Unique reference N°: MGjv-BP-250117.1

Kingfisher Ecology
Ecological and sustainable solutions

Horizontal Directional Drill (HDD) Vibration Monitoring Report

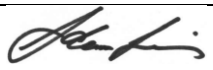
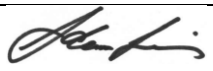
Botley Park, Hampshire. Grid reference: SU51115

On behalf of:

MGJV

January 2017

© Kingfisher Ecology 2017
www.kingfisherecology.co.uk

Written by:	Adam Lewins BSc (Hons) Ecology AIFM GradCIEEM		25/01/2017
Amended by:	Adam Lewins BSc (Hons) Ecology AIFM GradCIEEM		27/01/2017

Kingfisher Ecology, 1 Park Row, Redlynch. Wiltshire. SP5 2HB.
Email: adam@kingfisherecology.co.uk Website: www.kingfisherecology.co.uk
Phone: 07979 960 775

Contents

1.	**Summary**	4
2.	**Introduction and Site Description**	5
	2.1 Site Location	5
	2.2 Site Description	5
	2.3 Proposed development	5
	Fig 2.1. The HDD process	6
3.	**Methodology**	7
	3.1. Peak Particle Vibration (PPV) monitoring	7
	Fig 3.1. Image showing the Vibrock V9000 seismograph with the transducer placed at 62m from the drilling rig above the line of bisection	8
	Fig 3.2. Image showing the Vibrock V9000 seismograph with the transducer placed at 10m from the drilling rig above the line of bisection	8
4.	**Survey Results**	8
	Fig 4.1. Data from pilot drilling at 62m from the HDD point of entry into the ground with a drill head depth of 8 – 9 meters	9
	Fig 4.2. Data from pilot drilling at 10m from the HDD point of entry into the ground	10
	Fig 4.3. Data from 1st stage reaming showing an initial spike in PPV due to the setting up of the seismograph. The monitoring location was 62m from the HDD point of entry with a drill head depth of 8 – 9 meters.	11
	Fig 4.4. Aerial map showing the location of the HDD on Botley Golf course	12
5.	**Conclusions**	13
6.	**Recommendations**	13
7.	**Survey Limitations**	13
8.	**References**	14
9.	**Appendices**	15
	9.1. Aerial map of the HDD location on the golf course showing the location of borehole BH03 and BH03A	15
	9.2. Table illustrating the strata recorded in the BH03 borehole	16
	9.3. Table illustrating the strata recorded in the BH03A borehole	17

©This report is the copyright of Kingfisher Ecology

	9.4. Aerial map of the Pudbrook Lake HDD crossing area showing the location of borehole BH08, BH08A, BH09 and BH09A	19
	9.5. Table illustrating the strata recorded in the BH08 borehole	20
	9.6. Table illustrating the strata recorded in the BH08A borehole	22

©This report is the copyright of Kingfisher Ecology

1. Summary

- Kingfisher Ecology was commissioned by MGjv to undertake vibration monitoring of the Horizontal Directional Drilling (HDD) undertaken as part of the Botley Park Trunk Sewer project.
- It is proposed that a new sewer pipeline is drilled underneath several locations along the pipeline route.
- The threshold of 13mm/s PPV has been recommended by the Environment Agency, as exceeding this level can cause disturbance to Salmonid spawning success. The reason to monitor the HDD on Botley Golf course was to record PPV prior to drilling under the Pudbrook Lake tributary to the Hamble River.
- The HDD site is located on the former Botley Golf Course, grid reference: SU51115. The HDD will pass beneath a designated Site of Importance to Nature Conservation (SINC) at a depth of 8-9 meters.
- Monitoring was undertaken during the pilot drill phase on 12th January 2017 and the 1st reaming phase on the 17th January 2017 as these 2 phases produce the highest amount of vibration during the HDD process.
- The seismograph was positioned at 2 locations along the line of bisection. The 1st location was at 10 meters from the HDD point of entry with the drill head depth 4 meters from the surface. The 2nd location was at 62 meters from the drilling rig with a drilling depth of 8 -9 meters from the surface.
- Drilling data shows that at each monitoring location PPV was recorded with a range between 0.050 – 0.300 mm/s for both the pilot drilling and 1st phase reaming when the seismograph is directly above the drill head.
- With a clay substrate and at a drilling depth of between 4 - 9 meters, the PPV caused during the pilot drilling and 1st phase reaming stages of HDD is significantly below the 13mm/s threshold.
- The results of the core samples taken from boreholes at the golf course HDD location show that the substrate composition is closely comparable to that found at the Pudbrook Lake “S-Curve” HDD location with firm dark sandy clay found at a depth of 8-9m.
- It is recommended that further data is collected during the HDD under Pudbrook Lake. A watching brief will set up the seismograph in the appropriate location along the line of bisection. Detailed monitoring of the PPV will be required in order to prevent PPV exceeding the threshold of 13mm/s.
- In the unlikely event that PPV reaches 13mm/s during the HDD under Pudbrook Lake, then the HDD will be terminated and Eastleigh Borough Council and the Environment Agency consulted.

©This report is the copyright of Kingfisher Ecology

2. Introduction and Site Description

Kingfisher Ecology was commissioned by MGjv to undertake vibration monitoring of the Horizontal Directional Drilling (HDD) undertaken as part of the Botley Park Trunk Sewer project. This report details the vibration caused by HDD in a clay substrate located on the former Botley Park Golf Course. Monitoring was undertaken on the 12th and 17th of January 2017 by Adam Lewins BSc (Hons) Ecology AIFM GradCIEEM. The purpose of the survey was to monitor and record if HDD caused Peak Particle Vibration (PPV) below a threshold of 13mm/s. The threshold of 13mm/s PPV has been recommended by the Environment Agency, as exceeding this level can cause disturbance to Salmonid spawning success. The reason to monitor the HDD on Botley Golf course was to record PPV prior to drilling under the Pudbrook Lake tributary to the Hamble River.

2.1. Site location

The HDD site is located on the former Botley Golf Course, grid reference: SU51115. The HDD will pass beneath a designated Site of Importance to Nature Conservation (SINC) at a depth of 8-9 meters.

2.2. Site Description

The HDD drill will travel beneath the ground in a clay substrate at a depth of 8-9 meters.

Above the line of bisection (drill route) there is predominantly deciduous woodland and scrub vegetation dominated by brambles.

2.3. Proposed Development

It is proposed that a new sewer pipeline is drilled underneath several locations along the pipeline route. Two areas of 2 tributaries of the River Hamble will eventually be drilled under, which may impact upon migrating Salmonids.

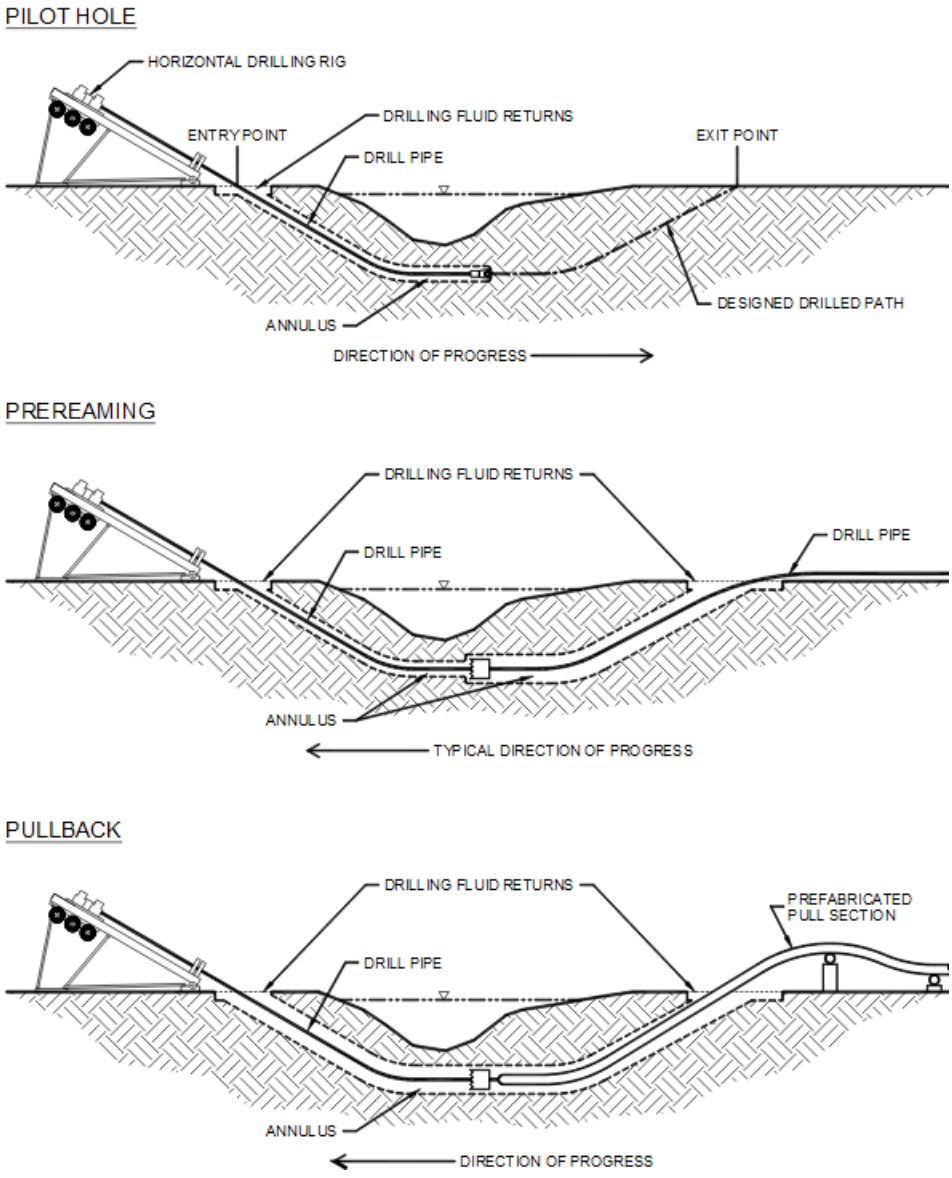
The HDD process for the Botley Trunk sewer consists of 4 stages:

1. Pilot drilling
2. 1st phase reaming (pre-reaming)
3. 2nd phase reaming (pre-reaming)
4. Pipe installation (Pullback)

Fig 2.1. illustrates the HDD process.

©This report is the copyright of Kingfisher Ecology

Fig 2.1. The HDD process



It is the pilot hole drilling and the 1st phase reaming process that causes the highest level of vibration throughout the HDD process.

©This report is the copyright of Kingfisher Ecology

3. Methodology

3.1. Peak Particle Vibration (PPV) monitoring

The vibration caused by the HDD process was recorded using a Vibrock V9000 seismograph.

The seismograph was positioned along the line of bisection of the drill and was set to record Peak Particle Velocity (PPV) at 5 second intervals. PPV is measured in mm/s.

The seismograph was set up in accordance with the manufacturers guidelines. A concrete block was positioned on the ground above the line of bisection and used to place the transducer on. Once the transducer was made level, a sand bag was placed on top of the transducer to provide weight, which allows for accurate vibration readings.

Monitoring was undertaken during the pilot drill phase on 12th January 2017 and the 1st reaming phase on the 17th January 2017 as these 2 phases produce the highest amount of vibration during the HDD process.

The seismograph was positioned at 2 locations along the line of bisection. The 1st location was at 10 meters from the HDD point of entry with the drill head depth 4 meters from the surface. The 2nd location was at 62 meters from the drilling rig with a drilling depth of 8 -9 meters from the surface.

During the 1st stage reaming process, the seismograph was set up with the drill head at a distance of 30m beyond the seismograph location. The PPV was recorded at 5 second intervals while the drill head passed under the seismograph location and travelled a further 10m towards the drilling rig before monitoring was terminated.

Data was generated and recorded during the 2 stages that cause the most vibration during the HDD process. These 2 phases are the pilot drilling phase and the 1st stage reaming phase.

©This report is the copyright of Kingfisher Ecology

Fig 3.1. Image showing the Vibrock V9000 seismograph with the transducer placed at 62m from the drilling rig above the line of bisection



Fig 3.2. Image showing the Vibrock V9000 seismograph with the transducer placed at 10m from the drilling rig above the line of bisection



4. Survey Results

Drilling data shows that at each monitoring location PPV was recorded with a range between 0.050 – 0.300 mm/s for both the pilot drilling and 1st phase reaming when the seismograph is directly above the drill head.

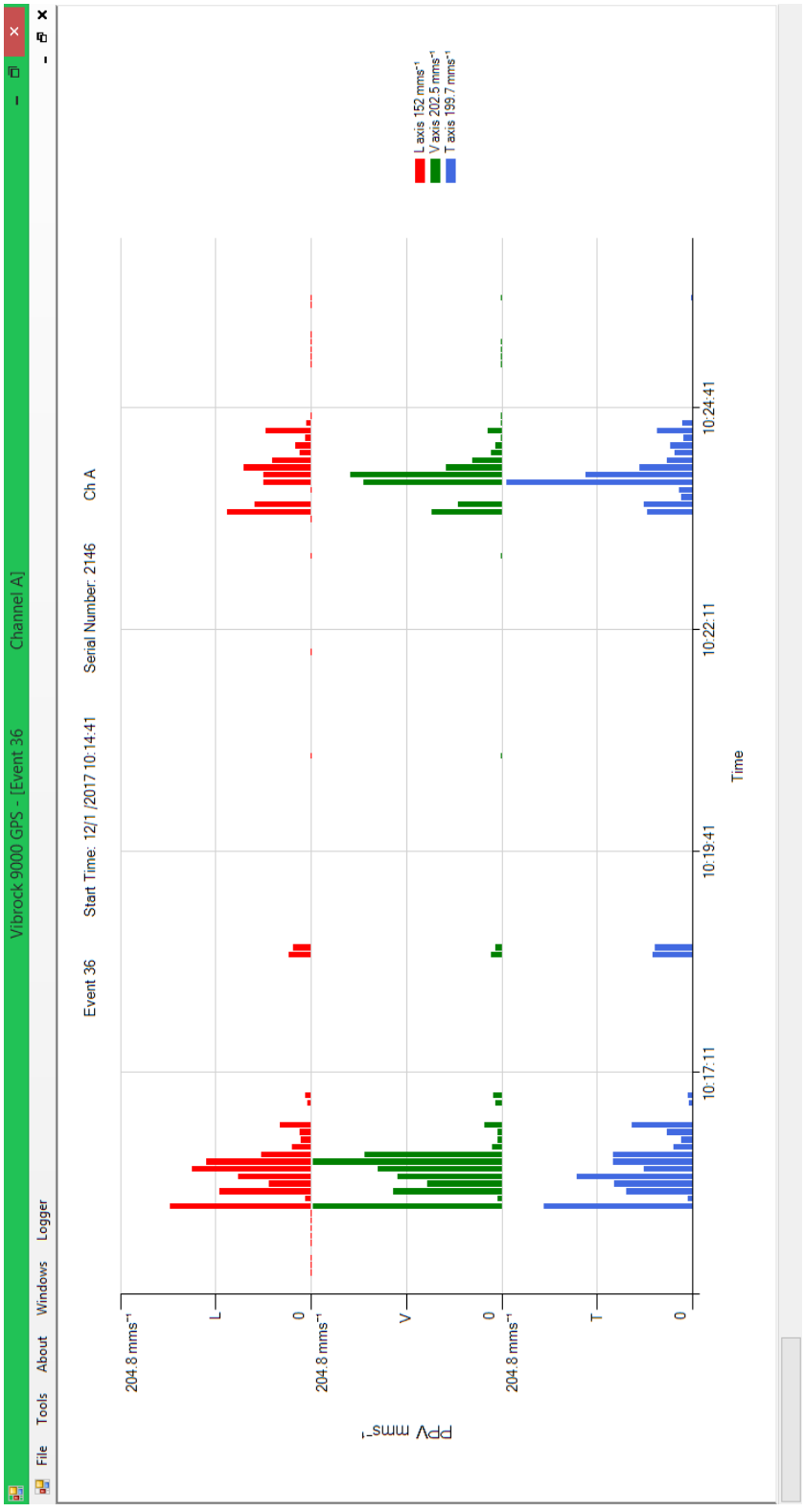
The following figures illustrate the readings captured during the pilot drilling phase and the 1st reaming phase of the HDD process.

The spikes shown on each graph indicate when the transducer was being positioned on the concrete block.

Figure 4.1. shows the level of vibration caused by jumping up and down next to the transducer. This is shown between 10:17 and 10:19 along the time axis.

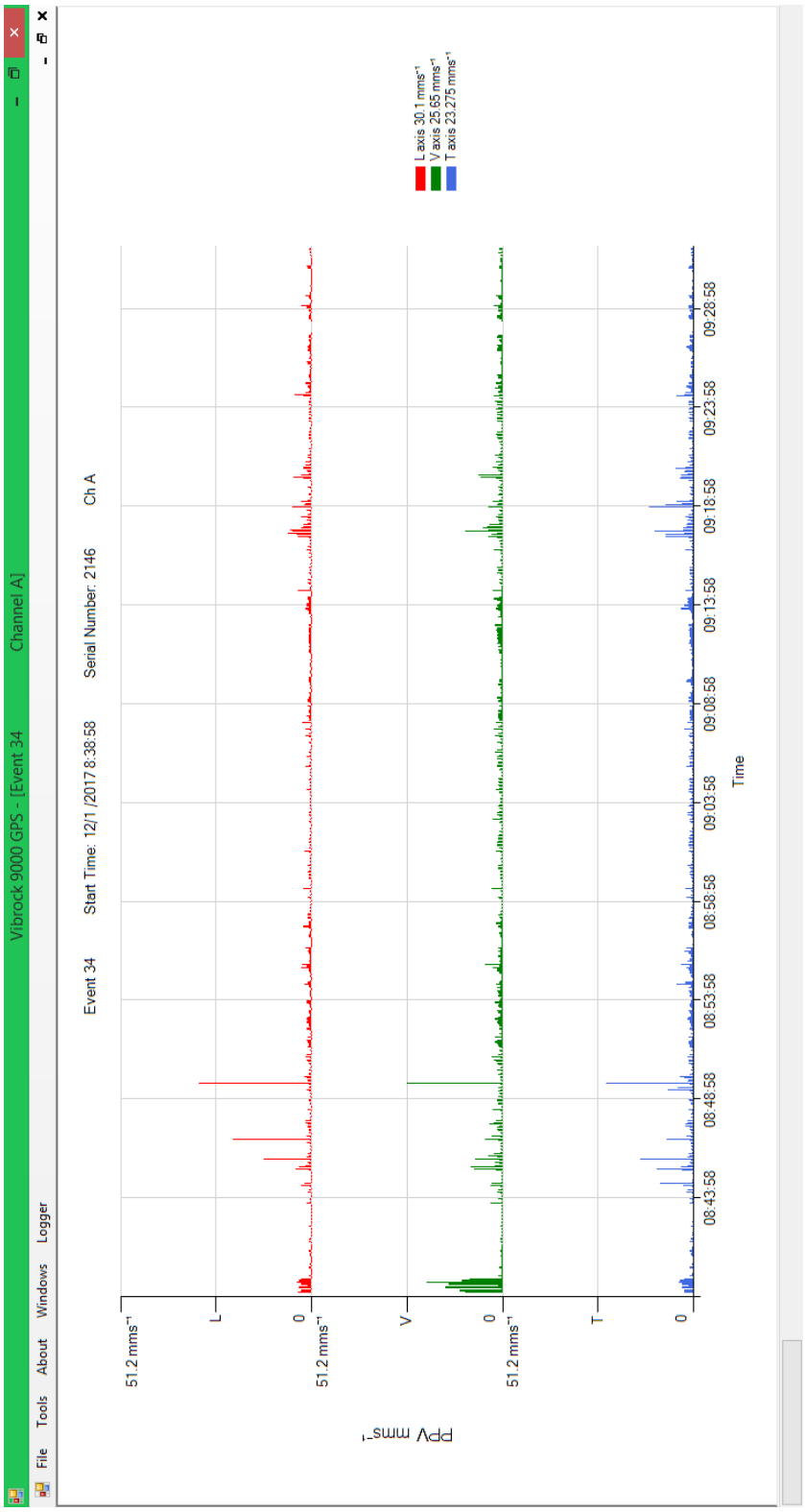
©This report is the copyright of Kingfisher Ecology

Fig 4.1. Data from pilot drilling at 62m from the HDD point of entry into the ground with a drill head depth of 8 – 9 meters



©This report is the copyright of Kingfisher Ecology

Fig 4.2. Data from pilot drilling at 10m from the HDD point of entry into the ground

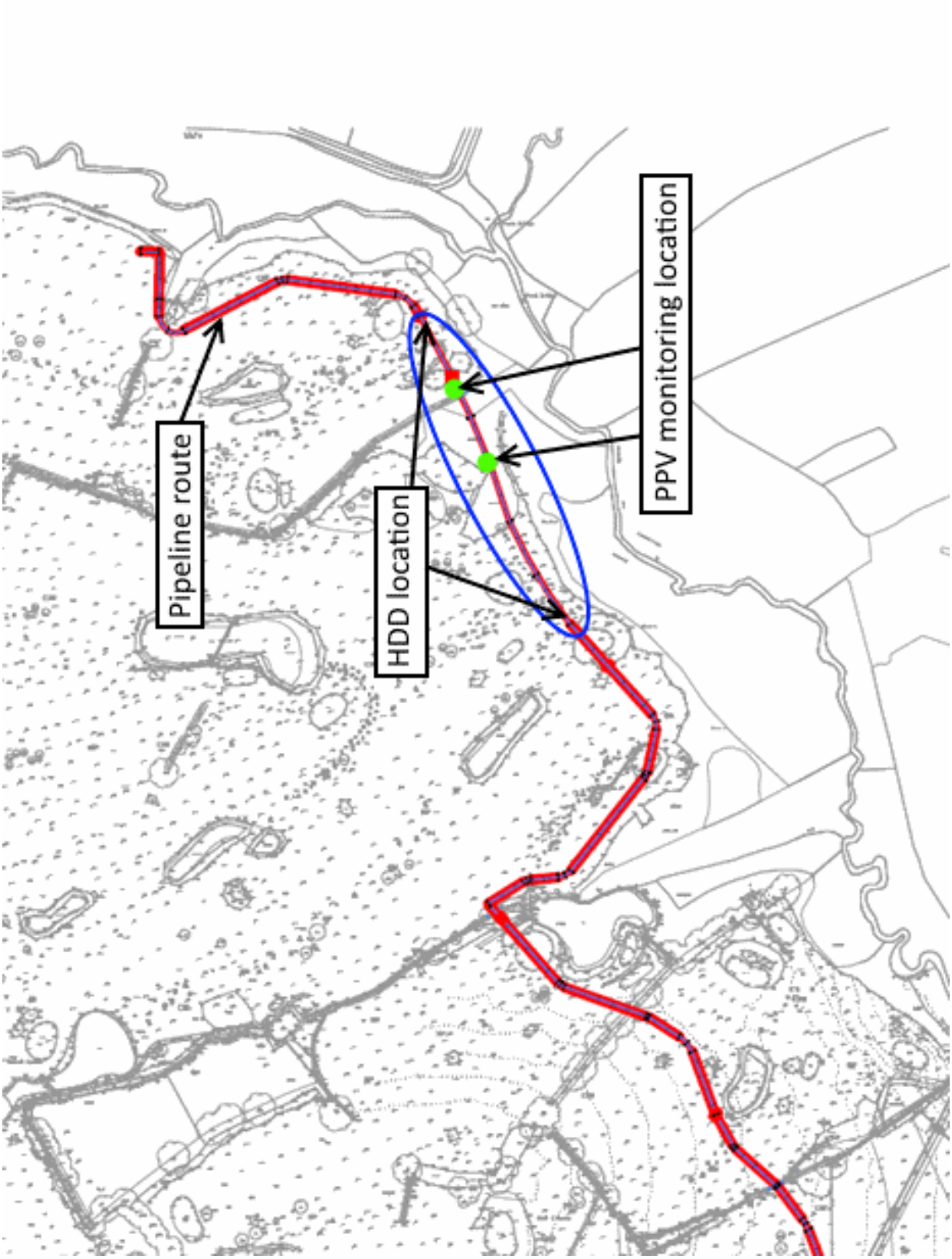


©This report is the copyright of Kingfisher Ecology

Fig 4.3. Data from 1st stage reaming showing an initial spike in PPV due to the setting up of the seismograph. The monitoring location was 62m from the HDD point of entry with a drill head depth of 8 – 9 meters.



Fig 4.4. Aerial map showing the location of the HDD on Botley Golf course



©This report is the copyright of Kingfisher Ecology

5. Conclusions

With a clay substrate and at a drilling depth of between 4 - 9 meters, the PPV caused during the pilot drilling and 1st phase reaming stages of HDD is significantly below the 13mm/s threshold.

The results of the core samples taken from boreholes at the golf course HDD location show that the substrate composition is closely comparable to that found at the Pudbrook Lake "S-Curve" HDD location with firm dark sandy clay found at a depth of 8-9m. Borehole BH08A shows stiff grey clay down to a depth of 22m (see appendix 8.1 – 8.6.)

6. Recommendations

It is recommended that further data is collected during the HDD under Pudbrook Lake. A watching brief will set up the seismograph in the appropriate location along the line of bisection. Detailed monitoring of the PPV will be required in order to prevent PPV exceeding the threshold of 13mm/s.

In the unlikely event that PPV reaches 13mm/s during the HDD under Pudbrook Lake, then the HDD will be terminated and Eastleigh Borough Council and the Environment Agency consulted.

Further data on the PPV created by HDD on a range of substrate types will be pursued. The purpose of generating further data is to better understand the vibration caused through HDD on a range of hard and soft substrate types. The data provided will allow for careful consideration in order to mitigate the potential affect that vibration caused by HDD can have on habitats surrounding the drill locations and the fauna that live within those habitats.

7. Survey Limitations

The seismograph readings provide data on the pilot drill phase and the 1st stage reaming phase of the HDD process only. The substrate was composed only of clay. Drilling through harder substrates may lead to higher levels of vibration.

The seismograph was turned on first and then positioned which has given spikes in the data recorded.

©This report is the copyright of Kingfisher Ecology

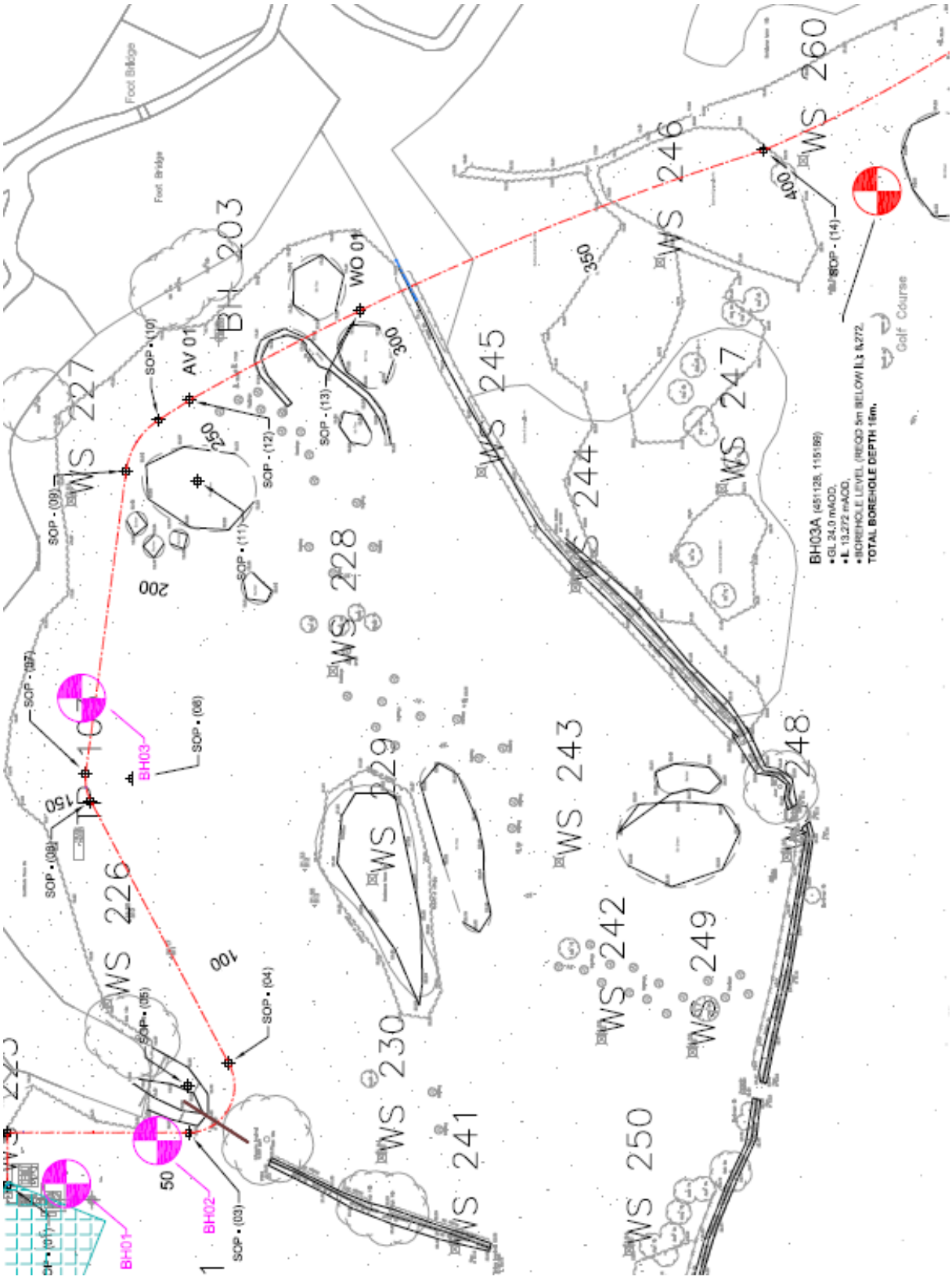
8. References

Vibrock Ltd (2015). *Vibrock V9000 Seismograph operator manual*.

©This report is the copyright of Kingfisher Ecology

9. Appendix

9.1. Aerial map of the HDD location on the golf course showing the location of borehole BH03 and BH03A



©This report is the copyright of Kingfisher Ecology

9.2. *Table illustrating the strata recorded in the BH03 borehole*

Borehole Log

ESG Environmental Scientifics Group

Drilled	GP	Start	27/06/2014	Equipment, Methods and Remarks	Depth from	to	Diameter	Casing Depth	Ground Level	+19.05 mOD
Logged	CP	End	27/06/2014	Dando 175 Hand dug inspection pit from GL to 1.20m depth. Cable Percussion boring from 1.20m to 10.50m depth.	0.00m	10.50m	150mm	4.50m	Coordinates	E 461006.40
Checked	SV								National Grid	N 115376.90
									Chainage	

Samples and Tests					Strata		
Depth	Type & No	Records	Date Casing	Time Water	Description		Depth, Level (Thickness)
					EARTH FILL (DRILLERS DESCRIPTION)		(0.30)
0.40 0.40 0.40-0.90 0.90-1.50	ES 1 D 2 B 3 B 6	4 samples taken			Firm yellowish brown slightly gravelly sandy CLAY. Sand is fine. Gravel is subrounded to subangular, fine to medium of white flint. (ALLUVIUM)	0.40-0.90 m Soft to firm very sandy clay with abundant rootlets.	0.30 +18.75 (1.60)
1.50 1.50	ES 4 D 5	4 samples taken					
1.90 2.00-2.45 2.00 2.00-2.50	D 7 SPT S D 8 B 9	N=22 (4,5/6,7,5,4)	1.50	dry	Firm yellowish brown to brown sandy gravelly CLAY. Gravel is subrounded to angular, fine to coarse of predominately white and brown flint. Sand is fine. (ALLUVIUM)	1.90-2.00 m Yellowish brown.	1.90 +17.15 (1.90)
2.50	ES 10	4 samples taken					
3.00	D 11					3.00-3.80 m Rare pockets 40 x 10 x 10mm of dark grey sandy clay.	
3.80	D 12				Firm dark grey sandy silty CLAY. Sand is fine. (WITTERING FORMATION)		3.80 +15.25
4.00-4.45 4.00-5.00	U 13 B 16	10 blows	4.00	dry		4.00-5.00 m Rare pockets 50 x 20 x 20mm of grey clay.	
4.50 4.60	D 14 ES 15	4 samples taken					(2.20)
6.00-6.45 6.00 6.00 6.50-7.00	SPT S D 17 D 18 B 19	N=16 (1,2/3,4,4,5)	4.50	1.50	Stiff dark grey slightly silty CLAY with abundant partings of 2mm light grey silty sand. Sand is fine to medium. (WITTERING FORMATION)		6.00 +13.05 (2.00)
8.00 8.00-8.45	D 20 U 21	20 blows	4.50	7.85	Stiff to very stiff dark grey silty CLAY. (LONDON CLAY FORMATION)		8.00 +11.05
8.50 9.00 9.50-10.00	D 22 D 23 B 24					8.50-9.00 m Fissured. Fissures are subhorizontal and subvertical, planar, smooth and extremely closely spaced. 9.00-10.00 m Very stiff.	(2.50)
Depth	Type & No	Records	Date Casing	Time Water	Stratum continues to 10.50 m		

Legend / Backfill/Instruments: SP

Groundwater Entries

No.	Struck (m)	Post strike behaviour	Depth sealed (m)
1	6.00	Rose to 5.70 m after 20 minutes.	-

Depth Related Remarks *

From	to (m)	
1.20	10.50	SPT Hammer ID SM35 (Er = 77%), rod type NWY

Chiselling

Depths (m)	Time	Tools used

Notes: For explanation of symbols and abbreviations see key sheet. All depths and reduced levels in metres. Stratum thickness given in brackets in depth column.

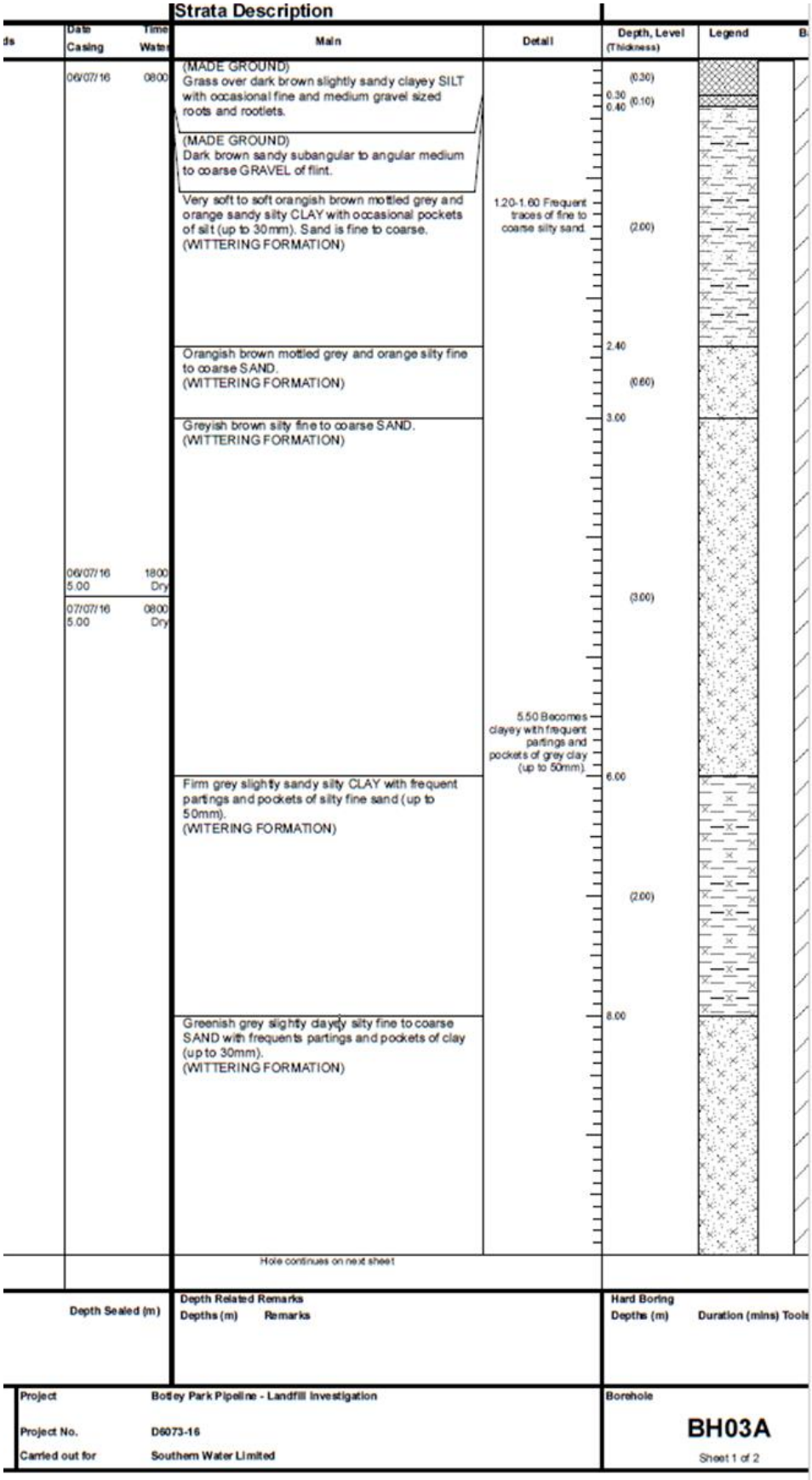
Scale 1:50

(c) ESG www.esg.co.uk

Project	Botley Park Pipeline, Botley
Project No.	D4039-14
Carried out for	Clancy Doowra

Borehole
BH03
Sheet 1 of 2

9.3. *Table illustrating the strata recorded in the BH03A borehole*



Strata Description

ds	Date / Casing	Time / Water	Main	Detail	Depth, Level (Thickness)	Legend	B
	06/07/16	0800	(MADE GROUND) Grass over dark brown slightly sandy clayey SILT with occasional fine and medium gravel sized roots and rootlets.		(0.30) 0.30 (0.10) 0.40		
			(MADE GROUND) Dark brown sandy subangular to angular medium to coarse GRAVEL of flint.				
			Very soft to soft orangish brown mottled grey and orange sandy silty CLAY with occasional pockets of silt (up to 30mm). Sand is fine to coarse. (WITTERING FORMATION)	1.20-1.60 Frequent traces of fine to coarse silty sand.	(2.00)		
			Orangish brown mottled grey and orange silty fine to coarse SAND. (WITTERING FORMATION)		2.40 (0.60)		
			Greyish brown silty fine to coarse SAND. (WITTERING FORMATION)		3.00		
	06/07/16 5.00	1800 Dry			(3.00)		
	07/07/16 5.00	0800 Dry		5.50 Becomes clayey with frequent partings and pockets of grey clay (up to 50mm).			
			Firm grey slightly sandy silty CLAY with frequent partings and pockets of silty fine sand (up to 50mm). (WITERING FORMATION)		6.00 (2.00)		
			Greenish grey slightly clayey silty fine to coarse SAND with frequents partings and pockets of clay (up to 30mm). (WITTERING FORMATION)		8.00		
			Hole continues on next sheet				

Depth Sealed (m)

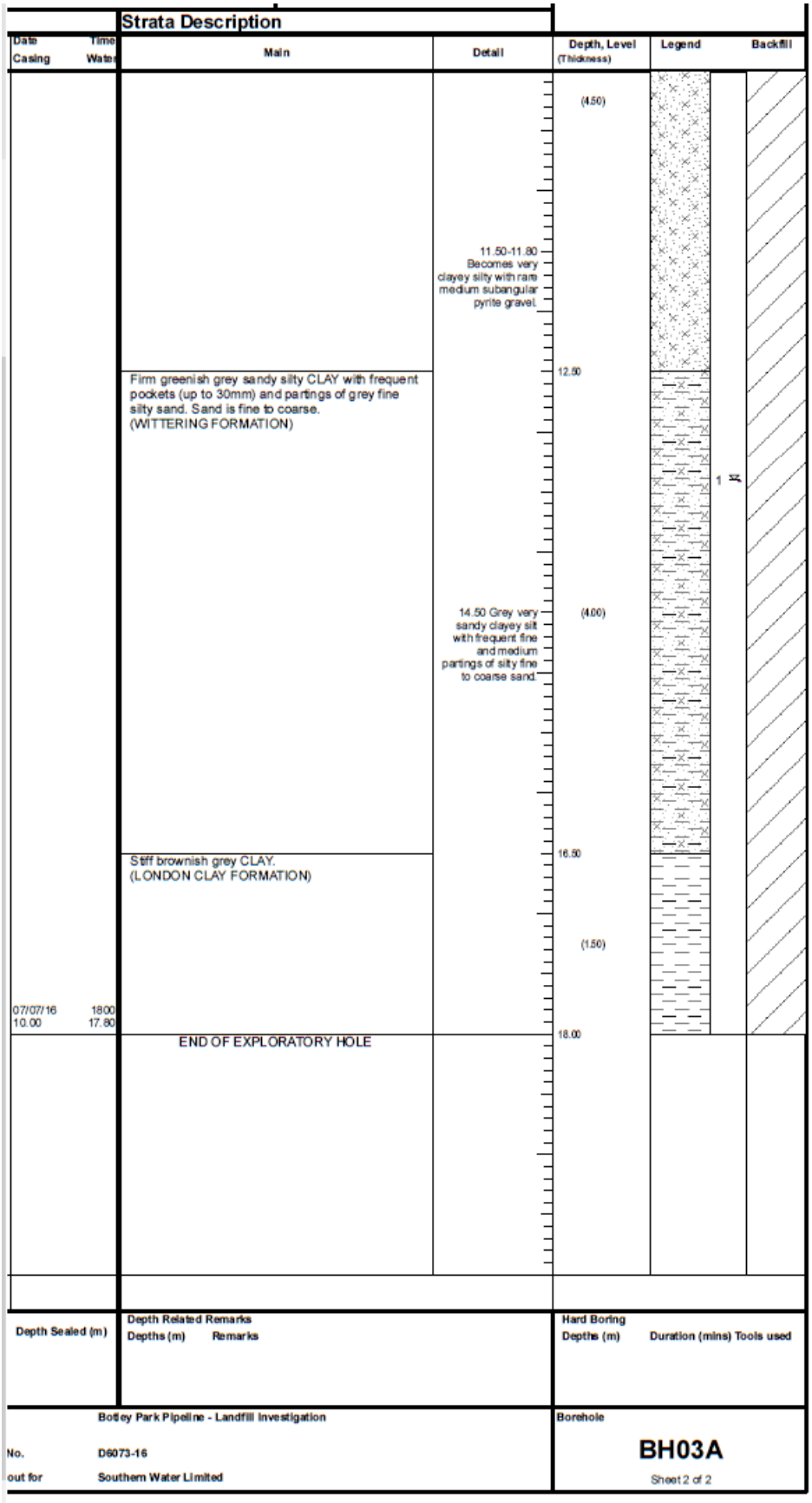
Depth Related Remarks
Depths (m) Remarks

Hard Boring
Depths (m) Duration (mins) Tools

Project: Botley Park Pipeline - Landfill Investigation
Project No.: D6073-16
Carried out for: Southern Water Limited

Borehole: **BH03A**
Sheet 1 of 2

©This report is the copyright of Kingfisher Ecology



Strata Description

Date / Casing	Time / Water	Main	Detail	Depth, Level (Thickness)	Legend	Backfill
				(4.50)		
			11.50-11.80 Becomes very clayey silty with rare medium subangular pyrite gravel.			
		Firm greenish grey sandy silty CLAY with frequent pockets (up to 30mm) and partings of grey fine silty sand. Sand is fine to coarse. (WITTERING FORMATION)		12.50		
			14.50 Grey very sandy clayey silt with frequent fine and medium partings of silty fine to coarse sand.	(4.00)		
		Stiff brownish grey CLAY. (LONDON CLAY FORMATION)		16.50		
				(1.50)		
07/07/16 10.00	1800 17.80					
		END OF EXPLORATORY HOLE		18.00		

Depth Sealed (m)

Depth Related Remarks
Depths (m) Remarks

Hard Boring
Depths (m) Duration (mins) Tools used

Botley Park Pipeline - Landfill Investigation

No. D6073-16

out for Southern Water Limited

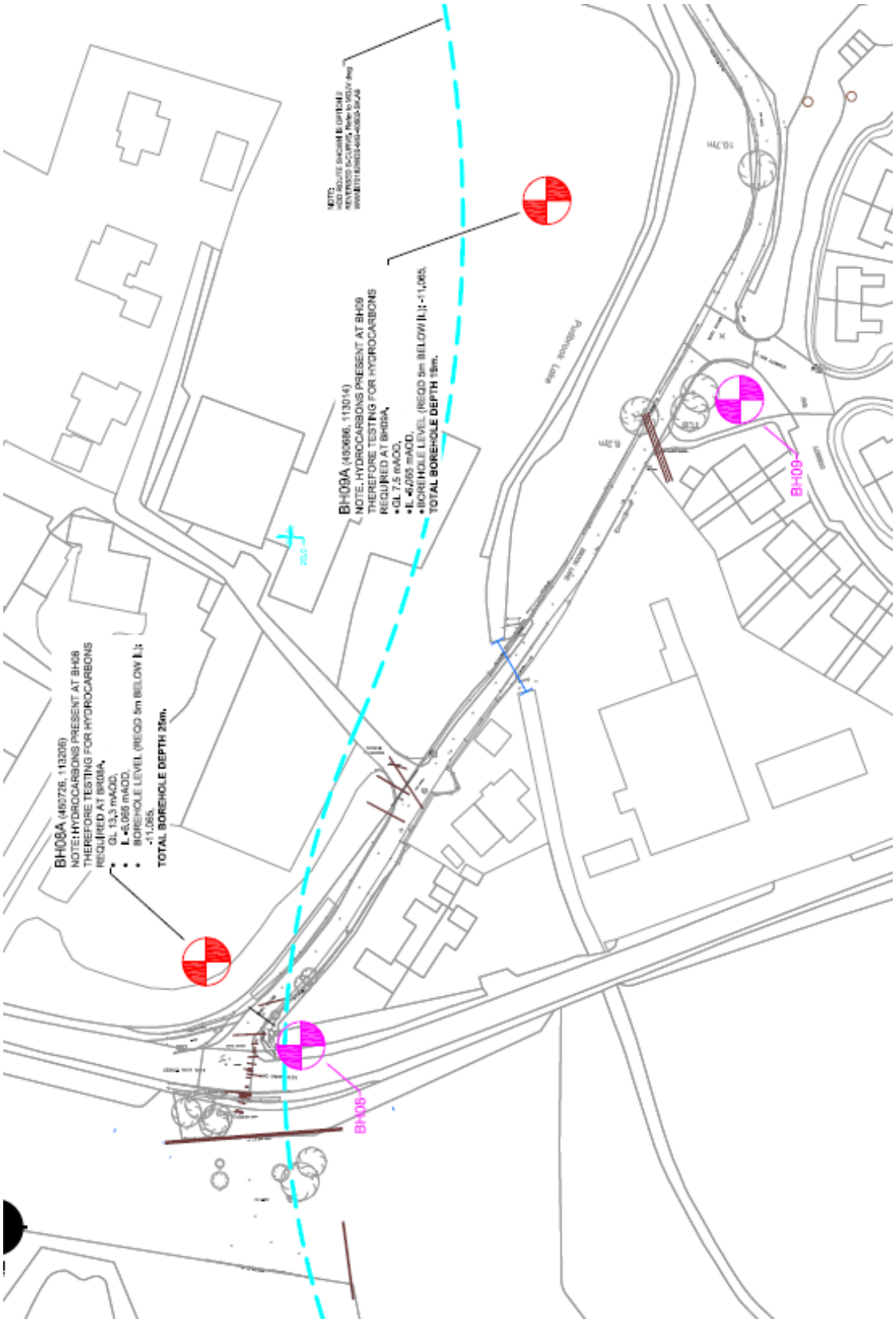
Borehole

BH03A

Sheet 2 of 2

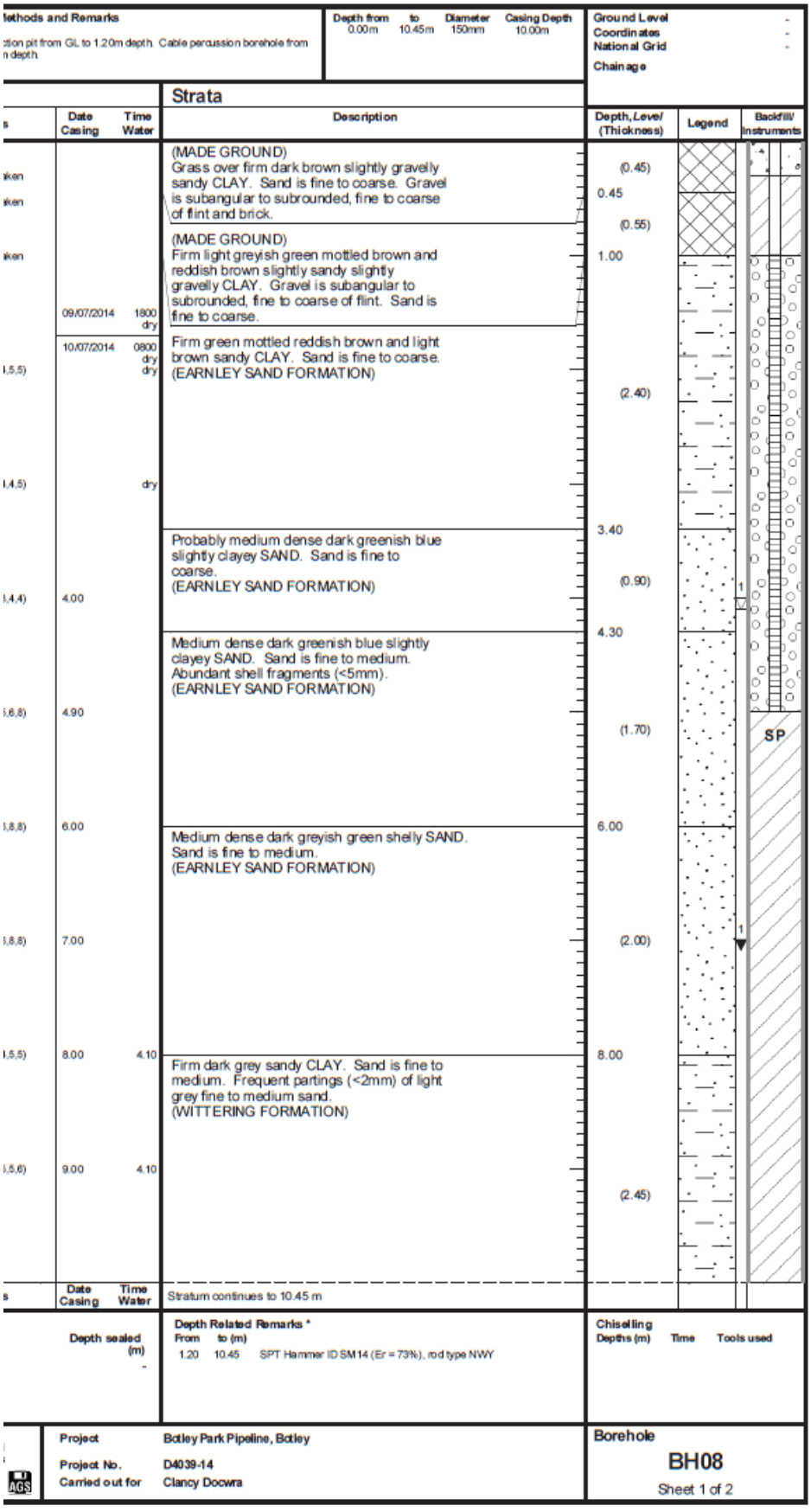
©This report is the copyright of Kingfisher Ecology

9.4. ***Aerial map of the Pudbrook Lake HDD crossing area showing the location of borehole BH08, BH08A, BH09 and BH09A***



©This report is the copyright of Kingfisher Ecology

9.5. *Table illustrating the strata recorded in the BH08 borehole*



Methods and Remarks

ction pit from GL to 1.20m depth. Cable percussion borehole from n depth

Depth from 0.00m to 10.45m Diameter 150mm Casing Depth 10.00m

Ground Level -
Coordinates -
National Grid -
Chainage

Strata

	Date Casing	Time Water	Description	Depth, Level (Thickness)	Legend	Backfill/ Instruments
iken			(MADE GROUND) Grass over firm dark brown slightly gravelly sandy CLAY. Sand is fine to coarse. Gravel is subangular to subrounded, fine to coarse of flint and brick.	(0.45) 0.45		
iken			(MADE GROUND) Firm light greyish green mottled brown and reddish brown slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded, fine to coarse of flint. Sand is fine to coarse.	(0.55) 1.00		
iken	09/07/2014	1800 dry				
	10/07/2014	0800 dry	Firm green mottled reddish brown and light brown sandy CLAY. Sand is fine to coarse. (EARNLEY SAND FORMATION)	(2.40)		
1.5,5)		dry				
1.4,5)		dry				
			Probably medium dense dark greenish blue slightly clayey SAND. Sand is fine to coarse. (EARNLEY SAND FORMATION)	3.40 (0.90)		
1.4,4)	4.00			4.30		
			Medium dense dark greenish blue slightly clayey SAND. Sand is fine to medium. Abundant shell fragments (<5mm). (EARNLEY SAND FORMATION)	(1.70)		SP
1.6,8)	4.90					
1.8,8)	6.00		Medium dense dark greyish green shelly SAND. Sand is fine to medium. (EARNLEY SAND FORMATION)	6.00 (2.00)		
1.8,8)	7.00					
1.5,5)	8.00	4.10	Firm dark grey sandy CLAY. Sand is fine to medium. Frequent partings (<2mm) of light grey fine to medium sand. (WITTERING FORMATION)	8.00		
1.5,6)	9.00	4.10		(2.45)		
	Date Casing	Time Water	Stratum continues to 10.45 m			

Depth sealed (m) -

Depth Related Remarks *
From to (m)
1.20 10.45 SPT Hammer ID SM14 (Er = 73%), rod type NWY

Chiselling
Depths (m) Time Tools used

Project Botley Park Pipeline, Botley
Project No. D4039-14
Carried out for Clancy Docwra

Borehole
BH08
Sheet 1 of 2

©This report is the copyright of Kingfisher Ecology

ods and Remarks

pit from GL to 1.20m depth. Cable percussion borehole from pth

Depth from	to	Diameter	Casing Depth
0.00m	10.45m	150mm	10.00m

Ground Level -
Coordinates -
National Grid -
Chainage

Strata

Date	Casing	Time	Water
	10.00		4.10
10/07/2014		1800	
	10.00		4.10

Description (Continued from Sheet 1)	Depth, Level (Thickness)	Legend	Backfill/ Instruments
Firm dark grey sandy CLAY. Sand is fine to medium. Frequent partings (<2mm) of light grey fine to medium sand. (WITTERING FORMATION)	10.45		
EXPLORATORY HOLE ENDS AT 10.45 m			

Date	Casing	Time	Water

Depth sealed (m)

Depth Related Remarks *
From to (m)

Chiselling
Depths (m) Time Tools used

Project Botley Park Pipeline, Botley
Project No. D4039-14
Carried out for Clancy Docwra

Borehole
BH08
Sheet 2 of 2

©This report is the copyright of Kingfisher Ecology

9.6. *Table illustrating the strata recorded in the BH08A borehole*

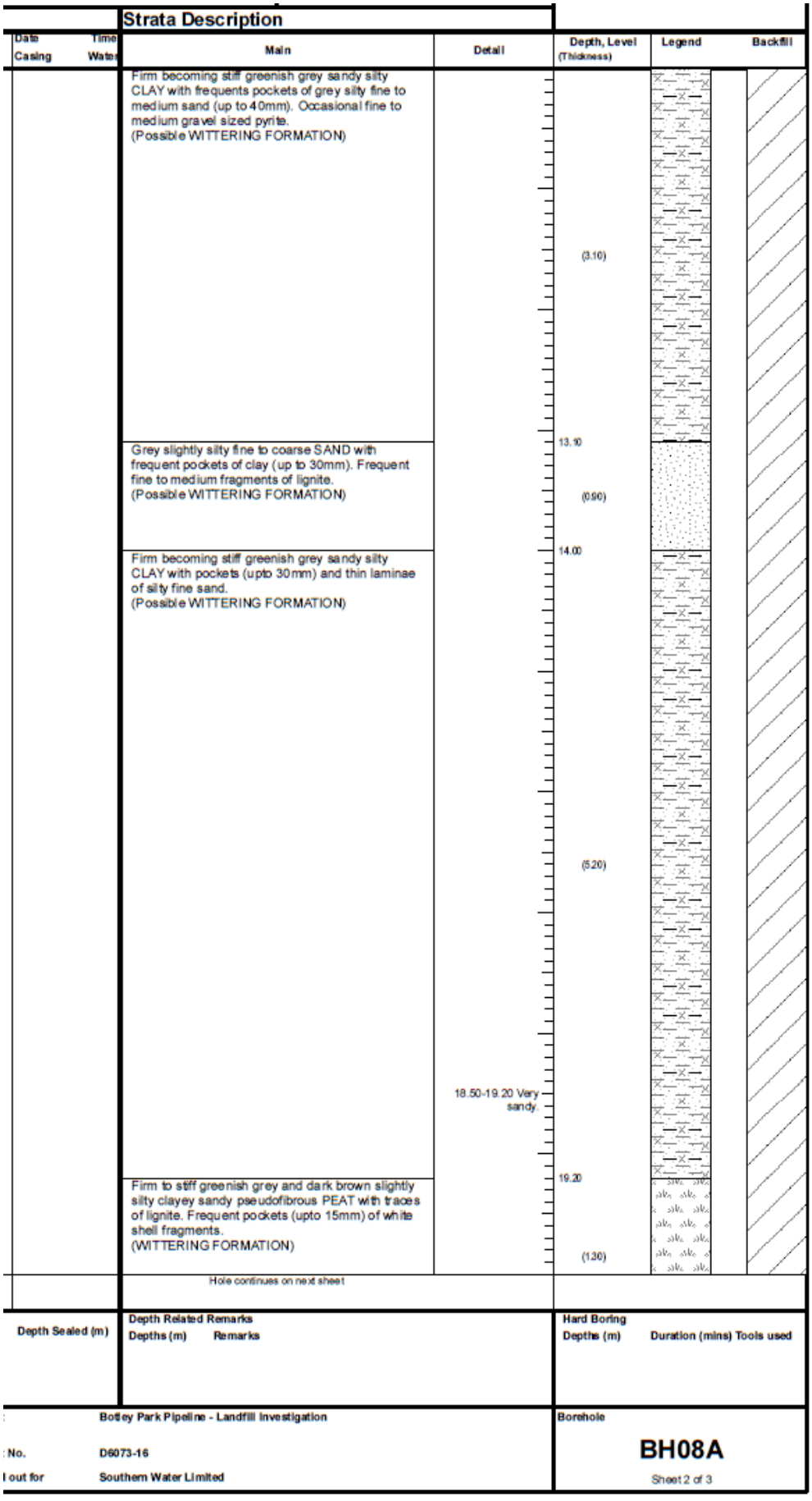
Strata Description

Date / Casing	Time / Water	Main	Detail	Depth, Level (Thickness)	Legend	Backfill
04/07/16	0800	(MADE GROUND) Grass over dark brown sandy subangular to angular fine to coarse flint GRAVEL with occasional fragments roots and rootlets, occasional clinker.		(0.40) 0.40		
		Orangish brown and green slightly silty fine to coarse glauconitic SAND. (EARNLEY SAND FORMATION)		(1.00) 1.40		
		Orangish brown and green silty fine to coarse glauconitic SAND. (EARNLEY SAND FORMATION)		(1.60) 3.00		
		Firm orangish brown mottled brown, green and orange sandy silty CLAY with frequent thin laminae of fine to medium silty sand. Sand is fine to coarse. (EARNLEY SAND FORMATION)		(0.60) 3.60		
		Greyish blue and green locally discoloured orange very sandy clayey SILT with occasional pockets of clay (up to 20mm). Sand is fine to coarse. (EARNLEY SAND FORMATION)		(2.40) 6.00		
		Greenish grey silty fine to coarse glauconitic SAND with frequent fine and medium gravel sized shell fragments. (EARNLEY SAND FORMATION)	9.50-9.80 Occasional fine to medium subangular pyrite gravel	(4.00) 10.00		
		Hole continues on next sheet				

Depth Sealed (m)	Depth Related Remarks Depths (m) Remarks	Hard Boring Depths (m) Duration (mins) Tools used

	Botley Park Pipeline - Landfill Investigation	Borehole
o.	D6073-16	**BH08A**
ut for	Southern Water Limited	Sheet 1 of 3

©This report is the copyright of Kingfisher Ecology



Strata Description

Date / Casing	Time / Water	Main	Detail	Depth, Level (Thickness)	Legend	Backfill
		Firm becoming stiff greenish grey sandy silty CLAY with frequents pockets of grey silty fine to medium sand (up to 40mm). Occasional fine to medium gravel sized pyrite. (Possible WITTERING FORMATION)		(3.10)		
		Grey slightly silty fine to coarse SAND with frequent pockets of clay (up to 30mm). Frequent fine to medium fragments of lignite. (Possible WITTERING FORMATION)		13.10 (0.90)		
		Firm becoming stiff greenish grey sandy silty CLAY with pockets (upto 30mm) and thin laminae of silty fine sand. (Possible WITTERING FORMATION)		14.00 (5.20)		
			18.50-19.20 Very sandy.			
		Firm to stiff greenish grey and dark brown slightly silty clayey sandy pseudofibrous PEAT with traces of lignite. Frequent pockets (upto 15mm) of white shell fragments. (WITTERING FORMATION)		19.20 (1.30)		

Hole continues on next sheet

Depth Sealed (m)

Depth Related Remarks
Depths (m) Remarks

Hard Boring
Depths (m) Duration (mins) Tools used

Botley Park Pipeline - Landfill Investigation

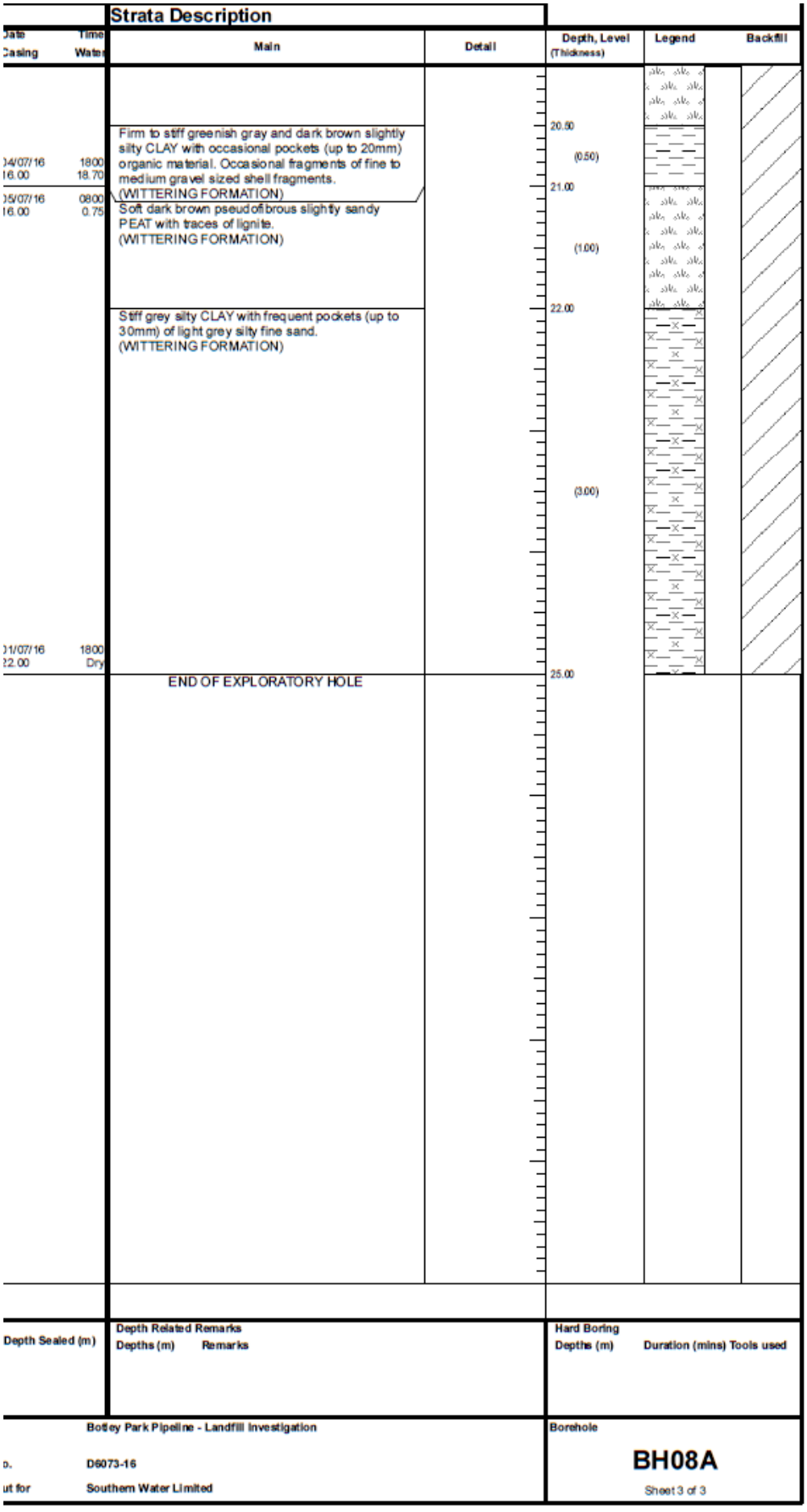
Borehole
BH08A

No. D6073-16

l out for Southern Water Limited

Sheet 2 of 3

©This report is the copyright of Kingfisher Ecology



©This report is the copyright of Kingfisher Ecology