Water Eaton

PR6a : Land East of Oxford Road

Flood Risk Assessment

Bellway | STRATEGIC LAND

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WE/ FRA/P 02

FLOOD RISK ASSESSMENT

Water Eaton

PR6a: Land East of Oxford Road

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Appendices

1.0 Introduction

1.1 This Flood Risk Assessment has been prepared by Glanville Consultants on behalf of Bellway Homes Limited and Christ Church, Oxford with respect to an outline planning application (with all matters except access reserved for future consideration) for development of land at Water Eaton, Oxford, OX2 8HF.

1.2 The Site is included in the Cherwell Local Plan 2011-2031 (Part 1) Partial Review as Site PR6a, Land East of Oxford Road. Site PR6a allocates the Site for mixed-use development including around 690 dwellings, a two form entry primary school, a local centre and recreation space. The strategic allocation extends to approximately 45.8 hectares of land to the east of the A4165, Oxford Road, as shown on the extract from the Cherwell Local Plan Partial Review included in Appendix A.

1.3 This report outlines the existing situation with regards to flood risk and drainage, and outlines the proposals for flood risk protection and resilience, and surface water drainage.

2.0 Development Proposals

2.1 A copy of the illustrative masterplan is included in Appendix B. The proposed development consists of:

- The demolition of existing buildings;
- Erection of up to 800 dwellings (Class C3);
- A two form entry primary school;
- A local centre comprising: convenience retailing (not less than 350sqm and up to 500sqm (Class E(a))), business uses (Class E(g)(i)) and/or financial and professional uses (Class E(c)) up to 500sqm, a café or restaurant (Class E(b)) up to 200sqm;
- Community building (Class E and F2);
- Car and cycle parking;
- Associated play areas, allotments, public open green space and landscaping.
- New vehicular, pedestrian and cycle access points, internal roads and paths and communal parking infrastructure.
- Associated works, infrastructure (including Sustainable Urban Drainage, services and utilities) and ancillary development.
- Works to the Oxford Road in the vicinity of the site to include, pedestrian and cycle infrastructure, drainage, bus stops, landscaping and ancillary development.

3.0 Existing Site Characteristics

3.1 This Section outlines the existing site characteristics. The site extends to approximately 45.8ha and is located to the east of the A4165, Oxford Road to the north of Oxford. The site largely consists of agricultural land, with Pipal Barns located in the north-west of the site alongside Oxford Road. St Frideswide's Farm is located adjacent to the eastern site boundary and Pipal Cottage is located adjacent to Pipal Barns outside of the site boundary. A site location plan is included in Appendix C.

Topography

3.2 The site generally falls away from two main high points. The first is located in the centre of the site along the western boundary with the A4165, with land falling to the north, and to the east towards St Frideswide's Farm. The second high point is located along the southern boundary, with land falling from this point to the east towards the River Cherwell, and to the north towards St Frideswide's Farm. The topographical survey is included in Appendix D.

Geology

3.3 Geological maps published by the British Geological Survey (BGS) indicate that the site is underlain by a bedrock geology of Oxford Clay Formation and West Walton Formation, consisting of mudstone. The maps indicate that there is no known superficial geology underlying the majority of the site, with a band of Wolvercote Sand and Gravel Member present between St Frideswide's Farm and the southern boundary. This is confirmed by BGS borehole records which show Oxford Clay Formation underlying the entire site, with some sand and gravel superficial deposits in the south-east between St Frideswide's Farm and the southern boundary. A band of Alluvium deposits is also shown along the site boundary in the south-eastern corner of the site, consisting of clay, sand, silt and gravel.

3.4 A preliminary phase 1 intrusive site investigation was undertaken across the site by ST Consult in August 2020, and the report is included in Appendix E. 14 no. boreholes were carried out across the site to a depth of up to 4m bgl. In general, the soils encountered comprised of topsoil over either the Wolvercote Sand and Gravel Member or a clay subsoil over the Oxford Clay Formation. Soils in the north of the site had a smaller granular fraction, and wet sandy horizons were encountered across the site.

3.5 Groundwater was struck within four of the fourteen boreholes at between 1.2-2.0m below ground level, which were all located in the southern part of the site.

3.6 A total of twelve falling-head permeability tests were undertaken across the site. The tests were very poor, recording infiltration rates of 0 – 1.77×10^{-7} m/s, with the exception of WS101, WS102 and WS103 (located in the southern part of the site) which completed a single test in the time allowed. Therefore, it is concluded that infiltration is poor across the majority of the site and therefore infiltration drainage techniques are not widely feasible, other than in the southern part of the site, where soils were more gravelly.

3.7 Following the shallow groundwater levels and more permeable deposits encountered during the preliminary site investigation, a second phase of investigation (phase 2) was undertaken by ST Consult in September 2021 to carry out a series of BRE365 soakage tests in areas identified as having soakage potential and install groundwater monitoring installations. Extracts of the phase 2 investigation report are included in Appendix E.

3.8 The phase 2 investigation works comprised 12 no. boreholes including the installation of groundwater monitoring wells and 20 no. trial pits carried out across the site to a depth of up to 3m bgl. In addition, 3 no. trial pits were carried out in the south of the site in the area where preliminary investigations indicated infiltration could be feasible.

3.9 Groundwater monitoring installations installed within the 12 no. boreholes were monitored over the 2021-22 winter period and groundwater was recorded in all of the boreholes in the range of 0.30 to 1.30m bgl, except for one which remained dry to 3.00m bgl.

3.10 A total of three soakage tests were carried out to BRE365 standards within the 3 no. trial pits located to the south of the site. The test results were good, recording rates of $1.41\text{x}10^{-5}$ – $9.58\text{x}10^{-6}$ m/s which indicates that infiltration drainage techniques could be feasible in these locations. However, groundwater monitoring installations located within close vicinity of the trial pits (WLS210 & WLS211) recorded groundwater levels between 0.70-1.30m bgl, indicating that infiltration drainage techniques would be constrained by high groundwater.

Hydrological and Hydrogeological Context

3.11 The existing drainage described in the following paragraphs is illustrated on the plan included in Appendix F.

3.12 A network of drainage ditches is located along field boundaries. These ditches generally flow in easterly and southerly directions, all eventually discharging to The River Cherwell, which is located approximately 0.5 miles to the east of the site at its closest point and is the closest watercourse designated as a main river by the Environment Agency (EA).

3.13 A pond is located at St Frideswide's Farm adjacent to the eastern boundary of the site, which is connected to the surrounding drainage ditches, although its water level is not greatly affected by the flow within the surrounding ditches.

3.14 No major artificial water bodies are located on or in the vicinity of the site. The closest artificial water feature is the Oxford Canal, located around 1km to the south-west of the site.

3.15 A CCTV survey has been undertaken to further investigate the existing drainage situation, and its findings are shown on the Existing Drainage Plan included in Appendix F.

3.16 The drainage ditches are culverted in some areas and are also understood to take flows from a number of off-site catchments. This includes:

- highway drainage along the A4165;
- potential overland flows from the Golf Course and its drainage ditches to the west of the A4165 via piped connection(s) under the A4165;
- a small urban catchment served by a Thames Water surface water sewer to the south of the site; and
- an existing agricultural field along the southern boundary and adjoining the A4165, for which a planning application was approved in August 2022 (Ref: 21/01449/FUL) for residential development by Croudace Homes. The proposed drainage strategy for this development involves continuing to discharge (at a restricted rate) into the drainage ditch which serves the undeveloped site and subsequently flows through the site subject of this report.

3.17 Rain falling over the area of the site is understood to infiltrate directly to ground in the first instance. The agricultural land is understood to be served by networks of land drains in some areas, which convey flows to the on-site ditch network. In more extreme events, where the infiltration capacity of the underlying soil has been reached, surface water run-off will be generated within the site. Overland flows will follow the topography of the site, with the flows directed to the ditch network. The existing overland flow paths are shown on the Surface Water Flood Risk Maps included in Appendix G.

3.18 The EA defines Source Protection Zones (SPZs) for groundwater used for public drinking water supply, which show the risk of contamination from activities that might cause pollution in the area. The site is not located within an SPZ.

3.19 The EA defines Drinking Water Safeguard Zones (SgZs) and Drinking Water Protected Areas (DWPAs) for water sources used for public drinking water supply. SgZs are non-statutory designations which define areas where additional pollution control measures are needed to avoid deterioration in water quality. DWPAs are areas where water sources need to be protected to prevent pollution. The site is located within a surface water SgZ, but not within a DWPA.

3.20 The groundwater vulnerability map published by the EA indicates that the bedrock geology underlying the site is associated with a negligibly permeable non-aquifer. The superficial deposits of sand and gravel in the south-east of the site are associated with a variably permeable minor aquifer of low leaching potential, with an area of high leaching potential just outside the southern boundary.

3.21 The bedrock aquifer designation map published by the EA shows the mudstone bedrock underlying the majority of the site is classified as unproductive strata. The superficial sand and gravel deposits in the south-east of the site are associated with a Secondary A aquifer. Unproductive Strata indicates regions where layers of rock or drift deposits have low permeability and have negligible influence on water supply or river base flow. Secondary A aquifers indicate regions where layers of rock or drift deposits are permeable and therefore are capable of supporting water supply on a local scale and may provide a source of base flow to rivers.

Existing Drainage

3.22 Thames Water is the statutory undertaker for surface water and wastewater drainage in Oxfordshire. The location of existing drainage infrastructure in the vicinity of the site obtained from Thames Water records are shown on the Existing Drainage Plan included in Appendix F.

3.23 The records do not indicate any public foul or surface water sewers within the site boundary, or along the A4165 adjacent to the site.

3.24 Gravity foul and surface water networks are indicated within the residential areas to the south of the site. Whilst the Thames Water foul water network flows away from the site to the south, a Thames Water surface water network is shown to discharge into a ditch which passes through the site subject of this report.

3.25 Pipal Cottage in the north-west of the site and St Frideswide's Farm to the east of the site are not known to connect into the public sewer network and instead are served by a septic tank / on-site treatment.

3.26 No private foul drainage infrastructure is known to be located within the site boundary. Private land drainage and culverted ditches are present within the site boundary, as described earlier in this section and shown on the Existing Drainage Plan included in Appendix F.

4.0 Flood Risk

4.1 Flood risk to the site is considered from all likely sources of flooding, as defined in the National Planning Policy Framework (NPPF) and the Planning Practice Guidance (PPG) to the NPPF on Flood Risk and Coastal Change. Flood risk information has been taken from Environment Agency (EA) mapping published online, modelling obtained from the EA, and mapping and information found within the Cherwell District Council (CDC) Strategic Flood Risk Assessment (SFRA) reports (Level 1 and Level 2, 2017).

Tidal / Coastal

4.2 The watercourses stated in Section 3 are not subject to tidal influences. The site is located at an elevation of 59.75m Above Ordnance Datum (AOD) and above. As such there is no risk to the site from tidal or coastal flooding.

Fluvial

Environment Agency (EA) Flood Map for Planning

4.3 The EA Flood Map for Planning indicates that the entire site is located within Flood Zone 1, land at the lowest risk of flooding (<1 in 1,000 year return period), with an area of land adjacent to the south-east site boundary within a mixture of Flood Zone 2 (between 1 in 100 year and 1 in 1,000 year return period) and Flood Zone 3 (> 1 in 100 year return period). An extract from this map is shown in Figure 1, with the flood zones plotted on the Fluvial Flood Risk Map included in Appendix H.

4.4 The area of land adjacent to the site within Flood Zones 2 and 3 is currently agricultural land, and the closest parcel of development is proposed green space. This can be seen on the extract from the CDC Local Plan Partial Review and masterplan in Appendices A and B respectively. This places any potential built development some 300m away from the Flood Zone, and at an elevation over 10m higher than the highest flood level.

Environment Agency Product 4 Data

4.5 EA Product 4 Flood Model Data relating to the site (Reference FRA4_THM64417) was first obtained in November 2017. It was confirmed by the EA in June 2021 that the hydraulic model relevant to the site has not been updated since 2017. The Product 4 Data is included in Appendix I.

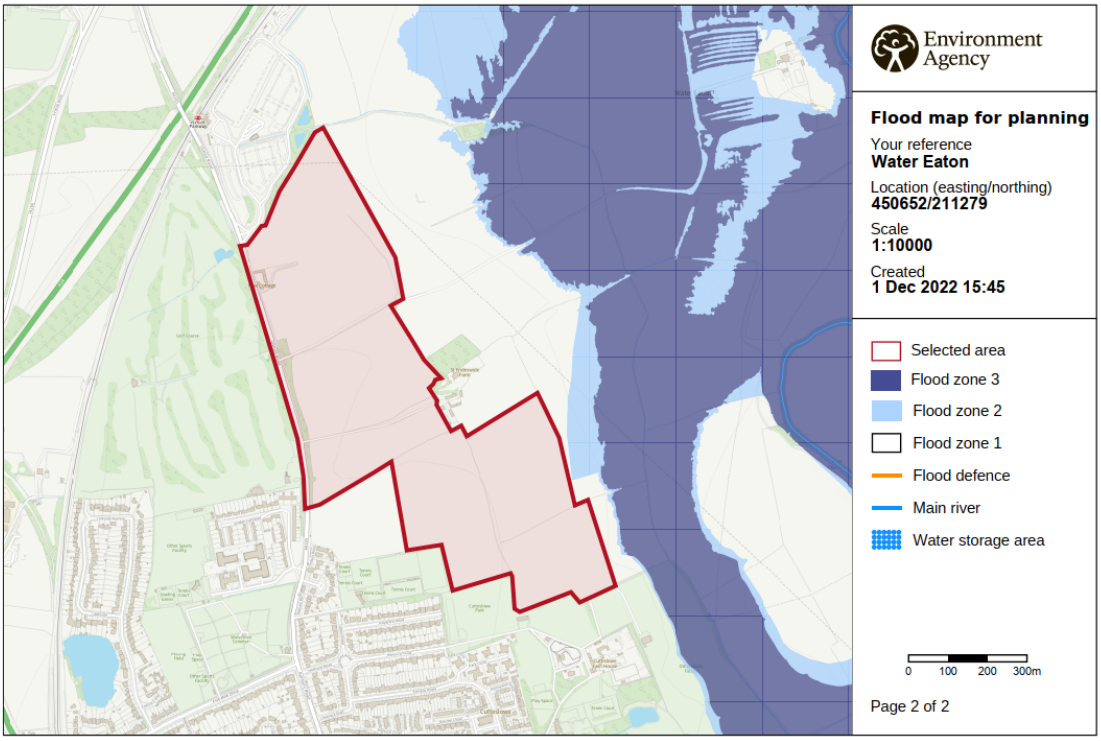


Figure 1: Environment Agency Flood Map for Planning

4.6 The EA Product 4 Data includes information from the River Cherwell (Thrupps Bridge to Thames Confluence) mapping and modelling study completed in 2006 using ISIS software. The map provided shows the modelled extents of the 1 in 5 year, 1 in 20 year (Flood Zone 3b) and 1 in 100 year (Flood Zone 3a) events. This map indicates the same extent of Flood Zone 3 as shown on the Flood Map for Planning.

Climate Change Assessment

4.7 Although the site is located entirely within Flood Zone 1, areas within close vicinity of the site are located within Flood Zone 2 and 3. As such it has been considered prudent to provide further assessment of flood levels and extents in accordance with EA document "Thames Area Climate Change Guidance", produced in January 2017 and EA Guidance "Climate Change Allowances", peak river flow guidance updated July 2022.

4.8 The EA Product 4 Data includes modelled flood levels. The site is located between nodes 06114_MN_CH.105 and 06114_MN_CH.100 and flood levels for the site have been interpolated from the data and are shown in Table 1.

Table 1: Modelled Fluvial Flood Levels

Return Period	**Flood Level (m AOD)**		
	06114_MN_CH.105	**Interpolated**	**06114_MN_CH.100**
1 in 5 years	57.970	57.920	57.870
1 in 20 years (Flood Zone 3b)	58.200	58.160	58.120
1 in 100 years (Flood Zone 3a)	58.380	58.350	58.320
1 in 100 years plus 20% CC	58.560	58.535	58.510

4.9 It is noted that the peak river flow climate change guidance given by the EA changed in both February 2016 and July 2021, however the models have not been updated to reflect these changes.

4.10 The 2016 climate change guidance for peak river flows for the Thames Basin District are shown in Table 2.

Table 2: EA Climate Change Guidance (Feb 2016)

Allowance category	**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	25%	35%	70%
Higher central	15%	25%	35%
Central	10%	15%	25%

4.11 The updated 2021 climate change guidance for peak river flows in the Cherwell and Ray Management Catchment of the Thames basin district are shown in Table 3. These climate change allowances are lower than the corresponding 2016 allowances.

Table 3: EA Climate Change Guidance (July 2021)

Allowance category	**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	24%	27%	49%
Higher central	11%	10%	25%
Central	6%	4%	15%

4.12 The total potential change for the '2080s' is assessed given the anticipated design life of the development. The 2021 EA guidance advises that the Central Allowance is used for More Vulnerable development. As such, the Central 2080s allowance of 15% should be used to assess the impact of climate change on the development. However, this development seeks to provide additional resilience, and as such, the Higher Central (25%) and Upper End (49%) will also be assessed. The 2016 Upper End allowance (70%) will also be assessed.

Detailed Modelling

4.13 EA document "Thames Area Climate Change Guidance" recommends different assessment approaches to account for flood risk impacts due to climate change in new development proposals. The development site is classified as a Large-Major development (30+ dwellings) including More Vulnerable uses (residential dwellings) and due to the vicinity of the Flood Zone 2 and 3 area to the site, it was considered prudent to adopt a detailed assessment approach. The EA have confirmed in correspondence that they consider the detailed approach appropriate for this site.

4.14 The detailed approach is defined in the “Thames Area Climate Change Guidance” as to “perform detailed hydraulic modelling, through either re-running Environment Agency hydraulic models (if available) or construction of a new model by the developer.” The EA’s River Cherwell (Thrupps Bridge to Thames Confluence) mapping and modelling study was obtained via Product 5 and 6 data request in 2021 and has been re-run with the appropriate climate change allowances detailed in paragraph 4.12: 15%, 25%, 49% and 70%.

4.15 The model has also been run for the 1 in 100 year event (Flood Zone 3), and the 1 in 1,000 year event (Flood Zone 2).

4.16 These model results have been used in conjunction with the detailed topographical survey of the site in order to establish the flood zone extents. This is shown on the Fluvial Flood Risk Map included in Appendix H. This confirms that the site lies entirely within Flood Zone 1, as shown on the Flood Map for Planning, and the closest proposed built development is a distance of c. 300m and an elevation of 10m above the most extreme fluvial flood scenario assessed. It should be noted that the modelled flood levels used in conjunction with topographically surveyed ground level information provide a more accurate representation of flood risk in comparison to the broad scale mapping of the Flood Map for Planning.

Historical Flooding

4.17 The EA Product 4 Data includes a historical flood map showing the approximate extents of historical fluvial flood events. From the six historical events reported, none have extended within the proposed site boundary.

Flood Zone 2 Extent Discrepancy

4.18 The modelled extent of Flood Zone 2 as shown in the Product 4 Data (Appendix I) differs from the Flood Map for Planning (Figure 1 and Appendix H) and modelled flood extents (Appendix H), with an additional triangular area just to the east of the site shown to be in Flood Zone 2 on the Flood Map for Planning. The outline of this area is very smooth and linear in parts, and corresponds to the recorded extent of the 1998 flood event. Therefore, it is believed that this area has been designated as Flood Zone 2 according to the extents of the 1998 event. Nevertheless, this zone is located outside of the site boundary.

Risk Assessment

4.19 The NPPF encourages a sequential, risk-based approach to determine the suitability of land for development. This document advises that the development of sites within Flood Zone 1 should be given preference where available.

4.20 Table 2 of the Planning Practice Guidance to the NPPF categorises different types of development into five flood risk vulnerability classifications. The NPPF classifies the proposed residential and educational uses of the site as being ‘More Vulnerable’, and retail and employment uses as being ‘Less Vulnerable’.

4.21 All proposed built development is located entirely within Flood Zone 1. Table 3 of the PPG states that all uses are appropriate for Flood Zone 1, distance of c. 300 m and an elevation of 10m above the most extreme fluvial flood scenario assessed. Therefore, the proposed development uses are compatible with the flood zone of the site and developing the site for its intended purposes is considered appropriate in terms of flood risk. As such, the Sequential Test and Exception Test are not required to be applied to this development.

Artificial Sources

4.22 As discussed in Section 3, the site is located a considerable distance from (around 1km) and elevated significantly above (>8 m) the nearest major artificial water feature, the Oxford Canal. The EA publishes indicative mapping on the GOV.UK website which shows the maximum extent of reservoir flooding in the unlikely event that a reservoir should fail. The mapping indicates that the site and the surrounding area are not located within a reservoir flood risk area. Therefore, the site is not considered to be at risk even in the event of a catastrophic breach event.

Risk Assessment

4.23 No existing flood risks have been identified and the development will not change this situation.

Groundwater

4.24 The Level 1 and Level 2 SFRAs include a map based on the EA Areas Susceptible to Groundwater (AStGW) dataset, which divides the district into 1km squares and indicates the proportion of each square that is susceptible to groundwater flood emergence, based on geological and hydrogeological conditions. The SFRA advises that this map does not show the likelihood of flooding and should only be used for high level assessment. On a site-specific scale it is recommended that the AStGW map is used in conjunction with other sources of data to assess the likely risk. The map shows that the majority of the site lies within a square in which less than 25% of the area is at risk of emergence, with a region along the southern boundary located within a square in which between 25% and 50% of the area is at risk of emergence. This risk is related to permeable superficial deposits which can have a high water table.

4.25 The British Geological Survey (BGS) publishes a map indicating the potential for groundwater flooding to occur. This map indicates that there is negligible potential for groundwater flooding to occur across the majority of the site, with potential for flooding of property situated below ground level in the area of the site associated with the permeable superficial deposits.

4.26 There have been anecdotal local reports of potential groundwater emergence, both at the lower end of the road serving the Water Eaton Estate, and at the lower end of the field to the southwest of St Frideswide’s Farm. The locations are shown in Figure 2. This is considered to be a combination of naturally high groundwater levels, and surface water infiltrating into the permeable superficial deposits, flowing underground downhill, before emerging at the lower end of the site.

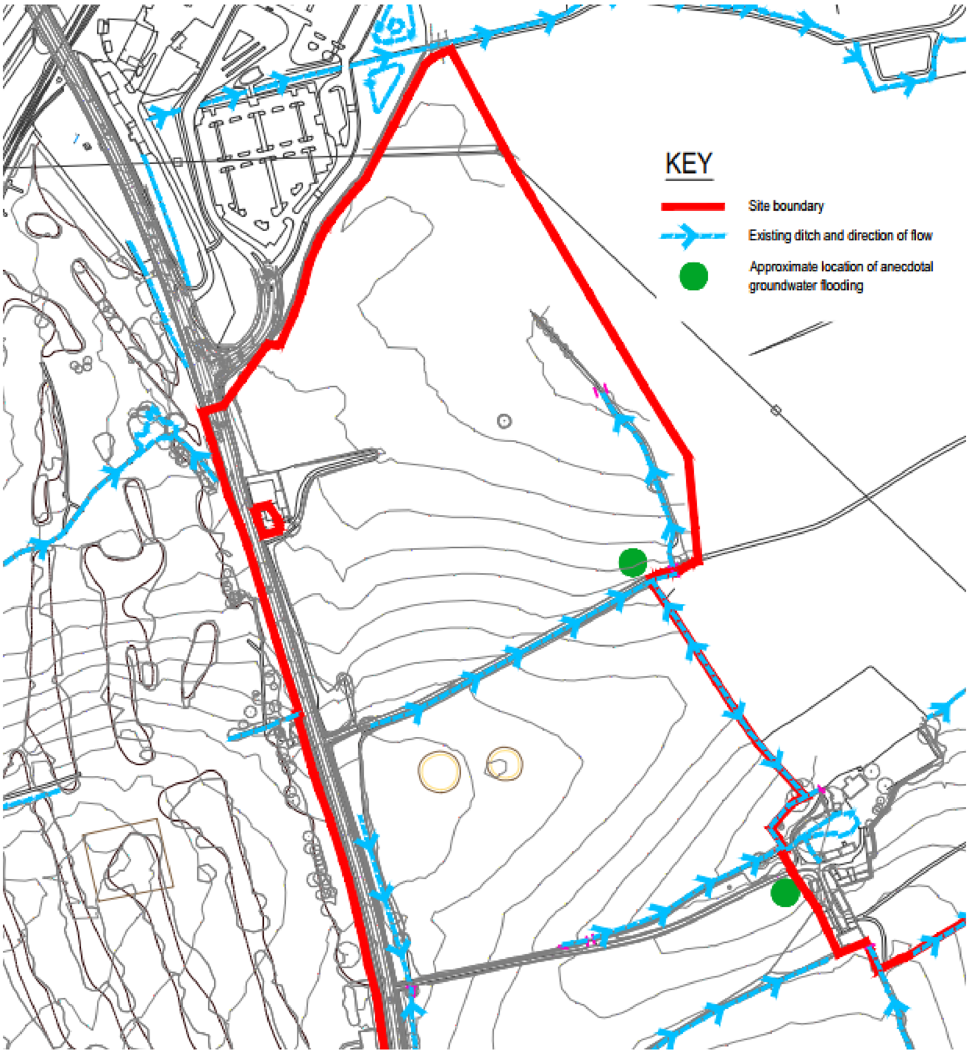


Figure 2: Locations of anecdotal groundwater flood events

4.27 12 no. boreholes on the site were monitored over the 2021-22 winter period and groundwater was recorded in all of the boreholes in the range of 0.30 to 1.30m bgl, except for one which remained dry to 3.00m bgl.

Risk Assessment

4.28 The risk of groundwater flooding is considered to be very low for the majority of the site, and low to medium at the lower ends of the site where historical events have been reported, as well as in areas where monitoring has identified groundwater closer to the surface. Open green space is proposed to be located at the lower (eastern) ends of the site, and as such groundwater flooding is not expected to pose an unacceptable risk to built development.

4.29 However, potential high groundwater levels which could affect the design of the development, even where no emergence occurs. Further groundwater monitoring on a tighter grid may be undertaken where necessary to inform any mitigation measures at a later stage. Appropriate mitigation measures will be implemented where necessary. For example, where high groundwater levels are encountered, drainage features (such as ponds or swales) may be lined with an impermeable membrane to prevent groundwater ingress, where deemed appropriate.

4.30 Based on the ground conditions and anecdotal reports, surface water run-off from the site which infiltrates into the ground and emerges at lower points in the topography contributes to this risk. Therefore, the introduction of a positive drainage system will reduce groundwater flood risk from this source.

4.31 The proposed drainage system (described in Section 5) also seeks to mimic the existing drainage situation by directing flows to existing outfalls and watercourses at the lower end of the site. As such, groundwater levels in locations downstream of the site, in particular at St Frideswide's Farm pond, will not be affected by the proposed development, as existing flow rates and volumes will be maintained to this area, despite the introduction of a positive drainage system. Further details can be found in Section 5 of this report.

Sewer

4.32 The SFRA includes data from the Thames Water DG5 sewer flooding register. This register provides information on the number of recorded sewer flooding incidents by postcode area in the time period 2006-2016. There are four recorded incidents of sewer flooding occurring in the postcode area associated with the site (OX2). It should be noted that maintenance work may have been undertaken by Thames Water since the flooding incidents occurred and therefore the risk may have been reduced or removed; as such these records do not necessarily represent the current or future sewer flood risk situation.

4.33 As discussed in Section 3, the Thames Water records indicate that there are no public sewers within the site boundary, however some private sewers and sewage treatment / storage is known to serve Pipal Cottage and St Frideswide's Farm.

Risk Assessment

4.34 Given that only a small number of private sewer networks exist in the vicinity of the site which have no historical reports of flooding, the risk of flooding from existing sewers is considered to be low. The new foul drainage infrastructure on the site will be designed in accordance with Building Regulations and Sewer Design and Construction Guidelines where appropriate, and therefore no significant flood risk is expected from the proposed on-site foul water drainage. New on-site surface water drainage will be designed to accommodate a 1 in 100 year with a 40% allowance for climate change without creating a flood hazard. Therefore, the risk of flooding from proposed sewers is very low. Appropriate maintenance of the proposed drainage systems will mitigate future risk of flooding from this source.

Surface Water

4.35 The SFRA includes the EA's updated Flood Map for Surface Water (uFMfSW). The uFMfSW is derived primarily from identifying topographical flow paths of existing watercourses or dry valleys that contain some isolated ponding locations in low-lying areas. This map shows the risk of flooding based on rainfall events with different return periods. The SFRA advises that this map should only be used for high level assessment, and not to understand flood risk to individual properties. On a site-specific scale it is recommended that the uFMfSW is used in conjunction with other sources of data to assess the likely risk.

4.36 This map indicates that the majority of the site is at very low risk of surface water flooding, with some areas at low (1 in 1,000 year return period), medium (1 in 100 year) and high (1 in 30 year) risk within the site. This is illustrated on the maps included in Appendix G, with an extract shown in Figure 3.

4.37 These at-risk areas are associated with overland exceedance flows which cross the site in times of heavy rainfall, ponding in localised depressions in the topography, which is expected due to the known impermeability of the underlying soils. Surface water flood risk on-site is generated largely by rain falling on the site area itself. Flows crossing and ponding on-site are only contributed to by off-site run-off and flows in the Low Risk scenario (1 in 1,000 years), and only in the south-west corner of the site adjacent to Oxford Road (Risk Area C on the Surface Water Flood Risk Maps in Appendix G) and south-east corner (Risk Area E).

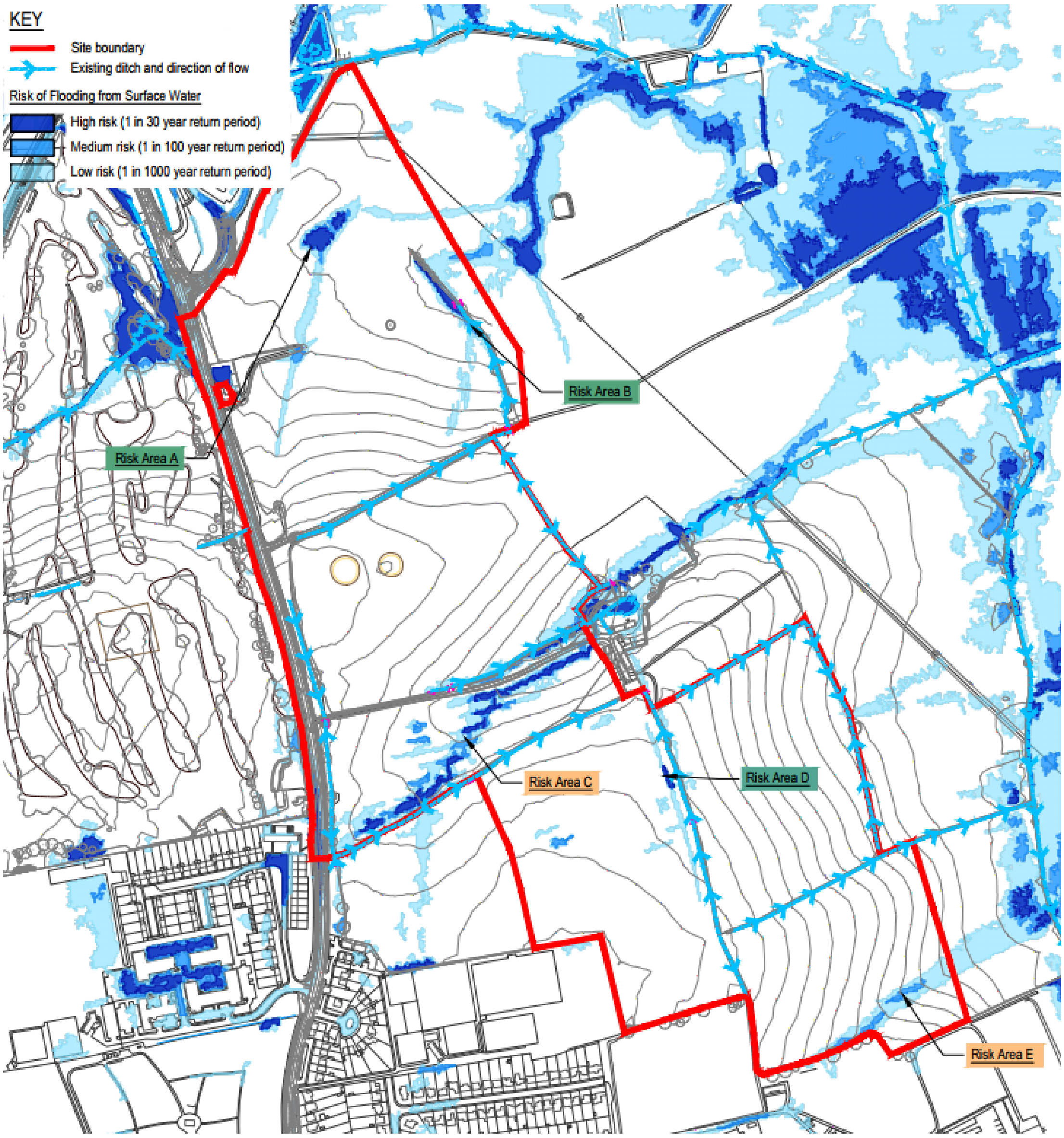


Figure 3: Environment Agency updated Flood Map for Surface Water

4.38 As described in Section 3, some off-site catchments drain by formal means into the drainage ditch system which serves the site itself. As such, it is possible that these off-site flows increase surface water flows and flood risk in and around the existing ditch system.

4.39 The EA online mapping also provides information on the flood depths and velocities for each of the risk scenarios. For the areas at medium and high risk, flood depths are generally less than 300mm and velocities over 0.25 m/s. In the low risk scenario, flood depths are generally less than 300mm, with some areas over 300mm, with the majority of flood flows greater than 0.25 m/s.

4.40 There have been anecdotal local reports of surface water flooding at St Frideswide's Farm on an annual basis. Water is said to run off fields to the south-west of the farm, flowing via the access track to the house as well as around the farm buildings, flooding the garden and house at St Frideswide's Farm. The water levels in the pond adjacent to the house are said not to rise, but the flood water surrounding the house drains into the pond. The flooding is considered to occur via a combination of the volume of surface run-off from the fields to the south-west, which does not infiltrate to ground due to the impermeability of the underlying soils, and is not effectively conveyed into the drainage ditch system, as well as the blockage and lack of maintenance of the ditches, culverts and pipe network upstream of the house, in particular through St Frideswide's Farm. These anecdotal reports correlate with Risk Area C shown on the surface water flood risk maps included in Appendix G. This flooding is likely to occur in conjunction with the groundwater emergence discussed earlier in this report. The flood routes and locations around St Frideswide's Farm are shown in Figure 4.

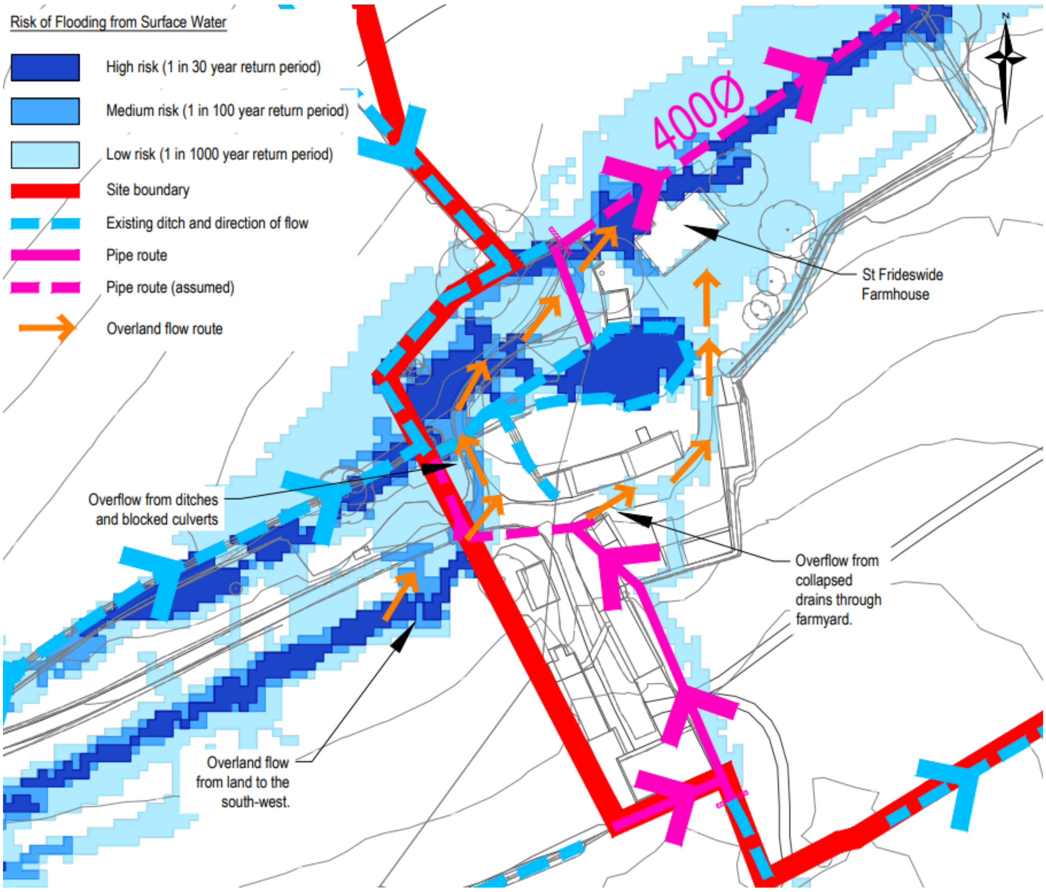


Figure 4: Flooding Mechanisms through St Frideswide's Farm

Risk Assessment

4.41 Some areas of the site are currently at low to high risk of surface water flooding.

4.42 Surface Water Flood Risk Areas C and E (refer to Appendix G) have some off-site contributions in the Low Risk scenario only. Therefore, Risk Areas C and E are proposed to be retained as green corridors through the site, in order to maintain flow routes through the development and act as exceedance flow paths post-development.

4.43 All other Surface Water Flood Risk Areas identified are generated by rain falling on the site area itself. Therefore, urbanising the catchment should remove this flood risk entirely. Therefore, there is no requirement to maintain these flow paths and/or avoid these areas for development. Nevertheless, consideration will be given to aligning road and green corridors within the development along exceedance flow paths which follow the site topography, directing flows which exceed the drainage system away from the proposed buildings.

4.44 Where flow routes are maintained, it is proposed to channel flows and attenuate ponding more effectively through careful consideration of the existing and proposed topography, potentially combined with swales, ditches and terraced areas where appropriate. Therefore, the footprint of the area at-risk will be reduced post-development. As such, although green corridors will follow the route of the overland flow paths, the entire footprint of at-risk areas has not been sterilised for built development on the proposed masterplan. This strategy will also enable green corridors to have usable open space, with landscaping and biodiversity designed specifically for dry or seasonally wet conditions.

4.45 A number of off-site catchments drain via the site via the network of drainage ditches, as described in Section 3 and shown in Appendix F. Existing formal drainage routes will be maintained through the development. Ditches carrying off-site flows will be retained as green corridors within the masterplan, and locally re-routed or culverted only where necessary (e.g. under roads). Improvements and clearance of existing drainage routes, including ditches and culverts, will be considered where necessary, removing blockages, improving flows and improving the routing of flows through the existing drainage system. Consideration will also be given to reinstating existing culverts to open ditches where possible and reasonable.

4.46 A plan showing the existing surface water flood risk areas overlaid on the emerging masterplan which demonstrates these principles is included in Appendix J.

4.47 The proposed surface levels will be designed to convey surface water to the sustainable drainage system described in the following section of this report. The system will be designed not to flood for a 1 in 100 year event with an allowance for climate change (refer to Section 5 for further details). Therefore, there is very low risk of flooding from the proposed drainage system. Any surface flooding during extreme events which may overload the drainage system will be routed via access roads, away from properties, overflowing towards the ditch systems, without creating any significant risk to people or property.

4.48 The provision of a new drainage system as described will also alleviate the surface water flooding on and around St Frideswide's Farm, by attenuating and releasing flows from land upstream of the Farm at restricted rates. Improvements and clearance of blockages from the existing drainage around the farm, including ditches and culverts, will also be considered where necessary, removing blockages, improving flows and improving routing of flows into the existing drainage system. Consideration could also be given to land drains and/or bunds within the green corridor between the built development and St Frideswide's Farm, to improve land drainage, divert flows around the existing house and improve the flood risk situation further.

4.49 Therefore, although there is currently a low to high risk of surface water flooding on-site and a high risk of flooding onto adjacent land from the site, the use of the following mitigation measures will reduce the post-development risks to very low and low for on-site and off-site risks respectively:

- Consideration of flood risk and overland flow paths within the masterplan;
- Introduction of positive drainage system designed with climate change resilience;
- Normal maintenance of drainage systems;
- Preservation and improvement of existing drainage routes; and
- Improvements to existing drainage surrounding St Frideswide's Farm.

4.50 Meetings were held between Glanville and Oxfordshire County Council (OXCC) in their role as Lead Local Flood Authority (LLFA) in November 2021 and November 2022. OXCC confirmed that the proposed approach to surface water flood risk management was appropriate. The points agreed are summarised as follows:

- The characterisation of overland flow paths into two classes of overland flow is considered appropriate i.e. where these are generated by or within the site catchment or where there is a contribution from off-site flows;
- Where flow paths can be shown to be generated solely by the site itself, there is no need to retain these routes as green corridors, however an exceedance flow route would still need to be considered in the normal way based on future site topography;
- The principle of narrowing existing overland flow paths and channelling flows through green corridors is appropriate and there is no need to sterilise the entire footprint of land shown to be "at risk" on mapping;
- Generally speaking, exceedance flows should be considered within the masterplan, demonstrating that exceedance flows can be managed and routed through the site without risk to properties. Exceedance flow routes should follow the existing natural topography where possible;
- Existing drainage ditches and culverts should be maintained as existing where appropriate. Where existing drainage (i.e. land drainage) serves no purpose post-development it can be removed;
- If existing drainage ditches are not along the natural topographical line, then there is scope to realign existing drainage ditches to follow the natural topography.

Flood Impacts, Mitigation and Residual Effects

4.51 Table 4 summarises the flood risks assessed in this report, taking into account the development design proposals as described in this report (including extent of the development within the site boundary). Risks are rated as none, low, medium and high based on an assessment of the facts relating to each source of flooding and the potential hazards.

4.52 This flood risk assessment has concluded that the flood risks associated with the site range between no risk to high risk, and that with appropriate design and mitigation measures these risks will be reduced to no-risk to very low-risk.

Table 4: Flood Risk Assessment

Type of Flood Risk	**Flood Risk Rating**	**Mitigation required?**	***Design and Mitigation Measure***	**Flood Risk Rating (after mitigation)**
Fluvial Flooding	None	No	-	None
Artificial sources	None	No	-	None
Groundwater	Medium	Yes	• *Design measures such as lining drainage features.*	Very Low
Sewers	Low	Yes	• *Design of new drainage infrastructure to all relevant standards.* • *Normal maintenance of drainage systems.*	Very Low
Surface water (existing and proposed)	Low-High	Yes	• *Consideration of flood risk and overland flow paths within the masterplan.* • *Introduction of positive drainage system designed with climate change resilience.* • *Preservation of existing drainage routes.* • *Normal maintenance of drainage systems.* • *Improvements to existing drainage surrounding St Frideswide's Farm.*	Very Low

Finished Floor Levels

4.53 The EA standing advice of finished floor levels (FFLs) includes recommendations for new development. Ground floor levels should be a minimum of whichever is higher of:

- 300mm above the general ground level of the site; or
- 600mm above the estimated river (1%) or sea (0.5%) flood level, including an allowance for climate change.

4.54 Since all built development is proposed to be located around 300m away from and at an elevation 10m higher than the closest and worst-case flood level, FFLs of all proposed buildings will be located at a minimum of 300mm above the general ground level.

Safe Access / Egress

4.55 The development site is proposed to be accessed from the A4165 Oxford Road, which is entirely located within Flood Zone 1. It is at low risk of surface water flooding at shallow depths, and is not at risk from any other form of flooding. As such, safe vehicular access and egress is capable of being provided to the entirety of the development during times of flooding.

Flood Resilience and Resistance

4.56 Given the development's location above the design fluvial flood level and being at very low risk of all forms of flooding following introduction of mitigation measures, flood resilience and resistance techniques are not required.

Flood Compensation

4.57 Given the development's location above the design fluvial flood level and being at very low risk of all forms of flooding following introduction of mitigation measures, flood compensation is not required.

5.0 Proposed Drainage Strategy

5.1 This section outlines the proposals for the surface water drainage scheme. This will be developed in-line with all relevant national and local standards and guidance, including the CIRIA SuDS Manual, Oxfordshire County Council's Local Standards and Guidance for Surface Water Drainage, and Defra's Non-Statutory Technical Standards for Sustainable Drainage Systems.

5.2 Meetings were held between Glanville and Oxfordshire County Council (OXCC) in their role as Lead Local Flood Authority (LLFA) in November 2021 and November 2022. OXCC confirmed that the approach to surface water drainage outlined in this section was appropriate.

Drainage Guidance and Hierarchy

5.3 The Guidance to the NPPF and Part H of the Building Regulations outline a hierarchy for the disposal of surface water drainage from new developments. Firstly, the guidance recommends that surface water run-off should discharge to an infiltration system where practical. Where infiltration is not feasible, disposal to a local watercourse should be investigated. It is only when these other means of discharge are not practicable, that discharge should be made to the local sewer.

5.4 As discussed in Section 3, falling-head infiltration tests undertaken across the site have conclude that infiltration drainage techniques are not feasible across the majority of the site. There may be some limited infiltration potential in the south of the site where gravelly deposits are encountered. Further BRE365 soakage tests were undertaken and groundwater monitoring installations put down in areas identified as having soakage potential. The tests were good, recording rates of $1.41x10^{-5}$ – $9.58x10^{-6}$ m/s which indicates that infiltration drainage techniques could be feasible in these locations. However, groundwater monitoring installations located within close vicinity of the trial pits recorded groundwater levels between 0.70-1.30m bgl, indicating that infiltration drainage techniques would be constrained by high groundwater.

5.5 As such there is limited potential for the use of infiltration drainage techniques.

5.6 In accordance with the hierarchy stipulated by Building Regulations outlined above, infiltration drainage is not feasible for the majority of the site, and as such surface water will be discharged into the network of ditches, mimicking the existing situation as described in Section 3 and shown on the plan in Appendix F. Despite good infiltration results in a small area in the south of the site, groundwater levels encountered mean that it is unlikely that even shallow infiltration techniques (such as permeable paving) would be feasible in the area of gravelly deposits. As such, this outline strategy has been prepared on this basis, with no infiltration drainage. At detailed design stage, at-source infiltration drainage techniques will be considered on a plot-by-plot basis in the southern area of the site at a more detailed design stage.

5.7 OXCC in their role as LLFA confirmed during pre-application meetings (see paragraph 5.2) that this approach would be appropriate.

Sustainable Drainage

5.8 The PPG recommends that priority should be given to the use of Sustainable Drainage Systems (SuDS) as they are designed to control surface water run-off where it falls and mimic natural drainage as closely as possible. SuDS also provide opportunities to reduce the causes and impacts of flooding, remove pollutants from urban run-off at source, and combine water management and green space with benefits for amenity, recreation and wildlife.

5.9 The proposed strategy will utilise sustainable drainage techniques in accordance with the guidance described in CIRIA document C753 'The SuDS Manual'. The selection of SuDS techniques for this site has followed the management train concept explained in The SuDS Manual. The concept is to use drainage techniques in series to incrementally reduce pollution, flow rates and volumes. The hierarchy of techniques to be used are as follows:

- Prevention – prevent runoff and pollution e.g. rainwater re-cycling, road sweeping.
- Source Control – control runoff at or near its source e.g. local infiltration methods.
- Site Control – routing water to site controls e.g. pipes to a large detention basin.
- Regional Control – routing water from several sites to regional controls e.g. pipes to a balancing pond or wetland.

5.10 Prevention techniques will be utilised as widely as possible within the development, with maintenance activities such as road sweeping will be carried out as standard.

5.11 Source control methods, such as private soakaways and pervious paving draining under its own footprint to ground, can only be utilised where infiltration drainage techniques are feasible. Therefore, these techniques are unable to be widely utilised on this site, although, as described in paragraph 5.6, they will be considered on a plot-by-plot basis in the southern part of the site at a more detailed design stage.

5.12 Given the impermeability of the strata underlying the site, site control techniques will be the primary SuDS techniques utilised in the proposed drainage strategy. Surface water run-off will be directed via piped or open drainage networks towards larger drainage features such as ponds and basins, which would serve natural catchment areas within the development. This is discussed in further detail in the following paragraphs.

Climate Change

5.13 The Environment Agency (EA) provides guidance on climate change allowances on the GOV.UK website which was updated in May 2022. This guidance stipulates climate change allowances for different management catchments, time frames representing the lifetime of the development (2050s epoch or 2070s epoch) and probability distributions of the scenario outputs (Upper End (90th percentile) or Central (50th percentile)).

5.14 It is considered that the lifetime of the development will be beyond 2100. As such, the 2070s epoch (2061-2125) would be appropriate, and an Upper allowance for this epoch should be used for both the 1 in 30 year and 1 in 100 year events. For the Cherwell and Ray Management Catchment in which the site is located, the drainage strategy should be assessed with a 35% climate change allowance for the 1 in 30 year event and a 40% allowance for the 1 in 100 year event. OXCC in their role as LLFA confirmed during pre-application meetings that this approach was appropriate.

5.15 Consideration will be given to including additional resilience against the potential future effects of climate change on rainfall, beyond the national guidance. Consideration will be given as to the level to which this additional resilience will be provided, as well as how this can be incorporated within the development and drainage proposals, at detailed design stage. Potential options include the design of usable open space around basins to be floodable, which would provide amenity benefits in all but extreme storm events, as well as the design of road and green networks through the site (as discussed in Section 4) to be located at lower points in the topography in order to route exceedance flows away from building and downstream into the open drainage system.

Discharge Rates

5.16 Surface water drainage should be designed such that volumes and peak flow rates are no greater than the rates and volumes prior to development. For a greenfield site such as this, the scheme should match the greenfield rates. In order to restrict to this rate, surface water run-off is primarily proposed to be attenuated within the site using site control techniques, in accordance with the Management Train approach described above.

5.17 The topography of the site leads to several catchment areas and "outfalls", as illustrated on the plan included in Appendix F. The proposed drainage strategy will seek to retain broadly similar catchments to the existing situation, and restrict run-off rates and volumes to each outfall point at or below the existing greenfield values for the existing catchment draining to each outfall point.

5.18 The greenfield run-off rates per hectare have been calculated using the ICP SuDS Method and are shown in Table 5, with MicroDrainage outputs included in Appendix K.

Table 5: Greenfield Run-off Rate

Return Period	**Greenfield Rate (l/s/ha)**
1 in 1 year	2.7
1 in 2 year	2.8
QBAR	3.2
1 in 30 year	7.2
1 in 100 year	10.1

5.19 The site has been split into catchments areas, and the total area, development area (total area excluding green space) and impermeable area (60% of the development area +10% allowance for urban creep) calculated for each. "QBAR" greenfield run-off rate has been calculated proportionately for each of these catchments based on the development area of the catchment, and this is set as the proposed discharge rate for each of these catchments. The areas and rates for each catchment are shown in Table 6.

5.20 OXCC in their role as LLFA confirmed during pre-application meetings that mimicking the existing catchments of the site and using multiple outfalls would be appropriate. OXCC also confirmed that the greenfield run-off rates should be calculated based on the development area of the site, with discharge rates restricted to Q1 for the 1 in 1 year event, and QBAR for the 1 in 2 year up to the design storm event.

Table 6: Proposed Catchment Areas and Discharge Rates

Outfall Ref.	Basin Ref.	Total Area (ha)	Development Area (ha)	Impermeable Area (ha)	Proposed Discharge Rate (l/s)	Basin Volume (m³)
A	A	2.060	1.004	0.663	3.2	573
B	B1	13.590	0.900	0.594	28.7	332
	B2		2.241	1.479		1457
	B3		3.701	2.443		2489
	B4		2.128	1.404		1298
C	C	6.120	2.858	1.886	9.1	1636
D	D1	10.440	2.544	1.679	24.0	1321
	D2		2.480	1.637		1367
	D3		2.475	1.634		2031
E	E	6.110	1.031	0.680	3.3	591
F	F	6.290	0.000	0.000	0.0	0
Total		**44.61***	**21.36**	**14.10**	**68.4**	**13095**

**Catchment assessment excludes the current adopted highway (Oxford Road corridor) which lies within the red line site boundary.*

SuDS Features

5.21 The choice of SuDS features needs to be assessed against site / development constraints. Table 7 details each of the SuDS features as set out in The SuDS Manual, outlines which features are most suitable for the development site and how these could be incorporated.

Table 7: SuDS Features

SuDS Feature	Description	Water Quality	Amenity	Biodiversity	*Site-Specific Suitability*
Rain water harvesting	Systems that collect runoff from roofs / surfaces for re-use	N	Y	N	*Use of these will be considered to reduce water consumption and reduce run-off rates and volumes into the downstream system. At this stage these features would not be modelled as storage within the drainage network, as these features should be assumed to be "full" to represent a worst-case scenario.*
Green roofs	Planted soil layers on roofs that slow and store runoff	Y	Y	Y	
Filter strips	Grass strips where water flows over the surface	Y	Y	Y	*Filter strips, drains and swales will be considered adjacent to main roads and along green corridors to replace conventional piped systems within the development wherever appropriate, conveying water to downstream SuDS features. Consideration will be given as to whether the highway and drainage*
Filter drains	Shallow stone-filled trenches that provide attenuation, conveyance and treatment	Y	Y	Y	

SuDS Feature	Description	Water Quality	Amenity	Biodiversity	*Site-Specific Suitability*
Swales	Vegetated channels used to convey/treat runoff	Y	Y	Y	*ownership and adoption will affect their design and / or ability to be provided.*
Bioretention systems	Shallow landscaped depressions allowing runoff to pond on the surface, before filtering through vegetation and underlying soils	Y	Y	Y	*Bioretention and tree pit systems work best when used on small drainage areas. Use of these features will be considered primarily in parking areas and public areas, and in order to enhance other features, such as swales and filter strips.*
Trees	Trees within soil-filled tree planters pits, or structural soils used to collect, store and treat runoff	Y	Y	Y	
Infiltration systems	Systems that collect and store runoff, allowing it to infiltrate to ground	Y	Y	Y	*If infiltration systems are proven to be feasible (see paragraph 5.4), source control techniques such as soakaways and unlined pervious pavements will be considered in these areas.*
Pervious pavements	Paving through which runoff soaks and is stored in the sub-base beneath, and/or allowed to infiltrate into the ground	Y	Y	Y	*Where infiltration is not feasible, lined pervious pavements will still be used for water treatment and attenuation. The optimum location for these are in car parking areas and driveways where there is lighter traffic but where pollution (e.g. oil spills) are more likely.*
Attenuation Storage	Below-ground voided spaces used to temporarily store runoff before infiltration, controlled release or use	N	N	N	*Below-ground features do not provide quality, amenity or biodiversity benefits and are therefore low down in the hierarchy of SuDS choices. As such, they have not been considered as a primary means of attenuation, however they may need to be considered in order to provide attenuation in areas with restricted space or to enhance the storage capacity of other SuDS features.*
Detention basins	Vegetated depressions that store and treat runoff	Y	Y	Y	*Basins will be used to provide attenuation and treatment of run-off prior to discharge off-site. Consideration will be given to permanent pools, which enhance biodiversity, within a selection or all of the basins.*
Ponds and wetlands	Permanent pools of water used to treat runoff with storage above the pool	Y	Y	Y	

5.22 It is proposed to utilise detention basins and ponds/wetlands as the primary form of storage on the site. These will be located at the lower end of each of the catchments, and attenuate and treat run-off prior to discharge to the ditch network.

5.23 At-source techniques, such as rainwater harvesting, green roofs, bioretention systems, pervious pavements and tree pits, will be incorporated throughout the development. These will reduce the rate and / or volume discharging into the downstream ponds / basins and receiving watercourses, as well as providing additional water quality treatment and biodiversity and amenity value.

5.24 Swales, filter strips or filter drains will be considered as means of flow conveyance through the site in-place of conventional pipe networks wherever practical. As such, additional width through road corridors, and green corridors following the site topography, will be considered within the masterplan in order to accommodate surface conveyance features such as these.

5.25 No surface water storage features will be located within the boundaries of the proposed school site, as per OXCC's school standards.

5.26 An Outline SuDS Strategy illustrating the SuDS features proposed is included in Appendix K. The SuDS Strategy illustrated on this drawing is outline only and is designed to give an idea of the type and mix of Sustainable Drainage Systems (SuDS) proposed within the development.

5.27 A more detailed outline strategy is shown in Appendix M. This demonstrates that basins sized to serve each catchment area as indicated in Table 6 can be accommodated within the masterplan. Calculations for each catchment are provided in Appendix N. These calculations, except for Catchment B, assume that all storage required is provided by the open basins at the downstream end of each catchment and are therefore considered to represent a worst-case scenario. Catchment B allows for some upstream storage to be provided within a variety of SuDS / storage features, as illustrated on the strategy drawing. The calculations will be refined at a more detailed design stage to model all part of the catchment networks including SuDS features.

5.28 It is expected that private gardens and green open space may need to be served by land drainage, due to the impervious nature of the underlying soils. Where this is required, the land drainage network would drain into existing watercourses as appropriate through the site.

MicroDrainage Calculations

5.29 All drainage calculations for the proposed drainage design use FEH rainfall data, with the exception of short duration events (less than 60 minutes), for which calculations have been run using FSR rainfall data as FEH data is less robust for short duration events. This is in accordance with OXCC's Local Standards.

5.30 The surface water drainage system will be designed to accommodate surface water run-off from all rainfall events up to and including the 1 in 100 year event, including a 40% increase in rainfall intensity as allowance for the potential effects of climate change, without flooding from surface water.

5.31 Drainage calculations have been undertaken assuming 60% of the developable area will be impermeable. An additional 10% allowance for the effects of urban creep have been included within rainfall calculations, as stipulated in OXCC's Local Standards and Guidance for Surface Water Drainage. and the Environment Agency (EA) guidance document "Rainfall Runoff Management for Developments".

Water Quality

5.32 Pollution control measures are designed to minimise the transmittal of any pollutants collected by runoff flowing over hard paved areas to the receiving watercourse.

5.33 The SuDS Manual indicates the minimum treatment indices for contributing pollution hazards for different land use classifications. The treatment indices for the land uses proposed within the development are shown in Table 8. In order to deliver adequate treatment, the selected SuDS components should have a total pollution mitigation index (for each contaminant type) that equals or exceeds the pollution hazard index. Table 9 indicates the SuDS mitigation indices for each of the SuDS features considered in Table 8, for discharge to surface waters.

5.34 The pollution indices in Table 8 should be compared with the mitigation indices in Table 9 and the following formulae applied.

Total SuDS Mitigation Index ≥ Pollution Hazards Index (for each contaminant type)

Total SuDS Mitigation Index = 1st Stage Mitigation Index + 0.5 (2nd Stage Mitigation Index)

5.35 In order to provide an adequate level of treatment, an assessment using this method should be carried out for each land use parcel and their respective SuDS features. This will be undertaken at the appropriate stage of the design process, once detailed site proposals are available.

5.36 Nevertheless, an initial appraisal of the outline strategy can be undertaken at this stage. From inspection of Tables 8 and 9, it can be seen that a detention basin on its own is sufficient to mitigate pollution risk from the majority of land uses (all roofs, individual driveways, residential car parks, low traffic roads and car parking with infrequent change). For commercial yard areas and car parking with frequent change, combining the detention basin with a swale, filter strip, filter drain, bioretention system or permeable pavement will provide sufficient mitigation from any pollution risk. Providing a pond/wetland rather than a basin would also provide sufficient mitigation on its own. As such, an adequate level of treatment for all land uses is capable of being provided within the development proposals.

5.37 In addition, treatment features such as catchpits for roof run-off, pervious paving for driveway areas, and proprietary treatment devices for road run-off will also be considered at detailed design stage in order to improve the quality of water entering downstream SuDS features.

Maintenance

5.38 All new surface water infrastructure would be designed in accordance with Sewers for Adoption, Building Regulations and current best practices as appropriate.

Table 8: Pollution Hazard Indices for Discharge to Surface Waters

Catchment Type	**Pollution Hazard Level**	**Requirements**	**Pollution Hazard Indices**		
			Suspended solids	**Metals**	**Hydro-carbons**
Residential roofs	Very low	Removal of gross solids / sediments	0.2	0.2	0.05
Other roofs	Low	Simple index approach	0.3	0.2	0.05
Individual property driveways, residential car parks, low traffic roads (e.g. cul-de-sacs, access roads) and non-residential car parking with infrequent change (e.g. schools, offices)	Low	Simple index approach	0.5	0.4	0.4
Commercial yard and delivery areas, non-residential car parking with frequent change (e.g. hospital, retail), all roads except low traffic roads / motorways	Medium	Simple index approach	0.7	0.6	0.7

Table 9: SuDS Mitigation Indices for Discharge to Surface Waters

Type of SuDS	**SuDS Mitigation Indices**		
	Suspended solids	**Metals**	**Hydro-carbons**
Filter strip	0.4	0.4	0.5
Filter drain	0.4	0.4	0.4
Swale	0.5	0.6	0.6
Bioretention system	0.8	0.8	0.8
Permeable pavement	0.7	0.6	0.7
Detention basin	0.5	0.5	0.6
Pond	0.7	0.7	0.5
Wetland	0.8	0.8	0.8

5.39 Drainage features, including both conventional piped networks and sustainable drainage features such as ponds and swales, are typically owned and maintained by the highway authority (Oxfordshire County Council), the statutory drainage undertaker (Thames Water) or by private management company. The mix of ownership would be determined at detailed design stage, however it is likely that open drainage features such as swales and ponds would be maintained by a private management company such that there is a greater level of autonomy over the frequency and standard to which they are maintained, in order to ensure they retain the visual, amenity, water quality and biodiversity benefits that they are intended to.

5.40 Where drainage features serve only the highway they would be offered for adoption by the highway authority (Oxfordshire County Council). Where drainage features serve both the highway and private areas, they would not be adopted by the highway authority, but OXCC would have a vested interest in their ownership and maintenance as the highway is dependent on the drainage feature(s) functioning.

5.41 All private pipework and drainage features within the curtilage and serving one property will be owned and maintained by the owner of that property.

5.42 A Drainage Management Plan would be prepared at the appropriate planning stage, which would outline typical management activities and their frequencies for each of the drainage features proposed.

Conclusions

5.43 The proposed surface water drainage system will demonstrate that there will be no increase flow rates off-site, and therefore the risk of flooding from surface water will not increase to the site and to the surrounding area. The introduction of a positive drainage system will in fact result in improvements to the surface water flood risk situation within the site and in the surrounding area, by directing flows more effectively to downstream watercourses at restricted rates where appropriate.

5.44 It should be noted that the drainage strategy provided at outline planning stage is subject to change and refinement as part of the detailed site and drainage design. Detailed drainage calculations would be provided at the appropriate stage of the design process.

6.0 Conclusions

6.1 This Flood Risk Assessment has been prepared by Glanville Consultants on behalf of Bellway Homes Limited and Christ Church, Oxford with respect to an outline planning application (with all matters except access reserved for future consideration) for development of land at Water Eaton, Oxford, OX2 8HF.

6.2 This report outlines the existing situation with regards to flood risk and drainage, and outlines the proposals for flood risk protection and resilience, and surface water drainage disposal.

6.3 This report concludes that the development site is not at risk of flooding from fluvial and artificial sources, and that any other flood risk sources (surface water, sewer and groundwater) can be adequately mitigated within the development proposals.

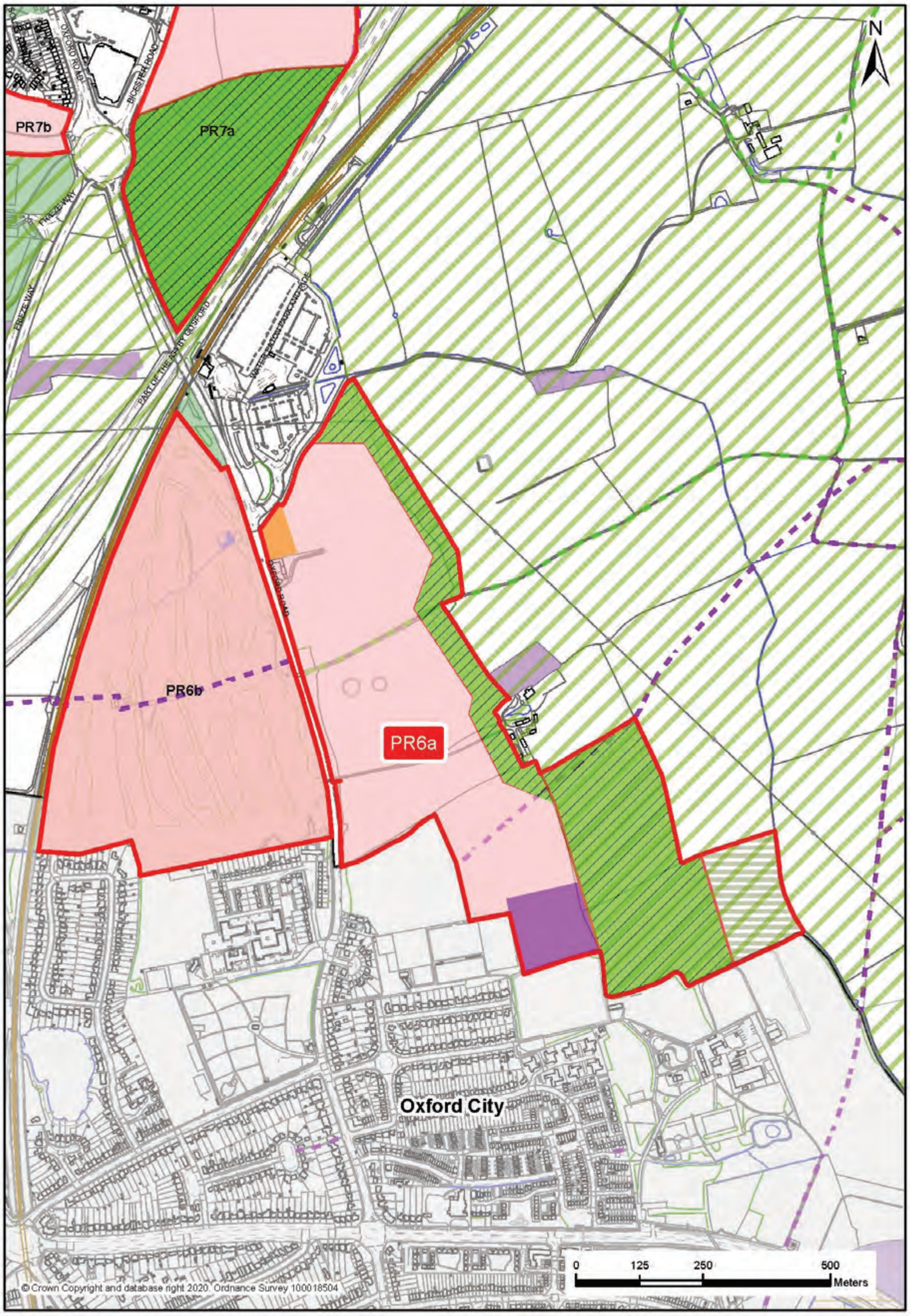
6.4 This report also outlines the proposals for a sustainable drainage system to serve the development which follows the drainage hierarchy and guidance and policy on sustainable drainage design. The drainage scheme will ensure that there is no increase flow rates or volumes off-site, and therefore the risk of flooding from surface water will not increase to both the site and to the surrounding area. The introduction of a positive drainage system will in fact result in improvements to the surface water flood risk situation within the site and in the surrounding area, by directing flows more effectively to downstream watercourses at restricted rates where appropriate. Furthermore, the drainage scheme will incorporate sustainable drainage features which will provide amenity, water quality and biodiversity benefits for the lifetime of the development, as well as resilience against the future effects of climate change on rainfall intensities.

Appendices

Appendix A

Cherwell Local Plan Partial Review – PR6a Extract

Policy PR6a - Policies Map - Land East of Oxford Road



▭	Site Boundary
▭	Cherwell District
▤	Conservation Target Areas
🟩	Existing Green Space
🟧	Local Centre
🟪	NERC Act. S41
▨	New Green Space/Parks
▩	Outdoor Sports Provision
⬚	Oxford City
🟪	Primary School Use
- - -	Public Bridleway
- - -	Public Footpath
▭	Residential
▤	Retained Agricultural Land
▨	Revised Green Belt

Policy PR6a - Land East of Oxford Road

An urban extension to Oxford city will be developed on 48 hectares of land to the east of Oxford Road as shown on inset Policies Map PR6a. Development proposals will be permitted if they meet the following requirements:

Key Delivery Requirements

1. Construction of 690 dwellings (net) on approximately 25 hectares of land (the residential area as shown).

2. The provision of 50% of the homes as affordable housing as defined by the National Planning Policy Framework.

3. The provision of a primary school with two forms of entry on 2.2 hectares of land in the location shown.

4. The provision of a local centre on 0.5 hectares of land in the location shown unless the location is otherwise agreed with Cherwell District Council. The Local Centre shall include provision for local convenience retailing (use class A1 - no more than 500 square metres net floorspace and no less than 350 square metres), ancillary business development (use class B1(a) only) and/or financial and professional uses (use class A2); a café or restaurant (use class A3); the provision of a community building to required standards providing the opportunity for social and childcare facilities, the opportunity for required health facilities to be provided and provision for required emergency services infrastructure.

5. The provision of facilities for formal sports, play areas and allotments to adopted standards within the developable area.

6. The provision of public open green space as an extension to Cutteslowe Park on 11 hectares of land in the location shown and including land set aside for the creation of wildlife habitats and for nature trail/circular walks accessible from the new primary school.

7. The creation of a green infrastructure corridor on 8 hectares of land incorporating a pedestrian, wheelchair and all-weather cycle route along the site's eastern boundary within the area of green space shown on the policies map. The route will connect Cutteslowe Park with Oxford Parkway Railway Station/Water Eaton Park and Ride and provide connection with the public rights of way network.

8. The retention of 3 hectares of land in agricultural use in the location shown.

Planning Application Requirements

9. The application(s) shall be supported by, and prepared in accordance with, a comprehensive Development Brief for the entire site to be jointly prepared and agreed in advance between the appointed representative(s) of the

landowner(s) and Cherwell District Council. The Development Brief shall be prepared in consultation with Oxfordshire County Council and Oxford City Council.

10. The Development Brief shall include:

(a) A scheme and outline layout for delivery of the required land uses and associated infrastructure. Minor variations in the location of specific uses will be considered where evidence is available.

(b) Two points of vehicular access and egress from and to existing highways, primarily from Oxford Road.

(c) An outline scheme for public vehicular, cycle, pedestrian and wheelchair connectivity within the site, to the built environment of Oxford, to Cutteslowe Park, to the allocated site to the west of Oxford Road (policy PR6b) enabling connection to Oxford City Council's allocated 'Northern Gateway' site, to Oxford Parkway and Water Eaton Park and Ride, and to existing or new points of connection off-site and to existing or potential public transport services. Required access to existing property via the site should be maintained.

(d) Protection and connection of existing public rights of way and an outline scheme for pedestrian and cycle access to the surrounding countryside.

(e) Design principles which seek to deliver a connected and integrated urban extension to Oxford and which respond to historic setting of the city.

(f) Outline measures for securing net biodiversity gains informed by a Biodiversity Impact Assessment in accordance with (11) below.

(g) The sites for the required school and the Local Centre.

(h) An outline scheme for vehicular access by the emergency services.

11. The application(s) shall be supported by the Biodiversity Impact Assessment (BIA) based on the DEFRA biodiversity metric (unless the Council has adopted a local, alternative methodology) to be agreed with Cherwell District Council.

12. The application(s) shall be supported by a proposed Biodiversity Improvement and Management Plan (BIMP) informed by the findings of the BIA and habitat surveys and to be agreed before development commences. The BIMP shall include:

(a) Measures for securing net biodiversity gain within the site and within the residential area and for the protection of wildlife during construction.

(b) Measures for retaining and conserving protected/notable species (identified within baseline surveys) within the development.

(c) Demonstration that designated environmental assets will not be harmed, including that there will be no detrimental impacts down-river in the Cherwell Valley through hydrological, hydro-chemical or sedimentation impacts.

(d) Measures for the protection and enhancement of existing wildlife corridors.

(e) The creation of a green infrastructure network with connected wildlife corridors, including within the residential area, and the improvement of the existing network including through the protection/enhancement of the existing hedgerow network and the protection of mature trees.

(f) Measures to minimise light spillage and noise levels on connective features and other habitat features of biodiversity value.

(g) The protection of the orchard and waterbody adjoining the site at St. Frideswide Farm.

(h) Farmland bird compensation.

(i) Proposals for long-term wildlife management and maintenance including for the wildlife habitats accessible from the primary school.

(j) A scheme for the provision for in-built bird and bat boxes, for wildlife connectivity between gardens and for the viable provision of designated green walls and roofs.

13. The application(s) shall be supported by a phase 1 habitat survey including habitat suitability index (HSI) survey for great crested newts, and protected and notable species surveys as appropriate, including great crested newt presence/absence surveys (dependent on HSI survey), surveys for badgers, breeding birds and reptiles, an internal building assessment for roosting barn owl, a tree survey and an assessment of the watercourse that forms the south-eastern boundary of the site and Hedgerow Regulations Assessment.

14. The application(s) shall be supported by a Transport Assessment and Travel Plan including measures for maximising sustainable transport connectivity, minimising the impact of motor vehicles on new residents and existing communities, and actions for updating the Travel Plan during construction of the development.

15. The application shall be supported by a Heritage Impact Assessment which will identify measures to avoid or minimise conflict with the identified heritage assets within the site, particularly the Grade 2* Listed St Frideswide Farmhouse. These measures shall be incorporated or reflected, as appropriate, in any proposed development scheme.

16. The application shall be supported by a Flood Risk Assessment informed by a suitable ground investigation, and having regard to guidance contained within the Council's Level 2 Strategic Flood Risk Assessment. A surface water management framework shall be prepared to maintain run-off rates to

greenfield run-off rates and volumes, with use of Sustainable Drainage Systems in accordance with adopted Policy ESD7, taking into account recommendations contained in the Council's Level 1 and Level 2 SFRAs.

17. The application should demonstrate that Thames Water and the Environment Agency have been consulted regarding wastewater treatment capacity and agreement has been reached in principle that foul drainage from the site will be accepted into the drainage network.

18. The application(s) shall be supported by a desk-based archaeological investigation which may then require predetermination evaluations and appropriate mitigation measures. The outcomes of the investigation and mitigation measures shall be incorporated or reflected, as appropriate, in any proposed development scheme.

19. The application(s) shall include proposals for securing the long-term use, management and maintenance of the community building, formal sports provision and play areas.

20. The application shall include a management plan for the appropriate re-use and improvement of soils.

21. The application(s) shall include proposals for securing the use, management and maintenance of the public open green space / extension to Cuttelowe Park and agricultural land in perpetuity.

22. A single comprehensive, outline scheme shall be approved for the entire site. The scheme shall be supported by draft Heads of Terms for developer contributions that are proposed to be secured by way of legal agreement. The application(s) shall be supported by a Delivery Plan demonstrating how the implementation and phasing of the development shall be secured comprehensively and how individual development parcels, including the provision of supporting infrastructure, will be delivered. The Delivery Plan shall include a start date for development, demonstration of how the development would be completed by 2031 and a programme showing how the site will contribute towards maintaining a five year supply of housing.

23. The application shall include an Employment, Skills and Training Plan to be agreed with the Council.

Place shaping principles

24. A layout, design and appearance for a contemporary urban extension to Oxford city that responds to the 'gateway' location of the site, is fully integrated and connected with the existing built environment, maximises the opportunity for sustainable travel into Oxford, provides a high-quality, publicly accessible and well connected green infrastructure and ensures a sensitive relationship with the site's Cherwell Valley setting.

25. The provision of a landscaped green infrastructure corridor at the eastern settlement edge which links Cutteslowe Park to Oxford Parkway, minimises the visual and landscape impact of the development, creates an appropriate setting to the Listed St. Frideswide Farmhouse and Wall, and provides a clear distinction between the site and the Green Belt.

26. The provision of connecting green infrastructure corridors running east-west across the site.

27. The provision of an active frontage along Oxford Road while maintaining a well treed streetscape.

28. The public open green space/extension to Cutteslowe Park and agricultural land to be kept free of buildings to avoid landscape impact.

29. The location of archaeological features, including the tumuli to the east of the Oxford Road, should be incorporated and made evident in the landscape design of the site.

30. Layout and design that encourages the sustainable and safe management of waste by individual households and by residents collectively while minimising the visual and pollution impacts.

Appendix B

Illustrative Masterplan

- Buildings
- Public open spaces and gardens
- Existing and proposed trees
- Drainage ponds (some will be permanently wet, some dry except in storm events)
- Allotments
- Community gardens/ orchards
- Destination play area
- Play areas
- Indicative locations for pedestrian/ cycle off-site connection
- Shared streets, cycleways, footpaths and leisure route through GI corridor
- Vehicular entrance to the site
- Carriageway

N

0 50 100 150 200

SCALE (m)
[1:5000]

PR6a, North Oxford

on behalf of Bellway Homes Limited and Christ Church, Oxford

drawing no.	42	drawing	Illustrative Masterplan		
revision	T	scale	1:5,000 @A3	job no.	477898
drawn by	AR	checked by	RL	date	17/01/2024

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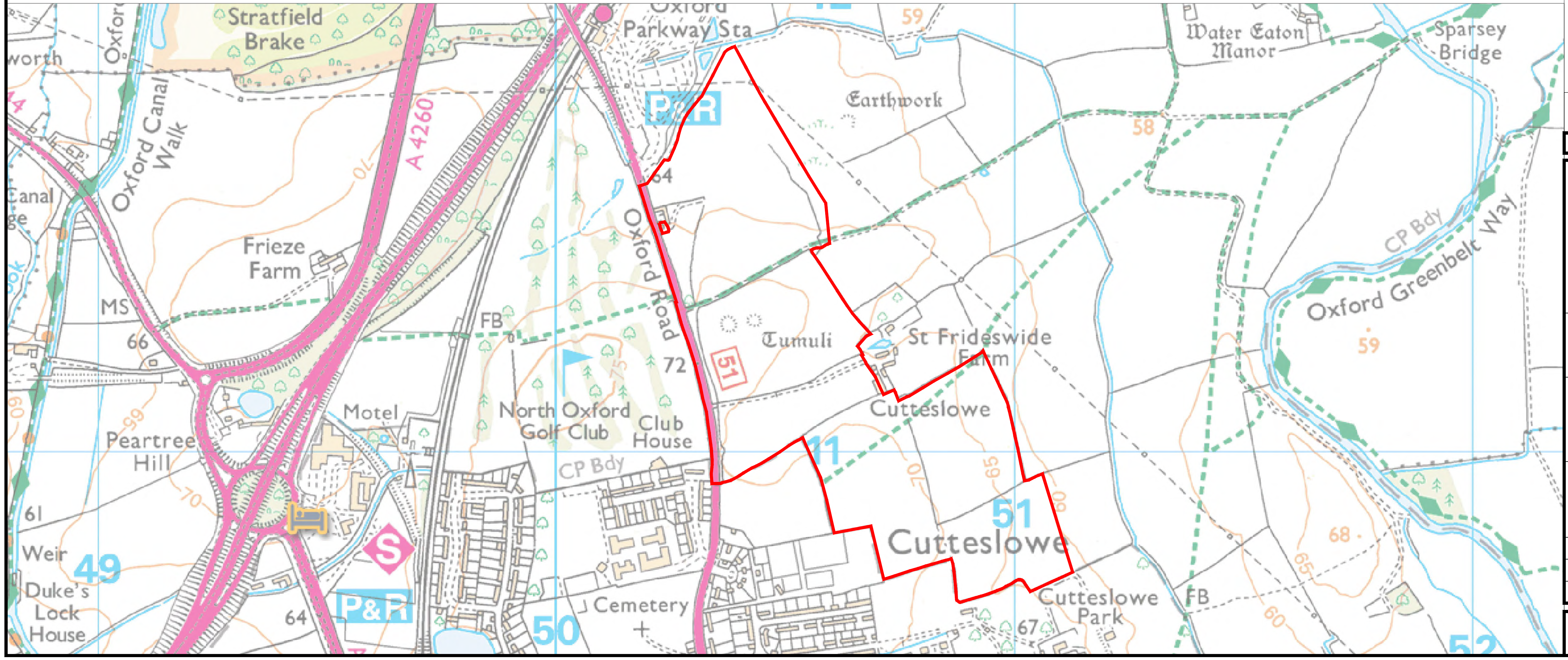
C:\Users\clare.mitchell\Box\UK Urban Design Projects\Christ Church Water Eaton Est\B) Drawings\INDD\477898 - INDD01 - PR6a Drawing Sheets 18/01/24

Urban
Design
Studio

savills

Appendix C

Site Location Plan



NOTES

1. This drawing is to be read in conjunction with all other documents and specifications
2. Drawing not to scale; dimensions not to be scaled.
3. Reproduced from Ordnance Survey digital data with the permission of the Controller of His Majesty's Stationery office Crown Copyright (100022432).

LOCATION

Nearby postcode:	OX2 8HF
Grid reference:	Easting: 450585 Northings: 211190

KEY

Approximate site boundary 🟥

Rev.	Description	Date	Chkd
PA1	Issued for Planning Approval	09/02/2023 BW	JH

Glanville

Cornerstone House
62 Foxhall Road, Didcot
Oxon, OX11 7AD
Tel: (01235) 515550 Fax: (01235) 817799
postbox@glanvillegroup.com www.glanvillegroup.com

Client :
Bellway Homes Limited
and Christ Church, Oxford

Project :
Water Eaton (Site PR6a)
Land East of Oxford Road

Title :
Site Location Plan

Project Engineer :	C.Salt	Scale :	NTS
Project Director :	J. Hanlon	Date :	February 2023
Status :	PLANNING APPROVAL		

Drawing No.	8210440-SK01	Rev PA1

Appendix D

Topographical Survey

Appendix E

ST Consult Site Investigation Reports Extracts

Southern Testing
Environmental & Geotechnical

Southern Testing Laboratories Ltd
Keeble House, Stuart Way
East Grinstead, West Sussex RH19 4QA

t 01342 333100 f 01342 410321
e info@southerntesting.co.uk w southerntesting.co.uk

Our Ref: ODJ/JK/RP/JN1597
Your Ref:

15th September 2021

Christ Church College
c/o Glanville Consultants
Cornerstone House
62 Foxhall Road
Didcot
OX11 7AD

For the attention of Christ Church College

Dear Sir/Madam,

Re: Site: Land East of Oxford Road, Water Eaton
Preliminary Soakage Assessment
National Grid Reference: SP 50500 11290
Geology: Wolvercote Sand and Gravel Member over Oxford Clay Formation

1 Authority

Our authority for carrying out this work is contained in an appointment email from Glanville Consultants dated 15th July 2021 and within an appointment document from the client's solicitors, Mills and Reeve.

2 Background and Objectives

The site is located approximately 1.2km to the south of Oxford Parkway train station in the fields surrounding St Frideswide Farm. The approximate National Grid Reference of the site is SP 50500 11290. The site location is indicated on Figure 1 within Appendix A.

This specific investigation, being one of several proposed for the site for this project, as requested by the clients engineer, was to provide a series of preliminary permeability tests, comprising eleven falling head tests, to assess the potential for subsequent large-scale BRE365 Soakage testing.

The fieldwork was carried out on Tuesday 3rd and Friday 6th August 2021. On both days the weather was generally overcast and cool. The fieldwork locations are shown on the attached Figure 2 within Appendix A.

3 Scope

This report presents our exploratory hole logs and permeability test results. As with any site, there may be differences in soil conditions between exploratory hole positions.

This report is not an engineering design and the figures and calculations contained in the report should be used by the Engineer, taking note that variations will apply, according to variations in design loading, in techniques used, and in site conditions. Our figures therefore should not supersede the Engineer's design.

A desk study, contamination assessment and wider geotechnical issues are not considered in this report.

The investigation was conducted and this report has been prepared for the sole internal use and reliance of Christ Church College and their appointed engineers Glanville Consultants. This report shall not be relied upon or transferred to any other parties without the express written authorisation of Southern Testing Laboratories Ltd. If an unauthorised third party comes into possession of this report they rely on it at their peril and the authors owe them no duty of care and skill.

4 Geology

The British Geological Survey Map No. 236 (Witney) indicates the site is underlain by Wolvercote Sand and Gravel Member over the Oxford Clay Formation. The Wolvercote Sands and Gravels are only mapped within the south of the site.

4.1 Wolvercote Sand and Gravel Member

These are predominantly cold phase sands and gravels that underlie the Wolvercote or Third Terrace of BGS maps. Dominated by clasts of Middle Jurassic limestone, but also containing "Bunter" quartz/quartzite and a proportion of flint.

4.2 Oxford Clay Formation

Silicate-mudstone, grey, generally smooth to slightly silty, with sporadic beds of argillaceous limestone nodules. Over most of the outcrop (except the Cleveland Basin, where only the upper part is present) it comprises a tripartite succession: lower part (Peterborough Member) silicate-mudstone, mainly brownish-grey, fissile, organic-rich ("bituminous"), with subordinate beds of pale to medium grey, blocky mudstone; middle part (Stewartby Member) silicate-mudstone, mainly pale to medium grey, smooth to slightly silty, blocky, with subordinate beds of silty shell-debris-rich mudstone; upper part (Weymouth Member) mudstone, mainly pale grey, calcareous, smooth, blocky. For more detail see Peterborough, Stewartby and Weymouth members.

5 Soils as Found

The soils encountered are described in detail on the exploratory hole logs in Appendix B below, but in general comprised a covering of topsoil over either the Wolvercote Sand and Gravel Member or a clay subsoil over the Oxford Clay Formation. The table below summarises the underlying strata.

The soils in the north of the site were observed to have a consistently smaller granular fraction. Wet sandy horizons were noted across the site.

Depth (m bgl)	Thickness (m)	Type	Description
GL – 0.20/0.35m	0.20 – 0.35m	TOPSOIL	Only seen within WLS108 – WLS114.
– 0.5/3.10m	0.30 – 1.80m	CLAY	Firm brown to dark brown sandy gravelly occasionally cobbly CLAY. OR Firm orange-brown sandy gravelly CLAY. Gravels in both units comprise fine to coarse sub-rounded to sub-angular flint and quartzite. Full depth not proven in WLS102
– 4.00m+	0.30 - 3.50m+	CLAY	Firm to stiff grey / brown mottled CLAY occasionally sandy, occasionally shelly Not proven in WLS102

6 Groundwater Strikes

Groundwater strikes were observed within four boreholes and are summarised in the table below.

Hole ID	Water Strike Depth (m bgl)	Standing Water Level (m bgl)	Stratum
WLS101	1.60m	1.4m	Wolvercote Sand and Gravel Member
WLS102	1.20m	1.20m	Wolvercote Sand and Gravel Member
WLS103	2.00m	1.60m	Oxford Clay Formation
WLS104	2.00m	Wet sand only	Wolvercote Sand and Gravel Member

7 Falling Head In-situ Permeability Tests

A total of twelve permeability tests were carried out across the site, at the locations shown on the attached site plan, Figure 2, Appendix A. The full results of the permeability tests are presented within Appendix C.

7.1 Test Method and Procedure

BS EN ISO 22292 describes a method for site testing to determine soil permeability where; boreholes are filled with water and the head loss is then recorded either until the level falls to the standing water level (or until dry), or a maximum two-hour period. Detailed guidance on falling-head permeability tests is given within BS EN ISO 22292. The infiltration rate from ach trial hole is summarised in the table below. The soakage rate in this report is expressed as ℓ/m²/minute, which is a convenient rate to use. The BRE use a unit of m/sec which is the value in ℓ/m²/minute divided by 60,000.

7.2 Test Results

Test ID	Test Depth (mbgl)	Design Infiltration Rate	
		ℓ/m²/minute	m/sec
WLS101	1.40m	0.877	1.46×10^{-5}
WLS102	1.20m	1.18	1.96×10^{-5}
WLS103	0.87m	0.895	1.49×10^{-5}
WLS104	4.00m	0.000	0.000
WLS105	4.00m	0.0002	2.76×10^{-9}
WLS106	4.00m	0.0003	5.50×10^{-9}
WLS107	4.00m	0.0021	3.56×10^{-8}
WLS108	4.00m	0.0074	1.23×10^{-7}
WLS109	4.00m	0.0007	1.19×10^{-8}
WLS110	4.00m	0.000	0.000
WLS111	4.00m	0.011	1.77×10^{-7}
WLS112	4.00m	0.0098	1.63×10^{-7}

In summary, the tests were very poor with exception of WLS101, WLS102 and WLS103 which completed a single test in the time allowed. The remaining tests recorded very little or no measurable drop in the water level.

8 Discussion and Recommendations

Generally, across the site drainage was negligible other than in the south-western corner where soils were generally more gravelly. Typically, a minimum soakage rate of 0.1 l/m^2/min is required for conventional soakaways to meet the BRE365 requirement of a soakaway half empty time of less than 24 hours. As such, it may be worth pursuing full scale testing in this area, although the depth of soakaway will be limited by the relatively shallow ground water identified here. It should be noted that seasonally higher groundwater may, in practical terms preclude the use of soakaways, although this cannot be determined without longer term monitoring.

If you have any queries or we can be of further assistance, please do not hesitate to contact us.

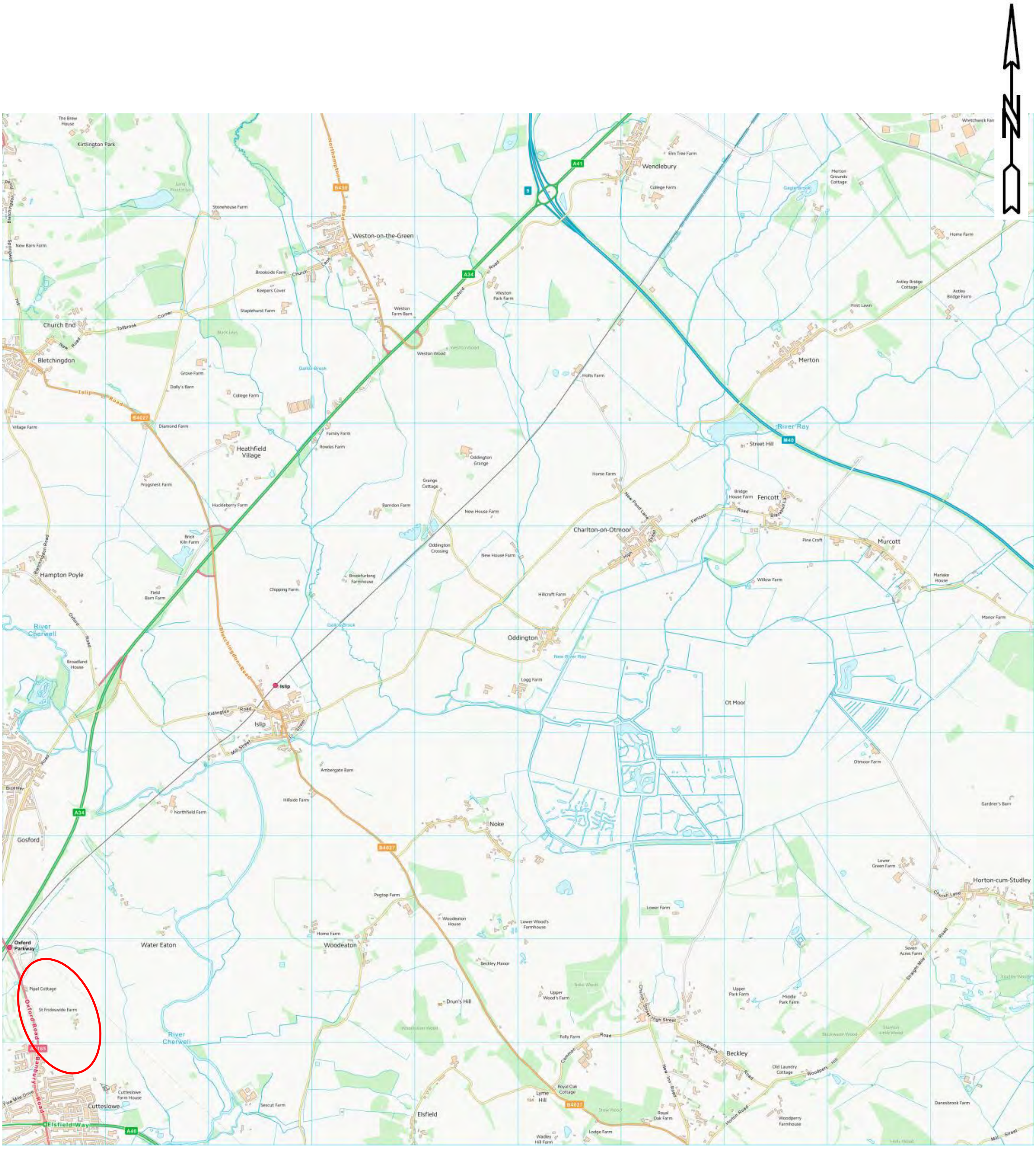
Yours faithfully,

Oliver de Jong

Oliver de Jong BSc MSc FGS
For and on behalf of
Southern Testing Laboratories Limited
DDI: 01604 - 500022
Email: odejong@stconsult.co.uk

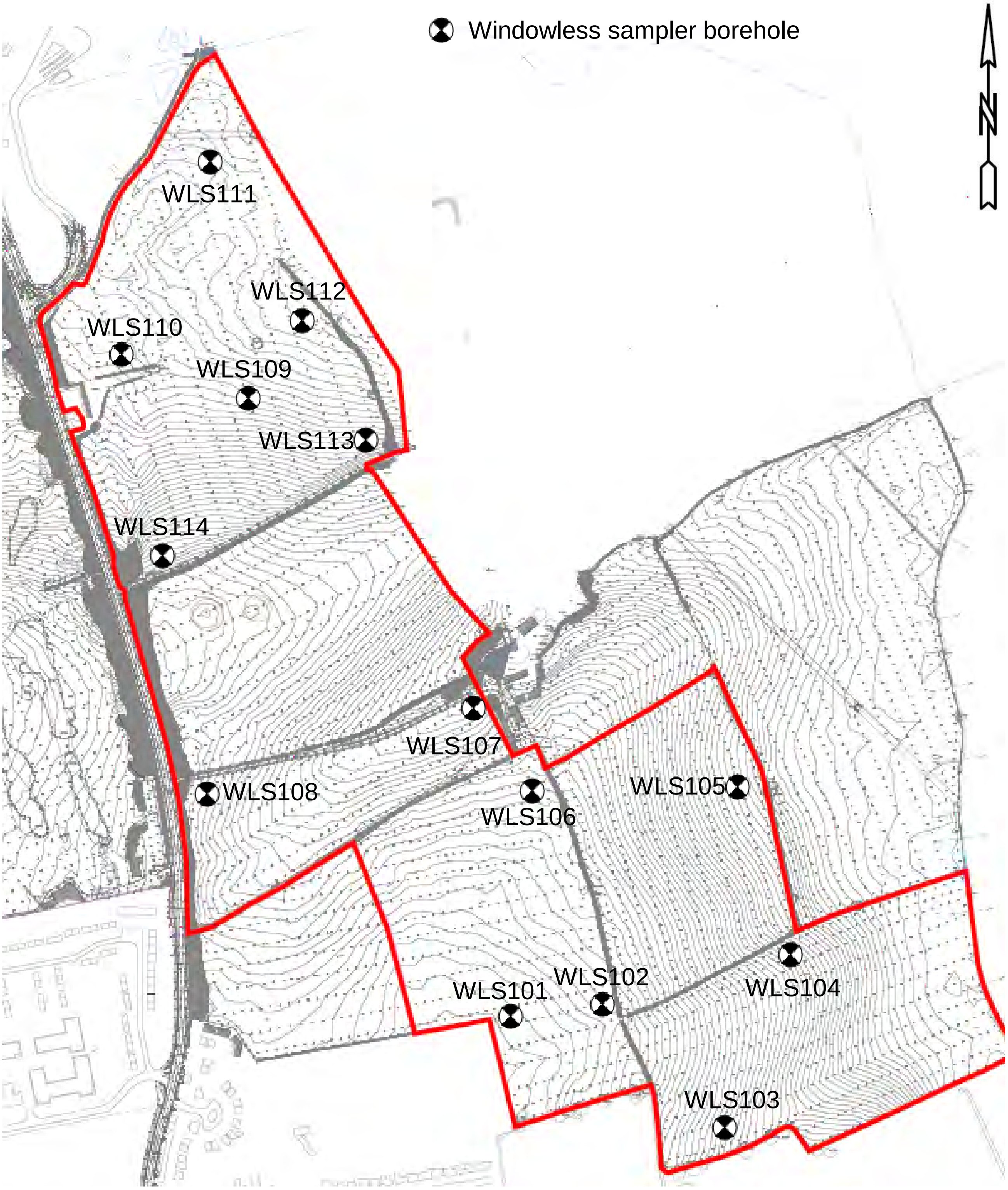
Appendix A: Site Plans
Appendix B: Logs
Appendix C: Soakage Results

Appendix A: Site Plans



NB: Positions of exploratory holes / test positions are only indicative unless dimensioned.

Site:	Land East of Oxford Road, Water Eaton	Project ID	JN1597
Figure 1	Site Location Plan	Date:	15/01/2021



NB: Positions of exploratory holes / test positions are only indicative unless dimensioned.

Site:	Land East of Oxford Road, Water Eaton	Project ID	JN1597
Figure 2	Proposed Site Investigation Layout Plan	Date:	15/01/2021

Appendix B: Logs

Key to Exploratory Hole Logs

General

All soil & rock descriptions in general accordance with BS5930:2015 + A2:2010, BS EN ISO 14688 & BS EN ISO 14689
The Geology Code only entered where positive identification of the sampled strata has been made

Sampling

ES	Environmental Sample (taken in appropriate sampling container)
D	Disturbed Sample
B	Bulk Sample
LB	Large Bulk for Earthworks testing
C	Core Sample
U	Undisturbed Sample (number of blows indicated in results column)
SPTLS	SPT Liner Sampler
P	Piston Sample
W	Water Sample

Insitu Tests

SPT	Standard Penetration Test in accordance with BS EN ISO 22476-3:2005+A1:2011
SPT (C)	Cone Penetration Test in accordance with BS EN ISO 22476-3:2005+A1:2011
PT	Penetration Test - STL documented equivalent SPT N Value
PPT	Perth Penetration Test - STL in house documented method (N Value)
UCS (⊥)	Unconfined Compressive Strength measure by hand penetrometer (kN/m^2)
IVN	Hand Vane (kPa)
PID	Photo Ionisation Detector Results (ppm)
MEXE	Mexecone CBR Result

Drilling Records

Depth to standing water level	▼
Depth to water strike	▽
TCR	Total Core Recovery (%)
SCR	Solid Core Recovery (%)
RQD	Rock Quality Index (%)
FI	Fracture Index

Backfill Symbols

Arisings	▨
Concrete	⁘
Blacktop	▩
Bentonite Seal	■
Gravel Filter	⁘
Sand Filter	⁙

Pipe Symbols

Plain Pipe	‖
Slotted Pipe	☰
Filter Tip	▦

Principal Soil Types

Topsoil	▨
Made Ground	▩
Clay	▤
Silt	☒
Sand	⁙
Gravel	⁘
Peat	⁂

Principal Rock Types

Mudstone/Claystone	▤
Siltstone	☒
Sandstone	⁘
Limestone	▥
Chalk	▥

Southern Testing ST Consult

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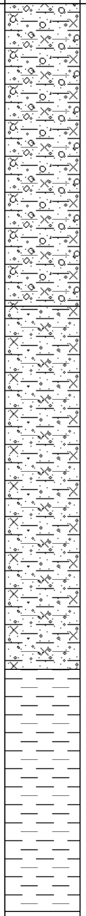
Start - End Date	**Project ID:**	**Hole Type:**	**WLS101**
03/08/2021	JN1597	WLS	Sheet 1 of 1

Project Name:	Land East of Oxford Road	**Remarks:**	**Co-ordinates:**	**Level:**	**Logger:**
					JH
Location:	Water Eaton	Groundwater strike at 1.60mbgl. Rising to 1.40 in 10 minutes.			
Client:	Glanville				



Well	Water Strikes	Samples and Insitu Testing			Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description
		Depth (m bgl)	Type	Results					
						(1.00)		1.00	Firm brown sandy slightly gravelly CLAY. Gravels comprise fine to coarse sub-rounded quartzite with occasional quartzite cobbles.
	▼ 1.60 ▽ 1.40					(1.20)		2.20	Firm orange-brown silty very sandy gravelly CLAY. *Becoming soft and wet and Orange sand horizon.*
						(0.80)		3.00	Stiff grey and brown mottled CLAY
									End of Borehole at 3.00m

1
2
3
4
5

Hole Details		**Casing Details**		**Waterstrike (m bgl)**						**Standing/Chiselling (m bgl)**			
Depth (m bgl)	Dia. (mm)	Depth (m bgl)	Dia. (mm)	Date	Depth Strike	Depth Casing	Depth Sealed	Rose to:	Time (mins)	From	To	Time	Remarks
					1.60			1.40	0				

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Start - End Date	**Project ID:**	**Hole Type:**	**WLS102**
03/08/2021	JN1597	WLS	Sheet 1 of 1

Project Name:	Land East of Oxford Road	**Remarks:**	**Co-ordinates:**	**Level:**	**Logger:**
					JH
Location:	Water Eaton	Groundwater strike at 1.20mbgl. Groundwater remained at level after 10 minutes.			
Client:	Glanville				

Well	Water Strikes	Samples and Insitu Testing			Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description	
		Depth (m bgl)	Type	Results						
	▼					(1.20)	▨	1.20	Firm brown sandy slightly gravelly CLAY. Gravels comprise fine to coarse sub-rounded quartzite.	1
						(0.80)	▨	2.00	Soft orange-brown sandy very gravelly CLAY. gravels comprise fine to coarse sub-rounded to sub-angular quartzite.	2
									End of Borehole at 2.00m	3
										4
										5

Hole Details		**Casing Details**		**Waterstrike (m bgl)**						**Standing/Chiselling (m bgl)**			
Depth (m bgl)	Dia. (mm)	Depth (m bgl)	Dia. (mm)	Date	Depth Strike	Depth Casing	Depth Sealed	Rose to:	Time (mins)	From	To	Time	Remarks
					1.20			1.20	0				

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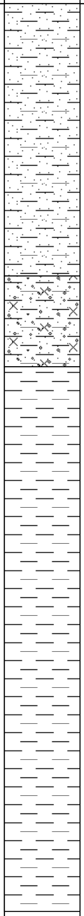
Start - End Date	Project ID:	Hole Type:	WLS103
03/08/2021	JN1597	WLS	Sheet 1 of 1

Project Name:	Land East of Oxford Road	**Remarks:**	**Co-ordinates:**	**Level:**	**Logger:**
					JH
Location:	Water Eaton	Groundwater strike at 2.0mbgl. Rising to 1.60mbgl in 10 minutes.			
Client:	Glanville				



Well	Water Strikes	Samples and Insitu Testing: Depth (m bgl)	Type	Results	Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description
						(0.90)		0.90	Firm orange-brown sandy CLAY.
						(0.30)		1.20	Stiff orange-brown very silty sandy gravelly CLAY. Gravels comprise of quartzite and flint. Slightly wet.
	▼ ▽					(1.80)		3.00	Stiff grey and brown mottled CLAY. *Orange gravelly wet sand horizon*
									End of Borehole at 3.00m

Hole Details: Depth (m bgl)	Dia. (mm)	Casing Details: Depth (m bgl)	Dia. (mm)	Waterstrike (m bgl): Date	Depth Strike	Depth Casing	Depth Sealed	Rose to:	Time (mins)	Standing/Chiselling (m bgl): From	To	Time	Remarks
					2.00			1.60	0				

Southern Testing ST Consult

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Start - End Date	**Project ID:**	**Hole Type:**	**WLS104**
03/08/2021	JN1597	WLS	Sheet 1 of 1

Project Name: Land East of Oxford Road

Location: Water Eaton

Client: Glanville

Remarks: Wet sand at 2.0mbgl.

Co-ordinates:	**Level:**	**Logger:**
		JH

Well	Water Strikes	Samples and Insitu Testing			Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description
		Depth (m bgl)	Type	Results					
						(1.00)		1.00	Firm dark brown slightly sandy slightly gravelly CLAY. Gravels comprise fine to coarse sub-rounded to sub-angular quartzite and flint.
						(0.60)		1.60	Stiff orange-brown slightly sandy slightly gravelly CLAY. Gravels comprise fine to coarse sub-rounded to sub-angular quartzite and flint. *Becoming grey mottled brown.*
	▼					(2.40)		4.00	Buff grey mottled brown CLAY.
									End of Borehole at 4.00m

1
2
3
4
5

Hole Details		**Casing Details**		**Waterstrike (m bgl)**						**Standing/Chiselling (m bgl)**			
Depth (m bgl)	Dia. (mm)	Depth (m bgl)	Dia. (mm)	Date	Depth Strike	Depth Casing	Depth Sealed	Rose to:	Time (mins)	From	To	Time	Remarks
					2.00			2.00	0				

Southern Testing ST Consult

www.southerntesting.co.uk tel:01342 333100 www.stconsult.co.uk tel:01604 500020

Start - End Date	Project ID:	Hole Type:	WLS105
03/08/2021	JN1597	WLS	Sheet 1 of 1

Project Name:	Land East of Oxford Road	**Remarks:**	**Co-ordinates:**	**Level:**	**Logger:**
					JH
Location:	Water Eaton				
Client:	Glanville				

Well	Water Strikes	Samples and Insitu Testing			Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description
		Depth (m bgl)	Type	Results					
						(0.30)		0.30	Soft dark brown and grey mottled slightly gravelly CLAY. Gravels comprise fine to coarse sub-rounded to sub-angular flint and quartzite.
						(2.80)		3.10	Firm to stiff brown-grey slightly sandy slightly gravelly CLAY. gravels comprise fine to coarse sub-rounded to sub-angular flint and quartzite.
						(0.90)		4.00	Stiff dark grey CLAY.
									End of Borehole at 4.00m

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Hole Details		Casing Details		Waterstrike (m bgl)						Standing/Chiselling (m bgl)			
Depth (m bgl)	Dia. (mm)	Depth (m bgl)	Dia. (mm)	Date	Depth Strike	Depth Casing	Depth Sealed	Rose to:	Time (mins)	From	To	Time	Remarks

Southern Testing **ST Consult**

www.southerntesting.co.uk tel:01342 333100 www.stconsult.co.uk tel:01604 500020

Start - End Date	Project ID:	Hole Type:	WLS106
06/08/2021	JN1597	WLS	Sheet 1 of 1

Project Name:	Land East of Oxford Road	**Remarks:**	**Co-ordinates:**	**Level:**	**Logger:**
Location:	Water Eaton				
Client:	Glanville				

Well	Water Strikes	Samples and Insitu Testing			Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description	
		Depth (m bgl)	Type	Results						
						(1.20)		1.20	Firm orange-brown slightly sandy slightly gravelly CLAY.	1
						(2.80)		4.00	Very Stiff grey and brown mottled CLAY.	2 3 4
									End of Borehole at 4.00m	5

Hole Details		Casing Details		Waterstrike (m bgl)						Standing/Chiselling (m bgl)			
Depth (m bgl)	Dia. (mm)	Depth (m bgl)	Dia. (mm)	Date	Depth Strike	Depth Casing	Depth Sealed	Rose to:	Time (mins)	From	To	Time	Remarks

Southern Testing ST Consult

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Start - End Date	Project ID:	Hole Type:	WLS107
06/08/2021	JN1597	WLS	Sheet 1 of 1

Project Name: Land East of Oxford Road

Location: Water Eaton

Client: Glanville

Remarks:

Co-ordinates:	Level:	Logger:
		JH

Well	Water Strikes	Samples and Insitu Testing			Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description
		Depth (m bgl)	Type	Results					
						(1.10)	▨	1.10	MADE GROUND: Firm to stiff brown sandy slightly gravelly CLAY. Gravels comprise fine angular to sub-angular brick fragments and limestone. Slightly wet.
						(2.90)	▨	4.00	Stiff grey/brown mottled slightly sandy CLAY.
									End of Borehole at 4.00m

Depth scale: 1, 2, 3, 4, 5

Hole Details		Casing Details		Waterstrike (m bgl)						Standing/Chiselling (m bgl)			
Depth (m bgl)	Dia. (mm)	Depth (m bgl)	Dia. (mm)	Date	Depth Strike	Depth Casing	Depth Sealed	Rose to:	Time (mins)	From	To	Time	Remarks

Southern Testing **ST Consult**

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Start - End Date	**Project ID:**	**Hole Type:**	**WLS108**
06/08/2021	JN1597	WLS	Sheet 1 of 1

Project Name:	Land East of Oxford Road	**Remarks:**	**Co-ordinates:**	**Level:**	**Logger:**
					JH
Location:	Water Eaton				
Client:	Glanville				

Well	Water Strikes	Samples and Insitu Testing			Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description
		Depth (m bgl)	Type	Results					
						(0.20)		0.20	TOPSOIL
						(1.80)		2.00	Firm to stiff orange-brown sandy slightly gravelly CLAY. Gravels comprise fine to coarse sub-rounded to sub-angular flint and quartzite. *Dry orange sand horizon.*
						(2.00)		4.00	Stiff grey / brown mottled slightly sandy CLAY. *Slightly wet sand horizon.*
									End of Borehole at 4.00m

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Hole Details		**Casing Details**		**Waterstrike (m bgl)**						**Standing/Chiselling (m bgl)**			
Depth (m bgl)	Dia. (mm)	Depth (m bgl)	Dia. (mm)	Date	Depth Strike	Depth Casing	Depth Sealed	Rose to:	Time (mins)	From	To	Time	Remarks

Southern Testing ST Consult

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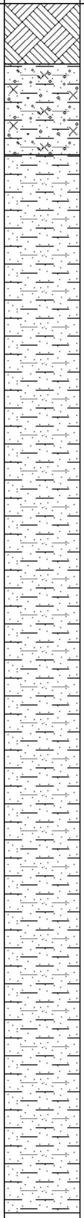
Start - End Date	Project ID:	Hole Type:	WLS109
06/08/2021	JN1597	WLS	Sheet 1 of 1

Project Name:	Land East of Oxford Road	**Remarks:**	**Co-ordinates:**	**Level:**	**Logger:**
					JH
Location:	Water Eaton				
Client:	Glanville				



Well	Water Strikes	Samples and Insitu Testing			Level (m AOD)	Thickness (m)	Depth (m bgl)	Stratum Description	
		Depth (m bgl)	Type	Results					
						(0.20)	0.20	TOPSOIL	
						(0.30)	0.50	Firm orange-brown silty sandy slightly gravelly CLAY. Gravels comprise sub-rounded quartzite	
						(3.50)	4.00	Firm brown mottled slightly sandy CLAY. *Sand horizon* *Sand horizon.* *Becoming stiffer* *Becoming dark purple/grey.*	1 2 3 4
								End of Borehole at 4.00m	5

Hole Details		Casing Details		Waterstrike (m bgl)						Standing/Chiselling (m bgl)			
Depth (m bgl)	Dia. (mm)	Depth (m bgl)	Dia. (mm)	Date	Depth Strike	Depth Casing	Depth Sealed	Rose to:	Time (mins)	From	To	Time	Remarks

Start - End Date	Project ID:	Hole Type:	WLS110
06/08/2021	JN1597	WLS	Sheet 1 of 1

Project Name:	Land East of Oxford Road	**Remarks:**	**Co-ordinates:**	**Level:**	**Logger:**
					JH
Location:	Water Eaton				
Client:	Glanville				

Well	Water Strikes	Samples and Insitu Testing			Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description
		Depth (m bgl)	Type	Results					
						(0.35)		0.35	TOPSOIL
						(0.65)		1.00	Stiff orange-brown CLAY.
						(1.00)		2.00	Firm to stiff grey / brown slightly sandy slightly gravelly CLAY. Gravels comprise fine to coarse mudstone.
						(1.00)		3.00	Firm to stiff grey CLAY with occaisonal shells.
						(1.00)		4.00	Very stiff dark grey CLAY with frequent shells.
									End of Borehole at 4.00m

Hole Details		Casing Details		Waterstrike (m bgl)						Standing/Chiselling (m bgl)			
Depth (m bgl)	Dia. (mm)	Depth (m bgl)	Dia. (mm)	Date	Depth Strike	Depth Casing	Depth Sealed	Rose to:	Time (mins)	From	To	Time	Remarks

Southern Testing ST Consult

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Start - End Date	Project ID:	Hole Type:	WLS111
06/08/2021	JN1597	WLS	Sheet 1 of 1

Project Name:	Land East of Oxford Road	**Remarks:**	**Co-ordinates:**	**Level:**	**Logger:**
					JH
Location:	Water Eaton				
Client:	Glanville				

Well	Water Strikes	Samples and Insitu Testing			Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description
		Depth (m bgl)	Type	Results					
						(0.30)	▨	0.30	TOPSOIL
						(0.40)	▤	0.70	Very stiff orange-brown CLAY.
						(0.60)	▦	1.30	Soft orange-brown very sandy CLAY.
						(0.30)	▤	1.60	Firm to stiff grey / brown mottled CLAY.
						(2.40)	▤	4.00	Stiff dark grey CLAY with frequent shells. *Becoming very stiff.*
									End of Borehole at 4.00m

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Hole Details		**Casing Details**		**Waterstrike (m bgl)**						**Standing/Chiselling (m bgl)**			
Depth (m bgl)	Dia. (mm)	Depth (m bgl)	Dia. (mm)	Date	Depth Strike	Depth Casing	Depth Sealed	Rose to:	Time (mins)	From	To	Time	Remarks

Southern Testing ST Consult

www.southerntesting.co.uk tel:01342 333100 www.stconsult.co.uk tel:01604 500020

Start - End Date	Project ID:	Hole Type:	WLS112
06/08/2021	JN1597	WLS	Sheet 1 of 1

Project Name:	Land East of Oxford Road	**Remarks:**	**Co-ordinates:**	**Level:**	**Logger:**
					JH
Location:	Water Eaton				
Client:	Glanville				

Well	Water Strikes	Samples and Insitu Testing Depth (m bgl)	Type	Results	Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description	
						(0.20)			TOPSOIL	
						(0.80)		0.20	Firm orange-brown CLAY.	
						(3.00)		1.00	Firm to stiff grey / brown mottled CLAY. *Very sandy horizon* *Becoming stiff with frequent shells* *Becoming very stiff and dark grey.*	1 2 3
								4.00	End of Borehole at 4.00m	4 5

Hole Details		Casing Details		Waterstrike (m bgl)						Standing/Chiselling (m bgl)			
Depth (m bgl)	Dia. (mm)	Depth (m bgl)	Dia. (mm)	Date	Depth Strike	Depth Casing	Depth Sealed	Rose to:	Time (mins)	From	To	Time	Remarks

Southern Testing ST Consult www.southerntesting.co.uk tel:01342 333100 www.stconsult.co.uk tel:01604 500020	**Start - End Date**	**Project ID:**	**Hole Type:**	**WLS113**
	06/08/2021	JN1597	WLS	Sheet 1 of 1

Project Name:	Land East of Oxford Road	**Remarks:**	**Co-ordinates:**	**Level:**	**Logger:**
					JH
Location:	Water Eaton				
Client:	Glanville				

Well	Water Strikes	Samples and Insitu Testing			Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description	
		Depth (m bgl)	Type	Results						
						(0.30)	▨	0.30	TOPSOIL	
						(0.70)	▤	1.00	Firm to stiff orange-brown CLAY.	
						(2.20)	▤	3.20	Stiff grey / brown mottled CLAY.	1 2 3
						(0.80)	▤	4.00	Very stiff dark grey CLAY.	
									End of Borehole at 4.00m	4 5

Hole Details		**Casing Details**		**Waterstrike (m bgl)**						**Standing/Chiselling (m bgl)**			
Depth (m bgl)	Dia. (mm)	Depth (m bgl)	Dia. (mm)	Date	Depth Strike	Depth Casing	Depth Sealed	Rose to:	Time (mins)	From	To	Time	Remarks

Southern Testing ST Consult

www.southerntesting.co.uk tel:01342 333100 www.stconsult.co.uk tel:01604 500020

Start - End Date	Project ID:	Hole Type:	**WLS114**
06/08/2021	JN1597	WLS	Sheet 1 of 1

Project Name:	Land East of Oxford Road	**Remarks:**	**Co-ordinates:**	**Level:**	**Logger:**
					JH
Location:	Water Eaton				
Client:	Glanville				

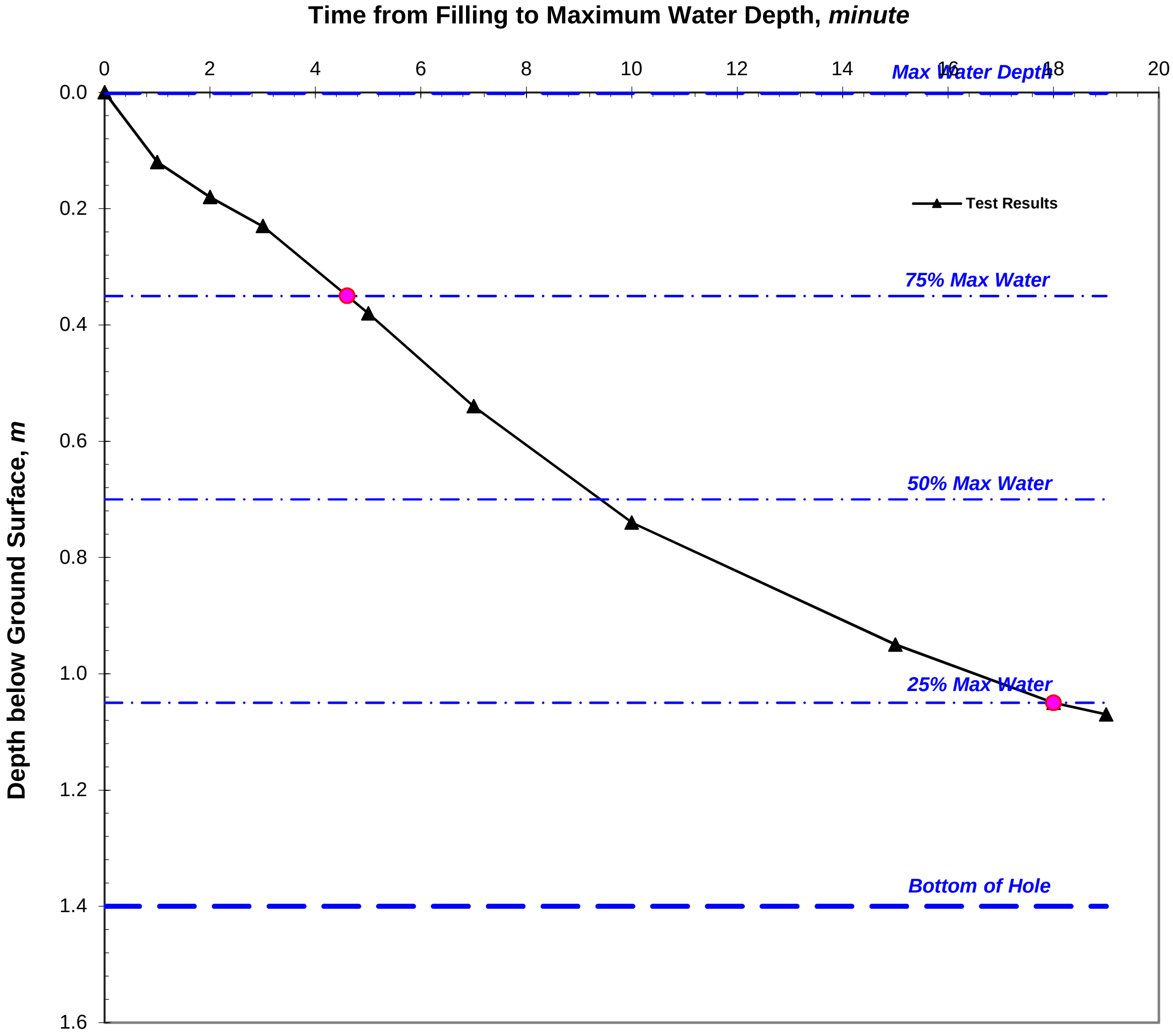
Well	Water Strikes	Samples and Insitu Testing			Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description
		Depth (m bgl)	Type	Results					
						(0.20)	▨	0.20	TOPSOIL
						(0.90)	░	1.10	Firm to stiff orange-brown sandy slightly gravelly CLAY.
						(2.90)	☰	4.00	Stiff grey / brown mottled CLAY. *Becoming occasional shelly*
									End of Borehole at 4.00m

Hole Details		**Casing Details**		**Waterstrike (m bgl)**						**Standing/Chiselling (m bgl)**			
Depth (m bgl)	Dia. (mm)	Depth (m bgl)	Dia. (mm)	Date	Depth Strike	Depth Casing	Depth Sealed	Rose to:	Time (mins)	From	To	Time	Remarks

Appendix C: Soakage Results

Preliminary Falling-Head Soakage Test

Test Hole No: WLS1
Test No: Test No 1 (Initial)



Diameter of Borehole, m	0.100	Depth to Water at Start of Test, ***m***	0.000
Depth to End of Borehole Casing, m		Max Water Dropdown during Test, ***m***	1.070
Depth to Borehole Base, m	1.400	Total Soakage Test Time, ***min***	19.0
Depth to Top of Permeable Soils, ***m***	0.100	Mean Internal Discharge Area, ***m***^{2}	0.228
Depth to Groundwater Surface, ***m***	1.400	Discharge Rate, ***litre/min***	0.200
Depth to Top of Granular Fill, ***m***	0.000	Soakage Rate, ***litre/m***^{2} ***/min***	**0.877**
Voids Assumed within Borehole, %	49%	BRE Soil Infiltration Rate, ***m/sec***	**1.46E-05**

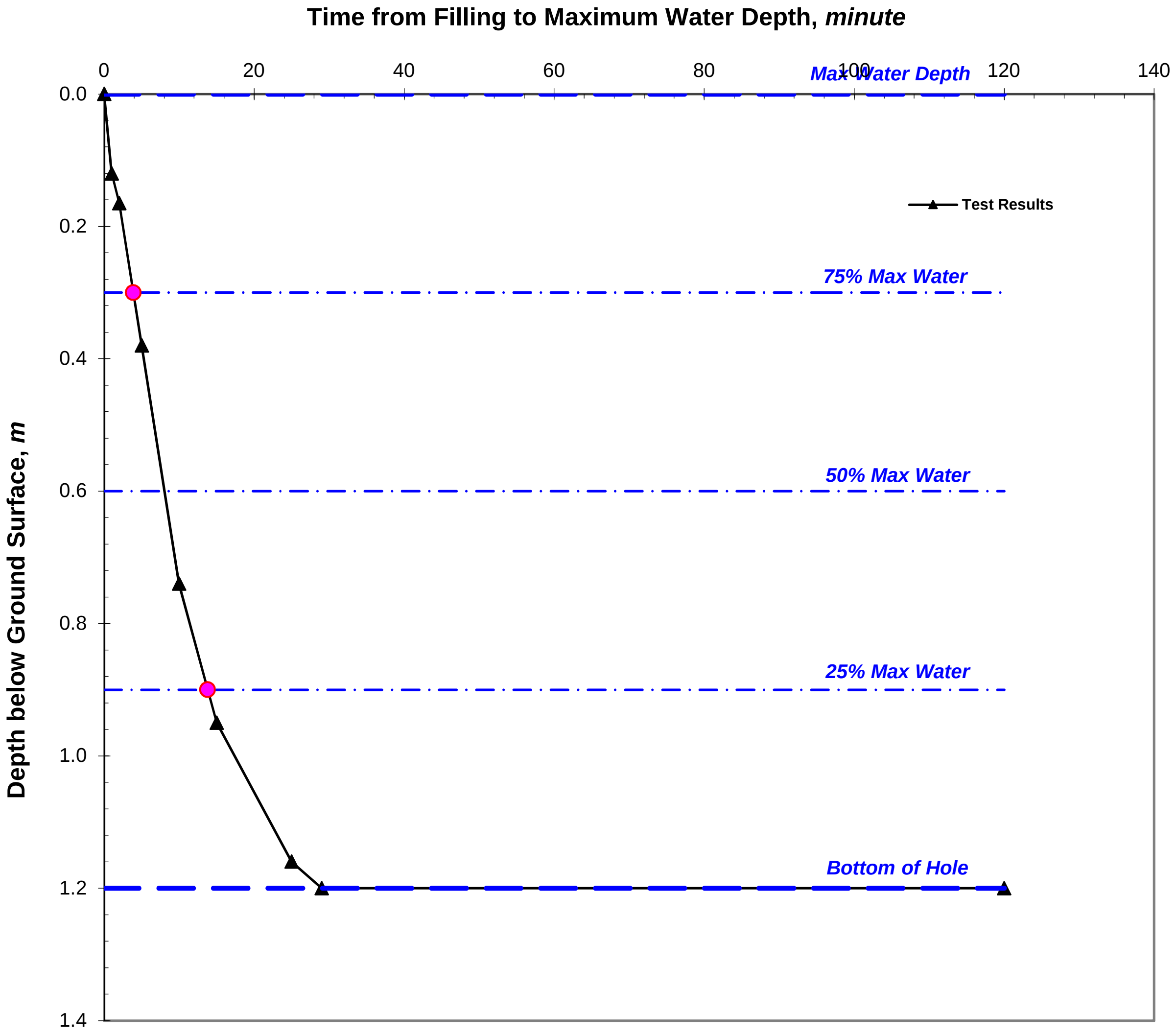
Comments:

Pit was nearly emptied at finish of test.

Client: Glanville	**Job No:**	JN1597	**Test Date:**	03/Aug/2021	
Site: Land East of Oxford Road, Oxford	**Tested By:**	PO/DR	**Engineer:**	JH/ OD	**Fig. S1**

Preliminary Falling-Head Soakage Test

Test Hole No: WLS2
Test No: Test No 1 (Initial)



Diameter of Borehole, m	0.100	Depth to Water at Start of Test, ***m***	0.000
Depth to End of Borehole Casing, m		Max Water Dropdown during Test, ***m***	1.200
Depth to Borehole Base, m	1.200	Total Soakage Test Time, ***min***	120.0
Depth to Top of Permeable Soils, ***m***	0.100	Mean Internal Discharge Area, ***m***^{2}	0.196
Depth to Groundwater Surface, ***m***	1.200	Discharge Rate, ***litre/min***	0.231
Depth to Top of Granular Fill, ***m***	0.000	Soakage Rate, ***litre/m***^{2} ***/min***	**1.18**
Voids Assumed within Borehole, %	49%	BRE Soil Infiltration Rate, ***m/sec***	**1.96E-05**

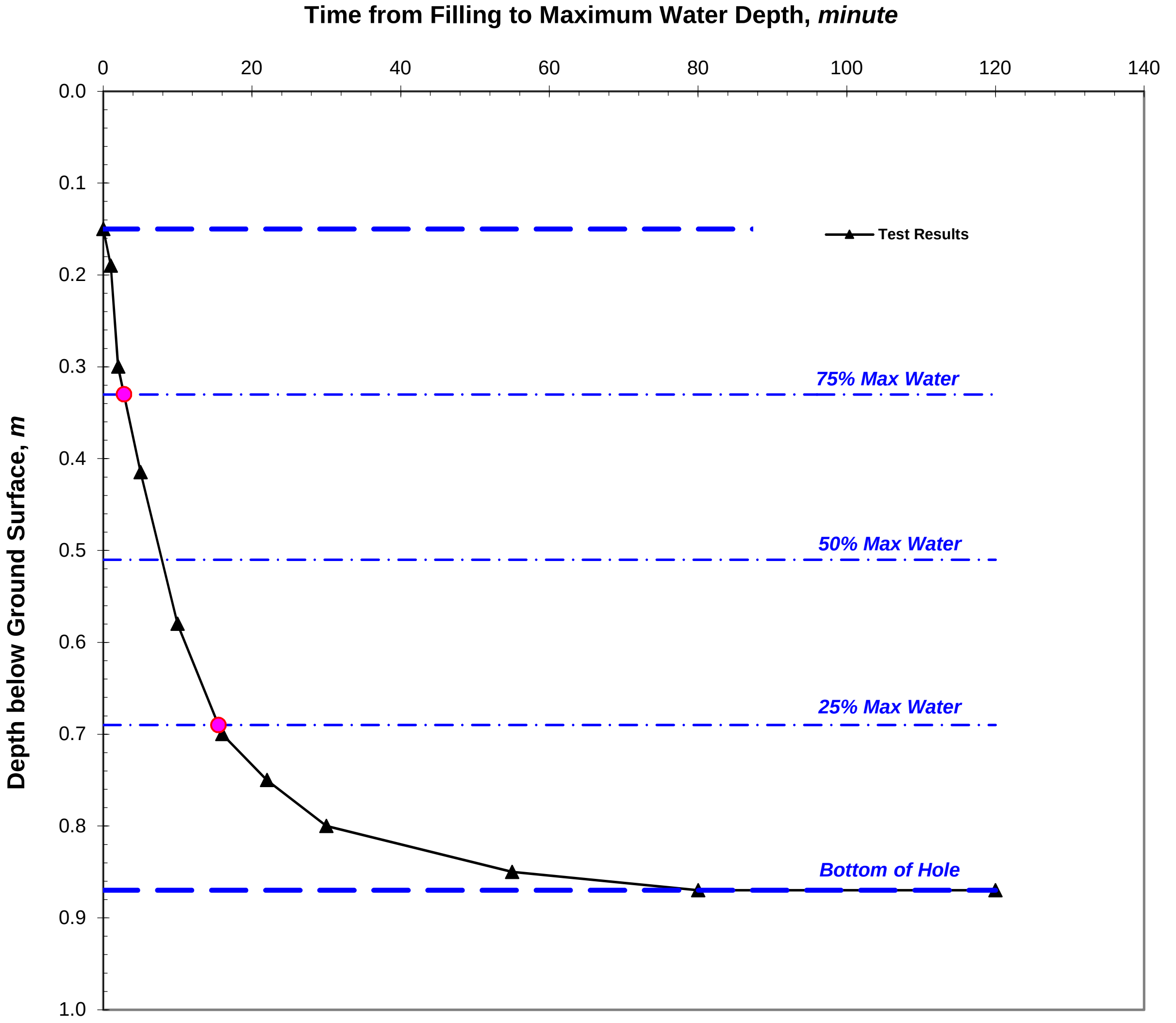
Comments:

Pit was emptied at finish of test.

Client: Glanville		**Job No:**	JN1597	**Test Date:**	03/Aug/2021
Site: Land East of Oxford Road, Oxford		**Tested By:**	PO/DR	**Engineer:** JH/ OD	**Fig. S2**

Preliminary Falling-Head Soakage Test

Test Hole No: WLS3
Test No: Test No 1 (Initial)



Diameter of Borehole, m	0.100	Depth to Water at Start of Test, ***m***	0.150
Depth to End of Borehole Casing, m		Max Water Dropdown during Test, ***m***	0.720
Depth to Borehole Base, m	0.870	Total Soakage Test Time, ***min***	120.0
Depth to Top of Permeable Soils, ***m***	0.100	Mean Internal Discharge Area, ***m^2***	0.121
Depth to Groundwater Surface, ***m***	0.870	Discharge Rate, ***litre/min***	0.108
Depth to Top of Granular Fill, ***m***	0.000	Soakage Rate, ***litre/m^2/min***	**0.895**
Voids Assumed within Borehole, %	49%	BRE Soil Infiltration Rate, ***m/sec***	**1.49E-05**

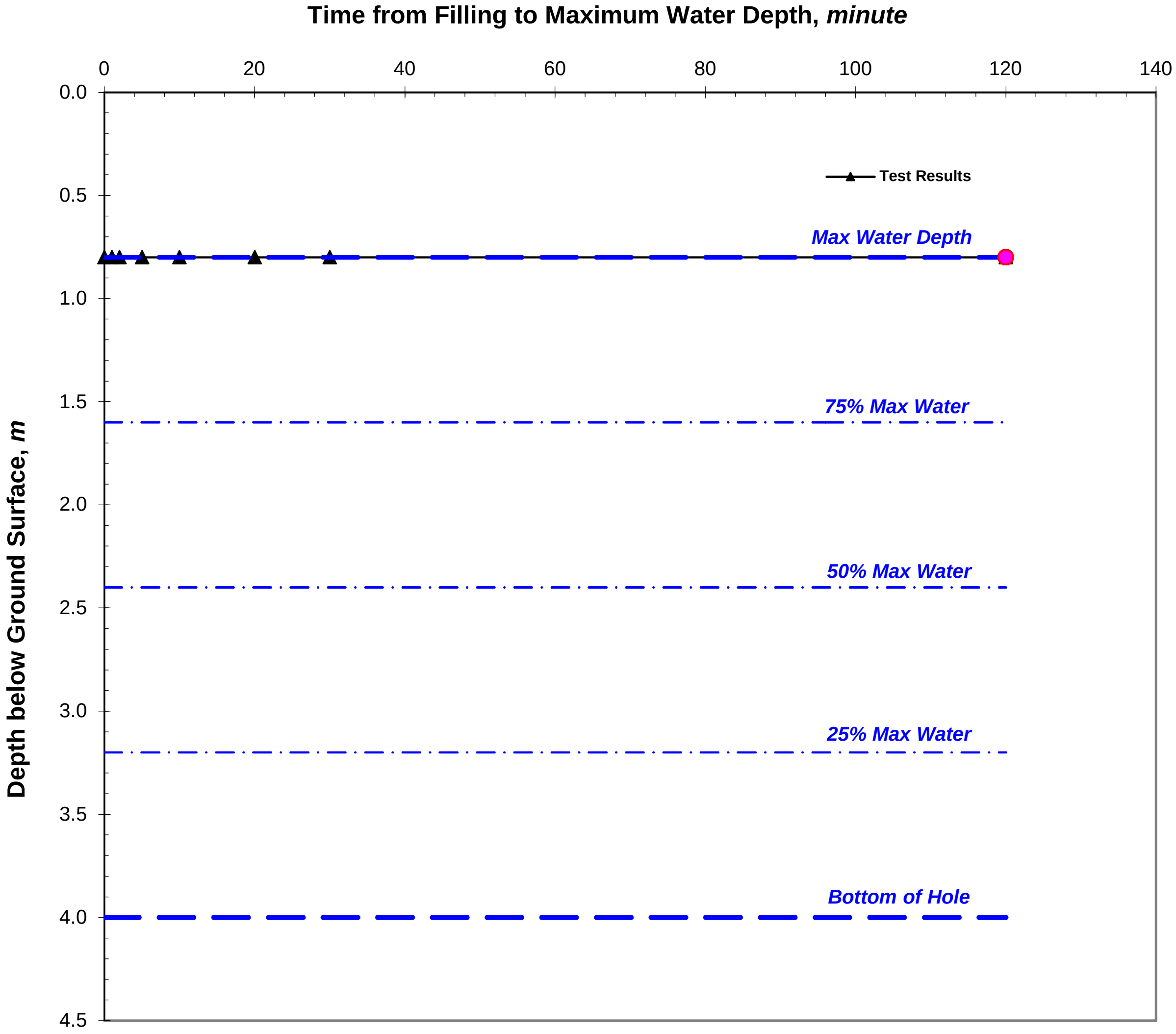
Comments:

Pit was emptied at finish of test.

Client: Glanville		**Job No:**	JN1597	**Test Date:**	03/Aug/2021
Site: Land East of Oxford Road, Oxford		**Tested By:**	PO/DR	**Engineer:** JH/ OD	**Fig. S3**

Preliminary Falling-Head Soakage Test

Test Hole No: WLS4
Test No: Test No 1 (Initial)



Diameter of Borehole, m	0.100	Depth to Water at Start of Test, ***m***	0.800
Depth to End of Borehole Casing, m		Max Water Dropdown during Test, ***m***	0.000
Depth to Borehole Base, m	4.000	Total Soakage Test Time, ***min***	120.0
Depth to Top of Permeable Soils, ***m***	0.100	Mean Internal Discharge Area, ***m***^{2}	1.013
Depth to Groundwater Surface, ***m***		Discharge Rate, ***litre/min***	0.000
Depth to Top of Granular Fill, ***m***		Soakage Rate, ***litre/m***^{2} ***/min***	**0.0000**
Voids Assumed within Borehole, %	100%	BRE Soil Infiltration Rate, ***m/sec***	**0.00E+00**

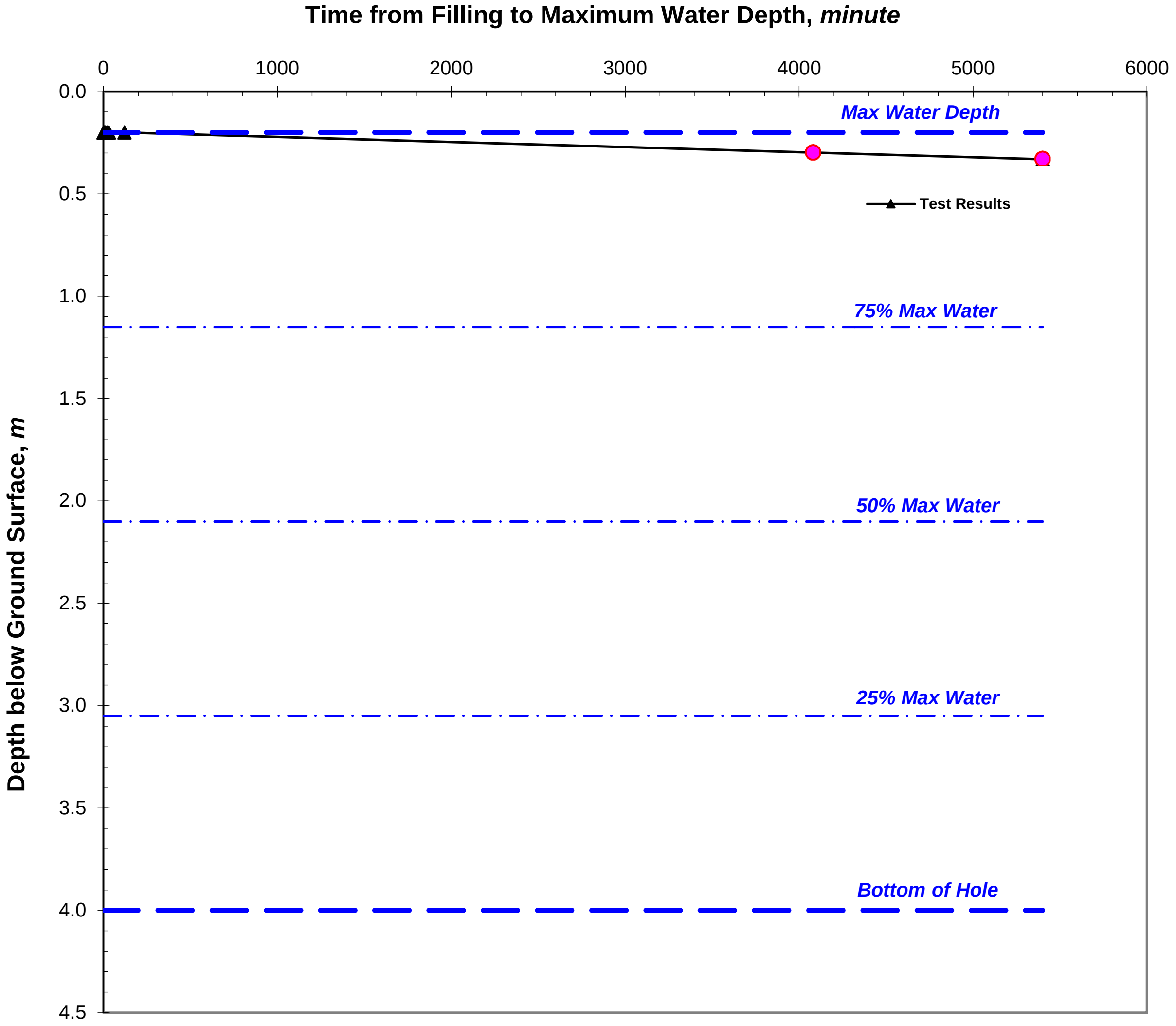
Comments:

Water level did not fall to 75% max water depth, calculations were based on actual fall of water level achieved.
Result not compliant with BRE365 requirement since water did not fall to 25% max water depth.

Client: Glanville		**Job No:**	JN1597	**Test Date:**	03/Aug/2021
Site: Land East of Oxford Road, Oxford		**Tested By:**	PO/DR	**Engineer:** JH/ OD	**Fig. S4**

Preliminary Falling-Head Soakage Test

Test Hole No: WLS5
Test No: Test No 1 (Initial)



Diameter of Borehole, m	0.100	Depth to Water at Start of Test, ***m***	0.200
Depth to End of Borehole Casing, m		Max Water Dropdown during Test, ***m***	0.130
Depth to Borehole Base, m	4.000	Total Soakage Test Time, ***min***	5400.0
Depth to Top of Permeable Soils, ***m***	0.100	Mean Internal Discharge Area, ***m***^{2}	1.166
Depth to Groundwater Surface, ***m***		Discharge Rate, ***litre/min***	0.000
Depth to Top of Granular Fill, ***m***		Soakage Rate, ***litre/m***^{2} ***/min***	**0.0002**
Voids Assumed within Borehole, %	100%	BRE Soil Infiltration Rate, ***m/sec***	**2.76E-09**

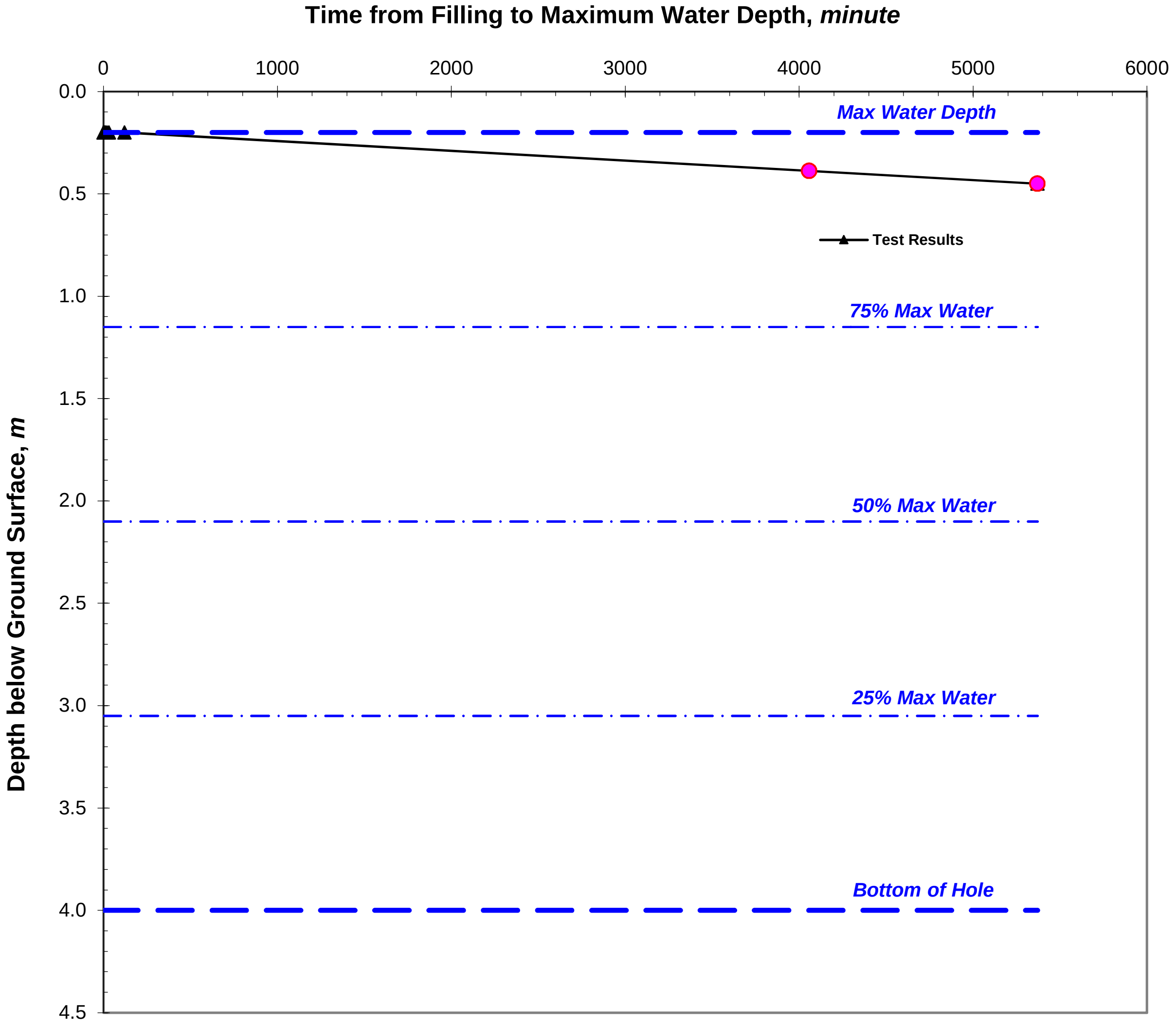
Comments:

Water level did not fall to 75% max water depth, calculations were based on actual fall of water level achieved.
Result not compliant with BRE365 requirement since water did not fall to 25% max water depth.

Client: Glanville		**Job No:**	JN1597	**Test Date:**	03/Jul/2021	
Site: Land East of Oxford Road, Oxford		**Tested By:**	PO/DR	**Engineer:**	JH/ OD	**Fig. S5**

Preliminary Falling-Head Soakage Test

Test Hole No: WLS6
Test No: Test No 1 (Initial)



Diameter of Borehole, m	0.100	Depth to Water at Start of Test, ***m***	0.200
Depth to End of Borehole Casing, m		Max Water Dropdown during Test, ***m***	0.250
Depth to Borehole Base, m	4.000	Total Soakage Test Time, ***min***	5370.0
Depth to Top of Permeable Soils, ***m***	0.100	Mean Internal Discharge Area, ***m***^{2}	1.133
Depth to Groundwater Surface, ***m***		Discharge Rate, ***litre/min***	0.000
Depth to Top of Granular Fill, ***m***		Soakage Rate, ***litre/m***^{2} ***/min***	**0.0003**
Voids Assumed within Borehole, %	100%	BRE Soil Infiltration Rate, ***m/sec***	**5.50E-09**

Comments:

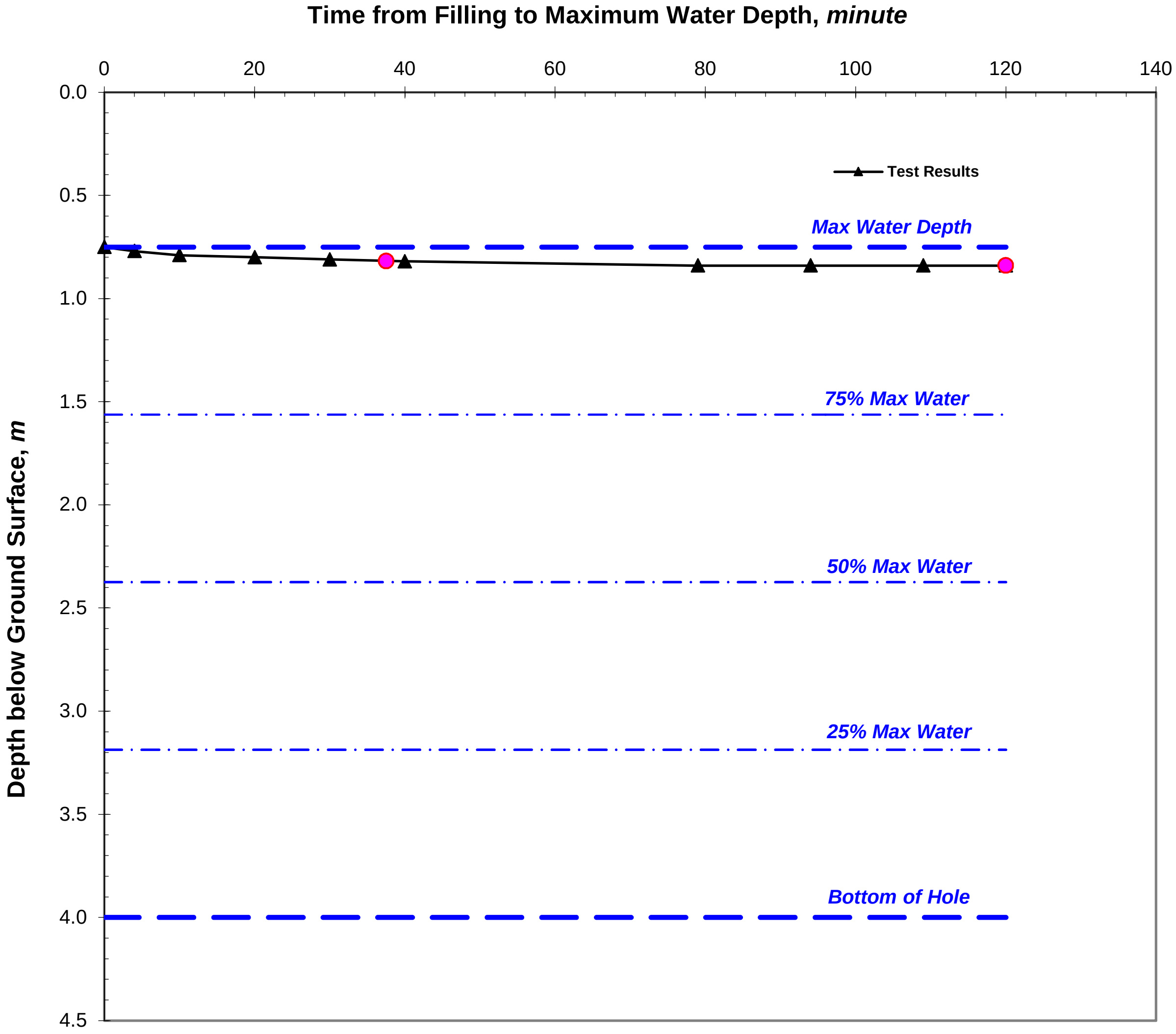
Water level did not fall to 75% max water depth, calculations were based on actual fall of water level achieved.

Result not compliant with BRE365 requirement since water did not fall to 25% max water depth.

Client: Glanville	**Job No:**	JN1597	**Test Date:**	03/Aug/2021		
Site: Land East of Oxford Road, Oxford	**Tested By:**	PO/DR	**Engineer:**	JH/ OD	**Fig.**	**S6**

Preliminary Falling-Head Soakage Test

Test Hole No: WLS7
Test No: Test No 1 (Initial)



Diameter of Borehole, m	0.100	Depth to Water at Start of Test, ***m***	0.750
Depth to End of Borehole Casing, m		Max Water Dropdown during Test, ***m***	0.090
Depth to Borehole Base, m	4.000	Total Soakage Test Time, ***min***	120.0
Depth to Top of Permeable Soils, ***m***	0.100	Mean Internal Discharge Area, ***m***^{2}	1.004
Depth to Groundwater Surface, ***m***		Discharge Rate, ***litre/min***	0.002
Depth to Top of Granular Fill, ***m***		Soakage Rate, ***litre/m***^{2}***/min***	**0.0021**
Voids Assumed within Borehole, %	100%	BRE Soil Infiltration Rate, ***m/sec***	**3.56E-08**

Comments:

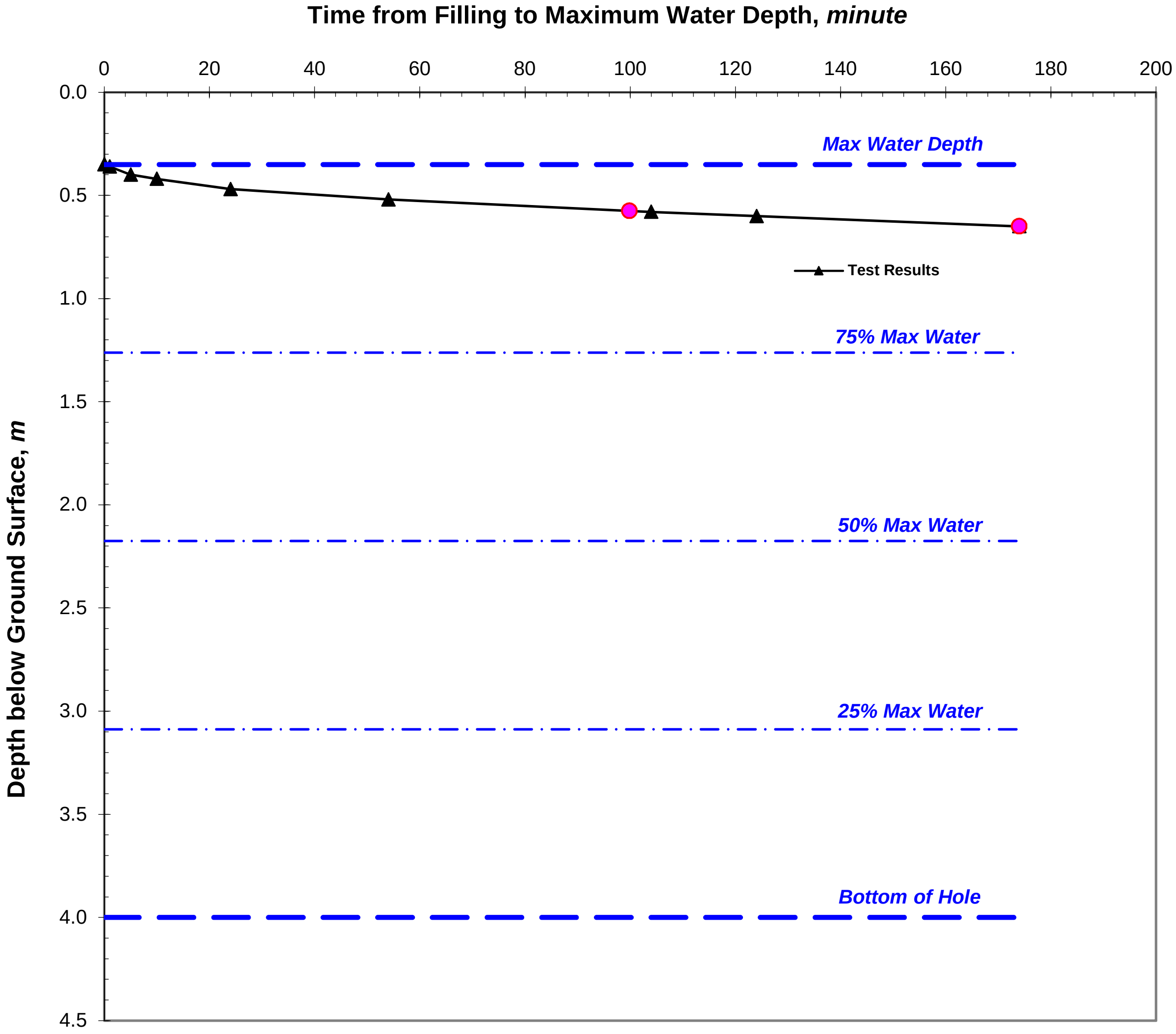
Water level did not fall to 75% max water depth, calculations were based on actual fall of water level achieved.

Result not compliant with BRE365 requirement since water did not fall to 25% max water depth.

Client: Glanville	**Job No:**	JN1597	**Test Date:**	06/Aug/2021		
Site: Land East of Oxford Road, Oxford	**Tested By:**	PO/DR	**Engineer:**	JH/ OD	**Fig. S7**	

Preliminary Falling-Head Soakage Test

Test Hole No: WLS8
Test No: Test No 1 (Initial)



Diameter of Borehole, m	0.100	Depth to Water at Start of Test, ***m***	0.350
Depth to End of Borehole Casing, m		Max Water Dropdown during Test, ***m***	0.300
Depth to Borehole Base, m	4.000	Total Soakage Test Time, ***min***	174.0
Depth to Top of Permeable Soils, ***m***	0.100	Mean Internal Discharge Area, ***m***^{2}	1.072
Depth to Groundwater Surface, ***m***		Discharge Rate, ***litre/min***	0.008
Depth to Top of Granular Fill, ***m***		Soakage Rate, ***litre/m***^{2} ***/min***	**0.0074**
Voids Assumed within Borehole, %	100%	BRE Soil Infiltration Rate, ***m/sec***	**1.23E-07**

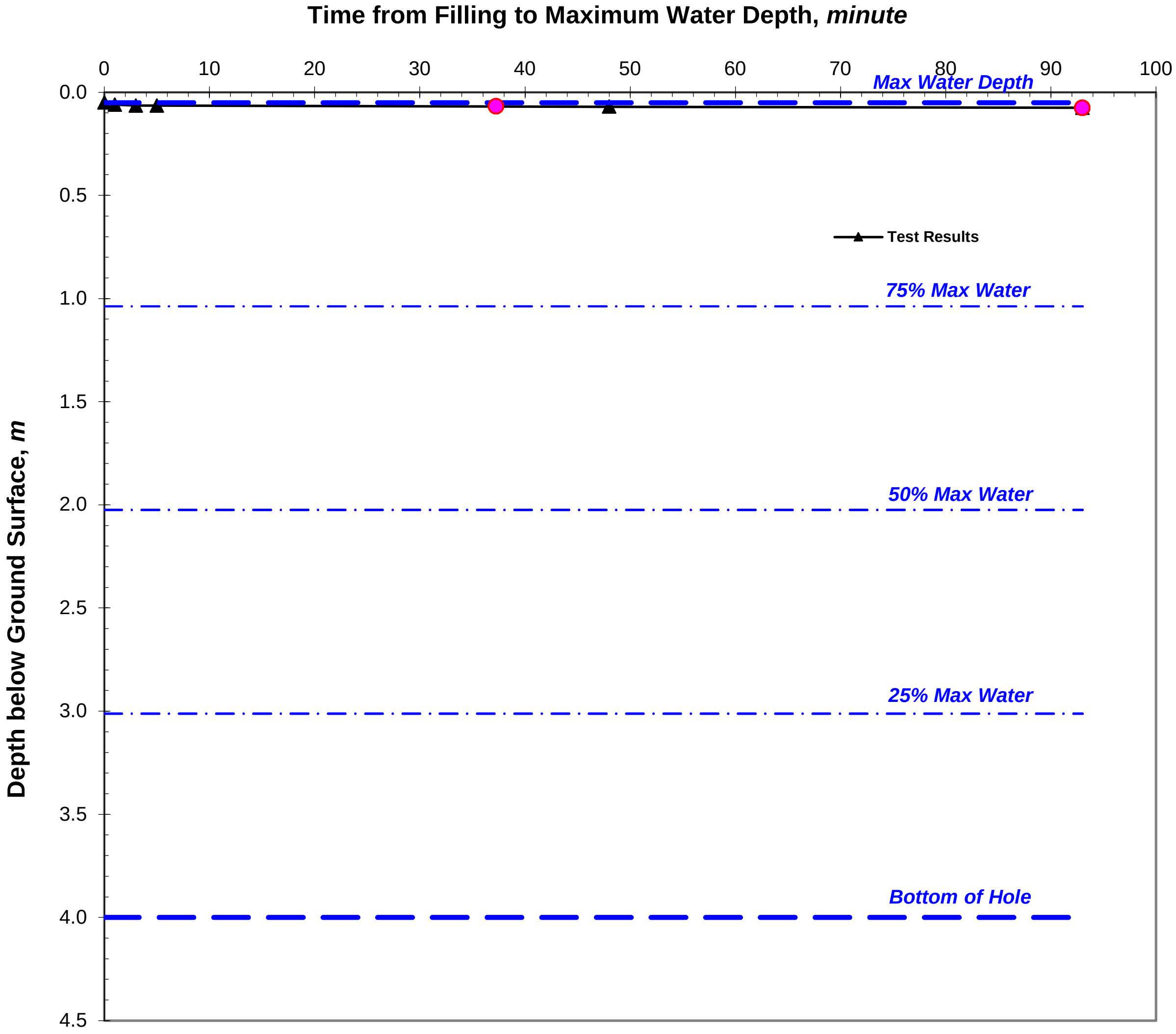
Comments:

Water level did not fall to 75% max water depth, calculations were based on actual fall of water level achieved.
Result not compliant with BRE365 requirement since water did not fall to 25% max water depth.

Client: Glanville		**Job No:**	JN1597	**Test Date:**	06/Aug/2021	
Site: Land East of Oxford Road, Oxford		**Tested By:**	PO/DR	**Engineer:**	JH/ OD	**Fig. S8**

Preliminary Falling-Head Soakage Test

Test Hole No: WLS9
Test No: Test No 1 (Initial)



Diameter of Borehole, m	0.100	Depth to Water at Start of Test, ***m***	0.050
Depth to End of Borehole Casing, m		Max Water Dropdown during Test, ***m***	0.025
Depth to Borehole Base, m	4.000	Total Soakage Test Time, ***min***	93.0
Depth to Top of Permeable Soils, ***m***	0.100	Mean Internal Discharge Area, ***m²***	1.233
Depth to Groundwater Surface, ***m***		Discharge Rate, ***litre/min***	0.001
Depth to Top of Granular Fill, ***m***		Soakage Rate, ***litre/m² /min***	**0.0007**
Voids Assumed within Borehole, %	100%	BRE Soil Infiltration Rate, ***m/sec***	**1.19E-08**

Comments:

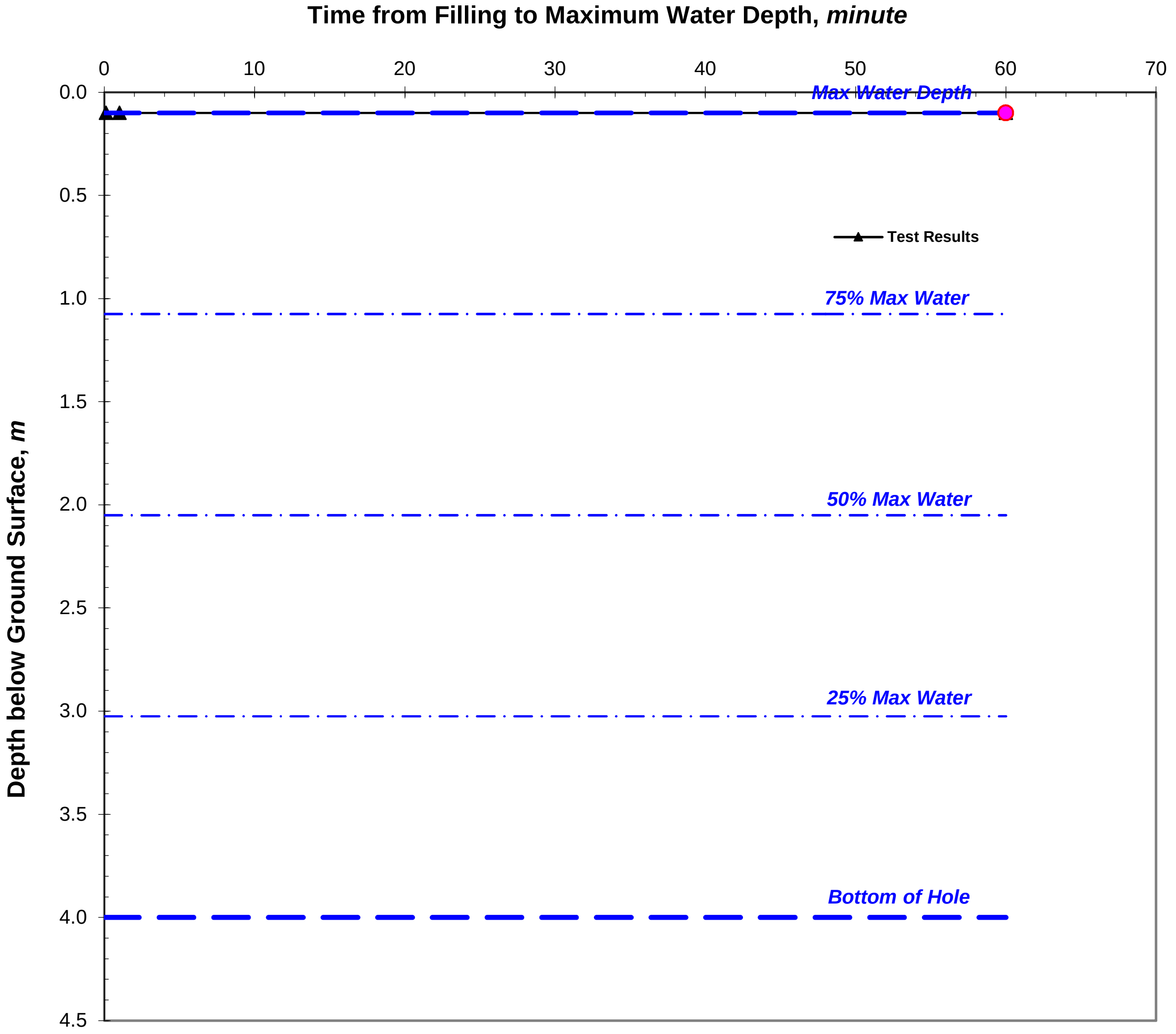
Water level did not fall to 75% max water depth, calculations were based on actual fall of water level achieved.

Result not compliant with BRE365 requirement since water did not fall to 25% max water depth.

Client: Glanville		**Job No:**	JN1597	**Test Date:**	06/Aug/2021	
Site: Land East of Oxford Road, Oxford		**Tested By:**	PO/DR	**Engineer:**	JH/ OD	**Fig. S9**

Preliminary Falling-Head Soakage Test

Test Hole No: WLS10
Test No: Test No 1 (Initial)



Diameter of Borehole, m	0.100	Depth to Water at Start of Test, ***m***	0.100
Depth to End of Borehole Casing, m		Max Water Dropdown during Test, ***m***	0.000
Depth to Borehole Base, m	4.000	Total Soakage Test Time, ***min***	60.0
Depth to Top of Permeable Soils, ***m***	0.100	Mean Internal Discharge Area, ***m***^{2}	1.233
Depth to Groundwater Surface, ***m***		Discharge Rate, ***litre/min***	0.000
Depth to Top of Granular Fill, ***m***		Soakage Rate, ***litre/m***^{2} ***/min***	**0.0000**
Voids Assumed within Borehole, %	100%	BRE Soil Infiltration Rate, ***m/sec***	**0.00E+00**

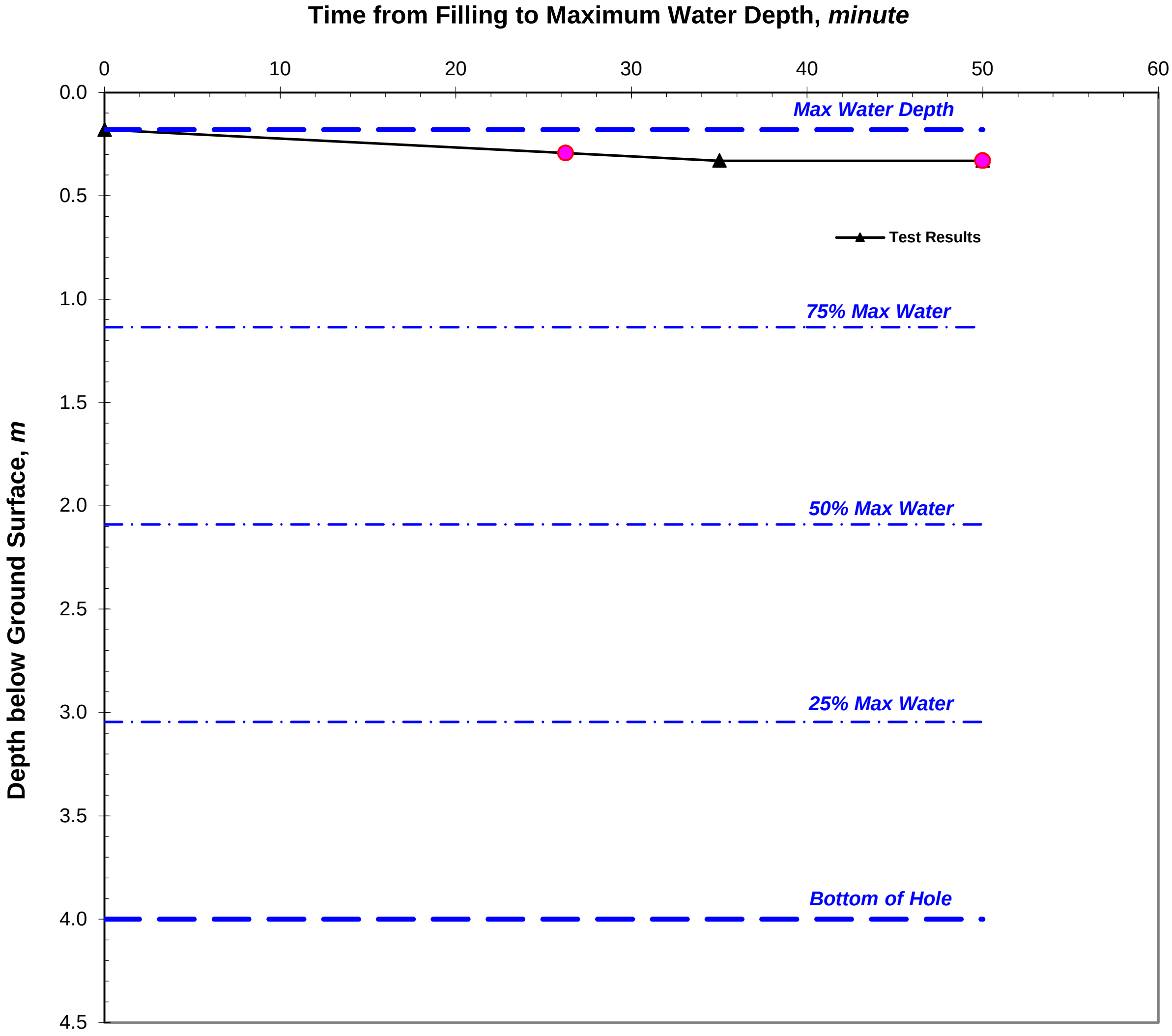
Comments:

Water level did not fall to 75% max water depth, calculations were based on actual fall of water level achieved.
Result not compliant with BRE365 requirement since water did not fall to 25% max water depth.

Client: Glanville		**Job No:**	JN1597	**Test Date:**	06/Aug/2021	
Site: Land East of Oxford Road, Oxford		**Tested By:**	PO/DR	**Engineer:**	JH/ OD	**Fig. S10**

Preliminary Falling-Head Soakage Test

Test Hole No: WLS11
Test No: Test No 1 (Initial)



Diameter of Borehole, m	0.100	Depth to Water at Start of Test, ***m***	0.180
Depth to End of Borehole Casing, m		Max Water Dropdown during Test, ***m***	0.150
Depth to Borehole Base, m	4.000	Total Soakage Test Time, ***min***	50.0
Depth to Top of Permeable Soils, ***m***	0.100	Mean Internal Discharge Area, ***m***^{2}	1.167
Depth to Groundwater Surface, ***m***		Discharge Rate, ***litre/min***	0.012
Depth to Top of Granular Fill, ***m***		Soakage Rate, ***litre/m***^{2}***/min***	**0.011**
Voids Assumed within Borehole, %	100%	BRE Soil Infiltration Rate, ***m/sec***	**1.77E-07**

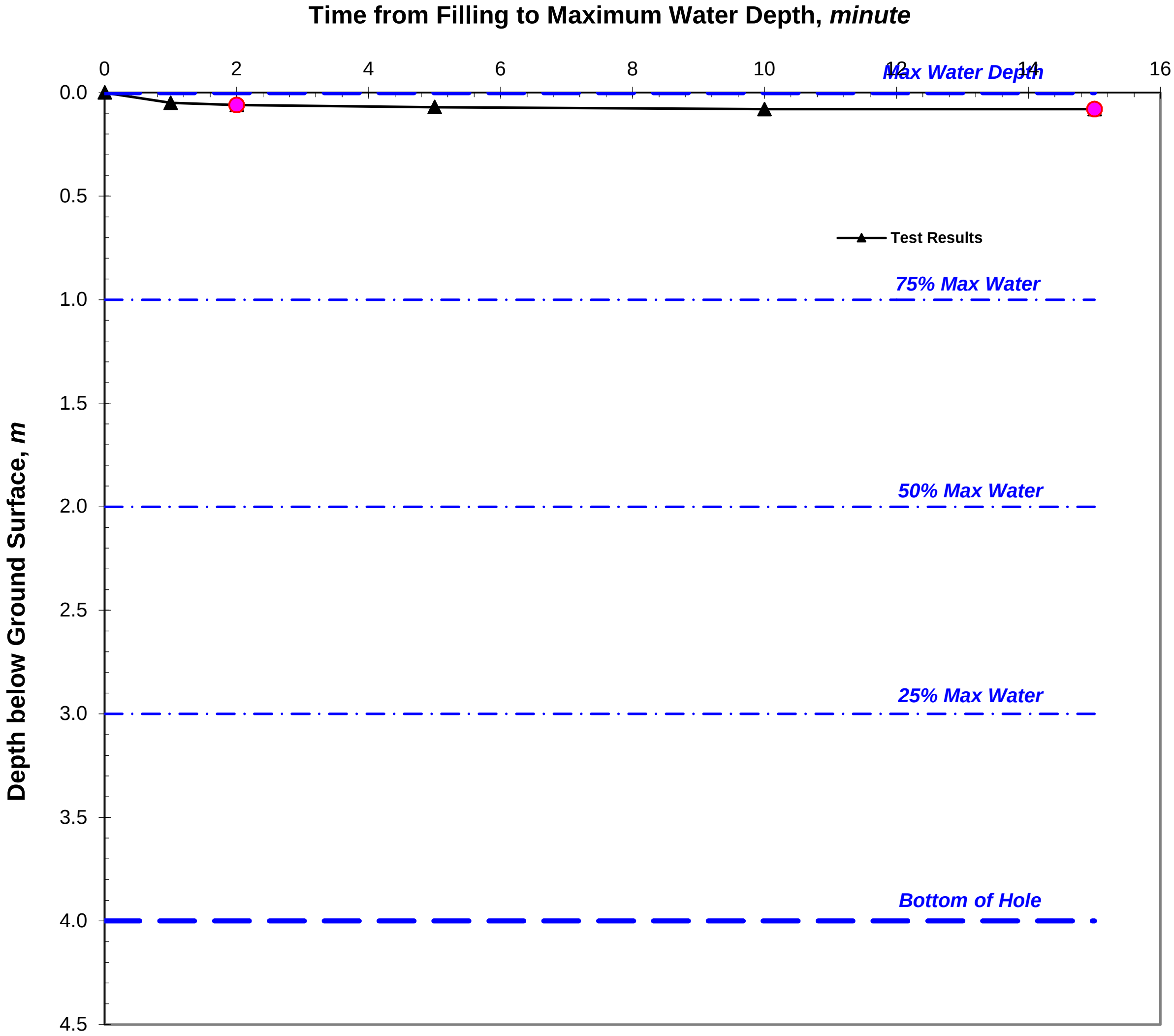
Comments:

Water level did not fall to 75% max water depth, calculations were based on actual fall of water level achieved.
Result not compliant with BRE365 requirement since water did not fall to 25% max water depth.

Client: Glanville		**Job No:**	JN1597	**Test Date:**	06/Aug/2021	
Site: Land East of Oxford Road, Oxford		**Tested By:**	PO/DR	**Engineer:**	JH/ OD	**Fig. S11**

Preliminary Falling-Head Soakage Test

Test Hole No: WLS12
Test No: Test No 1 (Initial)



Diameter of Borehole, m	0.100	Depth to Water at Start of Test, ***m***	0.000
Depth to End of Borehole Casing, m		Max Water Dropdown during Test, ***m***	0.080
Depth to Borehole Base, m	4.000	Total Soakage Test Time, ***min***	15.0
Depth to Top of Permeable Soils, ***m***	0.100	Mean Internal Discharge Area, ***m***^{2}	1.233
Depth to Groundwater Surface, ***m***		Discharge Rate, ***litre/min***	0.012
Depth to Top of Granular Fill, ***m***		Soakage Rate, ***litre/m***^{2} ***/min***	**0.0098**
Voids Assumed within Borehole, %	100%	BRE Soil Infiltration Rate, ***m/sec***	**1.63E-07**

Comments:

Water level did not fall to 75% max water depth, calculations were based on actual fall of water level achieved.

Result not compliant with BRE365 requirement since water did not fall to 25% max water depth.

Client: Glanville	**Job No:** JN1597	**Test Date:** 06/Aug/2021	
Site: Land East of Oxford Road, Oxford	**Tested By:** PO/DR	**Engineer:** JH/ OD	**Fig. S12**

Summary Sheet

Results of Preliminary Falling-Head Soakage Tests

Site : Land East of Oxford Road, Oxford

Job No : JN1597

Client : Glanville

O S Reference : SP 50500 11290

Tested By : PO/DR

Engineer: JH/ ODJ

Test Date : 07/Aug/2021

Hole No	Test No	Hole Depth	Soakage Rate for Each Test	Soakage Rate for Each Hole		Water Level at Finish of Test	Remarks
		m	litre/m^2/min	litre/m^2/min	m/sec		
WLS1	No 1	1.40	0.877	0.877	1.46E-5	Nearly empty pit.	Depth to top of permeable soils was 0.1m. Depth to existing ground water level was 1.4m.
WLS2	No 1	1.20	1.18	1.18	1.96E-5	Empty pit.	Depth to top of permeable soils was 0.1m. Depth to existing ground water level was 1.2m.
WLS3	No 1	0.87	0.895	0.895	1.49E-5	Empty pit.	Depth to top of permeable soils was 0.1m. Depth to existing ground water level was 0.87m.
WLS4	No 1	4.00	0.0000	0.0000	0.00E+0	Water level did not fall during test.	Depth to top of permeable soils was 0.1m.
WLS5	No 1	4.00	0.0002	0.0002	2.76E-9	Pit was not emptied; Non compliant value was calculated.	Depth to top of permeable soils was 0.1m.
WLS6	No 1	4.00	0.0003	0.0003	5.50E-9	Pit was not emptied; Non compliant value was calculated.	Depth to top of permeable soils was 0.1m.
WLS7	No 1	4.00	0.0021	0.0021	3.56E-8	Pit was not emptied; Non compliant value was calculated.	Depth to top of permeable soils was 0.1m.
WLS8	No 1	4.00	0.0074	0.0074	1.23E-7	Pit was not emptied; Non compliant value was calculated.	Depth to top of permeable soils was 0.1m.
WLS9	No 1	4.00	0.0007	0.0007	1.19E-8	Pit was not emptied; Non compliant value was calculated.	Depth to top of permeable soils was 0.1m.

Summary Sheet

Results of Preliminary Falling-Head Soakage Tests

Site :	Land East of Oxford Road, Oxford	**Job No :**	JN1597
Client :	Glanville	**O S Reference :**	SP 50500 11290
Tested By : PO/DR	**Engineer:** JH/ ODJ	**Test Date :**	07/Aug/2021

Hole No	**Test No**	**Hole Depth** *m*	**Soakage Rate for Each Test** *litre/m^2/min*	**Soakage Rate for Each Hole** *litre/m^2/min*	*m/sec*	**Water Level at Finish of Test**	**Remarks**
WLS10	No 1	4.00	0.0000	0.0000	0.00E+0	Water level did not fall during test.	Depth to top of permeable soils was 0.1m.
WLS11	No 1	4.00	0.011	0.011	1.77E-7	Pit was not emptied; Non compliant value was calculated.	Depth to top of permeable soils was 0.1m.
WLS12	No 1	4.00	0.0098	0.0098	1.63E-7	Pit was not emptied; Non compliant value was calculated.	Depth to top of permeable soils was 0.1m.
Mean Value of All Calculated Soakage Rates :				**0.248** *litre/m^2/min*	**4.14E-6** *m/sec*		