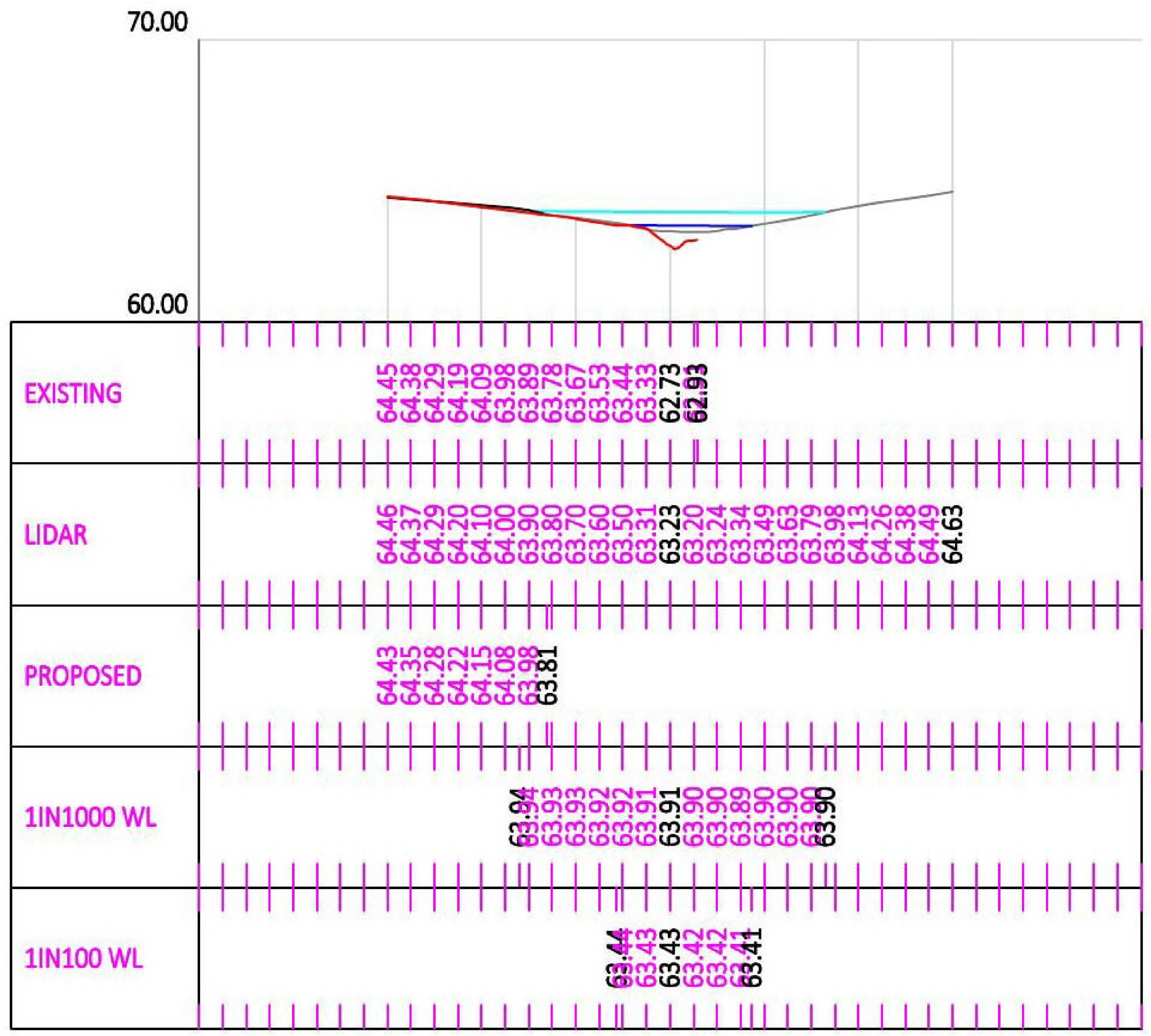
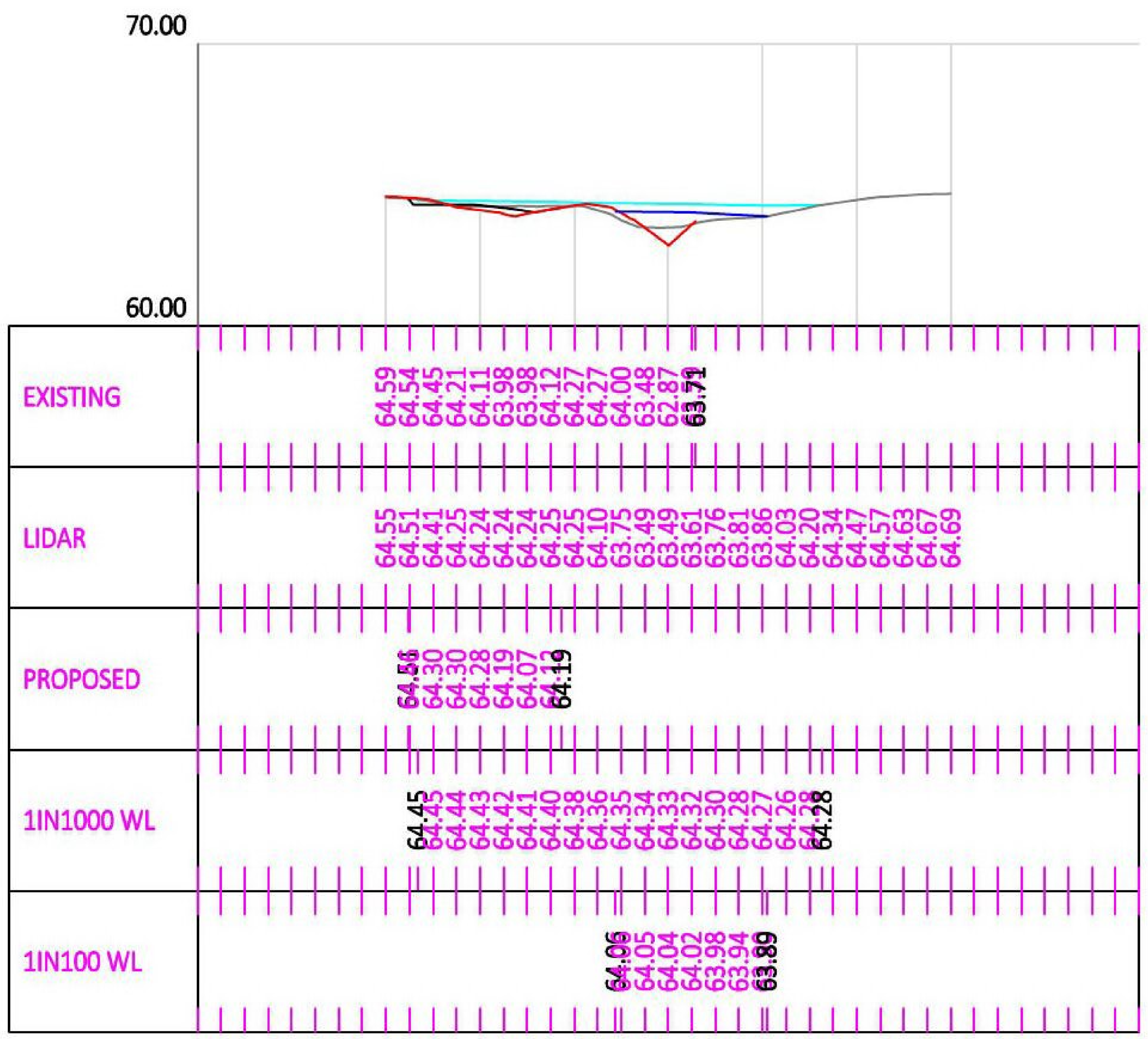


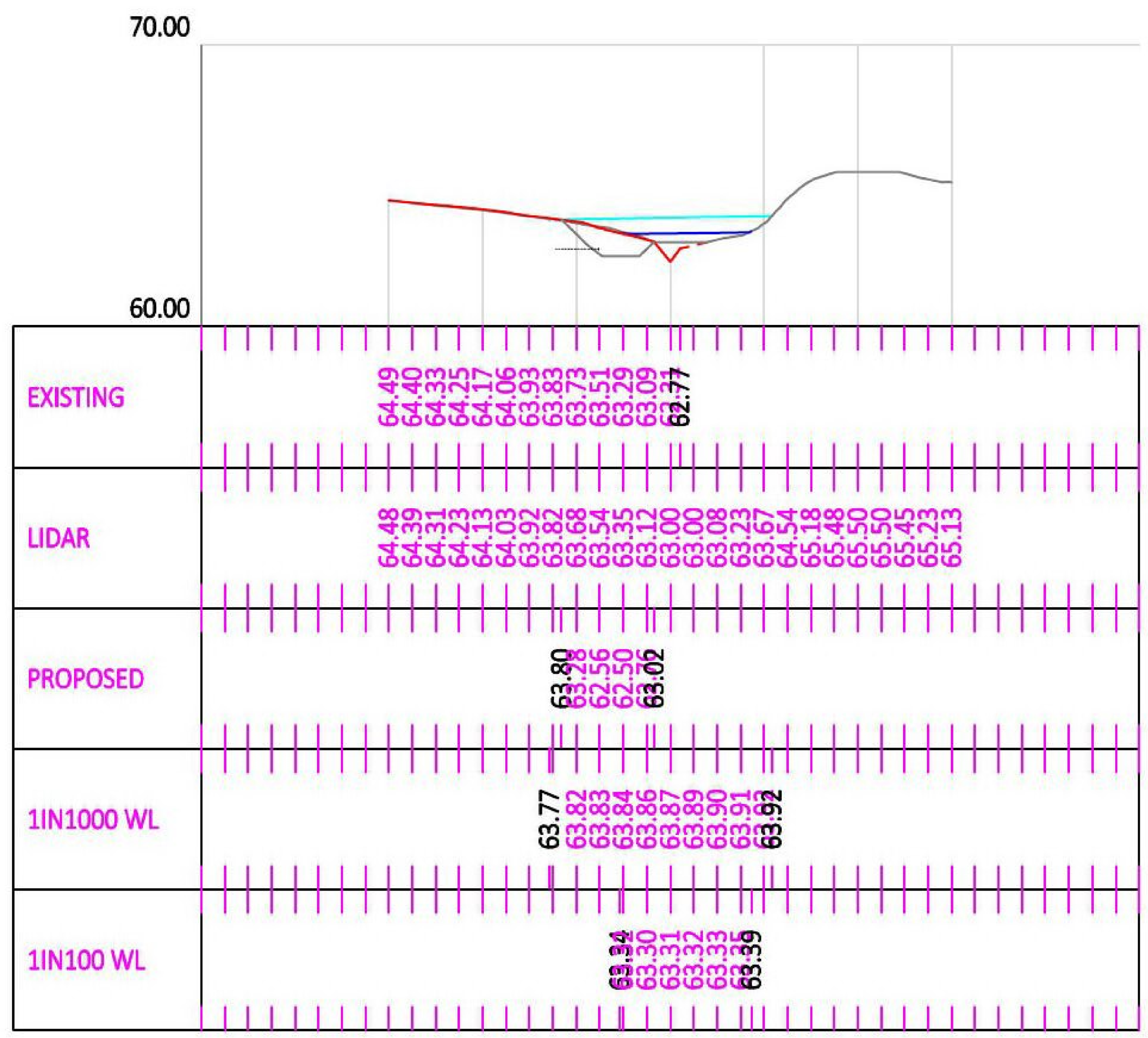
Section SL1



Section SL2



Section SL3



Section SL4

LIDAR GROUND PROFILE
PROPOSED GROUND PROFILE
TOPOGRAPHIC GROUND PROFILE
1IN1000YR WATER PROFILE
1IN100YR WATER PROFILE

FOR SITE SECTION LOCATIONS SEE DRAWING 5649 DR01

REV	DATE	CKD	APPD	BY	DESCRIPTION

PRELIMINARY DRAWING
FOR INFORMATION ONLY. NOT FOR CONSTRUCTION.

Client: Alan Bussey

AMBIENTAL
ENVIRONMENTAL ASSESSMENT

Project: Land Adj to Towsbourne, Winkfield Lane, Winkfield, SL4 4QU

Drawing: Site sections

Drawn by: mn | Date: Jan 21

Drawing No. 4460_DR06 | Revision -

Drawing Scale:

Drawing No:

Appendix 3 – Calculations

Greenfield Runoff

ICP SUDS Mean Annual Flood

Input

Return Period (years)	1	Soil	0.450
Area (ha)	0.080	Urban	0.000
SAAR (mm)	700	Region Number	Region 6

Results	**l/s**
QBAR Rural	0.4
QBAR Urban	0.4
Q1 year	0.3
Q1 year	0.3
Q30 years	0.8
Q100 years	1.1

Proposed Runoff

Summary of Results for 1 year Return Period (+40%)

Half Drain Time : 103 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	63.211	0.111	0.0	0.9	0.9	5.8	O K
30 min Summer	63.239	0.139	0.0	0.9	0.9	7.2	O K
60 min Summer	63.261	0.161	0.0	0.9	0.9	8.4	O K
120 min Summer	63.273	0.173	0.0	0.9	0.9	9.0	O K
180 min Summer	63.276	0.176	0.0	0.9	0.9	9.2	O K
240 min Summer	63.276	0.176	0.0	0.9	0.9	9.2	O K
360 min Summer	63.268	0.168	0.0	0.9	0.9	8.8	O K
480 min Summer	63.257	0.157	0.0	0.9	0.9	8.2	O K
600 min Summer	63.247	0.147	0.0	0.9	0.9	7.7	O K
720 min Summer	63.236	0.136	0.0	0.9	0.9	7.1	O K
960 min Summer	63.218	0.118	0.0	0.9	0.9	6.2	O K
1440 min Summer	63.191	0.091	0.0	0.8	0.8	4.7	O K
2160 min Summer	63.169	0.069	0.0	0.7	0.7	3.6	O K
2880 min Summer	63.158	0.058	0.0	0.6	0.6	3.0	O K
4320 min Summer	63.145	0.045	0.0	0.5	0.5	2.4	O K
5760 min Summer	63.139	0.039	0.0	0.4	0.4	2.0	O K
7200 min Summer	63.135	0.035	0.0	0.4	0.4	1.8	O K
8640 min Summer	63.132	0.032	0.0	0.3	0.3	1.7	O K
10080 min Summer	63.130	0.030	0.0	0.3	0.3	1.6	O K
15 min Winter	63.226	0.126	0.0	0.9	0.9	6.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	42.259	0.0	6.3	18
30 min Summer	27.522	0.0	8.2	32
60 min Summer	17.417	0.0	10.4	60
120 min Summer	10.801	0.0	12.9	94
180 min Summer	8.128	0.0	14.6	128
240 min Summer	6.636	0.0	15.9	162
360 min Summer	4.965	0.0	17.8	230
480 min Summer	4.025	0.0	19.3	298
600 min Summer	3.419	0.0	20.5	362
720 min Summer	2.993	0.0	21.5	426
960 min Summer	2.426	0.0	23.2	550
1440 min Summer	1.805	0.0	25.9	782
2160 min Summer	1.343	0.0	29.0	1128
2880 min Summer	1.089	0.0	31.3	1496
4320 min Summer	0.810	0.0	34.9	2204
5760 min Summer	0.657	0.0	37.8	2936
7200 min Summer	0.558	0.0	40.2	3672
8640 min Summer	0.489	0.0	42.2	4408
10080 min Summer	0.437	0.0	44.0	5136
15 min Winter	42.259	0.0	7.0	18

Summary of Results for 1 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	63.257	0.157	0.0	0.9	0.9	8.2	O K
60 min Winter	63.283	0.183	0.0	0.9	0.9	9.6	O K
120 min Winter	63.296	0.196	0.0	0.9	0.9	10.3	O K
180 min Winter	63.298	0.198	0.0	0.9	0.9	10.4	O K
240 min Winter	63.295	0.195	0.0	0.9	0.9	10.2	O K
360 min Winter	63.281	0.181	0.0	0.9	0.9	9.5	O K
480 min Winter	63.264	0.164	0.0	0.9	0.9	8.5	O K
600 min Winter	63.246	0.146	0.0	0.9	0.9	7.6	O K
720 min Winter	63.231	0.131	0.0	0.9	0.9	6.8	O K
960 min Winter	63.205	0.105	0.0	0.9	0.9	5.5	O K
1440 min Winter	63.173	0.073	0.0	0.8	0.8	3.8	O K
2160 min Winter	63.155	0.055	0.0	0.6	0.6	2.9	O K
2880 min Winter	63.145	0.045	0.0	0.5	0.5	2.4	O K
4320 min Winter	63.136	0.036	0.0	0.4	0.4	1.9	O K
5760 min Winter	63.132	0.032	0.0	0.3	0.3	1.7	O K
7200 min Winter	63.129	0.029	0.0	0.3	0.3	1.5	O K
8640 min Winter	63.127	0.027	0.0	0.2	0.2	1.4	O K
10080 min Winter	63.125	0.025	0.0	0.2	0.2	1.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	27.522	0.0	9.2	31
60 min Winter	17.417	0.0	11.7	60
120 min Winter	10.801	0.0	14.5	100
180 min Winter	8.128	0.0	16.3	138
240 min Winter	6.636	0.0	17.8	176
360 min Winter	4.965	0.0	20.0	250
480 min Winter	4.025	0.0	21.6	320
600 min Winter	3.419	0.0	22.9	386
720 min Winter	2.993	0.0	24.1	450
960 min Winter	2.426	0.0	26.0	570
1440 min Winter	1.805	0.0	29.0	792
2160 min Winter	1.343	0.0	32.5	1144
2880 min Winter	1.089	0.0	35.1	1500
4320 min Winter	0.810	0.0	39.1	2208
5760 min Winter	0.657	0.0	42.3	2944
7200 min Winter	0.558	0.0	45.0	3672
8640 min Winter	0.489	0.0	47.3	4344
10080 min Winter	0.437	0.0	49.3	5240

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.500	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.080

Time From:	(mins) To:	Area (ha)
0	4	0.080

Model Details

Storage is Online Cover Level (m) 64.250

Cellular Storage Structure

Invert Level (m) 63.100 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	55.0	70.0	0.801	0.0	97.2
0.800	55.0	97.2			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0049-1000-0800-1000
Design Head (m)	0.800
Design Flow (l/s)	1.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	49
Invert Level (m)	63.100
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.800	1.0
Flush-Flo™	0.215	0.9
Kick-Flo®	0.437	0.8
Mean Flow over Head Range	-	0.8

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.8	1.200	1.2	3.000	1.8	7.000	2.7
0.200	0.9	1.400	1.3	3.500	1.9	7.500	2.8
0.300	0.9	1.600	1.4	4.000	2.1	8.000	2.9
0.400	0.8	1.800	1.4	4.500	2.2	8.500	2.9
0.500	0.8	2.000	1.5	5.000	2.3	9.000	3.0
0.600	0.9	2.200	1.6	5.500	2.4	9.500	3.1
0.800	1.0	2.400	1.6	6.000	2.5		
1.000	1.1	2.600	1.7	6.500	2.6		

Summary of Results for 30 year Return Period (+40%)

Half Drain Time : 286 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	63.384	0.284	0.0	0.9	0.9	14.9	O K
30 min Summer	63.463	0.363	0.0	0.9	0.9	19.0	O K
60 min Summer	63.536	0.436	0.0	0.9	0.9	22.8	O K
120 min Summer	63.592	0.492	0.0	0.9	0.9	25.7	O K
180 min Summer	63.607	0.507	0.0	0.9	0.9	26.5	O K
240 min Summer	63.606	0.506	0.0	0.9	0.9	26.4	O K
360 min Summer	63.592	0.492	0.0	0.9	0.9	25.7	O K
480 min Summer	63.575	0.475	0.0	0.9	0.9	24.8	O K
600 min Summer	63.558	0.458	0.0	0.9	0.9	23.9	O K
720 min Summer	63.539	0.439	0.0	0.9	0.9	22.9	O K
960 min Summer	63.498	0.398	0.0	0.9	0.9	20.8	O K
1440 min Summer	63.425	0.325	0.0	0.9	0.9	17.0	O K
2160 min Summer	63.337	0.237	0.0	0.9	0.9	12.4	O K
2880 min Summer	63.274	0.174	0.0	0.9	0.9	9.1	O K
4320 min Summer	63.203	0.103	0.0	0.8	0.8	5.4	O K
5760 min Summer	63.173	0.073	0.0	0.8	0.8	3.8	O K
7200 min Summer	63.160	0.060	0.0	0.7	0.7	3.1	O K
8640 min Summer	63.152	0.052	0.0	0.6	0.6	2.7	O K
10080 min Summer	63.147	0.047	0.0	0.5	0.5	2.4	O K
15 min Winter	63.420	0.320	0.0	0.9	0.9	16.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	103.633	0.0	15.4	18
30 min Summer	67.486	0.0	20.1	33
60 min Summer	42.036	0.0	25.2	62
120 min Summer	25.426	0.0	30.5	122
180 min Summer	18.752	0.0	33.7	180
240 min Summer	15.046	0.0	36.1	240
360 min Summer	10.991	0.0	39.5	296
480 min Summer	8.795	0.0	42.2	360
600 min Summer	7.394	0.0	44.3	426
720 min Summer	6.414	0.0	46.1	496
960 min Summer	5.123	0.0	49.1	624
1440 min Summer	3.728	0.0	53.6	880
2160 min Summer	2.709	0.0	58.5	1252
2880 min Summer	2.159	0.0	62.1	1588
4320 min Summer	1.566	0.0	67.6	2288
5760 min Summer	1.247	0.0	71.8	2944
7200 min Summer	1.044	0.0	75.1	3672
8640 min Summer	0.903	0.0	78.0	4408
10080 min Summer	0.798	0.0	80.4	5136
15 min Winter	103.633	0.0	17.3	18

Summary of Results for 30 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	63.510	0.410	0.0	0.9	0.9	21.4	O K
60 min Winter	63.594	0.494	0.0	0.9	0.9	25.8	O K
120 min Winter	63.659	0.559	0.0	0.9	0.9	29.2	O K
180 min Winter	63.680	0.580	0.0	0.9	0.9	30.3	O K
240 min Winter	63.683	0.583	0.0	0.9	0.9	30.5	O K
360 min Winter	63.667	0.567	0.0	0.9	0.9	29.6	O K
480 min Winter	63.646	0.546	0.0	0.9	0.9	28.5	O K
600 min Winter	63.623	0.523	0.0	0.9	0.9	27.3	O K
720 min Winter	63.599	0.499	0.0	0.9	0.9	26.0	O K
960 min Winter	63.543	0.443	0.0	0.9	0.9	23.2	O K
1440 min Winter	63.424	0.324	0.0	0.9	0.9	16.9	O K
2160 min Winter	63.297	0.197	0.0	0.9	0.9	10.3	O K
2880 min Winter	63.222	0.122	0.0	0.9	0.9	6.4	O K
4320 min Winter	63.167	0.067	0.0	0.7	0.7	3.5	O K
5760 min Winter	63.152	0.052	0.0	0.6	0.6	2.7	O K
7200 min Winter	63.144	0.044	0.0	0.5	0.5	2.3	O K
8640 min Winter	63.140	0.040	0.0	0.4	0.4	2.1	O K
10080 min Winter	63.136	0.036	0.0	0.4	0.4	1.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	67.486	0.0	22.6	33
60 min Winter	42.036	0.0	28.2	62
120 min Winter	25.426	0.0	34.1	120
180 min Winter	18.752	0.0	37.8	176
240 min Winter	15.046	0.0	40.4	232
360 min Winter	10.991	0.0	44.3	334
480 min Winter	8.795	0.0	47.2	378
600 min Winter	7.394	0.0	49.6	456
720 min Winter	6.414	0.0	51.7	534
960 min Winter	5.123	0.0	55.0	692
1440 min Winter	3.728	0.0	60.0	940
2160 min Winter	2.709	0.0	65.5	1296
2880 min Winter	2.159	0.0	69.6	1616
4320 min Winter	1.566	0.0	75.7	2248
5760 min Winter	1.247	0.0	80.4	2944
7200 min Winter	1.044	0.0	84.2	3672
8640 min Winter	0.903	0.0	87.3	4408
10080 min Winter	0.798	0.0	90.1	5064

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.500	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.080

Time From:	(mins) To:	Area (ha)
0	4	0.080

Model Details

Storage is Online Cover Level (m) 64.250

Cellular Storage Structure

Invert Level (m) 63.100 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	55.0	70.0	0.801	0.0	97.2
0.800	55.0	97.2			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0049-1000-0800-1000
Design Head (m)	0.800
Design Flow (l/s)	1.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	49
Invert Level (m)	63.100
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.800	1.0
Flush-Flo™	0.215	0.9
Kick-Flo®	0.437	0.8
Mean Flow over Head Range	-	0.8

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.8	1.200	1.2	3.000	1.8	7.000	2.7
0.200	0.9	1.400	1.3	3.500	1.9	7.500	2.8
0.300	0.9	1.600	1.4	4.000	2.1	8.000	2.9
0.400	0.8	1.800	1.4	4.500	2.2	8.500	2.9
0.500	0.8	2.000	1.5	5.000	2.3	9.000	3.0
0.600	0.9	2.200	1.6	5.500	2.4	9.500	3.1
0.800	1.0	2.400	1.6	6.000	2.5		
1.000	1.1	2.600	1.7	6.500	2.6		

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 393 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	63.472	0.372	0.0	0.9	0.9	19.4	O K
30 min Summer	63.582	0.482	0.0	0.9	0.9	25.2	O K
60 min Summer	63.685	0.585	0.0	0.9	0.9	30.5	O K
120 min Summer	63.765	0.665	0.0	0.9	0.9	34.8	O K
180 min Summer	63.791	0.691	0.0	0.9	0.9	36.1	O K
240 min Summer	63.795	0.695	0.0	0.9	0.9	36.3	O K
360 min Summer	63.778	0.678	0.0	0.9	0.9	35.4	O K
480 min Summer	63.760	0.660	0.0	0.9	0.9	34.5	O K
600 min Summer	63.741	0.641	0.0	0.9	0.9	33.5	O K
720 min Summer	63.722	0.622	0.0	0.9	0.9	32.5	O K
960 min Summer	63.684	0.584	0.0	0.9	0.9	30.5	O K
1440 min Summer	63.612	0.512	0.0	0.9	0.9	26.7	O K
2160 min Summer	63.495	0.395	0.0	0.9	0.9	20.6	O K
2880 min Summer	63.396	0.296	0.0	0.9	0.9	15.5	O K
4320 min Summer	63.271	0.171	0.0	0.9	0.9	8.9	O K
5760 min Summer	63.208	0.108	0.0	0.9	0.9	5.7	O K
7200 min Summer	63.178	0.078	0.0	0.8	0.8	4.1	O K
8640 min Summer	63.165	0.065	0.0	0.7	0.7	3.4	O K
10080 min Summer	63.157	0.057	0.0	0.6	0.6	3.0	O K
15 min Winter	63.518	0.418	0.0	0.9	0.9	21.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	134.372	0.0	20.1	19
30 min Summer	88.266	0.0	26.4	33
60 min Summer	55.250	0.0	33.1	62
120 min Summer	33.426	0.0	40.1	122
180 min Summer	24.587	0.0	44.2	182
240 min Summer	19.657	0.0	47.1	240
360 min Summer	14.271	0.0	51.3	314
480 min Summer	11.374	0.0	54.5	378
600 min Summer	9.532	0.0	57.1	440
720 min Summer	8.247	0.0	59.3	508
960 min Summer	6.558	0.0	62.9	646
1440 min Summer	4.740	0.0	68.2	924
2160 min Summer	3.420	0.0	73.9	1316
2880 min Summer	2.711	0.0	78.0	1672
4320 min Summer	1.951	0.0	84.2	2336
5760 min Summer	1.543	0.0	88.9	3000
7200 min Summer	1.286	0.0	92.5	3680
8640 min Summer	1.107	0.0	95.6	4408
10080 min Summer	0.976	0.0	98.3	5136
15 min Winter	134.372	0.0	22.5	18

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	63.643	0.543	0.0	0.9	0.9	28.4	O K
60 min Winter	63.760	0.660	0.0	0.9	0.9	34.5	O K
120 min Winter	63.855	0.755	0.0	1.0	1.0	39.5	O K
180 min Winter	63.890	0.790	0.0	1.0	1.0	41.3	O K
240 min Winter	63.899	0.799	0.0	1.0	1.0	41.8	O K
360 min Winter	63.887	0.787	0.0	1.0	1.0	41.1	O K
480 min Winter	63.861	0.761	0.0	1.0	1.0	39.8	O K
600 min Winter	63.838	0.738	0.0	1.0	1.0	38.6	O K
720 min Winter	63.813	0.713	0.0	0.9	0.9	37.2	O K
960 min Winter	63.759	0.659	0.0	0.9	0.9	34.5	O K
1440 min Winter	63.653	0.553	0.0	0.9	0.9	28.9	O K
2160 min Winter	63.475	0.375	0.0	0.9	0.9	19.6	O K
2880 min Winter	63.336	0.236	0.0	0.9	0.9	12.4	O K
4320 min Winter	63.203	0.103	0.0	0.9	0.9	5.4	O K
5760 min Winter	63.167	0.067	0.0	0.7	0.7	3.5	O K
7200 min Winter	63.154	0.054	0.0	0.6	0.6	2.8	O K
8640 min Winter	63.147	0.047	0.0	0.5	0.5	2.4	O K
10080 min Winter	63.142	0.042	0.0	0.5	0.5	2.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	88.266	0.0	29.5	33
60 min Winter	55.250	0.0	37.1	62
120 min Winter	33.426	0.0	44.9	120
180 min Winter	24.587	0.0	49.5	178
240 min Winter	19.657	0.0	52.8	234
360 min Winter	14.271	0.0	57.5	342
480 min Winter	11.374	0.0	61.1	394
600 min Winter	9.532	0.0	64.0	466
720 min Winter	8.247	0.0	66.4	544
960 min Winter	6.558	0.0	70.4	700
1440 min Winter	4.740	0.0	76.3	998
2160 min Winter	3.420	0.0	82.7	1404
2880 min Winter	2.711	0.0	87.4	1732
4320 min Winter	1.951	0.0	94.3	2336
5760 min Winter	1.543	0.0	99.5	2960
7200 min Winter	1.286	0.0	103.7	3672
8640 min Winter	1.107	0.0	107.1	4408
10080 min Winter	0.976	0.0	110.1	5136

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.500	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.080

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.080

Model Details

Storage is Online Cover Level (m) 64.250

Cellular Storage Structure

Invert Level (m) 63.100 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	55.0	70.0	0.801	0.0	97.2
0.800	55.0	97.2			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0049-1000-0800-1000
Design Head (m)	0.800
Design Flow (l/s)	1.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	49
Invert Level (m)	63.100
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.800	1.0
Flush-Flo™	0.215	0.9
Kick-Flo®	0.437	0.8
Mean Flow over Head Range	-	0.8

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.8	1.200	1.2	3.000	1.8	7.000	2.7
0.200	0.9	1.400	1.3	3.500	1.9	7.500	2.8
0.300	0.9	1.600	1.4	4.000	2.1	8.000	2.9
0.400	0.8	1.800	1.4	4.500	2.2	8.500	2.9
0.500	0.8	2.000	1.5	5.000	2.3	9.000	3.0
0.600	0.9	2.200	1.6	5.500	2.4	9.500	3.1
0.800	1.0	2.400	1.6	6.000	2.5		
1.000	1.1	2.600	1.7	6.500	2.6		

Appendix 4 – General Requirements Maintenance

GENERAL REQUIREMENTS		Responsibility	
Generally	Frequency	Maintenance Company	Home Owner
Pipes and Litter: collect all litter or other debris and remove from site at each visit	Monthly	Yes, where draining more than one property or located in communal areas	Yes, where drains serve the one property only or within property boundary
INLETS, OUTLETS, CONTROLS, GULLIES, CHANNEL DRAINS, AND INSPECTION CHAMBERS			
Regular Maintenance	Frequency		
Inspect surface structures removing obstructions, sediment, oil/grease and floating debris and silt as necessary. Check there is no physical damage. Strim vegetation 1m min. surround to structures and keep hard aprons free from silt and debris.	Monthly	Yes, where draining more than one property or located in communal areas	Yes, where drains serve the one property only or within property boundary
Flow Control Devices (Hydrobrake): Inspect and remove blockages, hose down as required, check flow.	Six monthly	Yes	
Inspection chambers, Gullies, Channel Drains: Remove cover and inspect ensuring water is flowing freely and that the exit route for water is unobstructed. Remove debris and silt. Undertake inspection after leaf fall in autumn and major storm events	Annually	Yes, where draining more than one property or located in communal areas	Yes, where drains serve the one property only or within property boundary
Attenuation Tank (Geocellular): Inspect and remove blockages, Jet and camera as required, check flow. CCTV inspection at every inspection point is recommended: — after every major storm — at regular intervals. Silt traps prior to inlet pipework should be routinely inspected and cleaned out to minimise debris reaching the tank	Annually	Yes, maintenance to be undertaken by maintenance company.	
Occasional Maintenance			
Cleaning of the system if necessary. CCTV Survey and Jetting	As necessary	Yes, where draining more than one property or located in communal areas	Yes, where drains serve the one property only or within property boundary

Remedial work			
Inspect and remove baskets or similar silt-traps, clean and replace. Repair physical damage if necessary.	As necessary	Yes, where draining more than one property or located in communal areas	Yes, where drains serve the one property only or within property boundary
PERMEABLE AND POROUS SURFACES			
Regular Maintenance			
Cleaning Brush regularly and remove sweepings from all hard surfaces	Monthly	Yes, shared access road	Yes, private driveways
Occasional Maintenance			
Permeable Pavements. Brush and vacuum surface once a year to prevent silt blockage and enhance design life.	Annually	Yes, shared access road	Yes, private driveways
Remedial work			
Monitor effectiveness of permeable pavement and when water does not infiltrate immediately advise Client of possible need for reinstatement of top layers or specialist cleaning. Recent experience suggests jet washing and suction cleaning will substantially reinstate pavement to 90% efficiency.	As required	Yes, shared access road	Yes, private driveways
OVERLAND FLOW AND DESIGNED FLOODABLE AREAS			
Regular Maintenance			
Ensure flood flow routes or areas that are design to temporarily store flood water are not obstructed. Remove obstructions from site	Monthly	Maintenance Company in communal areas, home owners in private areas.	

SPILLAGE – EMERGENCY ACTION

Most spillages on development sites are of compounds that do not pose a serious risk to the environment if they enter the drainage in a slow and controlled manner with time available for natural breakdown in a treatment system. Therefore, small spillages of oil, milk or other known organic substances should be removed where possible using soak mats as recommended by the Environment Agency with residual spillage allowed to bio-remediate in the drainage system.

In the event of a serious spillage, either by volume or of unknown or toxic compounds, then isolate the spillage with soil, turf or fabric and block outlet pipes from chamber(s) downstream of the spillage with a bung(s). (A bung for blocking pipes may be made by wrapping soil or turf in a plastic sheet or close woven fabric.) Contact the Environment Agency immediately.