Bourne End Junior Sports Club: Drainage Strategy

A REPORT FOR BOURNE END JUNIOR SPORTS & RECREATIONAL CLUB
P22505_R2
8TH MARCH 2023

Document Control

Title

Bourne End Junior Sports Club: Drainage Strategy

Client

Bourne End Junior Sports & Recreational Club
New Road,
Bourne End,
SL8 5BS

Reference

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Final

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Contents

Tables

Figures

Appendices

1 Introduction

1.1 INSTRUCTION

Yellow Sub Geo Ltd (Yellow Sub) was instructed by Bourne End Junior Sports & Recreational Club (the Client) to provide a suitable Drainage Strategy for a parcel of land on the eastern side of New Road, Bourne End (the Site). Instruction to proceed was provided by email on the 2nd February 2023.

1.2 BACKGROUND

The Client is seeking to obtain planning permission to redevelop a parcel of land to the rear of the existing Bourne End Junior Sports Club (BEJSC). The proposed development is commercial in nature and the plot is currently occupied by tennis courts laid to asphalt. The proposed development comprises a swimming pool with associated parking area. Further details of the proposed development are provided in Section 3.

An initial drainage strategy was previously prepared by Lanes Group and submitted as part of the planning application. This received an objection from the Sustainable Drainage Team at Buckinghamshire Council in March 2022 in their role as Lead Local Flood Authority (LLFA) owing to insufficient information having been submitted and a following request for further information in January 2023.

This report comprises a sustainable drainage strategy to support the planning application which includes the results of Site specific infiltration testing and groundwater monitoring data.

When compared to the initial drainage strategy, the following key changes have been made:

- the deeper soakaway feature has been removed in preference of a shallower system; and,
- the previous drainage scheme encompassed a greater area than that covered by the planning application (previously this included the existing sports club building to the west of the application area and an existing car park). This report covers the proposed development and associated car park (which aligns with the planning application).

1.3 SCOPE OF THE REPORT

The scope of the assessment is as follows:

- Development of a sustainable drainage strategy to mitigate potential increases in runoff and deterioration in water quality as well as providing amenity and biodiversity benefits; and,
- Provision of data/ information requested by the LLFA.

This report also includes drainage calculations for all required storm events, with appropriate allowances for climate change, an updated layout plan and a maintenance schedule.

1.4 DATA SOURCES

The main sources of data utilised in this assessment are summarised below:

- Site topographical survey;
- Proposed Site development plans as provided by the Client;
- Thames Water sewer asset location plans;
- Site geology, groundwater level monitoring and infiltration test data;

- Buckinghamshire Developer Advice for Surface Water Drainage Strategies (Buckinghamshire Councy Council, 2020);
- LiDAR digital terrain model (DTM) data;
- Hydrological descriptor data from the Flood Estimation Handbook (FEH) website (UK Centre for Ecology & Hydrology, 2023);
- Environment Agency (EA) flood risk data; and
- Ordnance Survey mapping.

1.5 LIMITATIONS

This report is written strictly for the benefit of the Client and bound by the conditions presented in Appendix A.

2 Site setting

2.1 SITE DESCRIPTION

The Site is approximately 0.36 ha in size and located in Bourne End, Buckinghamshire (SL8 5BS) on the eastern side of New Road (see Figure 2.1).

Bourne End Academy is present to the south with East Ridge to the north. The east of the Site is bounded by a grass playing field with the area to the west of the Site occupied with the existing sports hall/ building and impermeable parking area. The Site itself currently comprises a tennis court facility. Figure 2.2 presents an aerial image of the Site area showing the current layout and condition.

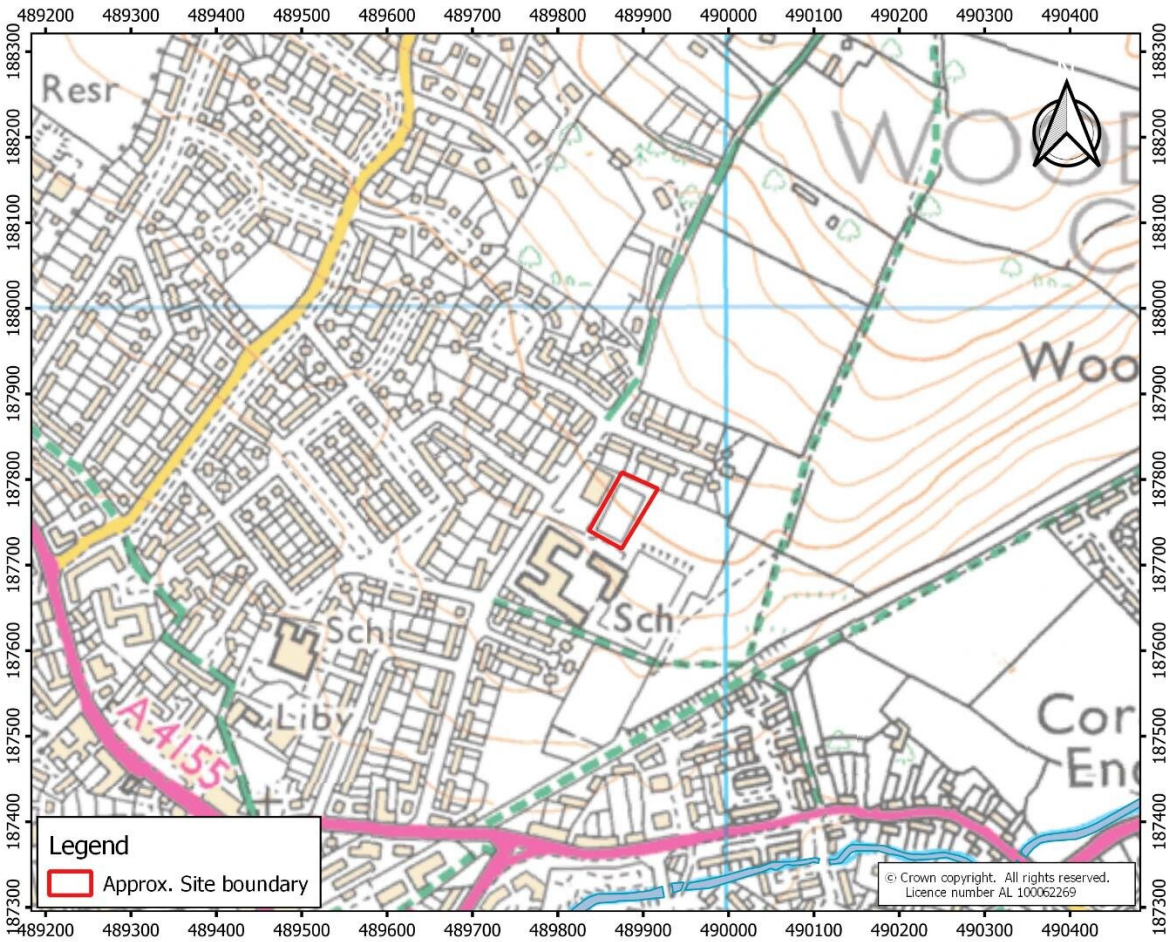


Figure 2.1 Site location

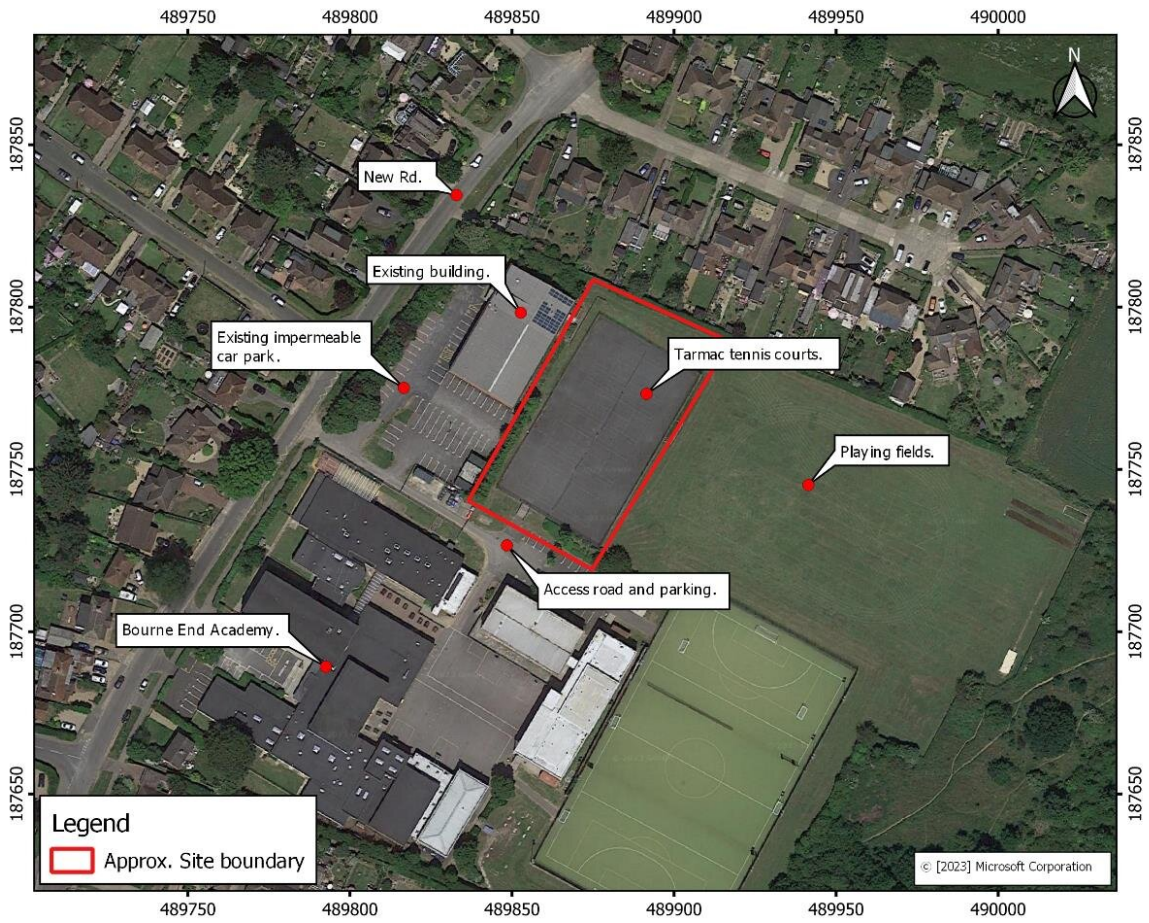


Figure 2.2 Existing Site layout

2.2 TOPOGRAPHY

Topographical data (LiDAR 1 m resolution Digital Terrain Model – DTM) is presented in Figure 2.3 for the Site and surrounding area. The land across the site slopes to the south, although much of the Site appears to have been levelled in the past, with a steep slope present along the northern Site boundary.

A topographical survey of the Site is presented in Appendix B.

2.3 CLIMATE AND HYDROLOGY

The Standard Average Annual Rainfall (SAAR) for the Site area is 674mm per annum (mm/a). There are no surface water features within 250m of the Site and according to the Environment Agency (EA) the Site is located in Flood Zone 1 (low risk).

2.4 CURRENT DRAINAGE ARRANGEMENTS

Public sewer asset plans for the Site and surrounding local area have been obtained and are presented in Appendix D.

Based on the Site topography, runoff naturally runs off in a southward direction from the topographical high point along the northern boundary (see Figure 2.3). The Site is assumed to be served by a private drainage system. Given the lack of surface water features and sewers in the area, and the nature of the underlying geology, disposal of runoff to ground seems the most likely scenario.

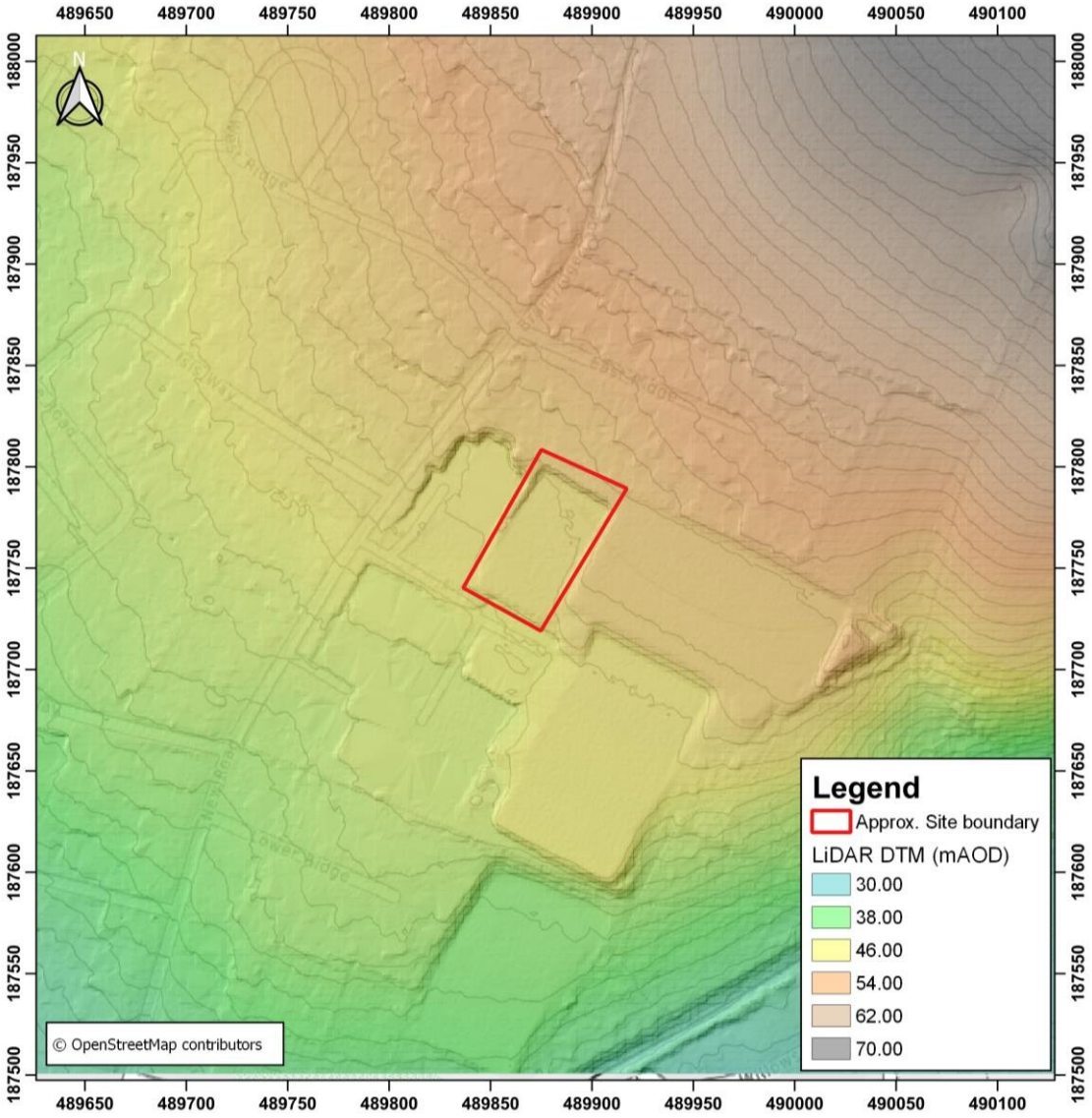


Figure 2.3 Site topography

2.5 GEOLOGY AND HYDROGEOLOGY

2.5.1 Ground investigation results

The following information has been compiled from intrusive site investigation works undertaken by Yellow Sub on 28th October 2022 (trial pitting and infiltration testing – see Appendix E).

The geological sequence underlying the Site is summarised in Table 2-1.

Table 2-1 Geological strata encountered at the Site

Strata	Description	Depth range (m bgl)	Typical thickness (m)
Topsoil	Encountered across Site with grass covering and abundant rootlets.	GL-0.1	0.1
Made Ground (reworked Taplow Gravel Member)	Encountered only in WS03 as a soft, dark brown, sandy, gravelly CLAY. Sand is fine to medium. Gravel is fine to coarse of flint and brick. Rare glass fragments noted.	0.1-0.8	0.7
Taplow Gravel Member	Encountered across the Site and varying between a sandy, gravelly CLAY, a clayey, sandy GRAVEL and a gravelly sand.	0.1-4.9	>4.8 (Base not proven)

GL: Ground Level

2.5.2 Hydrogeology

The underlying Taplow Gravel Member is classified by the EA as a "Secondary A Aquifer". These are described as:

> *"Permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers"*

The Site is located on the edge of Zone 1 of a Source Protection Zone (SPZ). This is associated with a pumping station in Well End, located approximately 700m west of the Site.

2.5.3 Infiltration capacity

Falling head permeability (infiltration) testing was undertaken in 2No. boreholes (WS01 and WS03) on 28th October 2022. Full details of the site investigation work is included in Appendix E and the results are summarised in Table 2-2. The infiltration values for each borehole have been calculated in accordance with the methodology set out in BRE 365. However, whilst it is acknowledged that the below is not strictly in accordance with BRE365, the results demonstrate the principal of infiltration which is considered suitable at this stage given the Site constraints (e.g. presence of an active car park). We have consulted with the LLFA on this matter who agree to the use of this data in principal (email dated 17/01/2023).

Table 2-2 Summary of on-Site infiltration test results

Borehole	Test	Depth of borehole (m)	Geology of test section	Permeability (m/s)	Average (m/s)
WS01	1	4.5	Taplow Gravel Member	1.32E-06	1.69E-06
	2			2.12E-06	
	3			1.65E-06	
WS03	1	2.4	Taplow Gravel Member	2.83E-06	2.83E-06

These test results are utilised in the subsequent calculations for the proposed drainage scheme (see Section 4.5). A value of 0.0081 m/hr was applied to the Taplow Gravel Member. This is an average of the final result obtained at WS01 and the only result obtained at WS03.

3 Proposed development

The illustrative masterplan for the Site is provided in Appendix C. The proposed development comprises construction of a new detached swimming pool building with associated infrastructure and parking area.

The proposed building will include a green roof and be located on the site of the existing impermeable asphalt tennis courts. The new parking area would comprise permeable paving to dispose of runoff from the development to ground (as discussed in Section 4). This would also be largely located on the existing impermeable tennis courts.

4 Sustainable Drainage Strategy

4.1 INTRODUCTION

The following sections describe the Sustainable Drainage Strategy (SuDS) for the proposed development, with due regard to DEFRA's Non-Statutory Technical Standards for SuDS (DEFRA, 2015) the CIRIA SuDS manual (CIRIA, 2015) and the PPG for Flood Risk and Coastal Change, which recommends the following hierarchy for the disposal of surface water from new developments:

1. Discharge to ground via infiltration techniques (most preferred)[1];
2. Discharge to a surface water body;
3. Discharge to a surface water sewer, highway drain or other drainage system; and,
4. Discharge to a combined sewer (least preferred).

Buckinghamshire's SUDS design guidance for Minor Developments includes a drainage hierarchy which agrees with the hierarchy above.

The proposed development will be located on previously developed land (a tennis court laid to asphalt). Surface runoff from the proposed development will be sustainably managed using SuDS, as described in the following sections. This will provide betterment with regards to off-Site runoff rates and volumes.

SuDS aim to mimic the natural drainage characteristics of a site prior to its development by controlling surface water runoff as close to where the rain falls as possible e.g. through interception and re-use, evaporation and infiltration into the ground. Furthermore, SuDS provide opportunities to remove pollutants from runoff and also provide amenity and biodiversity benefits.

4.2 RUNOFF DESTINATION AND PROPOSED SUDS LAYOUT

There are no surface water features in the immediate vicinity of the Site. Based on existing testing, the Taplow Gravel Member underlying the Site is considered to be sufficiently permeable to allow surface water from the proposed development to be discharged to ground using infiltration techniques.

The proposed development roof will comprise a green roof which will act to intercept the first 5mm of all rainfall as well as reducing the rates and volumes of runoff discharging to the infiltration feature. This feature will effectively manage rainfall from minor precipitation events (assuming the substrate is not already saturated) and provide some attenuation of runoff to the infiltration features during larger events.

The proposed car parking area will be constructed using a permeable/ porous surfacing with a stone blanket sub-base below. A diagram of the arrangement is presented below (see Figure 4.1) of the proposed layout with technical information is included in Appendix G. Two types of permeable/ porous surfaces are included below as the exact nature of the surface is yet to be finalised.

[1] On-site water reuse is now also considered to be a preferred method for surface water disposal.

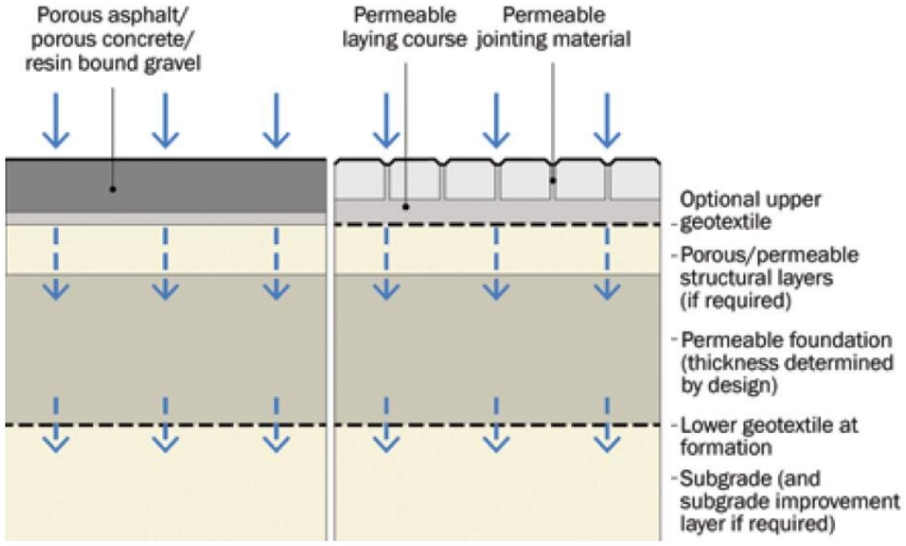


Figure 4.1 Porous surface/ permeable paving (CIRIA, 2015)

4.3 CLIMATE CHANGE

The potential increase in rainfall intensity needs to be considered when designing drainage systems. The recommended allowances for rainfall intensity in the Thames and South Chilterns Management Catchment are included in Table 4-1.

Table 4-1 Climate change allowances for rainfall in the Thames and South Chilterns Management Catchment

Epoch	1 in 30 year (3.3%)	1 in 100 (1%)
Central allowance		
2050s (operational phase)	20%	20%
2070s (restored phase)	25%	25%
Upper end allowance		
2050s (operational phase)	35%	40%
2070s (restored phase)	35%	40%

A 40% allowance for climate change has been utilised herein based on a previous consultation response from the LLFA (email dated 09/03/22).

4.4 GREENFIELD RUNOFF AND PERMISSIBLE DISCHARGE RATES

The greenfield runoff rates (based on a total Site area of 3,597m^2) have been calculated using the ICP SuDS method. The results are presented in Table 4-2 below.

Table 4-2 Greenfield runoff

Return period (yrs)	Runoff rate (l/s)
1	0.1
Qbar	0.1
30	0.3
100	0.5

All rainfall runoff will be discharged to ground post-development, so setting a permissible discharge rate is not required in this instance.

4.5 SUDS FEATURES DESIGN

The design of the SuDS features has been undertaken using MicroDrainage. Simulations were run for the 1 in 1, 1 in 30 and 1 in 100-year event plus a 40% allowance for climate change.

Hydrological descriptors for the Site were obtained from the Flood Estimation Handbook (FEH) website (UK Centre for Ecology & Hydrology, 2023). These are shown in Table 4-3 below.

Table 4-3 FEH Hydrological Descriptors

Catchment descriptor	Abbreviation	Value
Base Flow Index associated with each HOST soil class	BFIHOST19	0.873
Proportion of time when soil moisture deficit was equal to, or below, 6mm during 1961-90	PROPWET	0.29 (i.e. 29% of the time)
Average Annual Rainfall (1961 – 1990)	SAAR	674 mm

The sub-catchment areas draining the Site are summarised in Table 4-4 below.

Table 4-4 Catchment areas draining to each SuDS feature

Catchment	Total area (ha)
Green roof	0.1883
Permeable paving	0.0812

In some instances it is appropriate to uplift impermeable surface areas to account for future development (i.e. an urban creep factor). This is appropriate in larger residential development where areas of greenspace may be subject to development under permitted development rights (such as minor extensions etc.). This is not applicable in this instance as the entirety of the Site area is being developed and there is no scope to increase the developed area within the catchments (it is noted that there is some additional storage capacity remaining in the permeable paving – see results later – if this remains a concern).

The dimensions/ details of the permeable pacing are presented below in Table 4-5 and the infiltration rate for the permeable paving was set to 0.0081 m/hr as discussed in Section 2.5.3

Appendix F contains the outputs from the MicroDrainage simulations. This confirms that, based on the parameters described above, the proposed drainage scheme will be able to manage all runoff generated during the 1 in 100 year storm event with a 40% allowance for climate change. A summary of the performance of the permeable paving under storm conditions is included in Table 4-6.

Appendix G includes a technical details of the proposed drainage system and demonstrates that the system would be gravity fed.

Table 4-5 Details of permeable paving

Feature	Feature invert level (m aOD)	Feature Depth (m)	Area (m^2)	Porosity	Total volume (m^3)
Permeable paving	46.05	1.0	812.32	0.3	243.69

Table 4-6 Performance of the SuDS features under a 1 in 100 year + 40% storm event.

Feature	Critical duration (mins)	Max. water level (m aOD)	Min. freeboard remaining (m)	Half drain time (mins)
Permeable paving	960	46.93	0.12	1,917

4.6 EXCEEDANCE ROUTES

The available freeboard within the permeable paving will ensure that their respective capacity will, in reality, be somewhat greater than the 1 in 100-year (plus 40% for climate change) event. Due consideration, however, also needs to be given to the exceedance routes that could occur during events above the design standard.

Figure 4.2 shows the expected exceedance routes in the event of the permeable paving's storage capacity being exceeded. Under this extreme scenario, exceedance flows from the paving will run off to the south or southwest to the sports facility areas in the academy (as per the current arrangements).

Figure 4.2 Exceedance flow routes

4.7 WATER QUALITY

SuDS techniques can be used to effectively manage the quality of surface water flowing across a site. Different methods can be used to intercept pollutants and allow them to degrade or be stored in-situ without impacting the quality of water further downstream. Frequent and short duration rainfall events are those that are most loaded with potential contaminants (silts, fines, heavy metals and various organic and inorganic contaminants). Therefore, the first 5mm to 10 mm of rainfall (i.e. the 'first flush') should be adequately treated using SuDS.

The proposed development will include a commercial building (with a green roof), and a car park. The CIRIA SuDS manual categorises runoff from commercial developments as presenting a medium water quality hazard level (although a low-medium risk would probably be more accurate in this instance).

Table 4-7 Water quality hazard ratings (CIRIA, 2015)

Land use	Hazard level
Residential roof drainage	Very Low
Residential, amenity uses including low usage car parking spaces and roads, other roof drainage.	Low
Commercial uses including car parking spaces and roads (excluding low usage roads, trunk roads and motorways).	**Medium**

Land use	Hazard level
Sites with heavy pollution (e.g. haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemical and fuels (other than domestic fuel oil) are delivered, handled, stored used or manufactured, industrial sites.	High
Trunk roads and motorways	High

The qualitative approach to designing a SuDS scheme set out in the CIRIA SuDS manual (CIRIA, 2015) has been applied in this instance. As the proposed development is commercial in nature with a medium-low hazard rating, hazard indices of 0.6 for total suspended solids (TSS), 0.6 for metals and 0.6 for hydrocarbons are considered applicable.

The following measures are examples which are suitable for inclusion in a drainage strategy for a commercial development to mitigate a potential increase in pollutant load within on-site and off-Site runoff. Removal indices are included for each feature type relative to the specific pollutant.

Table 4-8 Mitigation indices for SuDS components (discharges to ground)

Characteristics of the material overlying the proposed infiltration surface, through which the runoff percolates[1]	TSS	Metals	Hydrocarbons
A layer of dense vegetation underlain by a soil with good contaminant attenuation potential[2] of at least 300 mm in depth[3]	0.6[4]	0.5	0.6
A soil with good contaminant attenuation potential[2] of at least 300 mm in depth[3]	0.4[4]	0.3	0.3
Infiltration trench (where a suitable depth of filtration material is included that provides treatment, ie graded gravel with sufficient smaller particles but not single size coarse aggregate such as 20 mm gravel) underlain by a soil with good contaminant attenuation potential[2] of at least 300 mm in depth[3]	0.4[4]	0.4	0.4
Constructed permeable pavement (where a suitable filtration layer is included that provides treatment, and including a geotextile at the base separating the foundation from the subgrade) underlain by a soil with good contaminant attenuation potential[2] of at least 300 mm in depth[3]	0.7	0.6	0.7
Bioretention underlain by a soil with good contaminant attenuation potential[2] of at least 300 mm in depth[3]	0.8[4]	0.8	0.8
Proprietary treatment systems[5, 6]	These must demonstrate that they can address each of the contaminant types to acceptable levels for inflow concentrations relevant to the contributing drainage area.		

The widespread use of permeable paving and a green roof included in the SuDS Strategy for the proposed development will provide adequate treatment to mitigate the low-medium hazard associated with runoff from the development.

Inspection chambers and catchpits will be included to facilitate the maintenance of the paving and pipework to help reduce the build-up of material within the features.

4.8 SUDS MAINTENANCE

Inspection and long-term maintenance of SuDS components ensures efficient operation and prevents failure. Table 4-9 describes the management and maintenance requirements for the permeable paving. These requirements will be implemented following the completion of the proposed development.

Table 4-9 Management and maintenance requirements for SuDS features

SuDS Device	Maintenance requirements	Maintenance frequency
Permeable paving	• Initial inspection. • Inspect silt accumulation rates and establish appropriate brushing frequencies. • Inspect for evidence of poor operation and/or weed growth – if required, take remedial action. • Remediate any landscaping which through vegetation maintenance or soil slip, has been raised to within 50mm of the level of the paving. • Rehabilitation of surface and upper substructure by remedial sweeping.	• Monthly for first three months. • Annual. • Three-monthly, 48 hours after large storms in first six months. • As required. • Every 10 to 15 years or as required.

4.9 BIODIVERSITY AND AMENITY

SuDS schemes present opportunities to enhance habitat for wildlife on-Site and this often improves the biodiversity of the surrounding areas. Ponds, constructed wetlands and other surface water features are landscape assets that have amenity value and improve the aesthetics of a site more than conventional drainage systems. The use of a green roof will enhance the biodiversity and amenity value of the Site post-development when compared to the existing use.

5 Conclusions

This report provides a SuDS Strategy for the Site. The proposals include a green roof across the proposed building and permeable paving for proposed car parking areas which will be used to manage surface water runoff effectively from the Site for the lifetime of the development.

SuDS features will be used to intercept, store and transfer surface water runoff, before discharging to ground. The viability of infiltration based SuDS has been demonstrated via on-Site testing and groundwater monitoring has demonstrated that the invert level of the proposed permeable paving will be above the peak groundwater elevations across all seasons.

An assessment of the performance of the proposed system under the 1 in 1, 1 in 30 and 1 in 100 year + 40% climate change storm has been undertaken and shows that the proposed permeable paving is capable of accommodating and discharging the required stormwater runoff rates and volumes.

Appropriate management and maintenance arrangements for the proposed SuDS scheme will be in place throughout the lifetime of the proposed development.

References

Buckinghamshire Councy Council. (2020). *Minor Applications Sustainable Drainage Guidance.* Sustainable Drainage Team - Strategic Flood Management.

CIRIA. (2015). *The SuDS Manual V2. C753* .

DEFRA. (2015). *Sustainable drainage systems: non-statutory technical standards.*

Environment Agency. (2022). *Flood risk assessments: climate change allowances.*

UK Centre for Ecology & Hydrology. (2023). *Flood Estimation Handbook Web Service*. Retrieved from https://fehweb.ceh.ac.uk/GB/map

Appendices

Appendix A: Report Conditions

Report Conditions

This report has been prepared by Yellow Sub Geo Ltd. (Yellow Sub Geo) in its professional capacity as soil and groundwater specialists, with reasonable skill, care and diligence within the agreed scope and terms of contract and taking account of the manpower and resources devoted to it by agreement with its client, and is provided by Yellow Sub Geo solely for the internal use of its client.

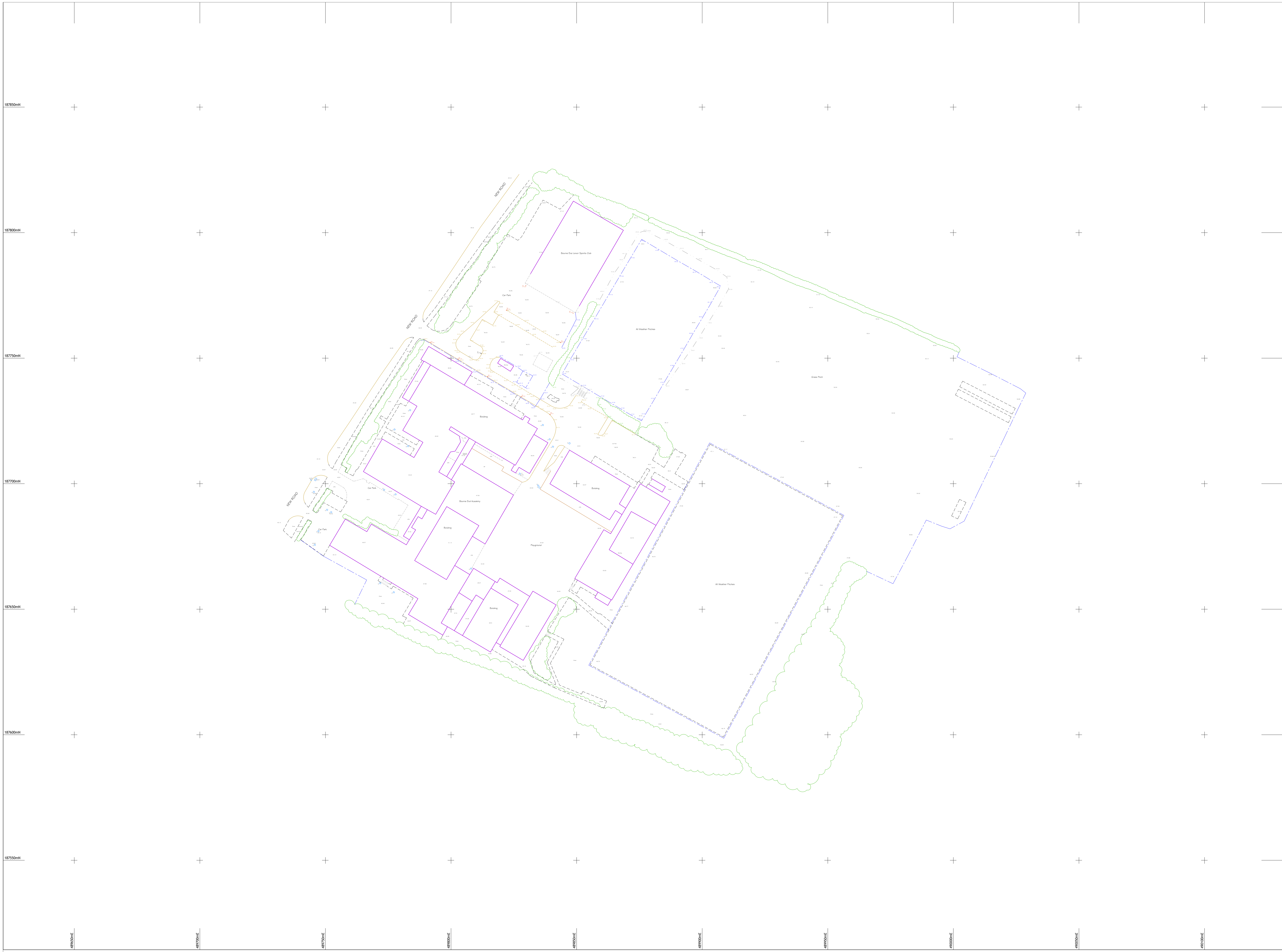
The advice and opinions in this report should be read and relied on only in the context of the report as a whole, taking account of the terms of reference agreed with the client. The findings are based on the information made available to Yellow Sub Geo at the date of the report (and will have been assumed to be correct) and on current UK standards, codes, technology and practices as at that time. They do not purport to include any manner of legal advice or opinion. New information or changes in conditions and regulatory requirements may occur in future, which will change the conclusions presented here.

Where necessary and appropriate, the report represents and relies on published information from third party, publicly and commercially available sources which is used in good faith of its accuracy and efficacy. Yellow Sub Geo cannot accept responsibility for the work of others.

Site investigation results necessarily rely on tests and observations within exploratory holes only. The inherent variation in ground conditions mean that the results may not be representative of ground conditions between exploratory holes. Yellow Sub Geo take no responsibility for variation in ground conditions between exploratory positions.

This report is confidential to the client. The client may submit the report to regulatory bodies, where appropriate. Should the client wish to release this report to any other third party for that party's reliance, Yellow Sub Geo may, by prior written agreement, agree to such release, provided that it is acknowledged that Yellow Sub Geo accepts no responsibility of any nature to any third party to whom this report or any part thereof is made known. Yellow Sub Geo accepts no responsibility for any loss or damage incurred as a result, and the third party does not acquire any rights whatsoever, contractual or otherwise, against Yellow Sub Geo except as expressly agreed with Yellow Sub Geo in writing. Yellow Sub Geo reserves the right to withhold and/ or negotiate the transference of reliance on this report, subject to legal and commercial review.

Appendix B: Topographical site survey



NOTES

1. The accuracy of this drawing is dependant on the original specification and MWSC should be consulted before use of other scales or use in CAD form.
2. Where underground services are shown, all reasonable care has been taken within the spirit of the original specification and requirement. Before use of this information the user should consult MWSC and satisfy themselves of the completeness and accuracy of such detail before undertaking any works.
3. All reasonable care has been taken in the survey detail represented on this drawing but any discrepancies must be reported to MWSC immediately. Our aim is to produce the best possible results within the specification and cost constraints of our clients. Any comments are most welcome.
4. This drawing is the property of MIKE WORBY SURVEY CONSULTANCY It may not be copied, altered or incorporated into any other data without prior consent
5. Layers prefixed by 'HIDE' contain level data that may be of interest to the user but have been 'turned off' to assist in the overall clarity of the drawing
6. Elevations are orthorectified images referenced to a single plane . Some distortion may occur where features do not lie on this plane.
7. Critical dimensions should be verified by the user on site.
8. Tree types shown on this drawing cannot be guaranteed and if critical should be verified by an arboriculturist.
9. Tree spreads and diameters are averages unless otherwise indicated.
10. This plan has been produced for the client detailed below or their appointed appointed agent to an agreed specification and defines the limit of MWSC liability
11. The Survey Reference System has been derived from Dual Frequency GPS Observations taken on Sept 3rd 2021 using Trimble VRS GNSS technology. Easting,Northing, Level values have been calculated from Ordnance Survey OSnet (GPS Satellite Transmissions) for the above date , the resultant grid coordinates derived from the OSGB36 reference framework and a 'plane' Grid created with scale factor = 1.0000 All levels are related to Ordnance Survey Orthometric Height.

N

ABBREVIATIONS

ab	Air Brick	dh	Duct Height	p/r/f	Post & Rail Fence
bol	Bollard or Bottom Heights	dp	Down Pipe	p/w/f	Post & Wire Fence
bb	Belisha Beacon	ecb	Electricity Control Box	r	Render
bd	Back Drop	elec	Electricity	rad	Radiator
bh	Borehole or Beam Height	pp	Electricity Pole	re	Rodding Eye
bl	Bed Level	fb	Flower Bed	rg	Rough Ground
bp	Brick Paviors	hyd	Fire Hydrant	rs	Road Sign
ret w	Brick Retaining Wall	ffl	Floor Level	rsj	Rolled Steel Joist
bs	Bus Stop	gul	Gully	rwp	Rain Water Pipe
bt	British Telecom	gsv	Gas Valve	s	Spread or Stone
btcb	BT Control Box	h	Height in Metres	sv	Stop Valve
bw	Brick Wall	h	Window Head Height	sl	Soffit Level or Skylight
b/w/f	Barbed Wire Fence	ht	Height	sp	Arch Springer Height
c	Window Cill Height	ic	Inspection Cover	sps	Stone Paving Slabs
cb	Control Box	il	Invert Level	sw	Stone Wall
c/b/f	Close Boarded Fence	i/r/f	Iron Railing Fence	tcsu	Traffic Control
cbw	Concrete Block Wall	iwf	Interwoven Fence	t	Top Heights
ccb	Cable TV Control Box	ko	Kerb Outlet	tl	Traffic Light
c/i/f	Corrugated Iron Fence	l	Light	tp	Telephone Pole
cl	Cover Level	lp	Lamp Post	tps	Tactile Paving Slabs
c/l/f	Chain Link Fence	mh	Manhole	utl	Unable To Lift
cl/s/f	Chain Link Security Fence	mkr	Marker	v	Vent
c/p/f	Concrete Panel Fence	ov	Over Flow Pipe	vp	Vent Pipe
cps	Concrete Paving Slabs	o/h	Overhead	w	Window
cr	Arch Crown Height	p	Post	wl	Water Level
crw	Concrete Retaining Wall	pal/f	Palisade Fence	wm	Water Meter
csu	Ceiling Slopes Up	p/f	Picket Fence	w/m/f	Wire Mesh Fence
catv	Cable Television	trp	Trial Pit	w/p/f	Wooden Panel Fence
cw	Concrete Wall	pl	Pavement Light	wsv	Water Valve
d	Diameter or Doors	pm	Parking Meter	ø	Diameter

SYMBOLS

Shrub
Tree (multibole)
Tree (single bole)
Top
Banks
Bottom
3.28 Floor to Ceiling Height
3.28 F False Ceiling Height
Overhead Detail
Change in Elevation
Fences
Overhead Cables
Change in Surface
Edge of Vegetation
Gate
Survey Station
Foul Water Sewer
Surface Water Sewer
Combined Sewer
Water Main
Gas Lp Main

0 5 10 25
scale bar (metres)

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MOBILE 07767 456196
EMAIL survey@mw-sc.co.uk

SURVEYORS TO THE THE BUILT ENVIRONMENT

CHARTERED LAND AND ENGINEERING SURVEYORS

Scale:	1 : 500 (A0)
Drawing no:	0821-16-01
Date:	surveyed Sept 2021
Drawn:	
File no.	

	Date	Amendments	Name
E			
D			
C			
B			
A			

BOURNE END SCHOOL – TOPOGRAPHIC SURVEY

Appendix C: Site development plans

EXISTING DORMER

EXISTING PITCHED ROOF

EXTG CAR PARK
66 SPACES

EXISTING CONIFER HEDGING

LINE OF PROPOSED POOL BUILDING

EXISTING TENNIS COURT

63 to 88 elsewhere on school grounds

NORTH

NEW ELECTRIC CHARGING 3 SPACES
EXISTING CAR PARK 65 SPACES
REVISED EXISTING CAR PARK 18 SPACES
NEW BUILDING CAR PARK 25 SPACES
SOMEWHERE ON SITE 35 SCHOOL SPACES

EXISTING BUILDING CAR PARK 35 SPACES NEEDED BASED 894M/2 DIVIDED 26
NEW BUILDING CAR PARK 60 SPACES NEEDED BASED 1583 + 277M/2 DIVIDED 26

STORR ARCHITECTURE

DESIGN / BUILD / PROJECT MANAGE

REV.	DATE	COMMENTS	AUTHOR / CHECKED

DRAWING NO. 501			**AGENT** STORR ARCHITECTURE
DATE MAY 21	**SCALE** 1:200	**SIZE** A1	**TITLE** BOURNE END JUNIOR SPORTS CLUB - SWIMMING POOL
STATUS FULL APPLICATION		**REV** .	**DETAIL** EXISTING SITE PLAN

0 200 400

SCALE BAR

M 2 10 20 30

EXISTING DORMER

EXISTING PITCHED ROOF

POTENTIAL GREEN WALL

NEW CURVED GREEN ROOF

EXTG CAR PARK
76 SPACES AFTER RE-ALIGNMENT

NEW SHEFFIELD CYCLE STANDS 12 NO

AMBULANCE ZONE

NORTH

NEW ELECTRIC CHARGING 3 SPACES
EXISTING CAR PARK 65 SPACES
REVISED EXISTING CAR PARK 18 SPACES
NEW BUILDING CAR PARK 25 SPACES
ELSEWHERE ON SITE 35 SCHOOL SPACES

EXISTING BUILDING CAR PARK 35 SPACES NEEDED
NEW BUILDING CAR PARK 60 SPACES NEEDED

STORR ARCHITECTURE
DESIGN / BUILD / PROJECT MANAGE

REV.	DATE	COMMENTS	AUTHOR / CHECKED

DRAWING NO. 502

AGENT STORR ARCHITECTURE

DATE MAY 21 | **SCALE** 1:200 | **SIZE** A1 | **TITLE** BOURNE END JUNIOR SPORTS CLUB - SWIMMING POOL

STATUS FULL-APPLICATION | **REV** . | **DETAIL** PROPOSED SITE PLAN

0 200 400

SCALE BAR
M 2 10 20 30

Appendix D: Thames Water sewer asset location plans

Asset location search

Property Searches

The Infrastructure Design Consultancy Ltd
48West End
WESTBURY
BA13 3JG

Search address supplied Bourne End Academy
New Road
Bourne End
SL8 5BW

Your reference BEJSC

Our reference ALS/ALS Standard/2021_4454598

Search date 23 June 2021

Knowledge of features below the surface is essential for every development

The benefits of this knowledge not only include ensuring due diligence and avoiding risk, but also being able to ascertain the feasibility of any development.

Did you know that Thames Water Property Searches can also provide a variety of utility searches including a more comprehensive view of utility providers' assets (across up to 35-45 different providers), as well as more focused searches relating to specific major utility companies such as National Grid (gas and electric).

Contact us to find out more.

Thames Water Utilities Ltd
Property Searches, PO Box 3189, Slough SL1 4WW
DX 151280 Slough 13

searches@thameswater.co.uk
www.thameswater-propertysearches.co.uk

0800 009 4540

Asset location search

Property Searches

Search address supplied: Bourne End Academy, New Road, Bourne End, SL8 5BW

Dear Sir / Madam

An Asset Location Search is recommended when undertaking a site development. It is essential to obtain information on the size and location of clean water and sewerage assets to safeguard against expensive damage and allow cost-effective service design.

The following records were searched in compiling this report: - the map of public sewers & the map of waterworks. Thames Water Utilities Ltd (TWUL) holds all of these.

This searchprovides maps showing the position, size of Thames Water assets close to the proposed development and also manhole cover and invert levels, where available.

Please note that none of the charges made for this report relate to the provision of Ordnance Survey mapping information. The replies contained in this letter are given following inspection of the public service records available to this company. No responsibility can be accepted for any error or omission in the replies.

You should be aware that the information contained on these plans is current only on the day that the plans are issued. The plans should only be used for the duration of the work that is being carried out at the present time. Under no circumstances should this data be copied or transmitted to parties other than those for whom the current work is being carried out.

Thames Water do update these service plans on a regular basis and failure to observe the above conditions could lead to damage arising to new or diverted services at a later date.

Contact Us

If you have any further queries regarding this enquiry please feel free to contact a member of the team on 0800 009 4540, or use the address below:

Thames Water Utilities Ltd
Property Searches
PO Box 3189
Slough
SL1 4WW

Email: searches@thameswater.co.uk
Web: www.thameswater-propertysearches.co.uk

Asset location search

Thames Water Property Searches

Waste Water Services

Please provide a copy extract from the public sewer map.

Enclosed is a map showing the approximate lines of our sewers. Our plans do not show sewer connections from individual properties or any sewers not owned by Thames Water unless specifically annotated otherwise. Records such as "private" pipework are in some cases available from the Building Control Department of the relevant Local Authority.

Where the Local Authority does not hold such plans it might be advisable to consult the property deeds for the site or contact neighbouring landowners.

This report relates only to sewerage apparatus of Thames Water Utilities Ltd, it does not disclose details of cables and or communications equipment that may be running through or around such apparatus.

The sewer level information contained in this response represents all of the level data available in our existing records. Should you require any further Information, please refer to the relevant section within the 'Further Contacts' page found later in this document.

For your guidance:

- The Company is not generally responsible for rivers, watercourses, ponds, culverts or highway drains. If any of these are shown on the copy extract they are shown for information only.
- Any private sewers or lateral drains which are indicated on the extract of the public sewer map as being subject to an agreement under Section 104 of the Water Industry Act 1991 are not an ‘as constructed’ record. It is recommended these details be checked with the developer.

Clean Water Services

Please provide a copy extract from the public water main map.

Enclosed is a map showing the approximate positions of our water mains and associated apparatus. Please note that records are not kept of the positions of individual domestic supplies.

For your information, there will be a pressure of at least 10m head at the outside stop valve. If you would like to know the static pressure, please contact our Customer Centre on 0800 316 9800. The Customer Centre can also arrange for a full flow and pressure test to be carried out for a fee.

For your guidance:

- Assets other than vested water mains may be shown on the plan, for information only.
- If an extract of the public water main record is enclosed, this will show known public water mains in the vicinity of the property. It should be possible to estimate the likely length and route of any private water supply pipe connecting the property to the public water network.

Payment for this Search

A charge will be added to your suppliers account.

Further contacts:

Waste Water queries

Should you require verification of the invert levels of public sewers, by site measurement, you will need to approach the relevant Thames Water Area Network Office for permission to lift the appropriate covers. This permission will usually involve you completing a TWOSA form. For further information please contact our Customer Centre on Tel: 0845 920 0800. Alternatively, a survey can be arranged, for a fee, through our Customer Centre on the above number.

If you have any questions regarding sewer connections, budget estimates, diversions, building over issues or any other questions regarding operational issues please direct them to our service desk. Which can be contacted by writing to:

Developer Services (Waste Water)
Thames Water
Clearwater Court
Vastern Road
Reading
RG1 8DB

Tel: 0800 009 3921
Email: developer.services@thameswater.co.uk

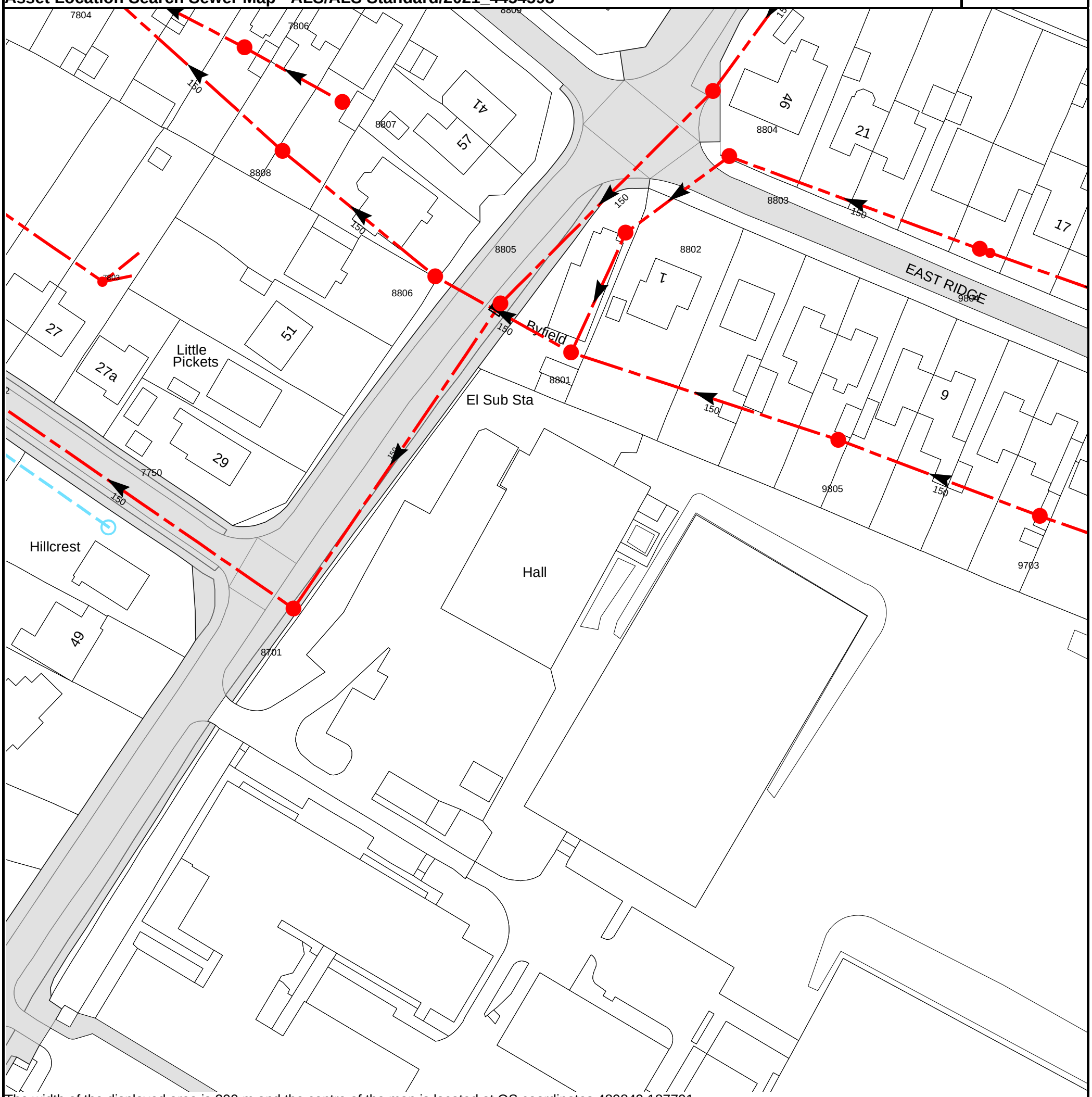
Clean Water queries

Should you require any advice concerning clean water operational issues or clean water connections, please contact:

Developer Services (Clean Water)
Thames Water
Clearwater Court
Vastern Road
Reading
RG1 8DB

Tel: 0800 009 3921
Email: developer.services@thameswater.co.uk

Asset Location Search Sewer Map - ALS/ALS Standard/2021_4454598



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 489849,187791

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

NB. Levels quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates that no survey information is available

Manhole Reference	Manhole Cover Level	Manhole Invert Level
7803	48.21	47.27
7750	47.14	45.84
7806	50.14	49.25
8808	50.02	48.24
8701	47.48	45.92
8807	50.76	49.87
8806	50.69	49.26
8805	50.06	48.78
8801	50.46	49.66
8802	51.12	50.19
8804	52.63	50.84
8803	52.65	51.36
9805	51.19	50.5
9804	53.73	52.21
9703	52.49	51.28

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

ALS Sewer Map Key

Public Sewer Types (Operated & Maintained by Thames Water)

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

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

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

Trunk Surface Water

Trunk Foul

Storm Relief

Trunk Combined

Vent Pipe

Bio-solids (Sludge)

Proposed Thames Surface Water Sewer

Proposed Thames Water Foul Sewer

Gallery

Foul Rising Main

Surface Water Rising Main

Combined Rising Main

Sludge Rising Main

Proposed Thames Water Rising Main

Vacuum

Sewer Fittings

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

Air Valve

Dam Chase

Fitting

Meter

Vent Column

Operational Controls

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

Control Valve

Drop Pipe

Ancillary

Weir

End Items

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

Outfall

Undefined End

Inlet

Other Symbols

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

Public/Private Pumping Station

Change of characteristic indicator (C.O.C.I.)

Invert Level

Summit

Areas

Lines denoting areas of underground surveys, etc.

Agreement

Operational Site

Chamber

Tunnel

Conduit Bridge

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

Foul Sewer

Surface Water Sewer

Combined Sewer

Gulley

Culverted Watercourse

Proposed

Abandoned Sewer

Notes:

1) All levels associated with the plans are to Ordnance Datum Newlyn.

2) All measurements on the plans are metric.

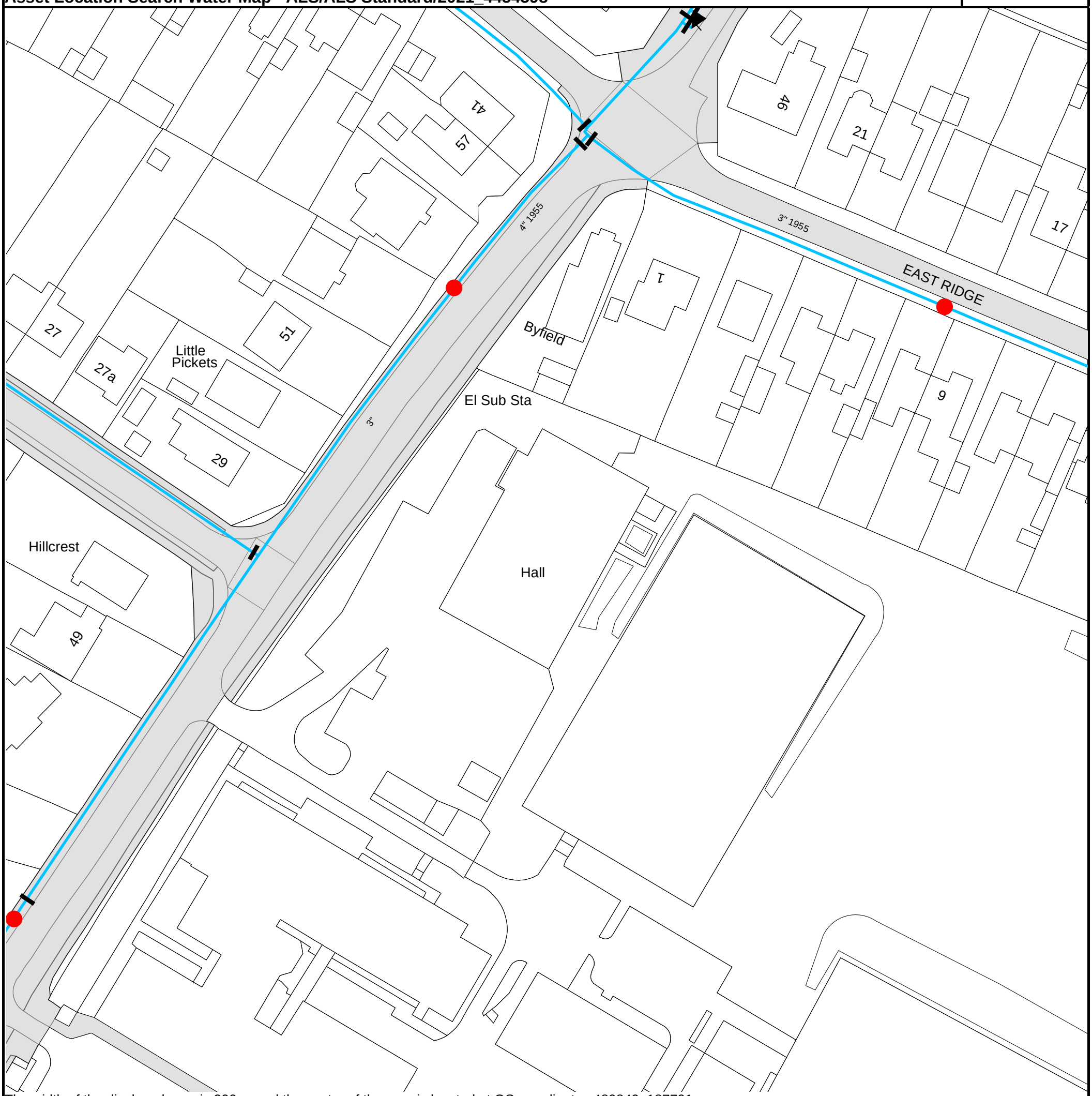
3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate direction of flow.

4) Most private pipes are not shown on our plans, as in the past, this information has not been recorded.

5) 'na' or '0' on a manhole level indicates that data is unavailable.

6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in milimetres. Text next to a manhole indicates the manhole reference number and should not be taken as a measurement. If you are unsure about any text or symbology present on the plan, please contact a member of Property Searches on 0800 009 4540.

Asset Location Search Water Map - ALS/ALS Standard/2021_4454598



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 489849, 187791.

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

ALS Water Map Key

Water Pipes (Operated & Maintained by Thames Water)

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

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

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

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

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

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

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

Valves

General Purpose Valve

Air Valve

Pressure Control Valve

Customer Valve

Hydrants

Single Hydrant

Meters

Meter

End Items

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

Blank Flange

Capped End

Emptying Pit

Undefined End

Manifold

Customer Supply

Fire Supply

Operational Sites

Booster Station

Other

Other (Proposed)

Pumping Station

Service Reservoir

Shaft Inspection

Treatment Works

Unknown

Water Tower

Other Symbols

Data Logger

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

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

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

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

Terms and Conditions

All sales are made in accordance with Thames Water Utilities Limited (TWUL) standard terms and conditions unless previously agreed in writing.

1. All goods remain in the property of Thames Water Utilities Ltd until full payment is received.
2. Provision of service will be in accordance with all legal requirements and published TWUL policies.
3. All invoices are strictly due for payment 14 days from due date of the invoice. Any other terms must be accepted/agreed in writing prior to provision of goods or service, or will be held to be invalid.
4. Thames Water does not accept post-dated cheques-any cheques received will be processed for payment on date of receipt.
5. In case of dispute TWUL`s terms and conditions shall apply.
6. Penalty interest may be invoked by TWUL in the event of unjustifiable payment delay. Interest charges will be in line with UK Statute Law 'The Late Payment of Commercial Debts (Interest) Act 1998'.
7. Interest will be charged in line with current Court Interest Charges, if legal action is taken.
8. A charge may be made at the discretion of the company for increased administration costs.

A copy of Thames Water's standard terms and conditions are available from the Commercial Billing Team (cashoperations@thameswater.co.uk).

We publish several Codes of Practice including a guaranteed standards scheme. You can obtain copies of these leaflets by calling us on 0800 316 9800

If you are unhappy with our service you can speak to your original goods or customer service provider. If you are not satisfied with the response, your complaint will be reviewed by the Customer Services Director. You can write to her at: Thames Water Utilities Ltd. PO Box 492, Swindon, SN38 8TU.

If the Goods or Services covered by this invoice falls under the regulation of the 1991 Water Industry Act, and you remain dissatisfied you can refer your complaint to Consumer Council for Water on 0121 345 1000 or write to them at Consumer Council for Water, 1st Floor, Victoria Square House, Victoria Square, Birmingham, B2 4AJ.

Ways to pay your bill

Credit Card	**BACS Payment**	**Telephone Banking**	**Cheque**
Call **0800 009 4540** quoting your invoice number starting CBA or ADS / OSS	Account number **90478703** Sort code **60-00-01** A remittance advice must be sent to: **Thames Water Utilities Ltd., PO Box 3189, Slough SL1 4WW.** or email **ps.billing@thameswater.co.uk**	By calling your bank and quoting: Account number **90478703** Sort code **60-00-01** and your invoice number	Made payable to '**Thames Water Utilities Ltd**' Write your Thames Water account number on the back. Send to: **Thames Water Utilities Ltd., PO Box 3189, Slough SL1 4WW** or by DX to **151280 Slough 13**

Thames Water Utilities Ltd Registered in England & Wales No. 2366661 Registered Office Clearwater Court, Vastern Rd, Reading, Berks, RG1 8DB.

Appendix E: Site investigation report

Bourne End Junior Sports Club: Ground Water Monitoring Report

P22505_R1_Rev1

March 2023

Table of Contents

Registered in England and Wales with Company No. 10888960 at 7 Neptune Court, Vanguard Way, Cardiff, CF24 5PJ.

Tables

Drawings

Appendices

Registered in England and Wales with Company No. 10888960 at 7 Neptune Court, Vanguard Way, Cardiff, CF24 5PJ.

Document Control

Title

Bourne End Junior Sports Club: Ground Water Monitoring Report

Client

Bourne End Junior Sports Club,
New Road,
Bourne End,
SL8 5BS

Reference

P22505_R1_REV1

Status

Final

Document Control

Document Reference	Issue Date	Comments	Written by	Approved by
P22505_R1	December 2022	First issue	RLW	JEM
P25505_R1_REV1	March 2023	Updated groundwater monitoring	RLW	JEM

Registered in England and Wales with Company No. 10888960 at 7 Neptune Court, Vanguard Way, Cardiff, CF24 5PJ.

1. Introduction

1.1. Instruction

Yellow Sub Geo Ltd (Yellow Sub) was instructed by Bourne End Junior Sports Club (BEJSC; the Client) to undertake a ground investigation and subsequent ground water monitoring for BEJSC, Bourne End (the Site).

1.2. Site description

The Site comprises a carpark which lies to the south of the existing sports club and a strip of land between the carpark and tennis courts of the adjacent Bourne End Academy. A Site location plan is presented in drawing P22505_R1_D01.

1.3. Brief and background

The Client is seeking to obtain planning permission for the construction of a detached pool and building with associated parking. Buckinghamshire Council (the Council) has objected to the proposed development on the basis of there being insufficient information regarding the proposed surface water drainage scheme. The Council state the following is required:

- *Ground investigations including:*
    - *Additional infiltration rate testing in accordance with BRE 365 (or as close to as reasonably practicable) the proposed depth and location of infiltrating SuDS components*
    - *Groundwater monitoring from November-March*
- *If ground investigations are unable to be completed at this stage of the planning process, an alternative viable scheme must be demonstrated*
- *Calculations to demonstrate that the system as a whole can contain up to the 1 in 30-year storm event. Any flooding between the 1 in 30 and 1 in 100 year plus 40% climate change storm allowance storm event should be safely contained onsite.*
- *Updated drainage layout clearly showing storage volumes of all SuDS components*

Yellow Sub have been instructed to provide a suitable Site investigation and assessment to support the removal of this objection. It is noted that this report does not cover all of the points listed above but sets out the ground conditions and principles behind adopting infiltration drainage at the Site such that the SuDS strategy may be updated.

1.4. Scope

The scope of work presented within this report pertains to the installation of groundwater monitoring wells and subsequent infiltration testing and monitoring results.

1.5. Limitations

This report is written strictly for the benefit of the Client and bound by the conditions presented in Appendix A.

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2. Fieldwork

Fieldwork was undertaken on the 28th October 2022 with the location of each exploratory hole agreed with the Client and designed to minimise Site damage whilst providing suitable coverage. Drawing P22505_R1_D02 details the locations of the exploratory holes with the ground conditions encountered discussed in Section 3. The works undertaken are summarised in Table 2-1.

Table 2-1 Summary of fieldwork undertaken

Work element	Comments/ rationale
Utilities and service clearance	Each position was checked for services by trained and competent Yellow Sub staff using non-intrusive CAT and Genny techniques.
Exploratory Positions	Three windowless sampler boreholes (WS01 to WS03) were drilled to depths of between 2.1m and 4.9m below ground level (m bgl). All three boreholes were terminated within the Taplow Gravel Member.
Logging of strata	All strata were logged by competent Yellow Sub staff in accordance with BS5930. The engineering logs are presented in Appendix B.
Installations	All 3No. boreholes were installed with a slotted observation pipe prior to being backfilled with arisings, a bentonite seal and a flush cover for future groundwater monitoring purposes.
Ground water monitoring	The installed groundwater monitoring wells have been subsequently monitored on an approximate fortnightly basis.
Infiltration testing	Falling head infiltration testing undertaken in WS01 and WS03 by inundating the installation with potable water to the required depth. Water levels were measured at regular intervals across the test period. Where successful, repeat up to a total of 3No. tests were undertaken in each borehole. The results of this testing are presented in Appendix C.

3. Ground conditions

3.1. Strata encountered

Engineering logs of each exploratory hole can be found in Appendix B. The location of each exploratory position is shown on drawing P22505_R1_D02. The strata encountered during the fieldwork are summarised Table 3-1.

Table 3-1 Strata encountered

Strata	Description	Depth range (m bgl)	Typical thickness (m)
Topsoil	Encountered across Site with grass covering and abundant rootlets.	GL-0.1	0.1
Made Ground (reworked Taplow Gravel Member)	Encountered only in WS03 as a soft, dark brown, sandy, gravelly CLAY. Sand is fine to medium. Gravel is fine to coarse of flint and brick. Rare glass fragments noted.	0.1-0.8	0.7
Taplow Gravel Member	Encountered across the Site and varying between a sandy, gravelly CLAY, a clayey, sandy GRAVEL and a gravelly sand.	0.1-4.9	>4.8 (Base not proven)

GL: Ground Level

3.2. Obstructions and Stability

The windowless sampler refused in the Taplow Gravel Member in all exploratory positions, the depths of which are summarised in Table 3-2 **Error! Reference source not found.** below.

Table 3-2 Summary of progress and obstructions

Exploratory position	Final drilled depth (m bgl)	Final installed depth (m bgl)	Stability
WS01	4.9	4.5	Borehole collapsed to 4.5m bgl.
WS02	2.1	2.1	Remained open and stable.
WS03	2.5	2.1	Borehole collapsed to 2.1m bgl.

3.3. Visual and olfactory evidence of contamination

There was no visual or olfactory evidence of contamination recorded in any of the exploratory positions.

3.4. Groundwater

3.4.1. Groundwater Strikes

Groundwater was not encountered in any of the exploratory positions.

3.4.2. Groundwater Monitoring

Groundwater levels were monitored at the cessation of fieldwork on the 28th October 2022 and again during return visits as summarised in Table 3-3.

Table 3-3 Summary of groundwater monitoring data

Exploratory hole	WS01 (m bgl)	WS02 (m bgl)	WS03 (m bgl)
2022			
28th October	Dry	Dry	Dry
7th November	Dry	Dry	Dry
14th November	Dry	Dry	Dry
21st November	Dry	Dry	Dry
30th November	Dry	1.99*	Dry
12th December	Dry	Dry	Dry
2023			
18th January	Dry	Dry	Dry
25th January	Dry	Dry	Dry
14th February	Dry	Dry	Dry
3rd March	Dry	Dry	Dry

* Water trapped in base of installation – bailed out

3.4.3. Summary of infiltration testing results

Falling head permeability (infiltration) testing was undertaken in WS01 and WS03 as summarised in

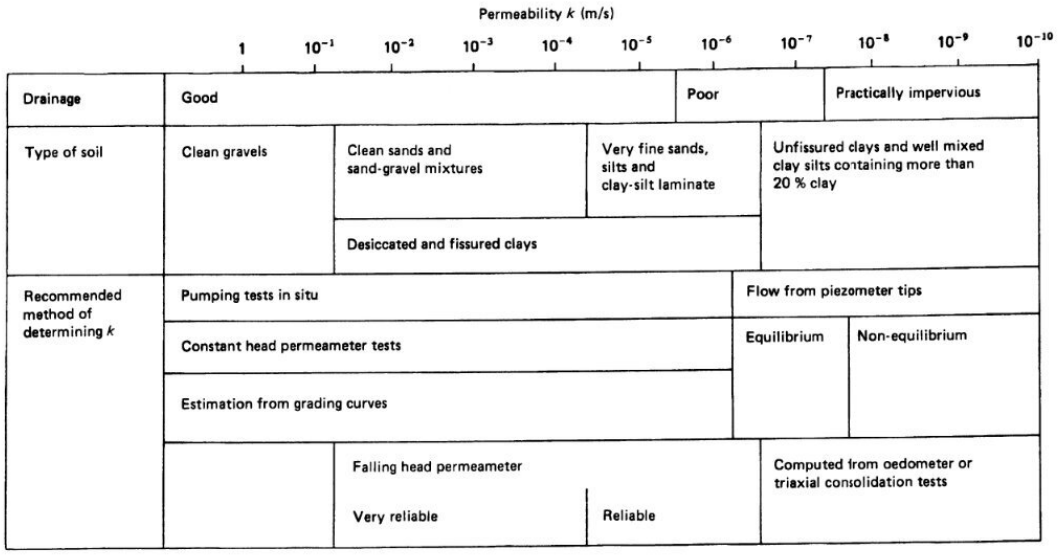
Table 3-4 below with full results presented in Appendix C. The infiltration values for each pit have been calculated in accordance with the methodology set out in BRE 365. However, whilst it is acknowledged that the below is not strictly in accordance with BRE365, the results demonstrate the principal of infiltration which is considered suitable at this stage given the Site constraints (active car park).

Table 3-4 Summary of infiltration testing

Borehole	Test	Depth of borehole (m)	Geology of test section	Permeability (m/s)	Average (m/s)
WS01	1	4.5	Taplow Gravel Member	1.32E-06	1.69E-06
	2			2.12E-06	
	3			1.65E-06	
WS03	1	2.4	Taplow Gravel Member	2.83E-06	2.83E-06

Figure 3-1 below classifies the soil as very fine sands, silts and clay-silt laminate with poor to good drainage. It should be noted that for each test completed, infiltration was rapid with water draining away completely within 10 minutes. The above differs to the current rate proposed in the SuDS strategy undertaken by Lanes Group Plc but remains a suitable value for infiltration drainage to be adopted at the Site.

Figure 3-1 Permeability and drainage characteristics of soils from BS 8004:2015+A1:2020



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4. Conclusions and recommendations

4.1. Ground conditions encountered

The site investigation confirmed the published geology at the Site which generally comprised limited Made Ground underlain by the Taplow Gravel Member to a maximum proven depth of 4.9m bgl.

No groundwater strikes were noted within any of the boreholes and all three boreholes remained dry throughout October and much of November. Limited groundwater was recorded in the base of WS02 in a return monitoring visit on 30th November and again in WS02 and WS03 on 12th December. However, a consistent groundwater table has not been identified across the Site despite a prolonged period of heavy rainfall in late October into mid November 2022.

4.2. Infiltration drainage potential

Falling head permeability (infiltration) testing was undertaken in WS01 and WS03 with three repeat tests completed for WS01. In all tests completed, infiltration was rapid, with water draining away entirely within 10 minutes. Based on this data, permeability at the Site is estimated to be between $1x10^{-6}$m/s and $1x10^{-5}$m/s. As all positions drained away within sufficient timescales, it is suggested that soakaway drainage will likely be appropriate for the Site.

4.3. Recommendations

Whilst not strictly in accordance with BRE365, the above is considered suitable to demonstrate that infiltration drainage is likely to be feasible at the Site using the proposed permeable paving sub-base to provide storage prior to discharge to ground.

Therefore, subject to a revised drainage strategy using the above calculated values, it is considered that the objection may be lifted pending further investigation and assessment to be delivered via a suitable condition of planning.

5. References

Building Research Establishment Digest 365: Soakaway Design, 2016

British Standards BS8004:2015+A1:2020

Drawings

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Vanguard Way, Cardiff, CF24 5PJ.

Appendices

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Vanguard Way, Cardiff, CF24 5PJ.

Appendix A: Report Conditions

Registered in England and Wales with Company No. 10888960 at 7 Neptune Court,
Vanguard Way, Cardiff, CF24 5PJ.

Report Conditions

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Appendix B: Engineering Logs

Registered in England and Wales with Company No. 10888960 at 7 Neptune Court,
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Borehole Log

WS01
Page 1 of 1

Project Name: Bourne End Junior Sports Club Project No: P22505

Location: New Road, Bourne End Co-ords: 51.581498 - -0.705071 Level:

Hole Type: WS Logged By: RLW Dates: 28/10/2022 - 28/10/2022

Client: BEJSC Consultant: RLW

Plant Used: DART 540 SPT Hammer Serial No:

Well	Water	Depth	Legend	Stratum Description	Detailed Description	Depth m
		0.10		Topsoil with grass and abundant rootlets		
				Soft, dark brown, slightly sandy, gravelly CLAY. Sand is fine to medium. Gravel is fine to coarse, predominantly coarse, sub angular of flint and rare fine brick. Abundant rootlets throughout. (TAPLOW GRAVEL MEMBER)	At 0.5-0.7m bgl: becoming lighter brown in colour and gravel beoming rare.	0.5
		0.70				
				Orangish brown, clayey, sandy GRAVEL. Sand is medium. Gravel is fine to coarse, predominantly coarse, sub angular to angular of flint. (TAPLOW GRAVEL MEMBER)	At 1.3m bgl: Flint cobble.	1.0
		1.40				
				Very stiff, orangish brown, sandy CLAY. Sand is fine to medium. (TAPLOW GRAVEL MEMBER)	At 1.8-1.9m bgl: Coarse gravel of flint. At 2-2.3m bgl: Mottled light grey. At 2.5m bgl: Becoming soft.	1.5 2.0 2.5
		2.60		Light grey, silty, gravelly CLAY. Gravel is coarse, sub rounded of weathered chalk and flint. (TAPLOW GRAVEL MEMBER)		
		3.00		No recovery.		3.0 3.5
		3.70		Orangish brown, sandy GRAVEL. Sand is coarse. Gravel is fine to coarse, angular of flint. (TAPLOW GRAVEL MEMBER)		
		4.00		No recovery.		4.0
		4.70		Orangish brown, sandy GRAVEL. Sand is coarse. Gravel is fine to coarse, angular of flint. Occassional shell fragments noted. (TAPLOW GRAVEL MEMBER)		4.5
		4.90				

Borehole cleared with CAT and genny and hand dug service pit to 1.2m bgl. Window sampling terminated at 4.9m bgl due to refusal in gravel. Position installedwith 0.5m and 4.5m slotted pipe.

Borehole Log

WS02
Page 1 of 1

Project Name: Bourne End Junior Sports Club Project No: P22505

Location: New Road, Bourne End Co-ords: 51.581521 - -0.704486 Level:

Hole Type: WS Logged By: RLW Dates: 28/10/2022 - 28/10/2022

Client: BEJSC Consultant: RLW

Plant Used: DART 540 SPT Hammer Serial No:

Well	Water	Depth	Legend	Stratum Description	Detailed Description	Depth m
		0.05		Topsoil with grass and abundant rootlets		
		0.60		Soft, dark brown, sandy, slightly gravelly CLAY. Sand is fine to medium. Gravel is fine to coarse, predominantly medium, sub angular of flint and occasional sandstone. Abundant roots up to 30cm. (TAPLOW GRAVEL MEMBER)		0.5
		1.70		Soft, orangish brown, gravelly CLAY. Gravel is fine to coarse, predominantly coarse of sub angular to sub rounded flint. Rare flint cobbles. (TAPLOW GRAVEL MEMBER)		1.0
		2.00		Stiff, orangish brown, sandy CLAY. Sand is fine to medium. (TAPLOW GRAVEL MEMBER)	At 1.9m bgl: Flint cobble.	1.5
		2.10		Orangish brown, gravelly SAND. Sand is medium to coarse. Gravel is fine to coarse, predominantly coarse, sub angular of flint. (TAPLOW GRAVEL MEMBER)		2.0
						2.5
						3.0
						3.5
						4.0
						4.5

Borehole cleared with CAT and genny and hand dug service pit to 1.2m bgl. Window sampling terminated at 2.1m bgl due to refusal in sand. Position installed with 0.5m plain and 1.6m slotted pipe.

Borehole Log

WS03
Page 1 of 1

Project Name: Bourne End Junior Sports Club Project No: P22505

Location: New Road, Bourne End Co-ords: 51.581612 - -0.703036 Level:

Hole Type: WS Logged By: RLW Dates: 28/10/2022 - 28/10/2022

Client: BEJSC Consultant: RLW

Plant Used: DART 540 SPT Hammer Serial No:

Well	Water	Depth	Legend	Stratum Description	Detailed Description	Depth m
		0.10		Topsoil with grass and abundant rootlets		
		0.80		MADE GROUND: Soft, dark brown, sandy, gravelly CLAY. Sand is fine to medium, gravel is fine to coarse, predominantly coarse, sub rounded of flint and occasional brick. Rare glass fragments.		
		1.50		Brown, slightly sandy, clayey GRAVEL. Sand is medium. Gravel is fine to coarse, predominantly coarse, angular of flint. (TAPLOW GRAVEL MEMBER)		
		1.70		Stiff, orangish brown, sandy, slightly gravelly CLAY. Sand is fine to medium. Gravel is fine of flint. (TAPLOW GRAVEL MEMBER)		
		2.50		Brown, slightly sandy, clayey GRAVEL. Sand is coarse. Gravel is fine to coarse, predominantly coarse, angular of flint. (TAPLOW GRAVEL MEMBER)		

0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5

Borehole cleared with CAT and genny and hand dug service pit to 1.2m bgl. Window sampling terminated at 2.5m bgl due to refusal in gravel. Borehole collapsed to 2.1m bgl before installation. Position installed with 1m plain and 1.1m slotted pipe.

Appendix C: Infiltration Testing

Registered in England and Wales with Company No. 10888960 at 7 Neptune Court,
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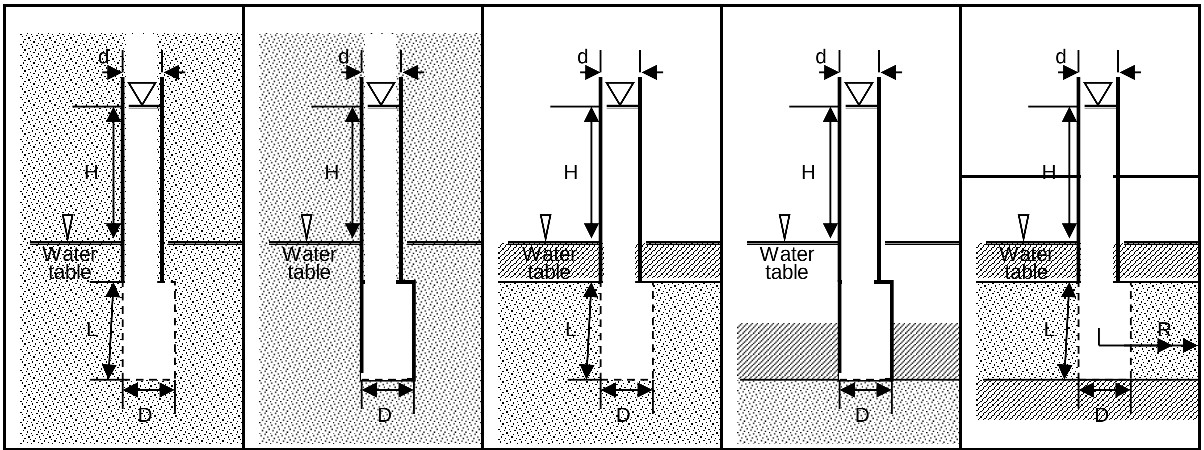
Project:	BEJSC			Project no.:	P22505
Borehole:	WS03	Test date:	30-Nov-22	Calc. by:	RLW	Checked by:	

Note: input data only into yellow-highlighted cells: do not amend any other cell, even if it appears blank.

Select test conditions, 1 to 5, from the list below: 1



1. Well in uniform soil	2. Flush bottom in uniform soil	3. Well at impervious boundary	4. Flush bottom at impervious boundary	5. Well with confined flow

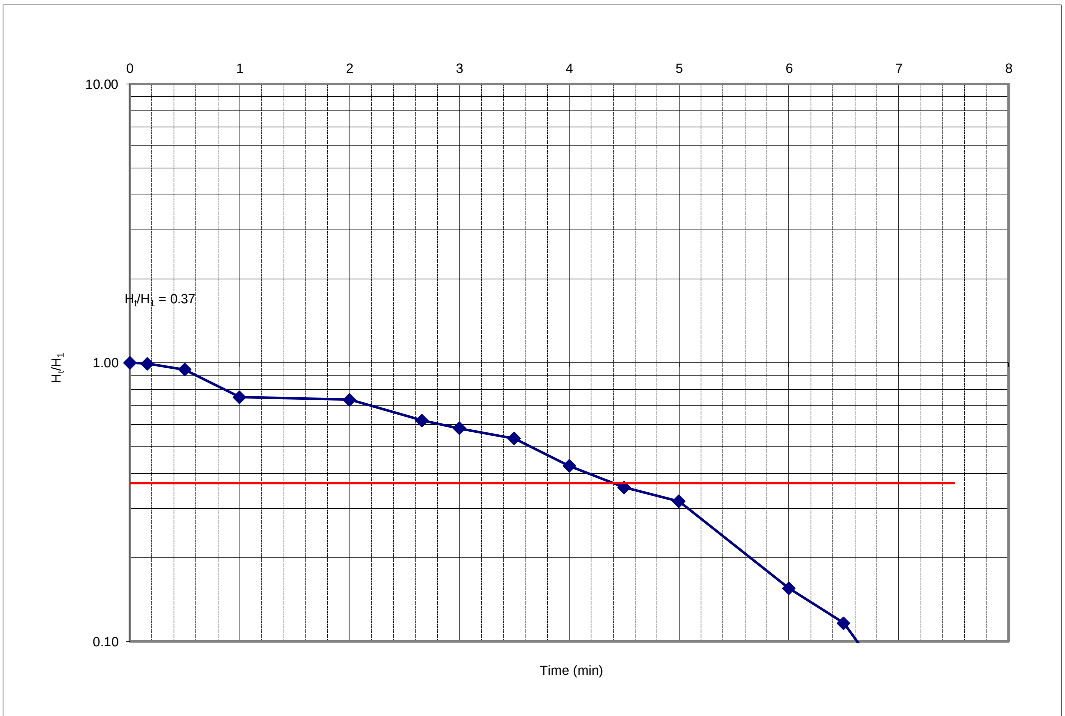
READINGS

Time (minutes)	Water depth (m from top of casing)	Proportional head, H_t/H_0
0	1.11	1.00
0.16	1.12	0.99
0.5	1.18	0.95
1	1.43	0.75
2	1.45	0.74
2.66	1.6	0.62
3	1.650	0.58
3.5	1.710	0.53
4	1.85	0.43
4.5	1.94	0.36
5	1.99	0.32
6	2.2	0.16
6.5	2.25	0.12
7	2.32	0.06
7.5	2.4	0.00
		1.86
		1.86
		1.86
		1.86
		1.86
		1.86
		1.86
		1.86
		1.86
		1.86
		1.86
		1.86
		1.86
		1.86
		1.86
		1.86
		1.86
		1.86
		1.86
		1.86

RESPONSE ZONE DETAILS

Top of test section (m bgl)	Bottom of test section (m bgl)	Height of casing above ground (m)	Casing or standpipe diameter, d (m)	Test section diameter, D (m)	Depth to water table (m bgl)	Dist. to water source (m) - condition 5 only
1.00	2.40	0.00	0.05	0.115	2.40	

ERROR MESSAGES



TIME LAG VALUE (FROM GRAPH)

BASIC TIME LAG, T (min to reach Ht/H_0=0.37) - from graph	4.2
BASIC TIME LAG (seconds)	252

CALCULATED VALUES

Length of test section, L	1.40
Initial head of water, H_0	1.29

PERMEABILITY (m/s)	2.83E-06

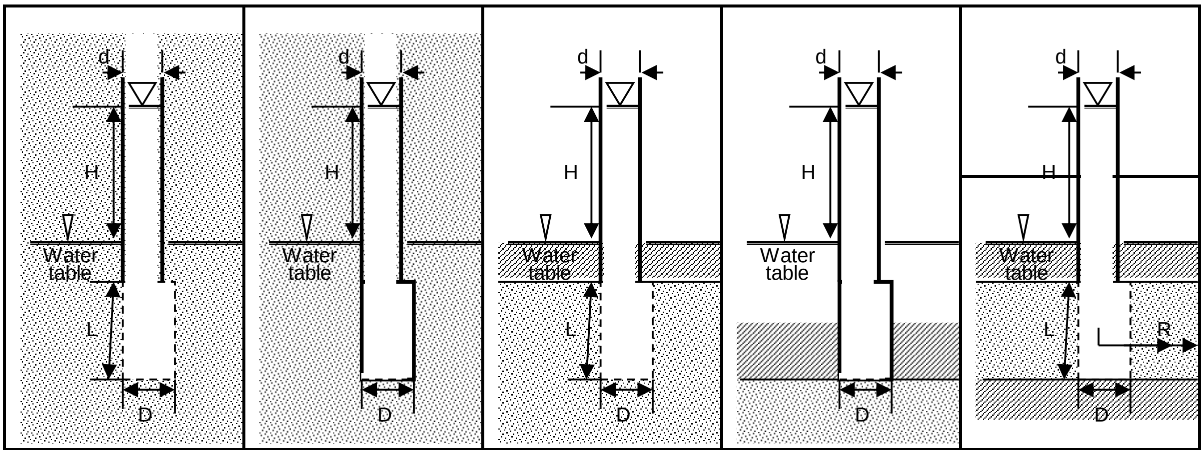
FIELD PERMEABILITY - TESTS WITHOUT OBSERVATION WELLS | 9-1

October 2007 | **APPENDIX TO CHAPTER 3** | **Sheet 3 of 4**

Project:	**BEJSC**			Project no.:	**P22505**
Borehole:	**WS01 Test 1**	Test date:	**30-Nov-22**	Calc. by: **RLW**	Checked by:

Note: input data only into yellow-highlighted cells: do not amend any other cell, even if it appears blank.

Select test conditions, 1 to 5, from the list below: 1



1. Well in uniform soil	2. Flush bottom in uniform soil	3. Well at impervious boundary	4. Flush bottom at impervious boundary	5. Well with confined flow

READINGS

Time (minutes)	Water depth (m from top of casing)	Proportional head, H_t/H_0
0	0.48	1.00
0.5	0.94	0.89
0.83	1.27	0.80
2	2.2	0.57
2.25	2.26	0.56
3	2.67	0.46
3.75	2.750	0.44
4.5	3.400	0.27
5.5	4.42	0.02
6	4.5	0.00
		1.12
		1.12
		1.12
		1.12
		1.12
		1.12
		1.12
		1.12
		1.12
		1.12
		1.12
		1.12
		1.12
		1.12
		1.12
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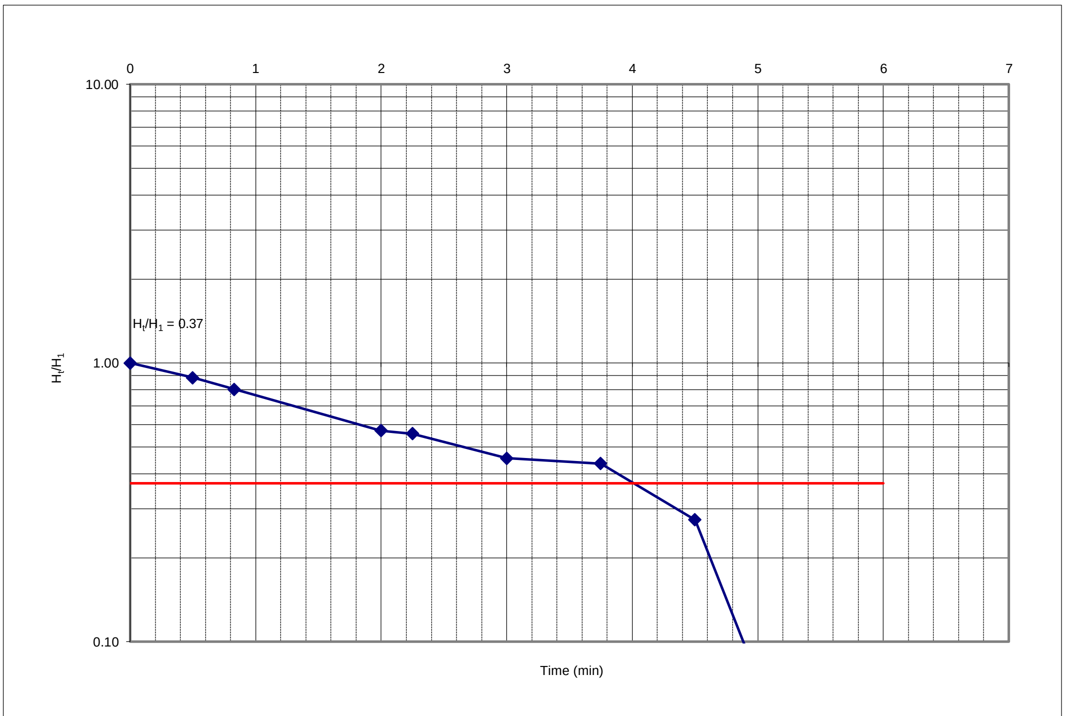
		1.12
		1.12
		1.12
		1.12
		1.12
		1.12
		1.12

RESPONSE ZONE DETAILS

Top of test section (m bgl)	Bottom of test section (m bgl)	Height of casing above ground (m)	Casing or standpipe diameter, d (m)	Test section diameter, D (m)	Depth to water table (m bgl)	Dist. to water source (m) - condition 5 only
0.50	4.50	0.00	0.05	0.115	4.50	

ERROR MESSAGES



TIME LAG VALUE (FROM GRAPH)

BASIC TIME LAG, T (min to reach Ht/H_0=0.37) - from graph	4.7
BASIC TIME LAG (seconds)	282

CALCULATED VALUES

Length of test section, L	4.00
Initial head of water, H_0	4.02

PERMEABILITY (m/s)	**1.18E-06**

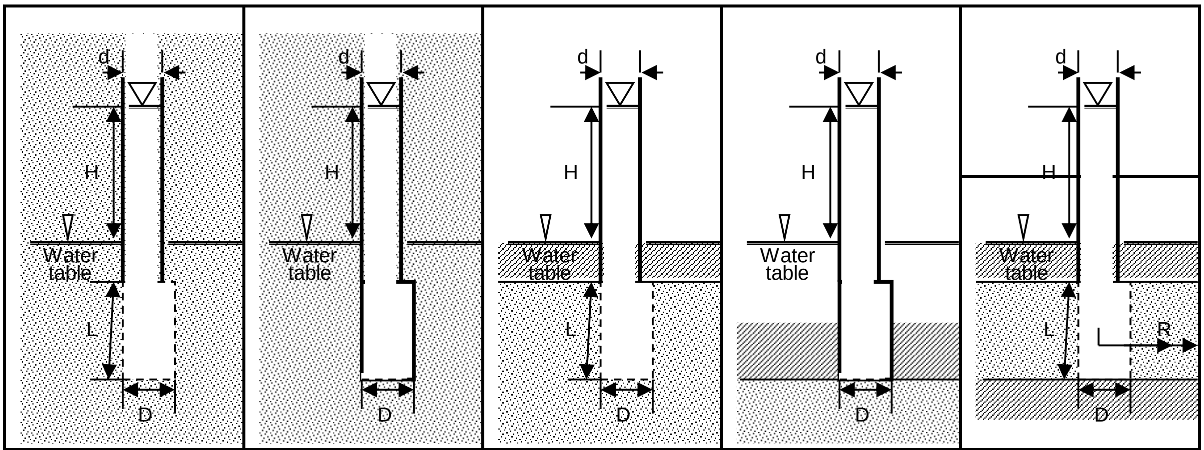
FIELD PERMEABILITY - TESTS WITHOUT OBSERVATION WELLS | 9-1

October 2007 | **APPENDIX TO CHAPTER 3** | **Sheet 3 of 4**

Project:	**BEJSC**			Project no.:	**P22505**
Borehole:	**WS01 Test 2**	Test date:	**30-Nov-22**	Calc. by: **RLW**	Checked by:

Note: input data only into yellow-highlighted cells: do not amend any other cell, even if it appears blank.

Select test conditions, 1 to 5, from the list below: 1



1. Well in uniform soil	2. Flush bottom in uniform soil	3. Well at impervious boundary	4. Flush bottom at impervious boundary	5. Well with confined flow

READINGS

Time (minutes)	Water depth (m from top of casing)	Proportional head, H_t/H_0
0	1.07	1.00
0.5	1.42	0.90
1	1.72	0.81
2	2.69	0.53
2.66	3.65	0.25
3.5	3.9	0.17
4.25	4.500	0.00
		1.31
		1.31
		1.31
		1.31
		1.31
		1.31
		1.31
		1.31
		1.31
		1.31
		1.31
		1.31
		1.31
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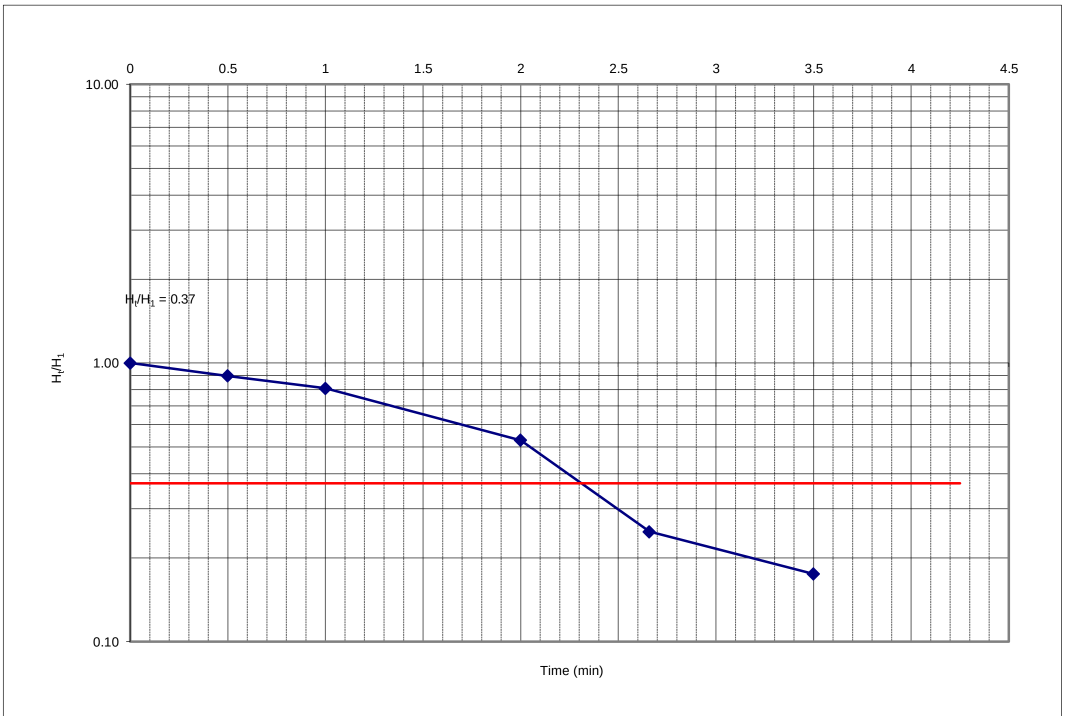
		1.31
		1.31
		1.31
		1.31
		1.31
		1.31
		1.31
		1.31

RESPONSE ZONE DETAILS

Top of test section (m bgl)	Bottom of test section (m bgl)	Height of casing above ground (m)	Casing or standpipe diameter, d (m)	Test section diameter, D (m)	Depth to water table (m bgl)	Dist. to water source (m) - condition 5 only
0.50	4.50	0.00	0.05	0.115	4.50	

ERROR MESSAGES



TIME LAG VALUE (FROM GRAPH)

BASIC TIME LAG, T (min to reach Ht/H_0=0.37) - from graph	2.7
BASIC TIME LAG (seconds)	162

CALCULATED VALUES

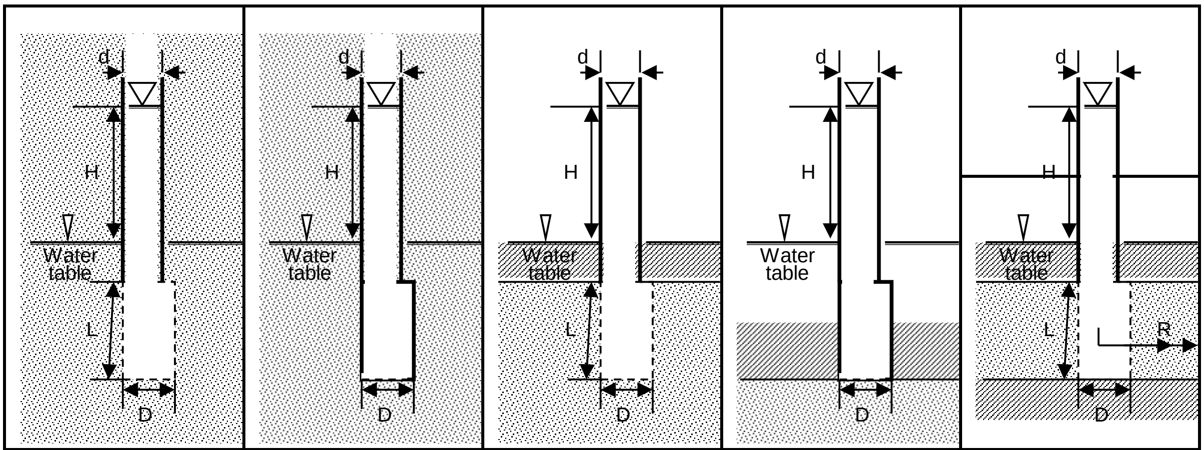
Length of test section, L	4.00
Initial head of water, H_0	3.43

PERMEABILITY (m/s)	**2.05E-06**

Project:	BEJSC			Project no.:	P22505
Borehole:	WS01 Test 3	Test date:	30-Nov-22	Calc. by:	RLW	Checked by:	

Note: input data only into yellow-highlighted cells: do not amend any other cell, even if it appears blank.

Select test conditions, 1 to 5, from the list below: 1



1. Well in uniform soil	2. Flush bottom in uniform soil	3. Well at impervious boundary	4. Flush bottom at impervious boundary	5. Well with confined flow

READINGS

Time (minutes)	Water depth (m from top of casing)	Proportional head, H_t/H_0
0	0.39	1.00
0.5	0.44	0.99
1	0.56	0.96
1.5	0.6	0.95
1.75	0.89	0.88
2.33	2.37	0.52
3.33	2.900	0.39
4	4.400	0.02
4.33	4.49	0.00
5	4.5	0.00
		1.09
		1.09
		1.09
		1.09
		1.09
		1.09
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		1.09
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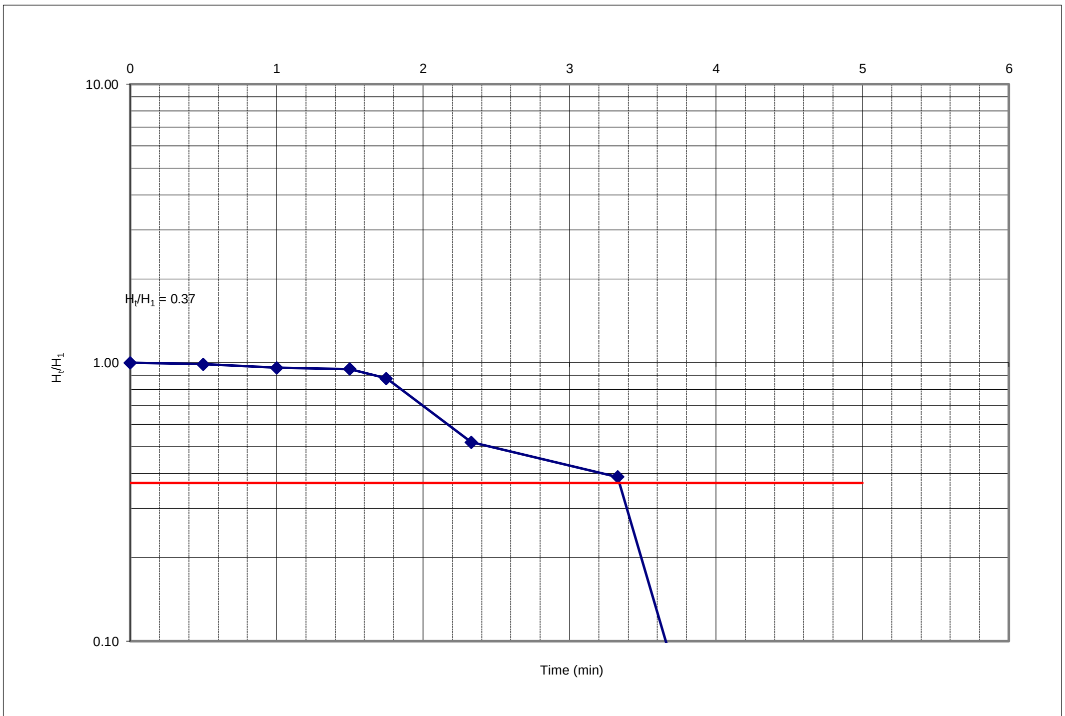
		1.09
		1.09
		1.09

RESPONSE ZONE DETAILS

Top of test section (m bgl)	Bottom of test section (m bgl)	Height of casing above ground (m)	Casing or standpipe diameter, d (m)	Test section diameter, D (m)	Depth to water table (m bgl)	Dist. to water source (m) - condition 5 only
0.50	4.50	0.00	0.05	0.115	4.50	

ERROR MESSAGES



TIME LAG VALUE (FROM GRAPH)

BASIC TIME LAG, T (min to reach Ht/H_0=0.37) - from graph	3.35
BASIC TIME LAG (seconds)	201

CALCULATED VALUES

Length of test section, L	4.00
Initial head of water, H_0	4.11

PERMEABILITY (m/s)	1.65E-06

Appendix F: MicroDrainage calculations

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

Half Drain Time : 1426 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	46.210	0.160	0.9	34.2	O K
30 min Summer	46.279	0.229	0.9	51.1	O K
60 min Summer	46.351	0.301	0.9	68.6	O K
120 min Summer	46.447	0.397	0.9	92.2	O K
180 min Summer	46.504	0.454	0.9	106.0	O K
240 min Summer	46.541	0.491	0.9	115.1	O K
360 min Summer	46.585	0.535	0.9	125.7	O K
480 min Summer	46.606	0.556	0.9	130.8	O K
600 min Summer	46.615	0.565	0.9	133.0	O K
720 min Summer	46.617	0.567	0.9	133.5	O K
960 min Summer	46.609	0.559	0.9	131.6	O K
1440 min Summer	46.577	0.527	0.9	123.8	O K
2160 min Summer	46.534	0.484	0.9	113.3	O K
2880 min Summer	46.497	0.447	0.9	104.2	O K
4320 min Summer	46.434	0.384	0.9	88.9	O K
5760 min Summer	46.382	0.332	0.9	76.2	O K
7200 min Summer	46.338	0.288	0.9	65.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	114.625	0.0	78
30 min Summer	74.480	0.0	91
60 min Summer	46.261	0.0	114
120 min Summer	29.365	0.0	158
180 min Summer	22.196	0.0	206
240 min Summer	18.057	0.0	260
360 min Summer	13.322	0.0	372
480 min Summer	10.626	0.0	486
600 min Summer	8.871	0.0	604
720 min Summer	7.633	0.0	722
960 min Summer	5.992	0.0	960
1440 min Summer	4.232	0.0	1212
2160 min Summer	2.984	0.0	1564
2880 min Summer	2.336	0.0	1964
4320 min Summer	1.671	0.0	2768
5760 min Summer	1.330	0.0	3568
7200 min Summer	1.123	0.0	4328

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
8640 min Summer	46.302	0.252	0.9	56.6	O K
10080 min Summer	46.270	0.220	0.9	48.9	O K
15 min Winter	46.238	0.188	0.9	41.0	O K
30 min Winter	46.315	0.265	0.9	59.9	O K
60 min Winter	46.396	0.346	0.9	79.6	O K
120 min Winter	46.504	0.454	0.9	106.1	O K
180 min Winter	46.569	0.519	0.9	121.8	O K
240 min Winter	46.611	0.561	0.9	132.2	O K
360 min Winter	46.662	0.612	0.9	144.6	O K
480 min Winter	46.688	0.638	0.9	150.8	O K
600 min Winter	46.700	0.650	0.9	153.9	O K
720 min Winter	46.705	0.655	0.9	155.1	O K
960 min Winter	46.701	0.651	0.9	154.0	O K
1440 min Winter	46.668	0.618	0.9	145.9	O K
2160 min Winter	46.611	0.561	0.9	132.0	O K
2880 min Winter	46.560	0.510	0.9	119.7	O K
4320 min Winter	46.468	0.418	0.9	97.3	O K
5760 min Winter	46.388	0.338	0.9	77.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
8640 min Summer	0.983	0.0	5104
10080 min Summer	0.883	0.0	5848
15 min Winter	114.625	0.0	80
30 min Winter	74.480	0.0	94
60 min Winter	46.261	0.0	116
120 min Winter	29.365	0.0	160
180 min Winter	22.196	0.0	208
240 min Winter	18.057	0.0	260
360 min Winter	13.322	0.0	370
480 min Winter	10.626	0.0	482
600 min Winter	8.871	0.0	598
720 min Winter	7.633	0.0	712
960 min Winter	5.992	0.0	938
1440 min Winter	4.232	0.0	1366
2160 min Winter	2.984	0.0	1688
2880 min Winter	2.336	0.0	2136
4320 min Winter	1.671	0.0	3024
5760 min Winter	1.330	0.0	3848

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
7200 min Winter	46.321	0.271	0.9	61.3	O K
8640 min Winter	46.264	0.214	0.9	47.4	O K
10080 min Winter	46.216	0.166	0.9	35.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
7200 min Winter	1.123	0.0	4616
8640 min Winter	0.983	0.0	5368
10080 min Winter	0.883	0.0	6064

Rainfall Details

Rainfall Model	FEH
Return Period (years)	30
FEH Rainfall Version	2013
Site Location	GB 489857 187799 SU 89857 87799
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Green Roof

Area (m³) 1883 Evaporation (mm/day) 3
Depression Storage (mm) 8 Decay Coefficient 0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.034218	32	36	0.006908	64	68	0.001395	96	100	0.000282
4	8	0.028015	36	40	0.005656	68	72	0.001142	100	104	0.000231
8	12	0.022937	40	44	0.004631	72	76	0.000935	104	108	0.000189
12	16	0.018779	44	48	0.003791	76	80	0.000765	108	112	0.000155
16	20	0.015375	48	52	0.003104	80	84	0.000627	112	116	0.000127
20	24	0.012588	52	56	0.002541	84	88	0.000513	116	120	0.000104
24	28	0.010306	56	60	0.002081	88	92	0.000420			
28	32	0.008438	60	64	0.001704	92	96	0.000344			

Time Area Diagram

Total Area (ha) 0.081

Time From:	(mins) To:	Area (ha)
0	4	0.081

Time Area Diagram

Total Area (ha) 0.000

Time Area Diagram

Time (mins) From:	To:	Area (ha)
0	4	0.000

Model Details

Storage is Online Cover Level (m) 47.050

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00810	Width (m)	41.7
Membrane Percolation (mm/hr)	1000	Length (m)	19.5
Max Percolation (l/s)	225.9	Slope (1:X)	500.0
Safety Factor	2.0	Depression Storage (mm)	4
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	46.050	Membrane Depth (m)	0

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

Half Drain Time : 1917 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	46.277	0.227	0.9	50.6	O K
30 min Summer	46.372	0.322	0.9	73.7	O K
60 min Summer	46.469	0.419	0.9	97.5	O K
120 min Summer	46.585	0.535	0.9	125.9	O K
180 min Summer	46.656	0.606	0.9	143.1	O K
240 min Summer	46.704	0.654	0.9	154.7	O K
360 min Summer	46.761	0.711	0.9	168.7	Flood Risk
480 min Summer	46.792	0.742	0.9	176.2	Flood Risk
600 min Summer	46.808	0.758	0.9	180.0	Flood Risk
720 min Summer	46.814	0.764	0.9	181.7	Flood Risk
960 min Summer	46.811	0.761	0.9	180.9	Flood Risk
1440 min Summer	46.772	0.722	0.9	171.4	Flood Risk
2160 min Summer	46.709	0.659	0.9	156.1	O K
2880 min Summer	46.658	0.608	0.9	143.5	O K
4320 min Summer	46.574	0.524	0.9	123.2	O K
5760 min Summer	46.507	0.457	0.9	106.8	O K
7200 min Summer	46.452	0.402	0.9	93.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	147.665	0.0	83
30 min Summer	97.197	0.0	97
60 min Summer	60.756	0.0	118
120 min Summer	37.841	0.0	162
180 min Summer	28.430	0.0	212
240 min Summer	23.064	0.0	264
360 min Summer	16.966	0.0	376
480 min Summer	13.528	0.0	492
600 min Summer	11.289	0.0	608
720 min Summer	9.707	0.0	724
960 min Summer	7.602	0.0	962
1440 min Summer	5.333	0.0	1402
2160 min Summer	3.721	0.0	1704
2880 min Summer	2.885	0.0	2060
4320 min Summer	2.028	0.0	2856
5760 min Summer	1.590	0.0	3656
7200 min Summer	1.326	0.0	4464

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
8640 min Summer	46.405	0.355	0.9	81.9	O K
10080 min Summer	46.365	0.315	0.9	72.0	O K
15 min Winter	46.313	0.263	0.9	59.4	O K
30 min Winter	46.419	0.369	0.9	85.3	O K
60 min Winter	46.528	0.478	0.9	112.0	O K
120 min Winter	46.659	0.609	0.9	143.9	O K
180 min Winter	46.739	0.689	0.9	163.4	O K
240 min Winter	46.794	0.744	0.9	176.7	Flood Risk
360 min Winter	46.861	0.811	0.9	193.0	Flood Risk
480 min Winter	46.898	0.848	0.9	202.1	Flood Risk
600 min Winter	46.918	0.868	0.9	207.1	Flood Risk
720 min Winter	46.929	0.879	0.9	209.6	Flood Risk
960 min Winter	46.930	0.880	0.9	210.0	Flood Risk
1440 min Winter	46.898	0.848	0.9	202.0	Flood Risk
2160 min Winter	46.821	0.771	0.9	183.4	Flood Risk
2880 min Winter	46.757	0.707	0.9	167.6	Flood Risk
4320 min Winter	46.643	0.593	0.9	139.9	O K
5760 min Winter	46.544	0.494	0.9	115.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
8640 min Summer	1.150	0.0	5208
10080 min Summer	1.024	0.0	5968
15 min Winter	147.665	0.0	85
30 min Winter	97.197	0.0	99
60 min Winter	60.756	0.0	122
120 min Winter	37.841	0.0	164
180 min Winter	28.430	0.0	212
240 min Winter	23.064	0.0	264
360 min Winter	16.966	0.0	374
480 min Winter	13.528	0.0	486
600 min Winter	11.289	0.0	602
720 min Winter	9.707	0.0	716
960 min Winter	7.602	0.0	946
1440 min Winter	5.333	0.0	1396
2160 min Winter	3.721	0.0	1988
2880 min Winter	2.885	0.0	2224
4320 min Winter	2.028	0.0	3116
5760 min Winter	1.590	0.0	3976

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
7200 min Winter	46.460	0.410	0.9	95.2	O K
8640 min Winter	46.387	0.337	0.9	77.5	O K
10080 min Winter	46.325	0.275	0.9	62.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
7200 min Winter	1.326	0.0	4792
8640 min Winter	1.150	0.0	5568
10080 min Winter	1.024	0.0	6352

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 489857 187799 SU 89857 87799
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Green Roof

Area (m³) 1883 Evaporation (mm/day) 3
Depression Storage (mm) 8 Decay Coefficient 0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.034218	32	36	0.006908	64	68	0.001395	96	100	0.000282
4	8	0.028015	36	40	0.005656	68	72	0.001142	100	104	0.000231
8	12	0.022937	40	44	0.004631	72	76	0.000935	104	108	0.000189
12	16	0.018779	44	48	0.003791	76	80	0.000765	108	112	0.000155
16	20	0.015375	48	52	0.003104	80	84	0.000627	112	116	0.000127
20	24	0.012588	52	56	0.002541	84	88	0.000513	116	120	0.000104
24	28	0.010306	56	60	0.002081	88	92	0.000420			
28	32	0.008438	60	64	0.001704	92	96	0.000344			

Time Area Diagram

Total Area (ha) 0.081

Time From:	(mins) To:	Area (ha)
0	4	0.081

Time Area Diagram

Total Area (ha) 0.000

Time Area Diagram

Time (mins) From:	To:	Area (ha)
0	4	0.000

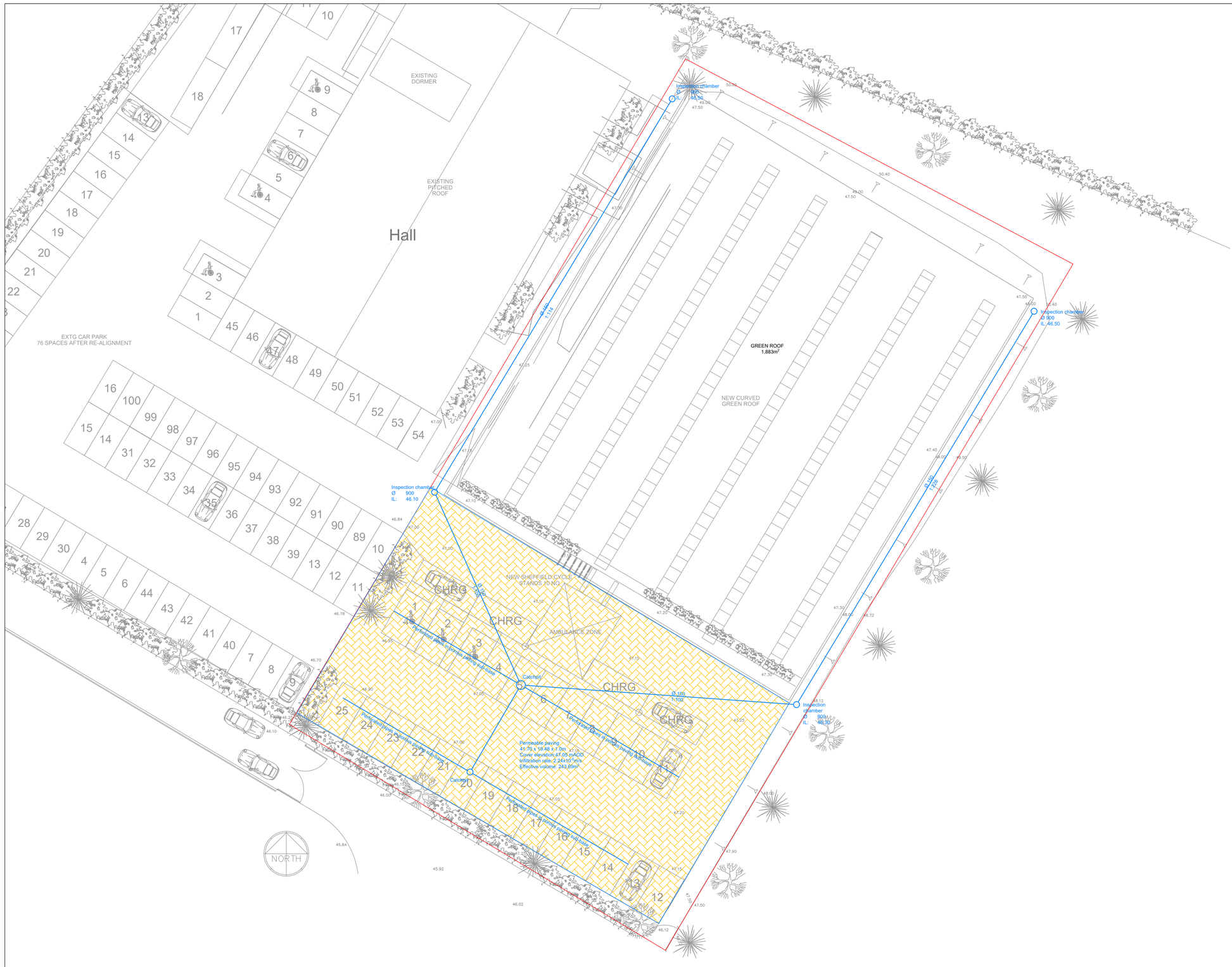
Model Details

Storage is Online Cover Level (m) 47.050

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00810	Width (m)	41.7
Membrane Percolation (mm/hr)	1000	Length (m)	19.5
Max Percolation (l/s)	225.9	Slope (1:X)	500.0
Safety Factor	2.0	Depression Storage (mm)	4
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	46.050	Membrane Depth (m)	0

Appendix G: Proposed drainage system layout



General Notes

Notes

1. Drawing based on:
   - LiDAR Topographical data collected in 2020..
   - Site layout and post-development topography provided by Client.
2. All cover levels shown are indicative only, actual level to be used on site. Additional protection may be required for shallower pipes.
3. All private drainage is to be constructed in accordance with the Building Regulations as current at construction.
4. All drains to have Class S granular bed and surround, except where:

a: cover beneath roads or hardstanding is less than 0.90 m.

b: cover beneath soft landscaping is less than 0.60 m

In which case class Z concrete bed and surround is required.

5. Side connections to SW to be 100Ø @1/100 gradient unless stated otherwise.
13. All private drainage pipes to be constructed of suitable materials as defined in the Building Regulations Document H. All systems to be installed in accordance with manufacturers recommendations and with appropriate bed and surround. All pipe systems must have appropriate levels of ring stiffness- typically 8kN/m^3 and jetting pressure resistance of 2600 psi without damage as per the 'Sewer Jetting Code of Practice 2nd Edition (2005-2006).Additional concrete protection must be provided where side support may be lost in the future due to parallel trench excavation e.g. for services or drain repair/replacement.
14. Where pipes pass through the manhole wall a joint must be formed with 150 mm of the wall.
15. All pipes to enter manhole with soffits level.
16. Where drains pass through footings and openings are formed provide lintels over, ensuring 50 mm minimum clearance all around. Pipe is to be provided with compressible material surround. The opening is to be masked by rigid sheet, i.e. cement particle board material to prevent ingress of vermin.
17. New pipeline design is based on the drains final loading on completion of the roads and landscaping above, additional protection may be required to these pipes :during construction,. particularly the shallower sections.
18. Maintenance of sewers, manholes. drainage channels and silt pits should be inspected at 6 monthly intervals and cleaned out at 12 monthly intervals. A full CCTV survey should also be carried out at 10 yearly intervals. In all instances, inspection and cleaning should be carried out only be a specialist contractor and in accordance with the guidelines given in “Safe working in Sewers and Sewage Works” published by National Joint Health and Safety Committee for the Water Services.
19. All private drainage is to be tested for water tightness in accordance with the Building Regulations Document H.

No.	Revision/Issue	Date
01	v1.1	03/03/23

Firm Name and Address

Yellow Sub Geo Ltd.
7 Neptune Court
Vanguard Way
Cardiff
CF24 5PJ.

Project Name and Address

Bourne End Junior Sports Club - Detailed Drainage Design.
Bourne End Academy
Mew Road
Bourne End
SL8 5BS.

Project	BEJSC drainage design
Date	03/03/23
Scale	1:450
Sheet	1