

2nd November 2018

Our ref: GE17736/GR02/181102

Rachel Davies
Bargate Homes
The New Barn
Vicarage Farm Business Park
Winchester Road
Fair Oak
SO50 7HD



Dear Rachel,

RE: Manor Farm, Lower Road, Bedhampton

Further to your instruction, we write to present the results of the supplementary ground investigation and in-situ testing undertaken to assess the potential for use of borehole soakaways as part of a drainage solution for storm water discharge from the proposed development.

Background

The site has undergone two previous phases of intrusive investigation both of which have included trial pit soakage testing and both phases have demonstrated that near surface soils (up to c. 4.5m bgl) are not suitable for conventional soakaways. These findings were presented in a Ground Appraisal Report, ref. GE16507-GAR-NOV17v1.0 where eight tests were undertaken at four locations across the site, i.e. a shallow (0.5-1.5m bgl) test to target superficial River Terrace Deposits and a deep (3.0m bgl) test to target weathered Chalk at each location; and in a letter report ref. GE17642-RG01-181011 where four additional trial pits were excavated to target testing in the Chalk in pits excavated to 4.1-4.6m bgl.

In both investigations, there was insufficient fall in water level during the first test cycle (BRE Digest 365 requires three filling and drainage cycles) for an infiltration rate to be derived, even with tests in the second phase of investigation being left to run for up to three consecutive days.

Thus, on the basis of the trial pit soakage testing undertaken, it was considered that conventional soakaways would not be suitable for the disposal of storm water run-off on this site.

Under the SuDS hierarchy, discharge of storm water to the ground should be utilised wherever possible. This includes consideration of borehole soakaways where shallow soils are not suitable. On-site measures such as swales and detention basins should also be considered. Where on-site solutions are not viable, alternative options such as discharge to surface water under extension of riparian rights, or connection into existing drainage systems could then be considered.

Testing to date has demonstrated that the River Terrace Deposits and weathered Chalk beneath the site (to at least 4.6m bgl) are not suitable for the discharge of storm water via soakaways. Whilst there may be scope to utilise swales and a detention basin within the site, there are boundary constraints in relation to Network Rail land, i.e. railway lines in cutting forming the southern boundary, which may limit the extent and/or positioning of any such features, thereby limiting on-site storage capacity.

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The site is underlain by Chalk, which is a Principal Aquifer, and the outer edge of a groundwater Source Protection Zone (SPZ 1c) is located 21m to the north-east of the site. The groundwater abstraction point is located within the area of Havant town centre and draws water from the Chalk for drinking water supply.

Supplementary investigation

Following unsuccessful trial pit soakage testing as described above, a supplementary investigation was undertaken to construct two cable percussion boreholes within the site and to undertake falling head tests to assess infiltration to strata at depth beneath the site. A groundwater monitoring well was also installed with a screened section located wholly within the Chalk at depth. The supplementary investigation was undertaken on 30th and 31st October 2018. The locations to be investigated were confirmed by the Client's Drainage Consultant.

Ground and Groundwater Conditions

The ground conditions encountered within the two cable percussion boreholes were consistent with those encountered during previous phases of investigation, i.e. Topsoil overlying a succession of gravelly clay (River Terrace Deposits) and highly weathered structureless Chalk, with less weathered Chalk at depth. A summary of the ground conditions encountered is presented in Table 1 below. For further details, reference should be made to the borehole logs enclosed herein.

Top (m bgl)	Base (m bgl)	Description
0	0.2	TOPSOIL
0.2	1.7 – 2.9	RIVER TERRACE DEPOSITS: Firm brown sandy gravelly CLAY
1.7 – 2.9	9.7 – 12.5	CHALK: Structureless CHALK composed of off-white and cream sand and silt sized matrix with gravel sized clasts of weak chalk. CIRIA Grade Dm grading to Dc
9.7 – 12.5	15+	CHALK: Recovered as white and off-white weak CHALK clasts with some silt and sand size chalk. Tentatively assessed as CIRIA Grade C/B

Table 1 Summary of ground conditions encountered in boreholes BH101 and BH102

There was a gradual reduction in weathering of the Chalk with depth such that there was no clear junction between highly weathered structureless Chalk and underlying less weathered structured Chalk and thus the base of the structureless Chalk indicated in Table 1 was assessed based on the condition of chalk clasts and general appearance of the Chalk recovered from the boreholes.

The site was located on the southern flank of the Portsdown anticline, a ridge of Chalk forming the hill to the north of Portsmouth. This ridge plunges to the east and west as well as folding of the chalk strata from south to north. Whilst solution features are present to the north of the Portsdown anticline, e.g. where strata such as the Lambeth Group thin out over the Chalk, solutioning to depth in the Chalk on the southern flank and coastal plain to the south of the Portsdown anticline is much less common and typically at higher elevation than the subject site, i.e. higher up Portsdown Hill.

The boreholes were cased during drilling and clean water was added to aid the drilling process. Nonetheless, water ingress was recorded in both boreholes during drilling as summarised in Table 2. A groundwater monitoring well was installed in borehole BH102 with a screened well section located at 10-15m bgl and sealed with bentonite from 10m bgl to ground level, i.e. to enable measurement of groundwater depth within the Chalk.

Borehole	Strike depth (m bgl)	Standing depth (m bgl)	Comment
BH101	7.90	6.20	Standing depth measured after drilling suspended for 20 minutes.
BH102	7.90	6.70	Standing depth measured after drilling suspended for 20 minutes.
BH102	-	4.38	Measured in monitoring well on 02/11/2018.

Table 2 Summary of groundwater records

Falling head tests

Falling head tests were proposed to be undertaken at two depths in each borehole, these provisionally being at c. 8m bgl and 15m bgl. However, water ingress occurred in borehole BH101 at a depth of 7.9m bgl and rose to 6.2m bgl and thus the test at 8m (proposed to be above groundwater) was not undertaken and only a single test at 15m bgl was undertaken in BH101. The shallow test was amended to 5m bgl in borehole BH102 to account for the conditions encountered in BH101.

Each of the falling head tests were undertaken within the cable percussion boreholes with casing installed such that a specific section of ground was tested. For the shallow test in BH102, the uncased borehole section extended from 3-5m bgl, i.e. in the structureless Grade Dc Chalk. Both of the deep tests were undertaken with an uncased borehole section from 14-15m bgl, i.e. within the less weathered Chalk at depth. The water levels fell within each of the falling head tests undertaken and results and plots are enclosed herein.

Infiltration rates as summarised in Table 3 have been derived from the testing undertaken.

Borehole	Test location depth	Infiltration rate (m/s)
BH101	14-15m bgl	1.63×10^{-4}
BH102	3-5m bgl	1.00×10^{-5}
BH102	14-15m bgl	1.37×10^{-4}

Table 3 Infiltration rates from falling head tests

Conclusions and Recommendations

Whilst an infiltration rate of 1.0×10^{-5} m/s was derived from the shallower falling head test undertaken in BH102, it should be noted that trial pit soakage testing in similar ground conditions, a similar test depth range and in the same area of the site was unsuccessful and thus the rate of infiltration would appear not to be uniform and consistent.

The falling head tests at depth within both boreholes were undertaken below the depth at which water ingress occurred, i.e. the tests were surcharging groundwater. Whilst a potentially suitable infiltration rate has been derived for the falling head tests at depth, direct discharge of storm water into groundwater is not normally acceptable. As such, consultation with the EA and Portsmouth Water should be sought at the earliest opportunity.

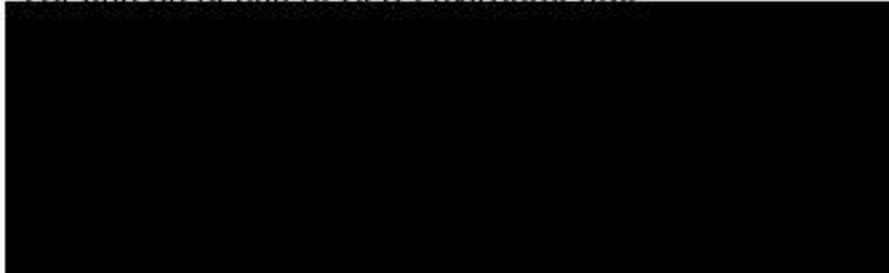
If storm water discharge at depth is not acceptable, it is considered that the testing undertaken to date provides evidence that the use of soakaways on this site is not viable and that off-site disposal of storm water would be required in addition to any on-site based storage and peak flow attenuation as part of an overall SuDS solution.

Closure

We trust we have interpreted your request correctly and provided sufficient information for your current requirements. Should you have any queries please do not hesitate to contact us.

Yours sincerely

For and on Behalf of Geo-Environmental



GAVIN ROBERTS CGeol, BEng (Hons), MSc, FGS

Technical Director

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Enc Figure 1 Site Location Plan
 Figure 2 Exploratory Hole Location Plan
 Borehole Logs
 Falling Head Test result sheets (BH101 at 15m, BH102 at 5m and BH102 at 15m)





Project:	Manor Farm, Lower Road, Bedhampton			Title	Site Location Plan	
Client:	Bargate Homes			 Geo-Environmental Geo-Environmental Services Ltd Unit 7 Danworth Farm, Cuckfield Road Hurstpierpoint, West Sussex BN6 9GL +44(0)1273 832972 www.gesl.net		
Ref No:	GE17736	Revision:	1.0			
Drawn:	GR	Date:	25/10/2018			
Figure:	1	Scale:	Not To Scale			

Project Title: Manor Farm, Bedhampton
Location : Manor Farm, Bedhampton, Hampshire,
PO9 3LH
Project No. : GE17736
Client : Bargate Homes

Title : Figure 2 - Exploratory Hole Location Plan
Scale: 1:3000
Engineer: GR



Geo-Environmental

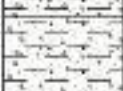
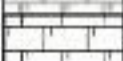
Legend Key

Locations By Type - CP



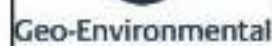
Microsoft product screen shot(s) reprinted with permission from Microsoft Corporation

 Unit 7, Danworth Farm Hurstpierpoint BN6 9GL www.gesl.net		Borehole Log			Borehole No. BH101 Sheet 1 of 2	
Project Name: Manor Farm, Bedhampton		Project No. GE17736		Co-ords: 470062E - 106081N		Hole Type CP
Location: Manor Farm, Bedhampton, Hampshire, PO9 3LH				Level:		Scale 1:50
Client: Bargate Homes				Dates: 30/10/2018		Logged By RG

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.20		 Topsoil TOPSOIL		
		0.50 - 1.00	B				 Firm light brown slightly sandy gravelly CLAY. Sand is coarse of flint. Gravel is fmc very angular to very rounded of flint. RIVER TERRACE DEPOSITS		
		1.00		N=9 (3,/2,2,3,2)		0.80		 Firm light brown sandy gravelly CLAY. Sand is medium to coarse of chalk and flint. Gravel is fmc angular to subrounded of flint. RIVER TERRACE DEPOSITS	1
		1.45	D						
		1.50 - 2.00	B						
		2.00		N=9 (3,/2,2,2,3)					2
		2.45	D						
		2.50 - 3.00	B						
		3.00		N=10 (3,/2,3,2,3)		2.90			3
		3.45	D					Structureless CHALK composed of off-white and cream silt sized matrix and sand sized clasts of weak chalk with rare gravel of flint. CIRIA Grade Dm. CHALK	
		4.00		N=7 (2,/1,2,2,2)					4
		4.45	D						
		5.00		N=6 (2,/1,1,2,2)					5
		5.45	D						
		6.00	D						6
		6.50		N=7 (2,/2,2,1,2)					
	6.95	D						7	
	7.50	D							
	8.00		N=11 (4,/3,2,3,3)					8	
	8.45	D							
	9.00	D						9	
	9.50		N=16 (2,/3,3,4,6)						
	9.95	D			9.70		 Recovered as white and off-white weak gravel sized clasts of CHALK with some silt and sand size chalk.	10	
Continued on Next Sheet									

Casing		Water Strikes (mbgl)		Chiselling (mbgl)		Remarks
Diameter	Depth (m)	Depth Strike	Rose to	Depth from	Depth to	
		7.90	6.20			





Borehole Log

Borehole No.

BH101

Sheet 2 of 2

Project Name: Manor Farm, Bedhampton

Project No.
GE17736

Co-ords: 470062E - 106081N

Hole Type
CP

Location: Manor Farm, Bedhampton, Hampshire, PO9 3LH

Level:

Scale
1:50

Client: Bargate Homes

Dates: 30/10/2018

Logged By
RG

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
		10.50	D	N=20 (5,5,5,5,5)	15.00			CHALK		
		11.00								11
		11.45	D							
		12.00	D	N=23 (7,6,5,6,6)						12
		12.50								
		12.95	D							13
		13.50	D	N=27 (7,6,7,7,7)						
		14.00								14
		14.45	D							
		15.00	D							15
							16			
							17			
							18			
							19			
							20			
Casing		Water Strikes (mbgl)		Chiselling (mbgl)		Remarks				
Diameter	Depth (m)	Depth Strike	Rose to	Depth from	Depth to					
		7.90	6.20							



 Unit 7, Danworth Farm Hurstpierpoint BN6 9GL www.gesl.net		Borehole Log			Borehole No. BH102 Sheet 1 of 2	
Project Name: Manor Farm, Bedhampton		Project No. GE17736		Co-ords: 469993E - 106022N		Hole Type CP
Location: Manor Farm, Bedhampton, Hampshire, PO9 3LH				Level:		Scale 1:50
Client: Bargate Homes				Dates: 30/10/2018		Logged By RG

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.20		 Topsoil TOPSOIL		
		0.50 - 1.00	B				 Firm light brown sandy gravelly CLAY. Sand is medium to coarse of chalk and flint. Gravel is fmc angular to subrounded of flint. RIVER TERRACE DEPOSITS	1	
		1.00		N=13 (5/3,3,4,3)					
		1.45 1.50 - 2.00	D B		1.70				
			2.00		N=10 (3/2,2,3,3)		 Structureless CHALK composed of cream and off-white silt sized matrix and sand and gravel sized clasts of weak chalk with occasional medium to coarse gravel of flint. CIRIA Grade Dm. CHALK	2	
		2.45 2.50 - 3.00	D B						
		3.00		N=11 (3/2,3,3,3)	3.20				
			3.45	D			 Structureless CHALK composed of cream and off-white silt sized matrix and sand to cobble sized clasts of weak chalk with occasional cobbles of flint. CIRIA Grade Dc. CHALK	3	
			4.00		N=10 (3/2,3,2,3)				4
			4.45	D					
			5.00		N=10 (4/2,3,2,3)				5
			5.45	D					
			6.00	D					6
			6.50		N=13 (4/3,3,3,4)			7	
			6.95	D					
			7.50	D					
			8.00		N=12 (3/3,2,3,4)			8	
		8.45	D						
		9.00	D				9		
		9.50		N=12 (4/3,3,3,3)					
		9.95	D				10		
Continued on Next Sheet									

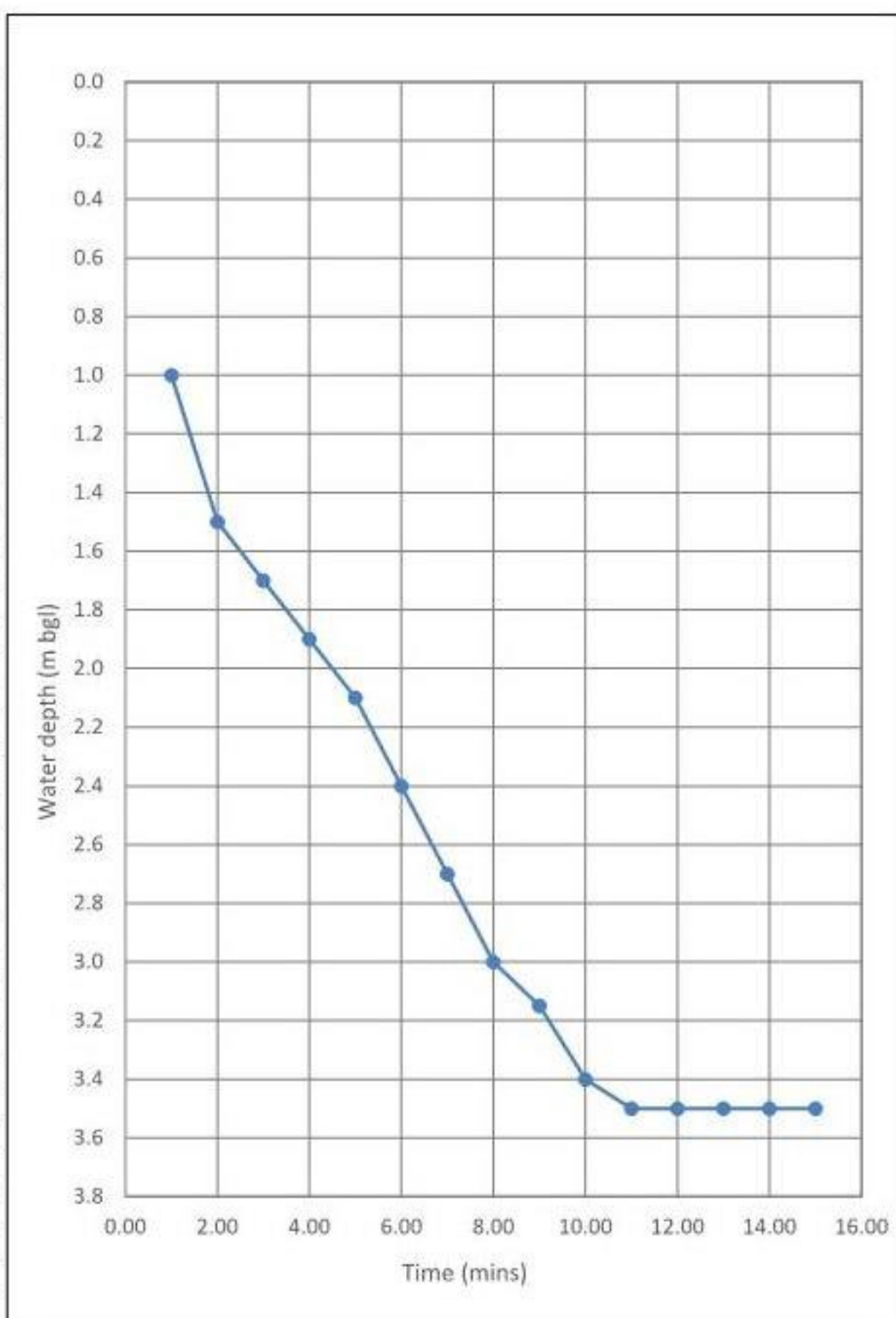
Casing		Water Strikes (mbgl)		Chiselling (mbgl)		Remarks	
Diameter	Depth (m)	Depth Strike	Rose to	Depth from	Depth to		
		7.90	6.70				

 Unit 7, Danworth Farm Hurstpierpoint BN6 9GL www.gesl.net		Borehole Log				Borehole No. BH102 Sheet 2 of 2	
Project Name: Manor Farm, Bedhampton		Project No. GE17736		Co-ords: 469993E - 106022N		Hole Type CP	
Location: Manor Farm, Bedhampton, Hampshire, PO9 3LH				Level:		Scale 1:50	
Client: Bargate Homes				Dates: 30/10/2018		Logged By RG	

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		10.50	D	N=13 (3/2,3,3,5)	12.50		Recovered as white and off-white weak gravel sized clasts of CHALK with some silt and sand size chalk. Gravel sized clasts occasionally iron stained. CHALK	11	
		11.00							
		11.45	D						
		12.00	D					12	
		12.50		N=20 (8/4,5,5,6)					
		12.95	D					13	
		13.50	D						
		14.00		N=25 (9/7,5,6,7)				14	
		14.45	D						
		15.00	D					15.00	15
End of Borehole at 15.00m								15	
								16	
								17	
								18	
								19	
								20	

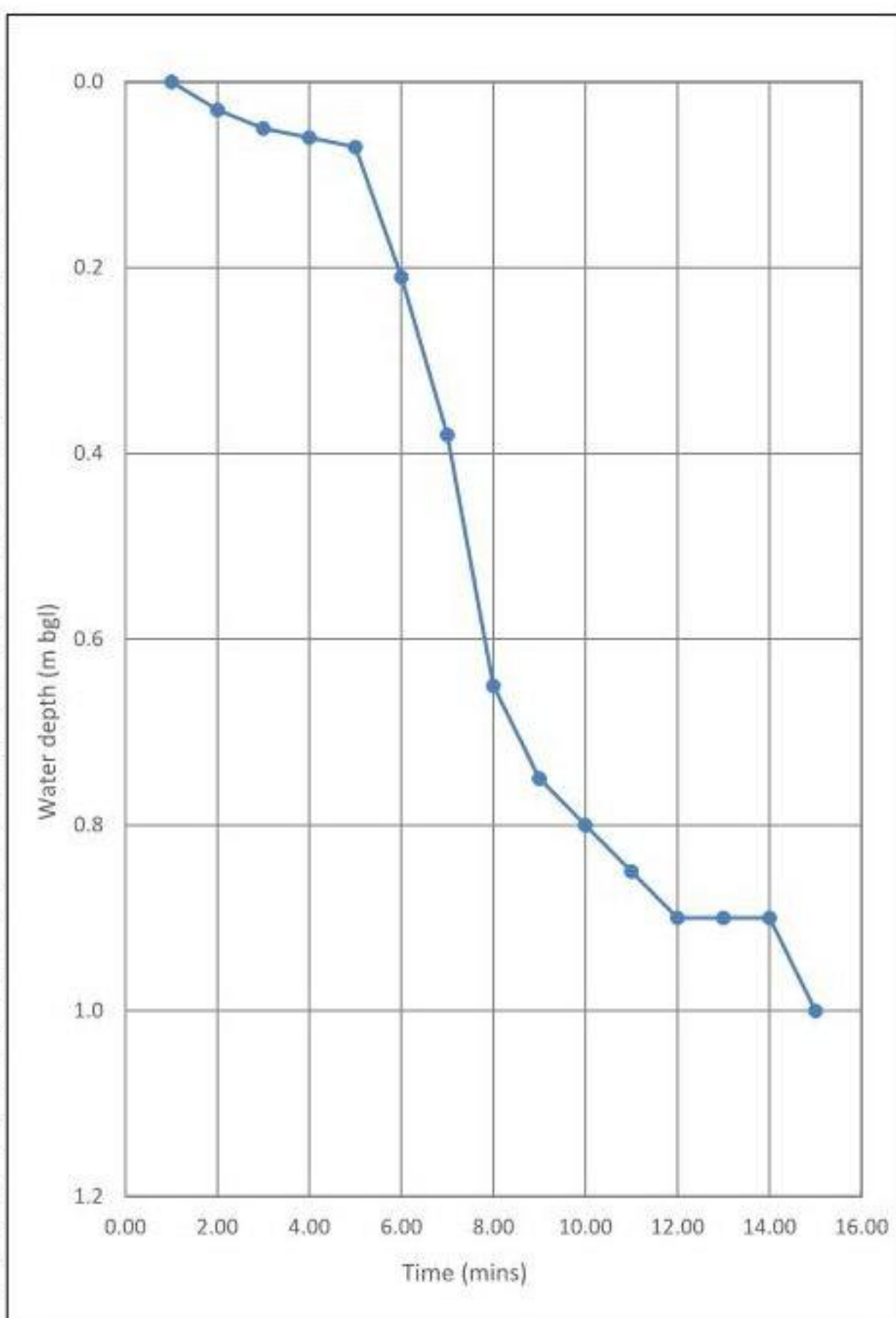
Casing		Water Strikes (mbgl)		Chiselling (mbgl)		Remarks	
Diameter	Depth (m)	Depth Strike	Rose to	Depth from	Depth to		
		7.90	6.70				

BH REF:	BH101	BH DEPTH (m bgl):	15	STANDING WATER DEPTH (m bgl):	6.2	
CASING DEPTH (m bgl):	14	BH DIAMETER (m):	0.15	CASING DIAMETER (m):	0.15	

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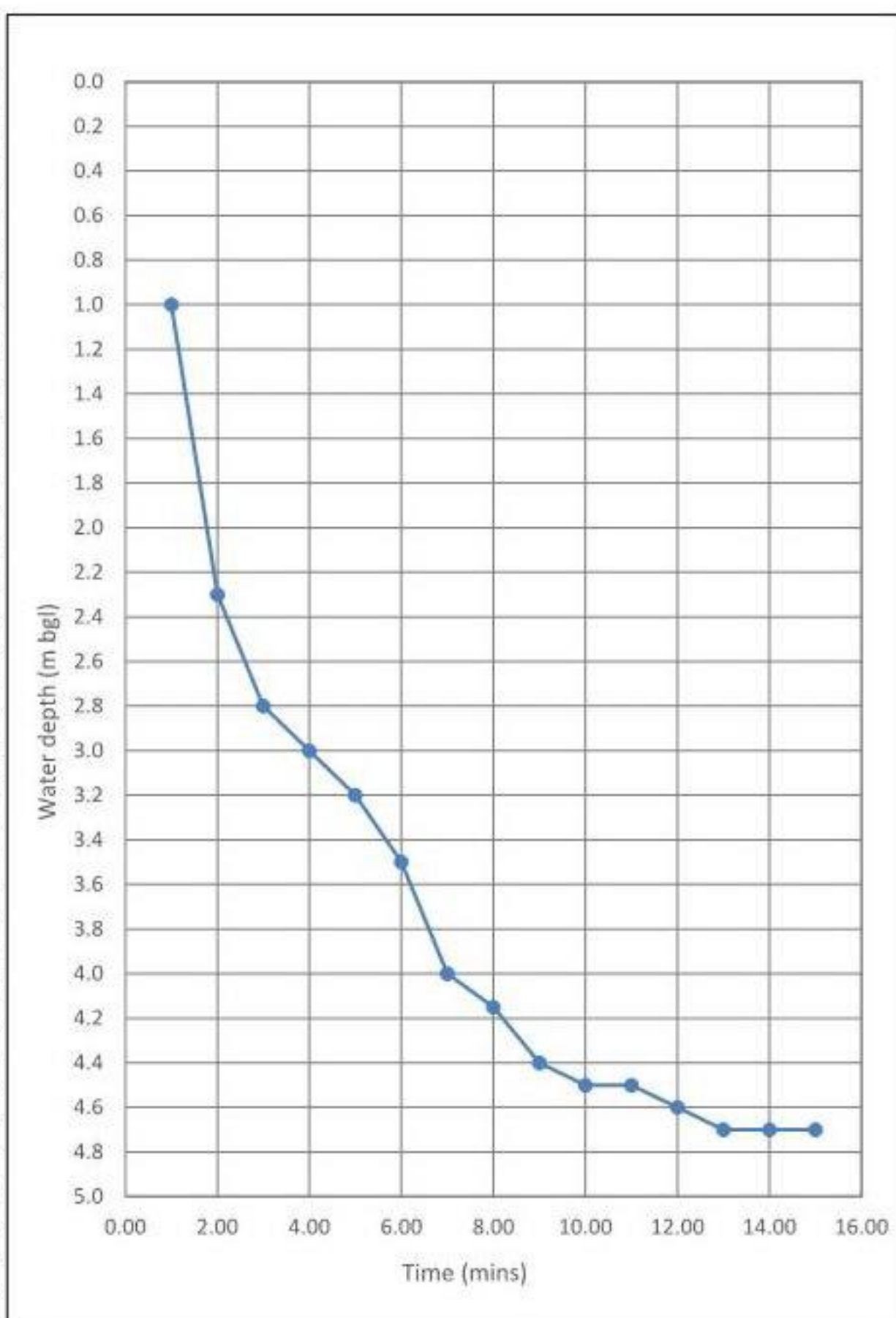
Project	Manor Farm, Bedhampton			Title	Falling Head Test in Borehole BH101 at 15m bgl		
Client:	Bargate Homes			Geo-Environmental Services Ltd Unit 7 Danworth Farm, Cuckfield Road Hurstpierpoint, West Sussex BN6 9GL +44(0)1273 832972 www.gesl.net		 Geo-Environmental	
Ref No:	GE17736	Revisio	1.0				
Drawn:	RG	Date:	01/11/2018				
Figure:	-	Scale:					

BH REF:	BH102	BH DEPTH (m bgl):	5	STANDING WATER DEPTH (m bgl):	DRY	
CASING DEPTH (m bgl):	3	BH DIAMETER (m):	0.15	CASING DIAMETER (m):	0.15	

[illegible]

Project	Manor Farm, Bedhampton			Title	Falling Head Test in Borehole BH102 at 5m bgl		
Client:	Bargate Homes			Geo-Environmental Services Ltd Unit 7 Danworth Farm, Cuckfield Road Hurstpierpoint, West Sussex BN6 9GL +44(0)1273 832972 www.gesl.net		 Geo-Environmental	
Ref No:	GE17736	Revisio	1.0				
Drawn:	RG	Date:	01/11/2018				
Figure:	-	Scale:					

BH REF:	BH102	BH DEPTH (m bgl):	15	STANDING WATER DEPTH (m bgl):	5	
CASING DEPTH (m bgl):	14	BH DIAMETER (m):	0.15	CASING DIAMETER (m):	0.15	

[illegible]

Project	Manor Farm, Bedhampton			Title	Falling Head Test in Borehole BH102 at 15m bgl		
Client:	Bargate Homes			Geo-Environmental Services Ltd Unit 7 Danworth Farm, Cuckfield Road Hurstpierpoint, West Sussex BN6 9GL +44(0)1273 832972 www.gesl.net		 Geo-Environmental	
Ref No:	GE17736	Revisio	1.0				
Drawn:	RG	Date:	01/11/2018				
Figure:	-	Scale:					