026/4390/AG/wn

18th December 2023

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Dear Liam

Wrawby Road, Brigg – groundwater monitoring results

As discussed, we have been monitoring groundwater levels in the six wells installed during our ground investigation back in November 2022. Results (7 visits over 12 months) are Appended below.

As expected, these results confirm a continuous shallow groundwater table, which fluctuates seasonally between 0.5m and 1.7m in winter to between 1.1m and 2.5m in summer; typically groundwater was highest (shallowest) in November 2023 and lowest in July 2023.

After an initial dip to record standing water level, the wells were bailed-out to establish an approximate rate of recharge during Visit 1 (17th January 2023). Findings are summarised in the table below:

Hole	Vol. removed /litres	Water level lowered by /m	From / to m bgl	Water level recovered to /m bgl	After / mins	Recovery rate
BH101	6	2.5	1.5 to 4.0	1.8	115	Steady
BH102	6	1.6	0.6 to 2.2	0.7	140	Slow
BH103	6	1.9	0.7 to 2.6	1.6	185	
BH104	6	0.8	0.6 to 1.4	0.8	35	Steady
BH105	6	1.5	0.7 to 2.2	0.7	60	
BH106	6	1.1	0.7 to 1.8	0.7	90	

It is apparent from the above that the ground is reasonably permeable, but variable. Groundwater levels are considered to be reflective of the true water table (rather than "trapped" waters associated with drilling or surface water run-off).

These results will likely be of interest to the appointed vibro contractor, as well as the drainage & foundation designers, and groundworker (especially if/where deep excavation is required).

Details of the monitoring wells are shown on the appended exploratory hole logs.

A very shallow water table would have implications for both excavation stability and bearing capacity; the latter should be halved if the standing water level is likely to rise above the base of the footing.

However, regardless of depth to groundwater in the north of the site, the foundation recommendations (vibro stone columns or piled foundations in Areas A & C) outlines in Section 14.3 of our SI Report (4390-3A, dated October 2023) stand.

Based on the most recent drainage layout, it appears that the attenuation basin invert level will lie below the water table during the winter months. Therefore, the basin will need to be lined.

Furthermore, due to the shallow water table, an allowance should be made for buoyancy (uplift) during the design and construction of the attenuation tank & pumping station. During the construction, groundwater control over and above normal site pumping practices will be required for any excavations in excess of 1.5m deep.

Should you require any further information, please contact the undersigned.

Yours sincerely

[redacted]

Adam Gombocz
Director
for and on behalf of
LITHOS CONSULTING LIMITED

Encl.

Groundwater dip data
Drawing 439086 BH location plan
Borehole logs

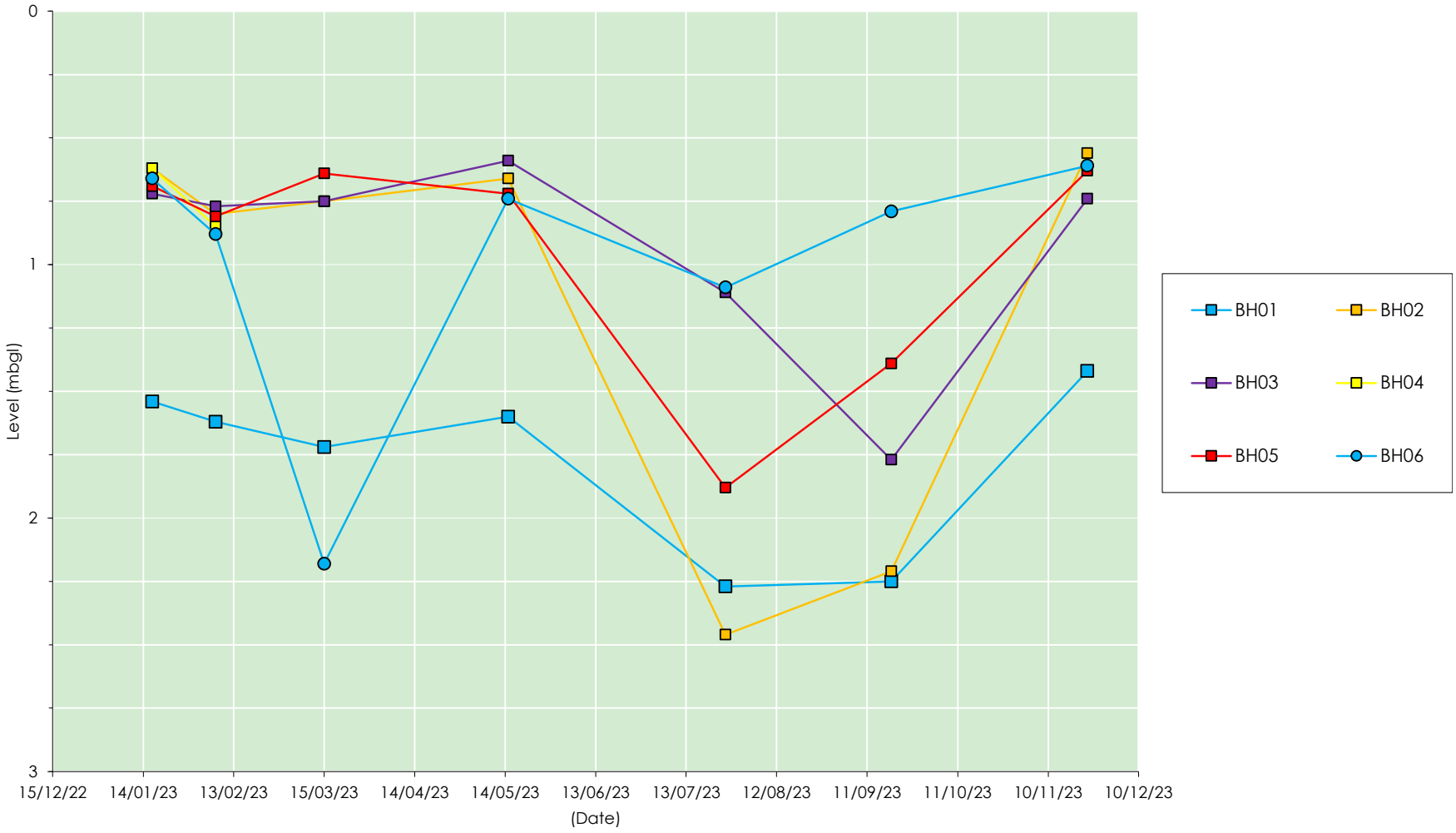
Summary of Groundwater Monitoring Data

Hole ID	GL (mAOD)	Visit 1			Visit 2			Visit 3			Visit 4		
		17/01/2023			07/02/2023			15/03/2023			15/05/2023		
		Base of well (mbgl)	Depth (m bgl)	Depth (mAOD)	Base of well (mbgl)	Depth (m bgl)	Depth (mAOD)	Base of well (mbgl)	Depth (m bgl)	Depth (mAOD)	Base of well (mbgl)	Depth (m bgl)	Depth (mAOD)
BH01	4.27	10.26	1.54	2.73	10.18	1.62	2.65	10.18	1.72	2.55	10.11	1.60	2.67
BH02	4.09	3.05	0.62	3.47	3.01	0.80	3.29	2.99	0.75	3.34	2.81	0.66	3.43
BH03	3.89	4.50	0.72	3.17	4.48	0.77	3.12	4.49	0.75	3.14	4.38	0.59	3.30
BH04	4.29	4.45	0.62	3.67	4.27	0.85	3.44	NR	NR	NR	NR	NR	NR
BH05	4.65	6.18	0.69	3.96	6.15	0.81	3.84	6.12	0.64	4.01	5.98	0.72	3.93
BH06	5.04	4.84	0.66	4.38	4.68	0.88	4.16	4.68	2.18	2.86	4.50	0.74	4.30

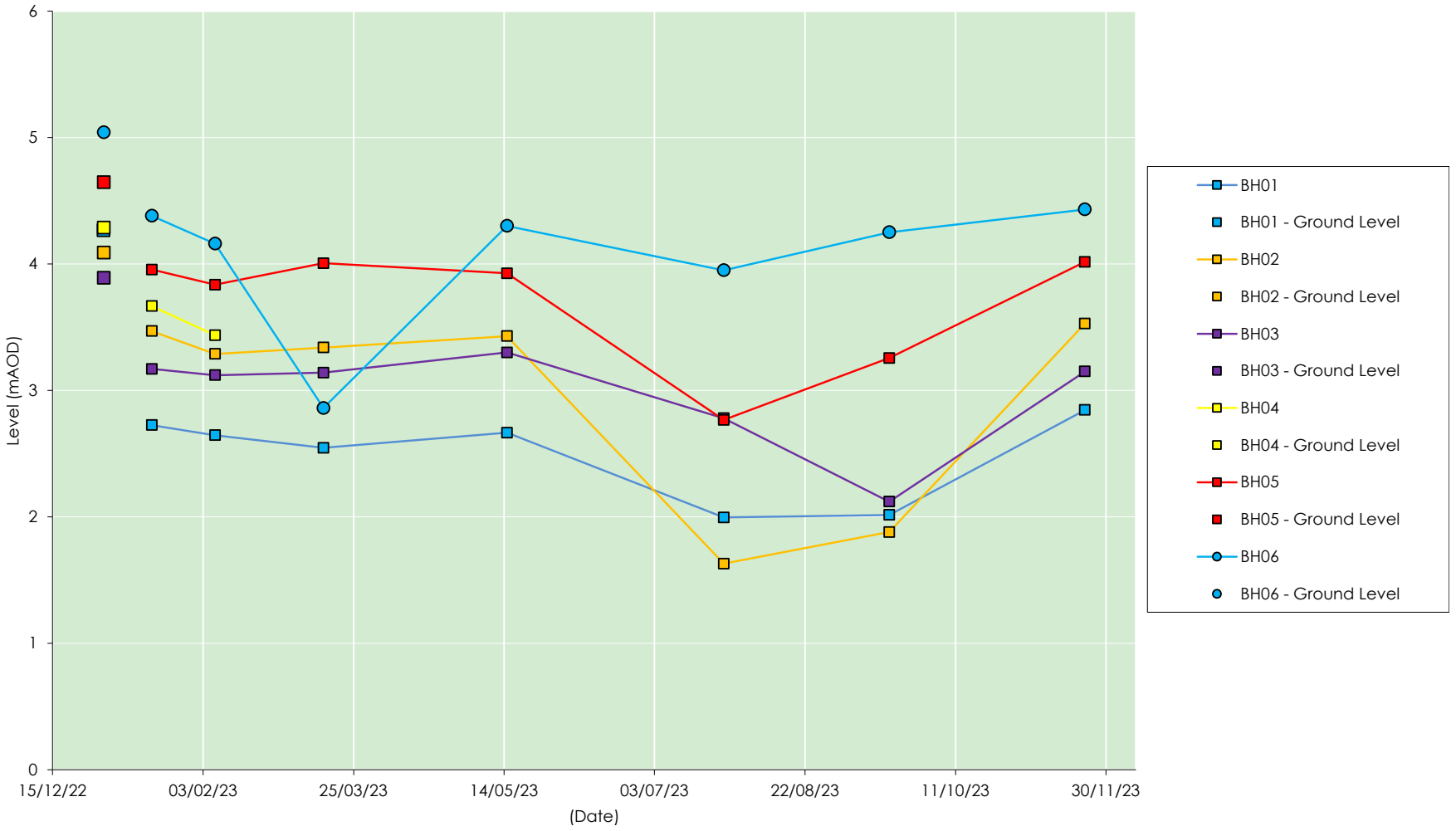
Summary of Groundwater Monitoring Data

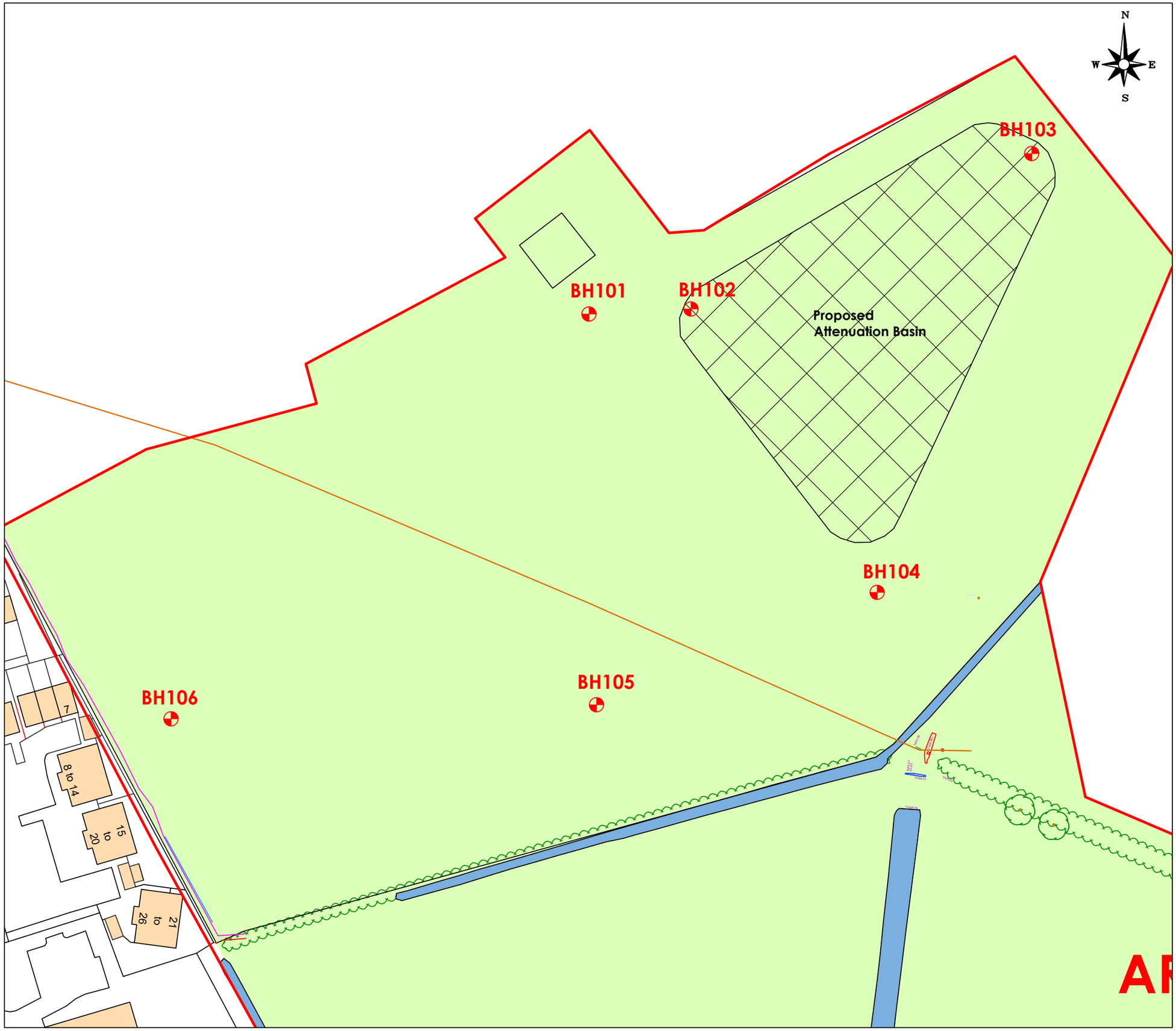
Hole ID	GL (mAOD)	Visit 5			Visit 6			Visit 7		
		26/07/2023			19/09/2023			23/11/2023		
		Base of well (mbgl)	Depth (m bgl)	Depth (mAOD)	Base of well (mbgl)	Depth (m bgl)	Depth (mAOD)	Base of well (mbgl)	Depth (m bgl)	Depth (mAOD)
BH01	4.27	10.12	2.27	2.00	10.10	2.25	2.02	10.11	1.42	2.85
BH02	4.09	2.82	2.46	1.63	2.82	2.21	1.88	2.85	0.56	3.53
BH03	3.89	4.38	1.11	2.78	4.36	1.77	2.12	4.38	0.74	3.15
BH04	4.29	NR	NR	NR	NR	NR	NR	NR	NR	NR
BH05	4.65	5.99	1.88	2.77	5.97	1.39	3.26	5.98	0.63	4.02
BH06	5.04	4.49	1.09	3.95	4.46	0.79	4.25	4.43	0.61	4.43

Summary of Groundwater Levels (mbgl)



Summary of Groundwater Levels (m AOD)





NOTES

BOREHOLE LOCATION

APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE

LITHOS CONSULTING

info@lithos.co.uk
www.lithos.co.uk

Tel 01937 545330

CLIENT

BELLWAY
HOMES LTD
(YORKSHIRE)

JOB TITLE

WRAWBY ROAD,
BRIGG

DRAWING TITLE

MONITORING HOLE LOCATIONS

DRAWN	DATE	STATUS
WN	30 11 2022	FOR COMMENT ☐
CHECKED	DATE	FOR APPROVAL ☐
AG	02 12 2022	DRAFT ☐
		FINAL ☑

SCALE	SHEET	DRAWING NO.	REVISION
1:1000	A3	4390/8	

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Borehole Log

Borehole No. **BH101**

Sheet 1 of 2

Project Name: Wrawby Road,	Project No. 4390	Co-ords: 500819.29 - 408336.46	Hole Type CP
Location: Brigg		Level: 4.25	Scale 1:50
Client: Bellway Homes Ltd		Dates: 21/11/2022 - 21/11/2022	Logged By AP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.40	3.85		Dark brown sandy CLAY. Sand is fine to coarse. (TOPSOIL)
		1.00 1.00 - 1.45	D	N=4 (1,1/1,1,1,1)				Soft brown sandy CLAY. Sand is fine to coarse. (COHESIVE GLACIOLACUSTRINE DEPOSITS)
	▼	2.00 2.00 - 2.45	D	N=6 (1,1/1,1,1,3)				*At 2.0m - Slight groundwater seepage.*
		3.00 3.00 - 3.45	D	N=2 (1,0/1,0,1,0)				
					3.60	0.65		Firm dark grey CLAY. (WEATHERED OXFORD CLAY FORMATION)
		4.00 4.00 - 4.45	D	N=7 (1,1/1,2,2,2)				
				HVP=112				
		5.00 5.00 - 5.45	D U		5.00	-0.75		Stiff dark greenish grey CLAY. (WEATHERED OXFORD CLAY FORMATION)
		5.60	D					
		6.50 6.50 - 6.95	D	N=31 (4,5/6,7,9,9)				
				HVP=121	6.80	-2.55		Stiff dark grey CLAY. (WEATHERED OXFORD CLAY FORMATION)
		8.00 8.00 - 8.45	D U					
		8.60	D					
				HVP=140				
					10.00	-5.75		

Continued on next sheet

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater seepage was apparent at 2.0m during drilling. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.

AGS

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Borehole Log

Borehole No.
BH101
Sheet 2 of 2

Project Name:	Wrawby Road,	Project No. 4390	Co-ords:	500819.29 - 408336.46	Hole Type CP
Location:	Brigg		Level:	4.25	Scale 1:50
Client:	Bellway Homes Ltd		Dates:	21/11/2022 - 21/11/2022	Logged By AP

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		10.00		50 (7,10/50 for 285mm)				End of borehole at 10.00 m

11
12
13
14
15
16
17
18
19
20

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater seepage was apparent at 2.0m during drilling. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.

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Borehole Log

Borehole No.
BH102
Sheet 1 of 1

Project Name:	Wrawby Road,	Project No. 4390	Co-ords:	500845.89 - 408337.78	Hole Type CP
Location:	Brigg		Level:	4.10	Scale 1:50
Client:	Bellway Homes Ltd		Dates:	22/11/2022 - 22/11/2022	Logged By WN

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.30	3.80		Dark brown sandy CLAY. Sand is fine to coarse. (TOPSOIL)
								Firm brown and grey sandy silty CLAY. (COHESIVE GLACIOLACUSTRINE DEPOSITS)
					3.00	1.10		Firm brown CLAY. (WEATHERED OXFORD CLAY FORMATION)
					4.00	0.10		End of borehole at 4.00 m

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.

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Borehole Log

Borehole No.
BH103
Sheet 1 of 1

Project Name:	Wrawby Road,	Project No. 4390	Co-ords:	500934.68 - 408378.28	Hole Type CP
Location:	Brigg		Level:	3.90	Scale 1:50
Client:	Bellway Homes Ltd		Dates:	22/11/2022 - 22/11/2022	Logged By WN

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.30	3.60		Dark brown sandy CLAY. Sand is fine to coarse. (TOPSOIL)
								Firm brown mottled grey slightly sandy silty CLAY. (COHESIVE GLACIOLACUSTRINE DEPOSITS)
					2.80	1.10		Stiff to very stiff bluish grey CLAY. (WEATHERED OXFORD CLAY FORMATION)
					4.50	-0.60		End of borehole at 4.50 m

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.

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Borehole Log

Borehole No.
BH104
Sheet 1 of 1

Project Name:	Wrawby Road,	Project No. 4390	Co-ords: 500894.40 - 408263.94	Hole Type CP
Location:	Brigg		Level: 4.30	Scale 1:50
Client:	Bellway Homes Ltd		Dates: 22/11/2022 - 22/11/2022	Logged By WN

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.20	4.10		Dark brown sandy CLAY. Sand is fine to coarse. (TOPSOIL)
								Brown slightly clayey silty fine to medium SAND. (GRANULAR GLACIOLACUSTRINE DEPOSITS)
					1.50	2.80		Firm brown mottled grey slightly sandy silty CLAY. (COHESIVE GLACIOLACUSTRINE DEPOSITS)
					2.60	1.70		Stiff greenish grey CLAY with occasional fine to medium subangular to rounded gravels of coal and decomposed plant material. (WEATHERED OXFORD CLAY FORMATION)
					4.40	-0.10		Stiff to very stiff grey CLAY. (WEATHERED OXFORD CLAY FORMATION)
					4.50	-0.20		End of borehole at 4.50 m

1 2 3 4 5 6 7 8 9 10

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.

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Borehole Log

Borehole No. **BH105**

Sheet 1 of 2

Project Name: Wrawby Road,	Project No. 4390	Co-ords: 500821.26 - 408234.66	Hole Type CP
Location: Brigg		Level: 4.65	Scale 1:50
Client: Bellway Homes Ltd		Dates: 22/11/2022 - 23/11/2022	Logged By WN

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.40	4.25		Dark brown sandy CLAY. Sand is fine to coarse. (TOPSOIL)
								Firm brown very sandy silty CLAY. Sand is fine. (COHESIVE GLACIOLACUSTRINE DEPOSITS)
		1.00 1.00	D	N=4 (1,0/1,1,1,1)	1.00	3.65		Brown sandy clayey SILT. Sand is fine. (COHESIVE GLACIOLACUSTRINE DEPOSITS)
	▼	2.00 2.00	D	N=14 (1,1/4,4,3,3)	2.00	2.65		Medium dense brown and grey slightly clayey silty fine SAND. (GRANULAR GLACIOLACUSTRINE DEPOSITS)
		3.00 3.00	D	N=6 (1,1/1,1,2,2)	2.90	1.75		Firm brown CLAY. (WEATHERED OXFORD CLAY FORMATION)
		4.00 4.00 - 4.45	D U		4.00	0.65		Stiff to very stiff grey CLAY. (WEATHERED OXFORD CLAY FORMATION)
		5.00 5.00	D	N=1 (2,1/1,0,0,0)				
		6.50 6.50	D	N=29 (3,3/6,6,8,9)				
		8.00 8.00	D	N=29 (3,4/6,6,8,9)				
		9.50 9.50	D	N=42 (5,6/9,10,11,12)				

Continued on next sheet

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater seepage was apparent at 2.5m during drilling. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.

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Borehole Log

Borehole No.
BH105
Sheet 2 of 2

Project Name:	Wrawby Road,	Project No. 4390	Co-ords:	500821.26 - 408234.66	Hole Type CP
Location:	Brigg		Level:	4.65	Scale 1:50
Client:	Bellway Homes Ltd		Dates:	22/11/2022 - 23/11/2022	Logged By WN

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		11.00 11.00	D	N=38 (6,6/7,10,10,11)				
					12.00	-7.35		End of borehole at 12.00 m

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater seepage was apparent at 2.5m during drilling. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.

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Borehole Log

Borehole No.
BH106
Sheet 1 of 2

Project Name: Wrawby Road,	Project No. 4390	Co-ords: 500710.41 - 408230.99	Hole Type CP
Location: Brigg		Level: 5.05	Scale 1:50
Client: Bellway Homes Ltd		Dates: 24/11/2022 - 24/11/2022	Logged By WN

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.40 - 1.00	B		0.40	4.65		Dark brown slightly gravelly clayey SAND. (TOPSOIL)
		1.00 1.00	D	N=0 (1,0/0,0,0,0)				Loose light brown fine to medium SAND. (GRANULAR GLACIOLACUSTRINE DEPOSITS)
		2.00 2.00 2.00 - 2.40	D B	N=6 (0,0/1,2,1,2)	2.00	3.05		Low strength brown sandy clayey SILT with frequent pockets of silty CLAY. (COHESIVE GLACIOLACUSTRINE DEPOSITS)
	▼	3.00 3.00 - 3.45	D U					
		4.00 4.00	D	N=24 (1,2/7,5,6,6)				
		5.00 5.00 5.00 - 5.40	D B	N=13 (2,3/4,4,3,2)	5.40	-0.35		Firm brown CLAY (WEATHERED OXFORD CLAY FORMATION)
		6.50 6.50 - 6.95	D U					
		7.10	D		7.00	-1.95		Stiff to very stiff grey CLAY (WEATHERED OXFORD CLAY FORMATION)
		8.00 8.00	D	N=15 (2,1/2,4,4,5)				
		9.50 9.50 - 9.95	D U					

Continued on next sheet

Remarks
1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater seepage was apparent at 3.0m during drilling. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.

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Borehole Log

Borehole No. **BH106**

Sheet 2 of 2

Project Name:	Wrawby Road,	Project No. 4390	Co-ords:	500710.41 - 408230.99	Hole Type CP
Location:	Brigg		Level:	5.05	Scale 1:50
Client:	Bellway Homes Ltd		Dates:	24/11/2022 - 24/11/2022	Logged By WN

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
		10.10	D					
		11.00 11.00	D	50 (9,9/50 for 295mm)	11.00	-5.95		End of borehole at 11.00 m

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater seepage was apparent at 3.0m during drilling. 3. Exploratory hole surveyed in (level and co-ordinates) on completion.