

London Road Fire Station

Borehole Decommissioning Specification

Curtins Ref: 060270-CUR-00-XX-SP-GE-005-P02

Revision: P02

Issue Date: 28 September 2021

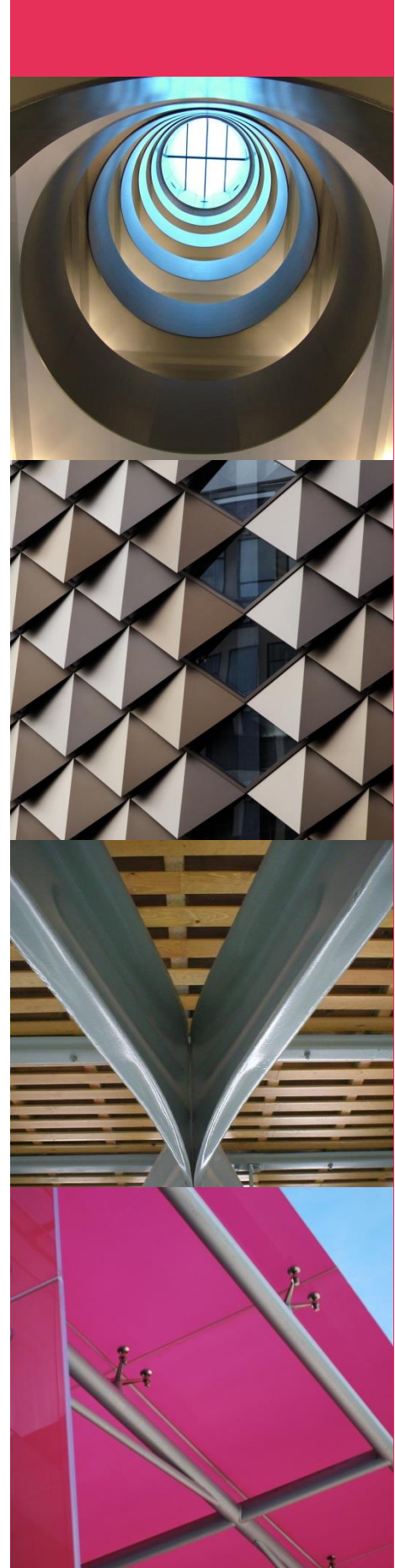
Client Name: Allied London

Client Address: Allied London, Suite 1, Bonded Warehouse, 18 Lower Byrom Street,
Manchester, Greater Manchester, England, M3 4AP

Site Address: London Road Fire Station, London Road, Manchester

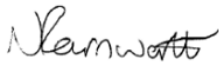
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Rev	Description	Issued by	Checked	Date
P01	Issue	NF	RA	13/09/2021
P02	Amendment to proposed development description	ZH	NF	28/09/2021

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Reviewed & Authorised	Signature	Date
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1.0 Introduction

This Borehole Decommissioning Specification has been prepared by Curtins for Allied London (the client) to provide guidance with respect to requirements for borehole decommissioning for the proposed development at London Road Fire Station, London Road, Manchester.

The proposed development on site comprises the refurbishment of the existing structure with extension to the eastern side. The mixed-use development is planned to include a hotel, restaurants, bars and retail units, and from the second floor upwards, residential apartments. The proposed development plans are included within *Appendix A* of this report.

The Environment Agency (EA) have been consulted by Manchester City Council (MCC) as part of the planning application ref. 125712/FO/2019. The EA have requested further information on items to ensure the groundwater underlying the site is protected, including providing written evidence and confirmation that BH02 and BH03 have been properly decommissioned, backfilled and sealed in accordance with DEFRA and EA guidance. The Specification has therefore been produced to detail the requirements for decommissioning.

1.1 Requirements of the Borehole Decommissioning Specification

This Borehole Decommissioning Specification is to account for the following:

- A summary of existing borehole construction.
- Recommendations for suitable and effective decommissioning.
- Recommendations for verification of decommissioning works.

1.2 Definitions

In this document the following definitions apply,

Contractor: Refers to the appointed contractor responsible for undertaking the remediation/ borehole decommissioning works.

Site Manager: Refers to a representative of the appointed contractor resident on site.

Engineer: refers to a suitably qualified representative from Curtins, who would not normally be resident on site.

1.3 References

This Borehole Decommissioning Specification has been prepared with reference to the following reports;

Reference 1: Curtins, Phase 1 Preliminary Site Assessment, May 2016 (B060270.001 Rev A/APA/6737).

Reference 2: Curtins, Phase 2 Intrusive Investigation, January 2017 (B061230/JB/8131).

Reference 3: Curtins, Piling Risk Assessment, August 2021, (060270-CUR-00-XX-SP-GE-002-P01).

Reference 4: The Environment Agency, Good Practice for Decommissioning Redundant Boreholes and Wells (2012)

2.0 Borehole Installation Details

Ground investigation fieldworks were undertaken by Ian Farmer Associates Ltd (IFA) between 22nd August and 5th September 2016. As part of the investigation the following (50mm) monitoring wells were installed:

Table 2.0 – Monitoring Well Response Zones

Borehole Ref.	Response Zone m bgl (m AOD)	Strata Description(s)
BH01	3.00-5.00	SUPERFICIAL DEPOSITS (CLAYS & GRAVELS)
BH02	9.00-12.00	SANDSTONE
BH03	1.00-6.00	MADE GROUND (CLAY) & SUPERFICIALS (CLAY & SAND) & SANDSTONE
WS03	1.00-3.50	SUPERFICIAL DEPOSITS

A bentonite seal was placed above and below the screened section of the borehole to minimise potential for downward migration of contaminants and the creation of a preferential migratory pathway. A gravel surround was installed in the annulus between the sides of the borehole and the slotted sections of pipe.

Copies of borehole logs can be referred to in *Appendix B* of this report along with an exploratory hole location plan in *Appendix A*.

Exploratory Boreholes BH02 and BH03 were installed with monitoring wells extending into the Chester Formation sandstone beneath the site whilst response zones of the other boreholes do not extend into the Chester Formation.

3.0 Decommissioning Specification

The Environment Agency (EA) have requested written evidence that BH02 and BH03 boreholes are decommissioned, backfilled and sealed.

Objectives of decommissioning include:

- To remove the hazard of an open hole.
- Prevent the borehole acting as a conduit for contamination at the surface to migrate into the Principal aquifer in the Chester Formation.
- Prevent the mixing of contaminated and uncontaminated groundwater from different aquifers.
- Prevent the flow of groundwater from one geological horizon to another.

With reference to EA guidance 'Good Practice for Decommissioning Redundant Boreholes and Wells' enclosed in Appendix C it is recommended that BH02 and BH03 are decommissioned in accordance with the specification below.

Step 1

Inspect existing borehole well to establish condition. Construction Details are as detailed in Section 2.0 and on the borehole logs included within Appendix A.

Step 2

Remove headworks and casing. The borehole must be free from all obstruction that may interfere with the sealing of the hole. Any pumps, pipework and dip tubes should be removed. The condition of any borehole casing and grout must be examined to ascertain whether its retention in the hole would prejudice any of the objectives of the abandonment. Assess if the well casing needs to be removed or if it can be retained.

Step 3

Backfill the borehole. The ground should be restored as close to its pre-drilled condition as possible. 'Clean' materials should be so that the permeability of the selected materials are similar to the properties of the geological strata surrounding them so groundwater flow and quality are not adversely affected. Permeable aggregates should be used in aquifer horizons whilst low permeability materials are used in low permeability horizons. Alternatively, the ensure borehole or well can be backfilled with low permeability materials that will prevent significant vertical or horizontal of groundwater through or along the borehole.

The borehole must be removed to a level at >1m below formation level for proposed redevelopment. The top of the borehole must be sealed with an impermeable plug to prevent entry of potentially contaminated surface run-off. This includes filling of the top 2m with a cement, concrete or bentonite grout.

A concrete cap is not deemed to be required given the central courtyard area which the boreholes are positioned is to be covered by hardstanding (permeable paving with type 2 sub-base and impermeable membrane underlying as further detailed in Reference 3). This hardstanding will act as a cap.

Backfill materials must be clean and must not cause pollution. Aggregates (pea gravel, shingle, sand etc) should have a suitable grain size for easy delivery into the borehole and to avoid bridging.

Considering the geology and response zone in BH02 as detailed in Table 2.0 and given that site levels are not anticipated to change significantly. The following backfill detail would be considered acceptable:

0.0-1.0m bgl- Borehole excavated and removed before backfilling with arisings.

1.0-3.0m bgl - Cement, concrete or bentonite grout plug below through made ground and stiff clay.

3.6-12m bgl - Permeable aggregate or low permeability fill e.g. bentonite, through geology of dense reddish brown silty sandy gravel (to 8.60m) and red brown sandstone below, initially recovered as a sand.

Considering the geology and response zone in BH03 as detailed in Table 2.0 the following backfill detail would be considered acceptable:

0.0-1.0m bgl- Borehole excavated and removed before backfilling with arisings.

1.0-4.0m bgl - Cement, concrete or bentonite grout plug below through made ground and firm clay.

4.0-6.0m bgl - Permeable aggregate or low permeability fill e.g. bentonite, through geology of reddish brown sand and red brown (to 5.90m) and weathered sandstone below.

Where other backfill details are being considered this should be in accordance with EA guidance and agreed with the engineer.

An accurate record of the works should be kept in accordance with the verification plan in Section 4.0.

4.0 Verification Plan & Reporting

EA guidance states that an accurate record of the abandonment details should be maintained for future reference including:

- The reasons for abandonment.
- Measurement of groundwater level prior to backfilling.
- The depth and position of each layer of backfilling and sealing materials.
- The type and quantity of backfilling and sealing materials used.
- Any changes made to the borehole/well during the abandonment (for example casing removal).
- Any problems encountered during the abandonment procedure.

The EA further recommend that the location of abandoned boreholes are marked clearly on site records and that boreholes are inscribed or marked as well/borehole to show what there use in the event they are discovered during future excavations.

Validation visits shall be undertaken by an appropriately qualified environmental engineer throughout the decommissioning phase to ensure that the requirements of this specification have been implemented at the site. It is anticipated records of the following will be taken during the below phases of work:

- Prior to and during borehole backfilling with suitable materials.
- Construction of appropriate plug.

All associated documentation pertaining to the above will be supplied to the Engineer and incorporated within a Borehole Decommissioning Completion Report.

A Completion Report will be required on completion of the works confirming that the remedial works have been completed satisfactorily. The report will contain information include the information requested by the EA, outlined above.

5.0 Appendices

Appendix A Exploratory Hole Location Plan



TP1 - TP4 - Machine excavated trial pits to determine the size, depth+construction of foundations. All pits to be extended to base of wall (foundation for inspection by Engineer)



BH1 and BH3 - Cable Percussion borehole to maximum 10m

BH2* Cable Percussion borehole to maximum 10m with 5m rotary core



WS1 - WS4 - Window Sample boreholes to maximum 5m



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INFORMATION

Project:

London Rd. Fire & Police Station

Dwg Title:

Proposed Exploratory Hole Location
Plan- Ground Floor

Scale:

Size:	First Issue:	Drawn:	Checked:
A3	17.05.2016	LR	SH

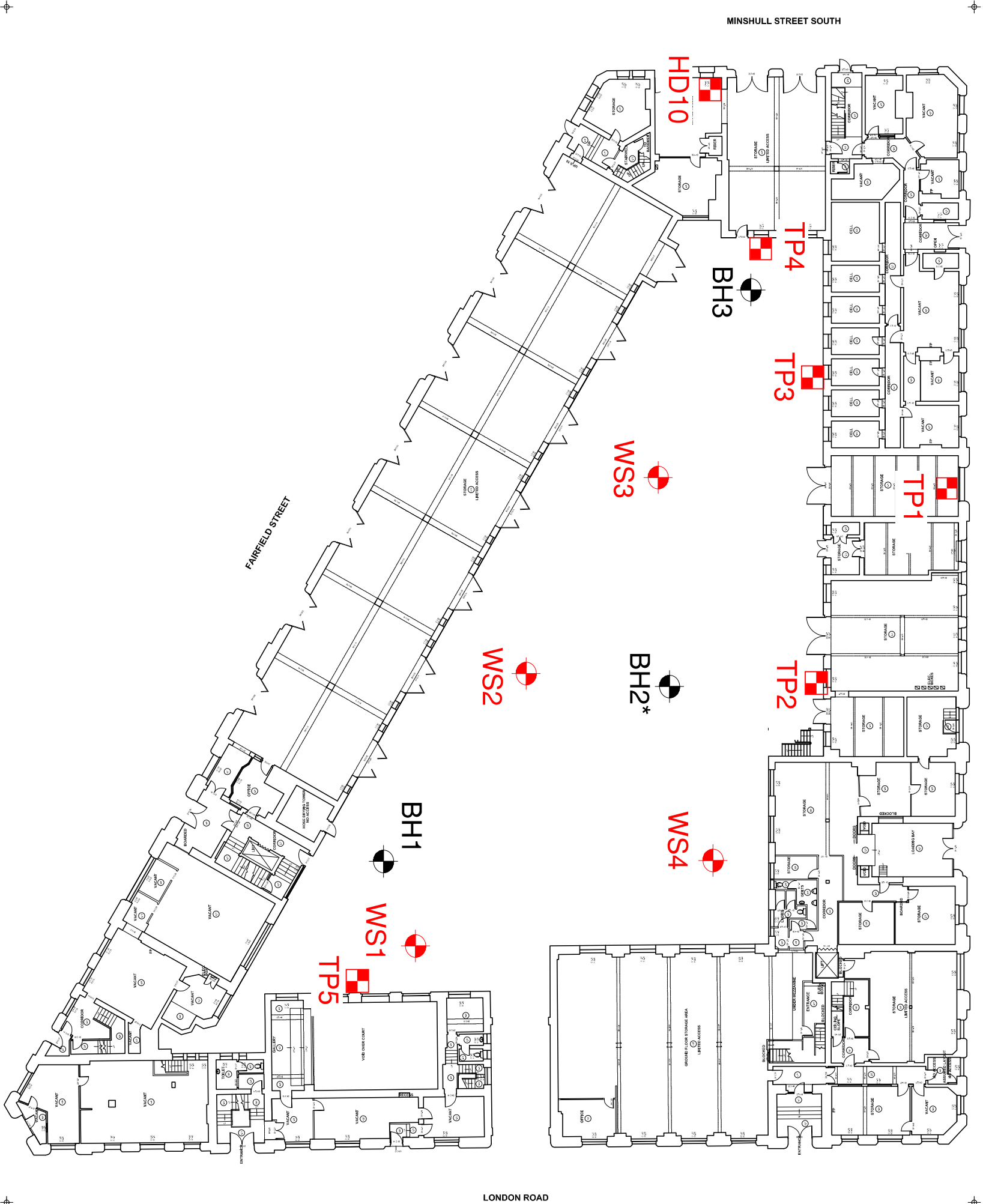
Dwg No:

B061230/L001

Rev:

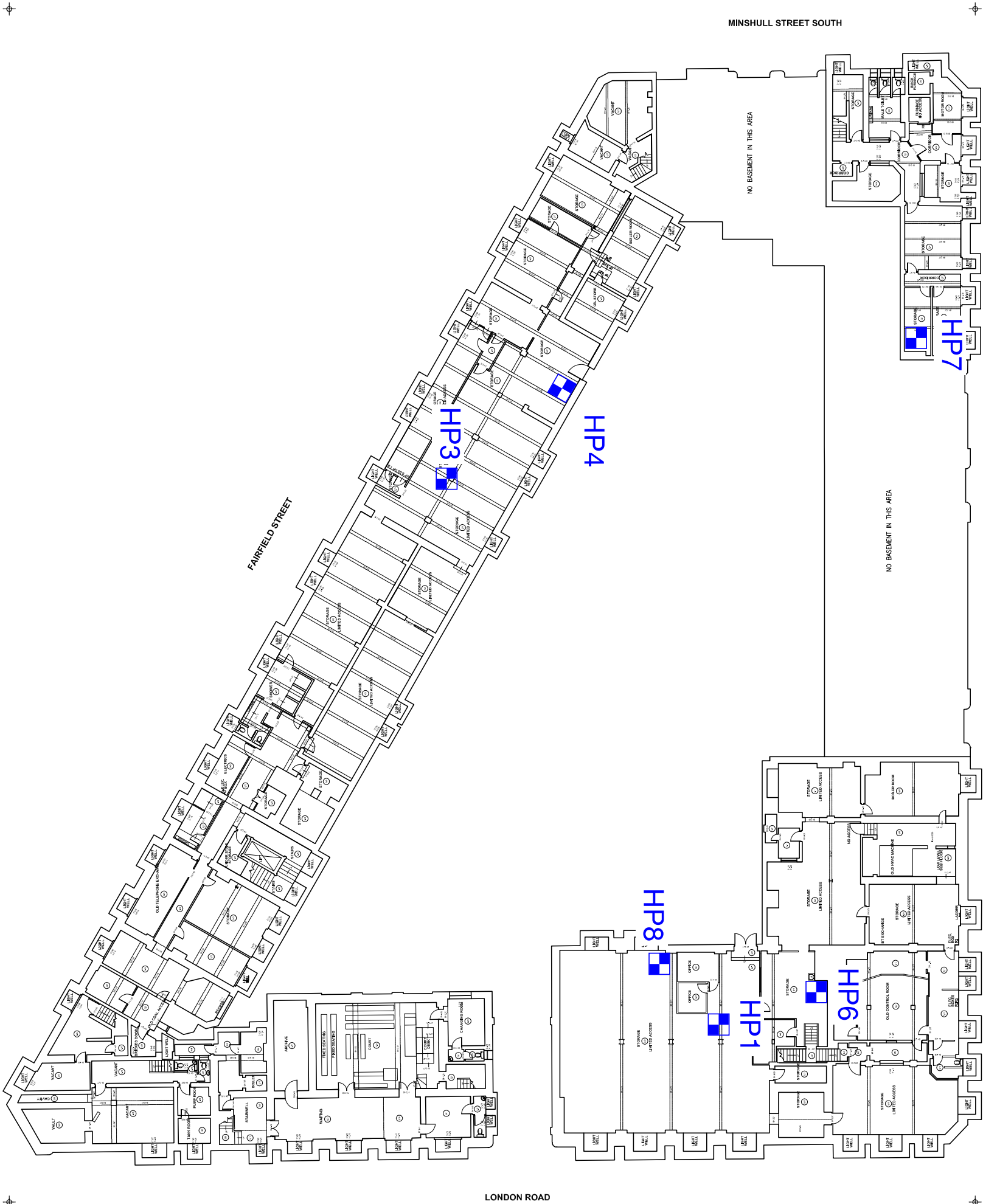
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HP 1 - HP 9 - Hand excavated trial pits to determine the size, depth+construction of foundations. All pits in basement require breakout of existing slab.



Rev:	Description:	Date:	By:	Chkd:
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Status:	INFORMATION
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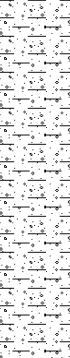
Project:	London Rd. Fire & Police Station
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Dwg Title:	Proposed Exploratory Hole Location Plan- Basement Floor
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Scale:	Size:	First Issue:	Drawn:	Checked:
	A3	17.05.2016	LR	SH

Dwg No:	Rev:
B061230/L002	C

Appendix B Borehole Logs

		Contract Name: London Road Fire Station, Manchester		Client: Allied London		Borehole ID: WS03													
		Contract Number: 41953	Date Started: 31/08/2016	Logged By: JM	Checked By: HH	Status: DRAFT	Sheet 1 of 1												
Dynamic Sample Borehole Log		Easting:		Northing:		Ground Level:		Plant Used:		Print Date: 02/11/2016		Scale: 1:50							
Weather:				Termination:				SPT Hammer: N/R, Energy Ratio: N/R											
Samples & In Situ Testing						Strata Details						Groundwater							
Depth		Sample ID		Test Result		Level (mAOD)		Depth (m) (Thickness)		Legend		Strata Description		Water Strike		Backfill/ Installation			
0.40		D7		SPT(S) N=22 (3,4/5,5,6,6)				0.05				MADEGROUND: Brick.							
0.40		ES9						0.24				MADE GROUND: Concrete.							
0.80		D6						(0.36)				MADE GROUND: Brown, dark brown, sandy, angular to subrounded, fine to coarse GRAVEL including brick, ash, coal and concrete.							
0.80		ES8						0.60				Stiff, brown, mottled grey, slightly sandy, slightly gravelly CLAY. Gravel is subangular to rounded, fine to coarse including sandstone, siltstone, limestone, quartzite and occasional coal.							
1.00																			
1.50		D5		SPT(S) N=27 (4,6/6,6,7,8)				(3.00)						1					
2.00														2					
2.50		D4												3					
3.00				SPT(S) N=40 (6,6/10,7,11,12)										3					
3.50		D3												4					
3.60		D2		SPT(S) 50 (27 for 135mm/50 for 115mm)				3.60				Dense, reddish brown, fine to coarse SAND (Possible weathered sandstone).		4					
3.80 - 4.05								4.05						5					
												End of Borehole at 4.05m		6					
														7					
														8					
														9					
														10					
Borehole Diameter				Installation				Remarks:											
Depth (m)		Dia (m)		Depth Top		Base (m)		Diameter		Pipe Type		Service inspection pit hand excavated from GL to 1.20m.							
				0.00		0.20				PLAIN									
				0.20		1.00				PLAIN									
				1.00		3.50				SLOTTED									
Water Strikes																			
Depth Strike		Depth Casing		Depth Sealed		Time (mins)		Rose to (m)		Remarks									
IFA DS Template Issue Number: 3 Issue Date: 07-09-16																			

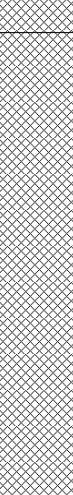
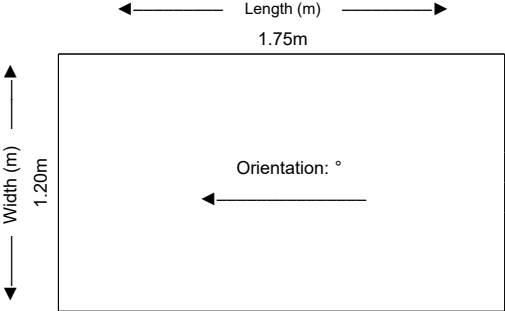
	Contract Name: London Road Fire Station, Manchester		Client: Allied London			Borehole ID: BH01	
	Contract Number: 41953	Date Started: 26/08/2016	Logged By: JM	Checked By: HH	Status: DRAFT		
Cable Percussion Borehole Log	Easting:	Northing:	Ground Level:	Plant Used:	Print Date: 02/11/2016	Sheet 1 of 1	
					Scale: 1:50		
Weather:		Termination:		SPT Hammer: N/R, Energy Ratio: N/R			
Samples & In Situ Testing			Strata Details				Groundwater
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike
0.20	D2	SPT(S) N=14 (2,3/3,4,3,4)		0.20		MADE GROUND: Concrete.	
0.20	ES1			(1.10)		MADE GROUND: Dark brown grey, sandy, angular to subrounded, fine to coarse GRAVEL with medium cobble content. Including brick, concrete and sandstone.	
0.50 - 1.00	B3						
1.00	D5	SPT(S) N=13 (2,3/3,3,4,3)		1.30		MADE GROUND: Firm, dark brown, sandy, very gravelly CLAY. Gravel is angular to subrounded, fine to coarse including brick, ash, concrete, sandstone and occasional wood.	1
1.00	ES4			(0.80)			
1.20	B6						
1.20 - 1.65	D8	SPT(S) N=48 (7,7/7,9,13,19)		2.10		Firm, brown, slightly sandy, slightly gravelly CLAY. Gravel is subangular to rounded, fine and medium including sandstone, siltstone, limestone, occasional quartzite and coal.	2
1.70	ES7						
2.00	B9						
2.00 - 2.45	ES10	115 blows. 100% recovery		(1.60)		Below 3.00m: stiff and very high strength.	3
2.70	U12						
3.00 - 3.45	D13						
3.50	D14	SPT(S) N=48 (7,7/7,9,13,19)		3.70		Dense, reddish brown, silty, sandy, subangular to rounded, fine and coarse GRAVEL including sandstone, siltstone, limestone, occasional quartzite and coal.	4
3.70	D14						
4.00	B15						
4.00 - 4.45	D16	SPT(S) 50 (10,11/50 for 220mm)		(1.90)			5
4.00 - 4.45	B15						
5.00	D19						
5.00 - 5.45	D18	SPT(S) 50 (25 for 87mm/50 for 147mm)		5.60		Weathered SANDSTONE recovered as, dense red brown, slightly gravelly, fine to coarse sand. Gravel is subangular to subrounded, fine to coarse including sandstone.	6
5.00 - 5.45	D18						
5.60	B20						
6.00	D21	SPT(S) 50 (25 for 85mm/50 for 85mm)		(2.40)			7
6.00 - 6.45	B20						
6.00 - 6.45	D21						
7.00	D22	SPT(S) 50 (25 for 85mm/50 for 85mm)		8.00		End of Borehole at 8.00m	8
7.50	B23						
7.50 - 7.67	D24						
7.50 - 7.67							9
							10
Start & End of Shift Observations			Borehole Diameter		Casing Diameter		Remarks:
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	
					8.00	150	Service inspection pit hand excavated from GL to 1.20m.
Chiselling			Installation		Water Strikes		
From (m)	To (m)	Duration	Remarks	Top (m)	Base (m)	Type	Dia (mm)
5.00	5.00	00:30		0.00	3.00	PLAIN	
7.70	8.00	01:00		3.00	5.00	SLOTTED	
					Strike (m) Casing (m) Sealed (m) Time (mins) Rose to (m) Remarks		
					0		
IFA CP Template Issue Number: 5 Issue Date: 04/10/16							

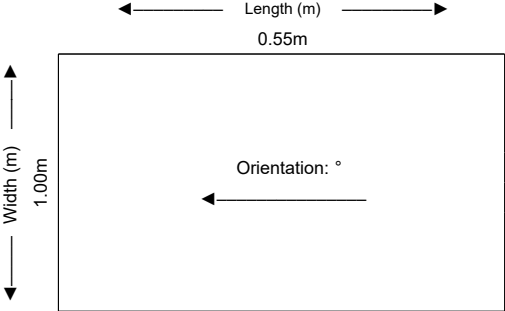
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		Contract Number: 41953	Date Started: 30/08/2016	Logged By: JM	Checked By: HH	Status: DRAFT	Sheet 1 of 2						
Cable Percussion Borehole Log		Easting:		Northing:		Ground Level:		Plant Used:		Print Date: 02/11/2016		Scale: 1:50	
		Weather:		Termination:				SPT Hammer: N/R, Energy Ratio: N/R					
Samples & In Situ Testing						Strata Details						Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description						Water Strike	Backfill/ Installation
0.20	ES1	SPT(S) N=20 (3,5/5,4,5,6)		0.07		MADE GROUND: Brick paving.							
				0.20		MADE GROUND: Concrete.							
0.50 - 1.00	B2			MADE GROUND: Dark brown, slightly clayey, sandy, angular to subrounded fine to coarse GRAVEL with medium cobble content., including brick, ash, concrete, sandstone and occasional wood.									
0.70	ES3												
1.20		120 blows. 100% recovery		(1.60)		Stiff, brown, slightly mottled grey, slightly sandy, slightly gravelly CLAY with medium cobble content. Gravel is subangular to rounded, fine and medium including sandstone. siltstone, limestone, occasional wood. <i>At 2.00m: very high strength</i>						1	
1.20 - 1.65	B4												
1.70	ES5												
1.80	D6												
2.00 - 2.45	U7												
2.50	D8			(1.80)								2	
2.70	ES9												
3.00													
3.00 - 3.45	B10												
3.00 - 3.45	D11												
3.60	D12	SPT(S) N=39 (5,8/8,9,10,12)		3.60		Dense, reddish brown, silty, sandy, subangular to rounded, fine and coarse GRAVEL with clay bands including sandstone, siltstone, limestone, occasional quartzite and coal.						3	
4.00													
4.00 - 4.45	B13												
5.00													
5.00 - 5.45	B14												
6.00		SPT(S) N=43 (6,7/9,10,11,13)		(5.00)								4	
6.00 - 6.33	B15												
6.00 - 6.33	D16												
6.80	D17												
7.50		SPT(C) 50 (25 for 95mm/50 for 130mm)										5	
7.50 - 7.91	B18												
8.60	D19												
9.00													
9.00 - 9.10	D20												
		SPT(S) 50 (25 for 35mm/50 for 60mm)		(1.40)		Weathered SANDSTONE recovered as very dense, reddish brown, slightly gravelly, fine to coarse SAND. Gravel is subangular to subrounded, fine to coarse including sandstone.						6	
				10.00								7	
												8	
												9	
												10	

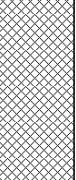
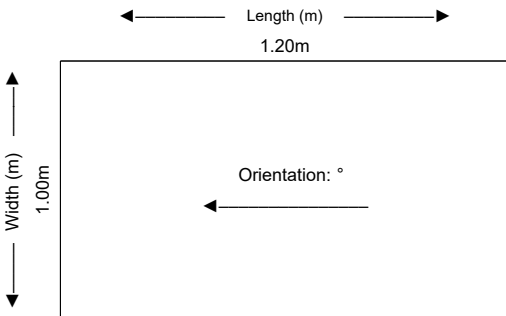
Start & End of Shift Observations					Borehole Diameter		Casing Diameter		Remarks: Service inspection pit hand excavated from GL to 1.20m. Chiselling: 9.70m to 10.00m = 1hr					
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)						
					10.00	150	9.00	150						
									Water Strikes					
Chiselling					Installation				Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
From (m)	To (m)	Duration	Remarks		Top (m)	Base (m)	Type	Dia (mm)						
6.20	6.50	01:15			0.00	9.00	PLAIN							
6.90	7.20	01:00			9.00	12.00	SLOTTED							
7.60	7.00	01:30												
IFA CP Template Issue Number: 5 Issue Date: 04/10/16														

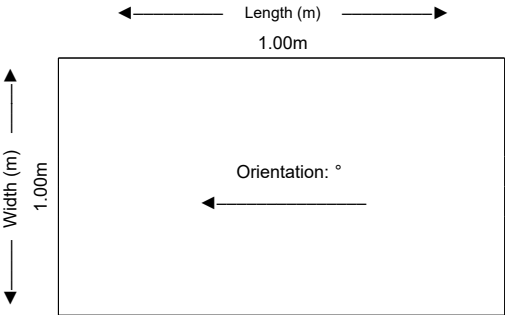
IAN FARMER ASSOCIATES						Contract Name: London Road Fire Station, Manchester							Client: Allied London								Borehole ID: BH02											
						Contract Number: 41953			Date Started: 30/08/2016			Logged By: JM			Checked By: HH			Status: DRAFT			Sheet 2 of 2											
Rotary Core Drilling Log						Easting:			Northing:			Ground Level:			Plant Used:			Print Date: 02/11/2016			Scale: 1:50											
Weather:											Termination:											SPT Hammer: N/R, Energy Ratio: N/R										
Coring Details											Strata Details											Groundwater										
Depth		TCR	SCR	RQD	Fracture Spacing	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description											Water Strike	Backfill/Installation											
10.00 - 11.50		67	41	0	10		(1.00)		Extremely weak, thinly bedded, reddish brown, medium and coarse grained SANDSTONE. Distinctly weathered. Subhorizontal (80 to 85 degrees), very closely spaced, undulating, rough, moderately open to open, sand infilled discontinuities. <i>At 10.15m, 10.16m, 10.42m, 10.75m and 10.80m, drilling induced fractures.</i>																							
					NR		11.00		Extremely weak, thinly bedded, reddish brown, medium and coarse grained SANDSTONE. Distinctly weathered. Horizontal to subhorizontal (80 to 90 degrees), closely spaced, undulating, rough, moderately open to open, sand infilled discontinuities. <i>Between 11.00m to 12.20m; assumed zone of core loss.</i>											11												
11.50 - 13.00		53	15	8	NI				<i>At 12.20m: non intact recovered as gravel.</i>											12												
					18																											
13.00 - 14.50		89	25	0	12		(6.00)		<i>At 13.48m: non intact recovered as gravel.</i>											13												
					26																											
					NI				<i>At 14.07m: non intact recovered as gravel.</i>											14												
					15				<i>Between 14.33m and 16.15m; assumed zone of core loss.</i>																							
14.50 - 16.00		0	0	0	NR															15												
16.00 - 17.00		85	31	11	NI		17.00		<i>At 16.15m: non intact recovered as gravel.</i>											16												
					18				<i>At 16.81m: very weak</i>																							
					6				<i>At 16.91m: non intact recovered as gravel.</i>																							
					28				End of Borehole at 10.000m											17												
																				18												
																				19												
																				20												
Start & End of Shift Observations											Borehole Diameter				Casing Diameter				Remarks:													
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)	Depth (m)	Dia (mm)	Service inspection pit hand excavated from GL to 1.20m. Chiselling: 9.70m to 10.00m = 1hr																					
					10.00	150	9.00	150																								
															Water Strikes																	
															Strike (m) Casing (m) Sealed (m) Time (mins) Rose to (m) Remarks																	
Flush Information											Installation																					
Top (m)	Base (m)	Flush Type	Return	Flush Colour	Top (m)	Base (m)	Type	Dia (mm)																								
					0.00	9.00	PLAIN																									
					9.00	12.00	SLOTTED		Fracture spacing as FI or Min, Average and Max in mm. TCR, SCR and RQD reported in %																							
IFA RC Issue Number: 2 Issue Date: 13/07/16																																

	Contract Name: London Road Fire Station, Manchester		Client: Allied London			Borehole ID: BH03							
	Contract Number: 41953	Date Started: 25/08/2016	Logged By: JM	Checked By: HH	Status: DRAFT								
Cable Percussion Borehole Log	Easting:	Northing:	Ground Level:	Plant Used:	Print Date: 02/11/2016	Sheet 1 of 1							
					Scale: 1:50								
Weather:		Termination:		SPT Hammer: N/R, Energy Ratio: N/R									
Samples & In Situ Testing			Strata Details				Groundwater						
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike						
0.20 0.20 - 0.70	ES1 B2			(0.30) 0.30		MADE GROUND: Brown, sandy, angular to subrounded, fine to coarse GRAVEL including brick, concrete, occasional sandstone and wood with medium cobble content.	1						
0.70	ES3					MADE GROUND: Very soft, dark brown, sandy, very gravelly CLAY with low cobble content. Gravel is angular to subrounded, fine to coarse including brick, ash, occasional concrete, sandstone and wood.							
1.20 1.20 - 1.65	B4	SPT(S) N=1 (1,0/0,0,1,0)		(2.40)			2						
1.70	ES5												
2.00 2.00 - 2.45	B6	SPT(S) N=2 (1,0/1,0,0,1)					3						
2.70 2.70	D8 ES7												
3.00 - 3.45	U9	63 blows. 100% recovery		(1.30)		Firm, brown, slightly mottled grey, slightly sandy, slightly gravelly CLAY. Gravel is subangular to rounded, fine and medium including sandstone, siltstone, limestone, occasional quartzite and coal. <i>At 3.00m: very high strength</i>	4						
3.50	D10												
4.00 4.00 - 4.45 4.00 - 4.45	B11 D12	SPT(S) N=11 (2,2/3,3,3,2)		4.00		Medium dense, reddish brown, silty, fine and medium SAND with clay bands.	5						
5.00 5.00 - 5.45 5.00 - 5.45	B13 D14	SPT(S) N=14 (2,3/3,4,4,3)		(1.90)									
6.00 6.00 - 6.20 6.00 - 6.20	B15 D16	SPT(S) 50 (25 for 100mm/50 for 100mm)		5.90		Weathered SANDSTONE recovered as, dense, reddish brown yellow, slightly gravelly, fine to coarse SAND. Gravel is subangular to subrounded, fine to coarse including sandstone.	6						
7.00	D17			(2.10)									
7.50 7.50 - 7.70 7.50 - 7.70	B18 D19	SPT(S) 50 (25 for 100mm/50 for 100mm)		8.00		End of Borehole at 8.00m	8						
							9						
							10						
Start & End of Shift Observations			Borehole Diameter		Casing Diameter		Remarks:						
Date	Time	Depth (m)	Casing (m)	Water (m)	Depth (m)	Dia (mm)		Depth (m)	Dia (mm)				
					8.00	150	7.50	150	Service inspection pit hand excavated from GL to 1.20m.				
Chiselling			Installation		Water Strikes								
From (m)	To (m)	Duration	Remarks	Top (m)	Base (m)	Type	Dia (mm)	Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks
7.70	8.00	01:00		0.00	0.20	PLAIN							
				0.20	1.00	PLAIN							
				1.00	6.00	SLOTTED							
IFA CP Template Issue Number: 5 Issue Date: 04/10/16													

	Contract Name: London Road Fire Station, Manchester		Client: Allied London			Trial Pit ID: HP01		
	Contract Number: 41953	Date: 22/08/2016	Logged By: JM	Checked By: HH	Status: DRAFT	Sheet 1 of 1		
Trial Pit Log	Easting:	Northing:	Ground Level:	Plant Used: Hand excavated	Date Printed: 02/11/2016	Scale: 1:40		
	Weather:		Hole Termination:		Stability: Hand pit remained dry and stable during excavation			
Samples & In Situ Testing			Strata Details					Water
Depths	Sample ID	Test Result	Reduced Level	Depth (m) (Thickness)	Legend	Strata Description		
0.20 - 1.00	B2			0.20		MADE GROUND: Concrete.		1
0.50	ES1			(2.45)		MADE GROUND: Brown, very sandy, angular to subrounded, fine to coarse GRAVEL with high cobble contents. Including concrete, brick, sandstone, siltstone and occasional wood.		
1.50 1.50 1.50 - 2.50	D5 ES3 D4			2.65		End of Trial Pit at 2.65m		2
								3
								4
								5
								6
Dimensions:			General Remarks:					
Final Depth: 2.65m			Refer to sketch for further details.					
								
			Water Strikes					
			Strike (m)	Time (mins)	Rose to (m)	Remarks		
HBSI TP Template Issue Number: 2 Issue Date: 27/04/16								

	Contract Name: London Road Fire Station, Manchester		Client: Allied London			Trial Pit ID: HP03										
	Contract Number: 41953	Date: 24/08/2016	Logged By: JM	Checked By: HH	Status: DRAFT	Sheet 1 of 1										
Trial Pit Log	Easting:	Northing:	Ground Level:	Plant Used:	Date Printed: 02/11/2016	Scale: 1:40										
	Weather:		Hole Termination:		Stability: Hand excavated.											
Samples & In Situ Testing			Strata Details					Water								
Depths	Sample ID	Test Result	Reduced Level	Depth (m) (Thickness)	Legend	Strata Description										
0.13 - 0.30	D3			0.13		MADE GROUND: Concrete.		1								
0.30 - 0.70	B2			0.30		MADE GROUND: Orangish brown, sandy, angular to subrounded, fine to coarse GRAVEL with low cobble content. including brick, concrete .										
				(0.40)		Stiff, greyish brown, slightly sandy, slightly gravelly CLAY. Gravel is subangular to rounded, fine to coarse including sandstone, siltstone and quartzite.										
0.70 - 1.46	B1			0.70		Dense, brown, clayey, gravelly, fine to coarse SAND. Gravel is subangular to rounded, fine to coarse including sandstone, siltstone and quartzite.										
				(0.76)												
				1.46		End of Trial Pit at 1.46m		2								
								3								
								4								
								5								
								6								
Dimensions:					General Remarks:											
Final Depth: 1.46m					Refer to sketch for further details.											
																
					Water Strikes											
					<table><tr><th>Strike (m)</th><th>Time (mins)</th><th>Rose to (m)</th><th>Remarks</th></tr><tr><td></td><td></td><td></td><td></td></tr></table>				Strike (m)	Time (mins)	Rose to (m)	Remarks				
Strike (m)	Time (mins)	Rose to (m)	Remarks													
					HBSI TP Template Issue Number: 2 Issue Date: 27/04/16											

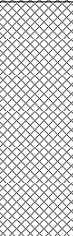
	Contract Name: London Road Fire Station, Manchester		Client: Allied London			Trial Pit ID: HP04													
	Contract Number: 41953	Date: 24/08/2016	Logged By: JM	Checked By: HH	Status: DRAFT	Sheet 1 of 1													
Trial Pit Log	Easting:	Northing:	Ground Level:	Plant Used: Hand excavated	Date Printed: 02/11/2016	Scale: 1:40													
	Weather:		Hole Termination:		Stability: Hand pit remained dry and stable during excavation.														
Samples & In Situ Testing			Strata Details					Water											
Depths	Sample ID	Test Result	Reduced Level	Depth (m) (Thickness)	Legend	Strata Description													
0.10 - 1.10	B1			0.10		MADE GROUND: Concrete.		1											
				(1.00)		MADE GROUND: Brown, very gravelly, fine to coarse SAND with low cobble content. Gravel is angular to subrounded, fine to coarse including brick, concrete, sandstone, plastic, occasional wood, plastic bags, cans and glass.													
1.10 - 1.40	B2			1.10 (0.30)		Extremely weathered SANDSTONE recovered as, reddish brown, slightly gravelly, fine to coarse sand. Gravel is subangular to subrounded, fine to coarse including sandstone.													
				1.40		End of Trial Pit at 1.40m		2											
								3											
								4											
								5											
								6											
Dimensions:			General Remarks:																
Final Depth: 1.40m			Refer to sketch for further details.																
																			
			<table><tr><th colspan="4">Water Strikes</th></tr><tr><th>Strike (m)</th><th>Time (mins)</th><th>Rose to (m)</th><th>Remarks</th></tr><tr><td></td><td></td><td></td><td></td></tr></table>					Water Strikes				Strike (m)	Time (mins)	Rose to (m)	Remarks				
Water Strikes																			
Strike (m)	Time (mins)	Rose to (m)	Remarks																
			HBSI TP Template Issue Number: 2 Issue Date: 27/04/16																

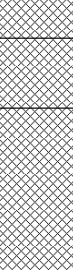
	Contract Name: London Road Fire Station, Manchester		Client: Allied London			Trial Pit ID: HP06		
	Contract Number: 41953	Date: 23/08/2016	Logged By: JM	Checked By: HH	Status: DRAFT	Sheet 1 of 1		
Trial Pit Log	Easting:	Northing:	Ground Level:	Plant Used: Hand excavated	Date Printed: 02/11/2016	Scale: 1:40		
	Weather:		Hole Termination:		Stability: Hand pit remained dry and stable during excavation.			
Samples & In Situ Testing			Strata Details					Water
Depths	Sample ID	Test Result	Reduced Level	Depth (m) (Thickness)	Legend	Strata Description		
0.10 - 0.33	B2			0.10		MADE GROUND: Concrete.		1
0.33 - 1.00	B1			0.33		MADE GROUND: Grey, slightly sandy, angular to subrounded, fine to coarse GRAVEL with medium cobble content, including brick, concrete and sandstone.		
				(0.87)		Reddish brown, slightly gravelly, fine to coarse SAND. Gravel is subangular to subrounded, fine to coarse including sandstone.		
				1.20		End of Trial Pit at 1.20m		
								2
								3
								4
								5
								6
Dimensions:					General Remarks:			
Final Depth: 1.20m					Refer to sketch for further details.			
								
					Water Strikes			
					Strike (m) Time (mins) Rose to (m) Remarks			
					HBSI TP Template Issue Number: 2 Issue Date: 27/04/16			

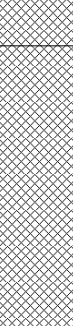
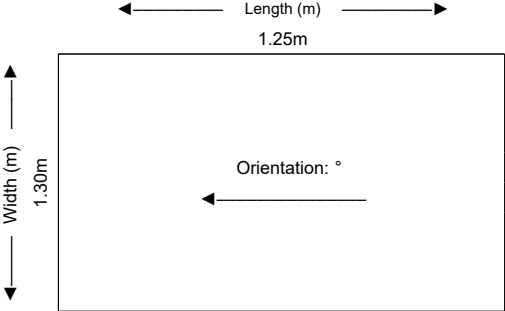
	Contract Name: London Road Fire Station, Manchester		Client: Allied London			Trial Pit ID: HP07													
	Contract Number: 41953	Date: 25/08/2016	Logged By: JM	Checked By: HH	Status: DRAFT	Sheet 1 of 1													
Trial Pit Log	Easting:	Northing:	Ground Level:	Plant Used: Hand excavated	Date Printed: 02/11/2016	Scale: 1:40													
	Weather:		Hole Termination:		Stability: Hand pit remained dry and stable during excavation														
Samples & In Situ Testing			Strata Details					Water											
Depths	Sample ID	Test Result	Reduced Level	Depth (m) (Thickness)	Legend	Strata Description													
0.10 - 0.33	D3			0.10		MADE GROUND: Concrete.		1											
0.33 - 0.77	B2			0.33		MADE GROUND: Dark brown grey, sandy, angular to subrounded, fine to coarse GRAVEL with low cobble content. Including brick, concrete and occasional wood.													
0.77 - 1.20	D1			(0.44)		Stiff, greyish brown, slightly sandy, slightly gravelly CLAY. Gravel is subangular to rounded, fine to coarse including siltstone, sandstone and quartzite.													
				0.77		Reddish brown, slightly gravelly, fine to coarse SAND. Gravel is subangular to subrounded, fine to coarse including sandstone and extremely weathered sandstone (Weathered sandstone).													
				(0.43)															
				1.20		End of Trial Pit at 1.20m		2											
								3											
								4											
								5											
								6											
Dimensions:			General Remarks:																
Final Depth: 1.20m			Refer to sketch for further details.																
← Length (m) → 0.69m ↑ Width (m) ↓ 0.66m Orientation: ° ←			<table><tr><th colspan="4">Water Strikes</th></tr><tr><th>Strike (m)</th><th>Time (mins)</th><th>Rose to (m)</th><th>Remarks</th></tr><tr><td></td><td></td><td></td><td></td></tr></table>					Water Strikes				Strike (m)	Time (mins)	Rose to (m)	Remarks				
Water Strikes																			
Strike (m)	Time (mins)	Rose to (m)	Remarks																
HBSI TP Template Issue Number: 2 Issue Date: 27/04/16																			

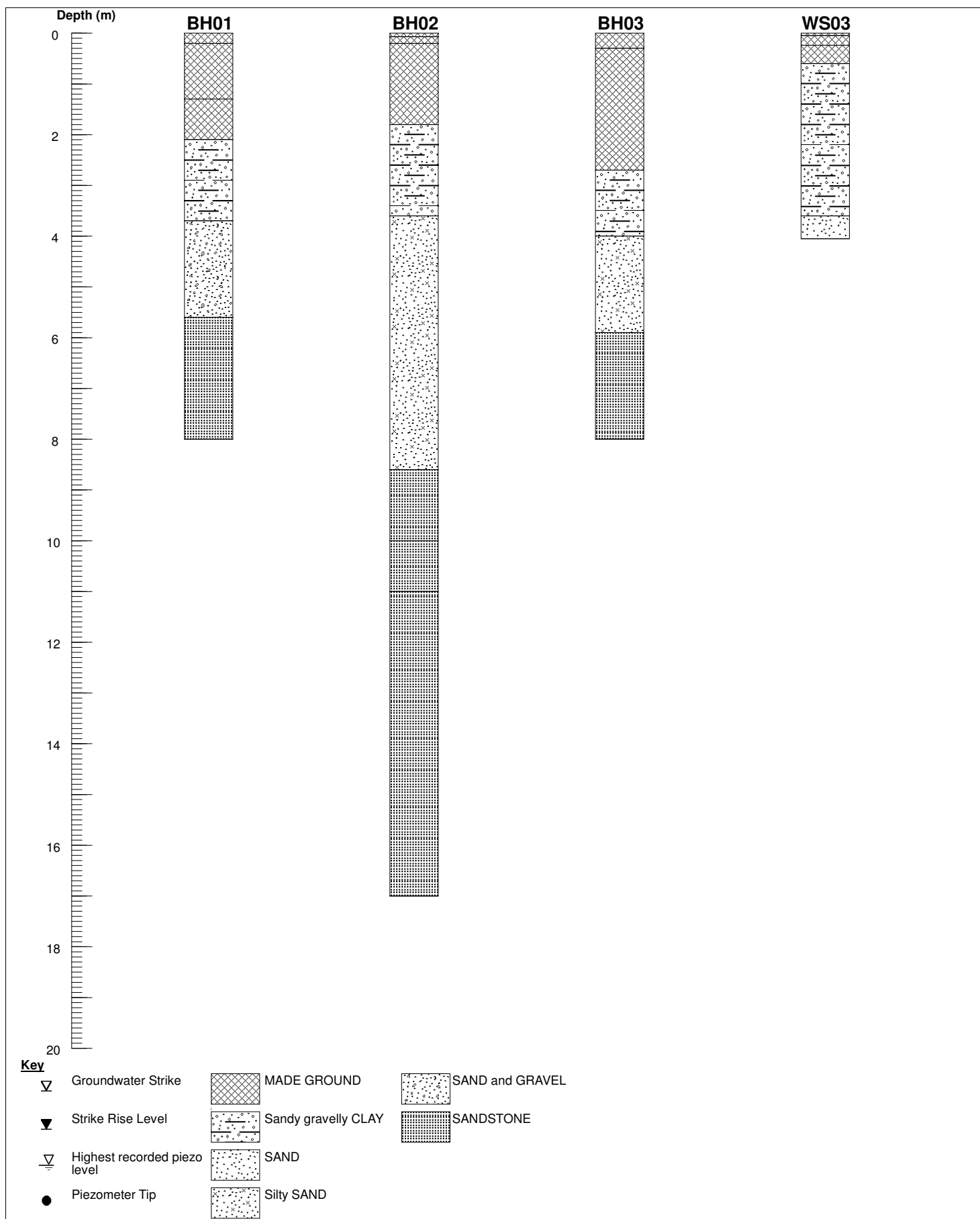
	Contract Name: London Road Fire Station, Manchester		Client: Allied London			Trial Pit ID: HP08													
	Contract Number: 41953	Date: 22/08/2016	Logged By: JM	Checked By: HH	Status: DRAFT	Sheet 1 of 1													
Trial Pit Log	Easting:	Northing:	Ground Level:	Plant Used: Hand excavated	Date Printed: 02/11/2016	Scale: 1:40													
	Weather:		Hole Termination:		Stability: Hand pit remained dry and stable during excavation.														
Samples & In Situ Testing			Strata Details					Water											
Depths	Sample ID	Test Result	Reduced Level	Depth (m) (Thickness)	Legend	Strata Description													
0.20 - 0.30	B1			0.12		MADE GROUND: Concrete.		1											
0.40 - 0.70	B2			0.35		MADE GROUND: Brown, slightly clayey, sandy, angular to subrounded, fine to coarse GRAVEL with medium cobble content. Including concrete, brick, occasional wood and ash.													
0.70 - 1.50	B3			(0.35)		Firm, brown, slightly sandy, slightly gravelly CLAY. Gravel is subangular to rounded, fine to coarse including sandstone and siltstone.													
				0.70		Brown, slightly gravelly, fine to coarse SAND. Gravel is subangular to subrounded, fine and medium including sandstone.													
				(1.20)				2											
				1.90		End of Trial Pit at 1.90m		3											
								4											
								5											
								6											
Dimensions:			General Remarks:																
Final Depth: 1.90m			Refer to sketch for further details.																
← Length (m) → 0.77m ↑ Width (m) ↓ 1.50m Orientation: ° ←																			
			<table><tr><th colspan="4">Water Strikes</th></tr><tr><th>Strike (m)</th><th>Time (mins)</th><th>Rose to (m)</th><th>Remarks</th></tr><tr><td></td><td></td><td></td><td></td></tr></table>					Water Strikes				Strike (m)	Time (mins)	Rose to (m)	Remarks				
Water Strikes																			
Strike (m)	Time (mins)	Rose to (m)	Remarks																
			HBSI TP Template Issue Number: 2 Issue Date: 27/04/16																

	Contract Name: London Road Fire Station, Manchester		Client: Allied London			Trial Pit ID: TP01														
	Contract Number: 41953	Date: 05/09/2016	Logged By: JM	Checked By: HH	Status: DRAFT	Sheet 1 of 1														
Trial Pit Log	Easting:	Northing:	Ground Level:	Plant Used: 1 ton tracked excavator	Date Printed: 02/11/2016	Scale: 1:40														
	Weather:		Hole Termination:		Stability: Trial pit remained dry and stable during excavating															
Samples & In Situ Testing			Strata Details					Water												
Depths	Sample ID	Test Result	Reduced Level	Depth (m) (Thickness)	Legend	Strata Description														
				0.05		MADE GROUND: Concrete.		1												
				0.25		MADE GROUND: Brown, slightly clayey, gravelly, fine to coarse SAND with low cobble content. Gravel is angular to subangular, fine to coarse including brick, concrete, mudstone and coal.														
0.50 0.50 0.70	D2 ES1 B3					MADE GROUND: Firm, brown, mottled blackish red, sandy, gravelly CLAY. With low cobble content. Gravel is angular to subangular, fine to coarse including brick, concrete, mudstone, ceramic and coal.														
1.00	ES4			(1.75)				2												
1.70	B5																			
2.00 2.00	D7 ES6			2.00		End of Trial Pit at 2.00m														
								3												
								4												
								5												
								6												
Dimensions:					General Remarks:															
Final Depth: 2.00m					No foundations encountered.															
← Length (m) → 1.15m ↑ Width (m) ↓ 1.25m Orientation: ° ←					<table><tr><th colspan="4">Water Strikes</th></tr><tr><th>Strike (m)</th><th>Time (mins)</th><th>Rose to (m)</th><th>Remarks</th></tr><tr><td></td><td></td><td></td><td></td></tr></table>				Water Strikes				Strike (m)	Time (mins)	Rose to (m)	Remarks				
Water Strikes																				
Strike (m)	Time (mins)	Rose to (m)	Remarks																	
HBSI TP Template Issue Number: 2 Issue Date: 27/04/16																				

	Contract Name: London Road Fire Station, Manchester		Client: Allied London			Trial Pit ID: TP02														
	Contract Number: 41953	Date: 01/09/2016	Logged By: JM	Checked By: HH	Status: DRAFT	Sheet 1 of 1														
Trial Pit Log	Easting:	Northing:	Ground Level:	Plant Used: 1 ton tracked excavator	Date Printed: 02/11/2016	Scale: 1:40														
	Weather:		Hole Termination:		Stability:															
Samples & In Situ Testing			Strata Details					Water												
Depths	Sample ID	Test Result	Reduced Level	Depth (m) (Thickness)	Legend	Strata Description														
0.18 - 1.00	B1			0.18		MADE GROUND: Concrete with rebar.		1												
0.50	ES2			(1.30)		MADE GROUND: Firm, dark brown, sandy, gravelly CLAY with medium cobble content. Gravel is angular to subrounded, fine to coarse including brick, ash, concrete, slab and sandstone.														
1.48 - 2.00	B3			1.48		MADE GROUND: Stiff, brown, mottled grey, slightly sandy, slightly gravelly CLAY. Gravel is angular to rounded, fine and medium including sandstone, siltstone, limestone, brick, concrete and coal (Reworked natural).			2											
1.50	ES4	(0.52)	End of Trial Pit at 2.00m																	
				2.00				3												
								4												
								5												
								6												
Dimensions:			General Remarks:																	
Final Depth: 2.00m			Refer to sketch for further details.																	
← Length (m) → 1.30m ↑ Width (m) ↓ 1.20m Orientation: ° ←																				
			<table><tr><th colspan="4">Water Strikes</th></tr><tr><th>Strike (m)</th><th>Time (mins)</th><th>Rose to (m)</th><th>Remarks</th></tr><tr><td></td><td></td><td></td><td></td></tr></table>						Water Strikes				Strike (m)	Time (mins)	Rose to (m)	Remarks				
Water Strikes																				
Strike (m)	Time (mins)	Rose to (m)	Remarks																	
			HBSI TP Template Issue Number: 2 Issue Date: 27/04/16																	

	Contract Name: London Road Fire Station, Manchester		Client: Allied London			Trial Pit ID: TP03														
	Contract Number: 41953	Date: 01/09/2016	Logged By: JM	Checked By: HH	Status: DRAFT	Sheet 1 of 1														
Trial Pit Log	Easting:	Northing:	Ground Level:	Plant Used: 1 ton tracked excavator.	Date Printed: 02/11/2016	Scale: 1:40														
	Weather:		Hole Termination:		Stability: Trial pit remained dry and stable during excavation															
Samples & In Situ Testing			Strata Details					Water												
Depths	Sample ID	Test Result	Reduced Level	Depth (m) (Thickness)	Legend	Strata Description														
				0.23		MADE GROUND: Concrete with rebar.		1												
0.50 0.60	D1 ES2			(0.37) 0.60		MADE GROUND: Dark grey, dark brown, slightly clayey, very sandy, angular to subrounded, fine to coarse GRAVEL with medium cobble content. Including brick, concrete, ash and slate.														
1.00	B3			(0.93)		MADE GROUND: Dark brown, soft, sandy, gravelly CLAY with low cobble content. Gravel is angular to subrounded, fine to coarse including brick, concrete, ash and slate.														
1.60 1.60	B4 ES5			1.53 1.70		Stiff, brown mottled grey, slightly sandy, slightly gravelly CLAY. Gravel is subangular to rounded, fine and medium including limestone, siltstone, sandstone, occasional quartzite and coal.		2 3 4 5 6												
						End of Trial Pit at 1.70m														
Dimensions:			General Remarks:																	
Final Depth: 1.70m			Refer to sketch for further details.																	
← Length (m) → 1.29m ↑ Width (m) ↓ 1.27m Orientation: ° ←																				
			<table><tr><th colspan="4">Water Strikes</th></tr><tr><th>Strike (m)</th><th>Time (mins)</th><th>Rose to (m)</th><th>Remarks</th></tr><tr><td></td><td></td><td></td><td></td></tr></table>						Water Strikes				Strike (m)	Time (mins)	Rose to (m)	Remarks				
Water Strikes																				
Strike (m)	Time (mins)	Rose to (m)	Remarks																	
			HBSI TP Template Issue Number: 2 Issue Date: 27/04/16																	

	Contract Name: London Road Fire Station, Manchester		Client: Allied London			Trial Pit ID: TP04														
	Contract Number: 41953	Date: 30/08/2016	Logged By: JM	Checked By: HH	Status: DRAFT	Sheet 1 of 1														
Trial Pit Log	Easting:	Northing:	Ground Level:	Plant Used: 1 ton tracked excavator	Date Printed: 02/11/2016	Scale: 1:40														
	Weather:		Hole Termination:		Stability:															
Samples & In Situ Testing			Strata Details					Water												
Depths	Sample ID	Test Result	Reduced Level	Depth (m) (Thickness)	Legend	Strata Description														
0.27 - 1.76	B1			0.27		MADE GROUND: Concrete.		1												
				(1.49)		MADE GROUND: Orangish brown, sandy, angular to subrounded, fine to coarse GRAVEL including brick, concrete, occasional wood and clinker.														
1.50	D2			1.76		End of Trial Pit at 1.76m		2												
								3												
								4												
								5												
								6												
Dimensions:			General Remarks:																	
Final Depth: 1.76m			Concrete encountered at 1.76m. Refer to sketch for further details.																	
																				
			<table><tr><th colspan="4">Water Strikes</th></tr><tr><th>Strike (m)</th><th>Time (mins)</th><th>Rose to (m)</th><th>Remarks</th></tr><tr><td></td><td></td><td></td><td></td></tr></table>						Water Strikes				Strike (m)	Time (mins)	Rose to (m)	Remarks				
Water Strikes																				
Strike (m)	Time (mins)	Rose to (m)	Remarks																	
			HBSI TP Template Issue Number: 2 Issue Date: 27/04/16																	



Nominal Section: Strata from Ground Level

Site London Road Fire Station, Manchester	Date Drawn 08/11/2016	Date Checked	Sheet 1/1	Job Number 41953
Client Allied London	Drawn By	Checked By	Scale 1:100[V]	Figure No. Figure A1.3

Appendix C EA Guidance

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Good practice for decommissioning redundant boreholes and wells

October 2012

What's the purpose of this guidance?

Redundant boreholes and wells must be dealt with appropriately to make them safe and secure, and also to ensure they don't cause groundwater pollution or loss of water supplies. This guidance focuses on groundwater protection aspects but there are many other important factors owners and developers need to consider when designing and carrying out decommissioning works. These will be site specific, depending on the situation and intended afteruse. For example, boreholes near landfills or other sources of soil gas may require an opening to the air to prevent the build-up of noxious, explosive or flammable gas. Therefore, you should seek expert site-specific advice.

Legal framework

The Environment Agency (EA) has a duty to promote the sustainable use of water and to ensure it is protected from pollution. The Environmental Permitting (England and Wales) Regulations 2010 require the EA to take all necessary measures to prevent input of so called hazardous substances (for example pesticides) and limit the input of other non-hazardous pollutants (such as nitrate) into groundwater*, including for example contaminated run-off directly entering groundwater via an uncapped borehole.

**Groundwater is defined as water that is below the surface of the ground in the saturated zone and is in direct contact with the ground or subsoil.*

Why is it important to decommission properly?

Boreholes and wells are constructed for a variety of purposes including water supply, de-watering excavations, collecting geological information, investigating or sampling soils and groundwater and, increasingly, for ground source heating and cooling and geothermal (non-carbon) energy production. Many old water wells and boreholes are redundant as most properties are now connected to a mains water supply.

Improperly abandoned boreholes and wells can provide preferential pathways for groundwater or contaminant movement. This may result in the contamination of groundwater, the mixing of groundwaters of variable quality from different aquifers, or contribute to the loss of aquifer yield and water pressure (referred to as the potentiometric or piezometric head) as groundwater flows out of the system. This can threaten the availability and quality of groundwater resources for other users and potentially have an impacts on wetlands. Abandoned boreholes and wells can also present a physical hazard to people and property.

Artesian boreholes (where groundwater at depth in a 'confined aquifer' is at sufficient pressure to cause water to discharge either at the ground surface or into another overlying aquifer without any pumping) can be particularly problematic. They require special attention to prevent uncontrolled discharge of groundwater or cross-contamination of different aquifer units.

Therefore, site owners need to ensure that redundant boreholes and wells are made both safe and structurally stable, and also backfilled or sealed to prevent groundwater pollution and flow of water

between different aquifer units. This is particularly important where other potable groundwater supplies are at risk.

However, in certain circumstances they may be adapted for use as a groundwater monitoring facility.

You must not use wells or boreholes as soakaways for foul or surface water drainage because they provide a direct discharge route into groundwater and, as such, pose a risk of groundwater pollution.

This is prohibited by the Environmental Permitting (England & Wales) Regulations 2010.

Firstly, what are the construction details?

When considering how best to backfill and seal a borehole or well, or whether it could be adapted for monitoring purposes – you should first obtain information on the geological strata encountered by the borehole and how it was constructed (including depth, diameter and casing details). These can usually be obtained from site records or the original driller's log; the British Geological Survey holds the national water well archive and other borehole databases.

Is the site suitable for groundwater monitoring?

There are many good reasons for collecting groundwater samples or measuring groundwater levels; the information can, for example, help to validate the success of any remedial works being undertaken on a contaminated land site. Therefore, before decommissioning a borehole you should consider whether you wish to retain it as a monitoring facility. If it is to fulfil part of a planning condition or other legal monitoring requirement you may wish to discuss the details of how you do this with the Environment Agency.

If not, it is still worth contacting us via our National Customer Contact Centre (NCCC) to check whether we would be interested in incorporating it into our strategic groundwater level or quality monitoring networks.

If the borehole is not going to be converted then it should be abandoned using the guidelines below and the British Geological Survey should be informed.

Decommissioning

Each situation is different in terms of its location, geological setting, borehole construction, dimensions, hazards and, very importantly, intended site afteruse. Therefore the most appropriate abandonment procedure will vary from site to site. It is strongly recommended that you engage the services of a proficient well contractor with a good knowledge of the local geology and well abandonment procedures. For large boreholes and wells you may need to seek engineering advice. **(Note that structural aspects are outside the scope of this guidance.)**

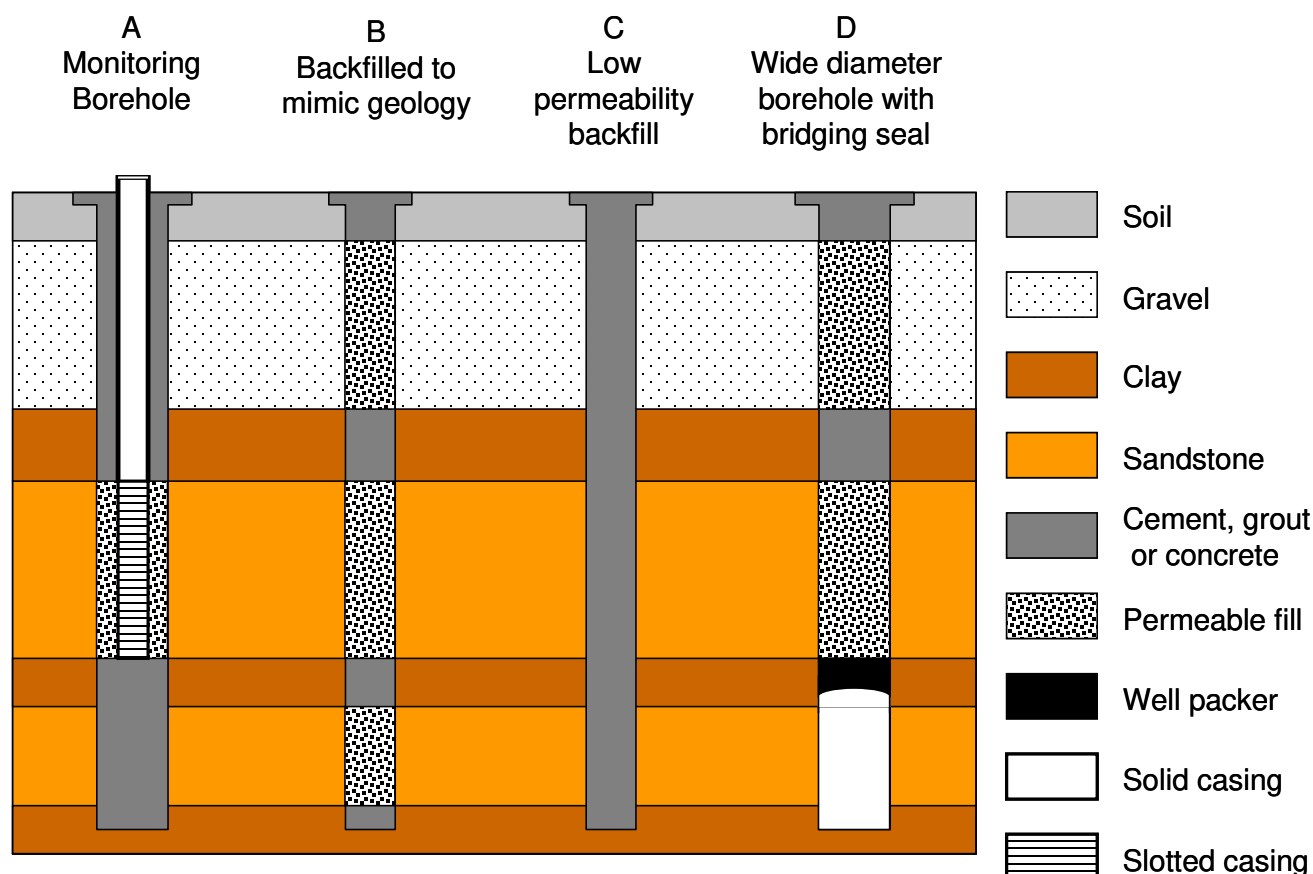


Figure 1: Schematic options (B–D) for decommissioning wells and boreholes

Step 1 - Defining the objectives

When planning the decommissioning works, in addition to any site specific afteruse considerations, the method should address the following objectives:

- Remove the hazard of an open hole (safety issues).
- Prevent the borehole acting as a conduit for contamination of groundwater.
- Prevent the mixing of contaminated and uncontaminated groundwater from different aquifers.
- Prevent the flow of groundwater from one geological horizon to another.
- Prevent the wastage of groundwater from the overflow of artesian boreholes.

Step 2 - Removing headworks and casing

It is crucial to ensure that the borehole or well is free from all obstructions that may interfere with the sealing of the hole. In particular, the pump and pipework should be removed, together with any other infrastructure (dip tubes etc).

The condition of any borehole casing and grout must be examined to ascertain whether its retention in the hole would prejudice any of the objectives of the abandonment. For many holes, examination of the casing from the ground surface will be adequate. However, deep boreholes may require the use of closed-circuit television (CCTV) to examine the casing at depth.

Where the casing has corroded or broken, or the grouting has failed, depending on the setting it may be necessary to remove those materials to prevent any flow of groundwater around the outside of the borehole. However, this is not without its own risks since removal of the well casing can result in collapse of the borehole walls (particularly in unconsolidated materials) and possible subsidence at ground level. If the well casing needs to be removed, a specialist well contractor can advise on appropriate techniques and associated risks.

Step 3 - Backfilling

General considerations

For most purposes the ground should be restored as closely as possible to its pre-drilled condition. The borehole or well should be backfilled with clean (washed), uncontaminated materials so that the permeability of the selected materials are similar to the properties of the geological strata against which they are placed. The backfilled borehole will then mimic the surrounding natural strata and groundwater flow and quality will be protected.

Restoration will require a variety of materials to be used so that permeable aggregates (for example pea gravel and sand) are positioned adjacent to aquifer horizons, whilst low permeability materials (usually clay, bentonite cement grout, or concrete) are positioned adjacent to low permeability horizons (see Fig. 1(B)). Alternatively, the entire borehole or well can be backfilled with low permeability

materials that will prevent significant vertical or horizontal movement of groundwater through or along the borehole (see Fig. 1(C)).

The backfill materials must be clean, inert and non-polluting. Suitable materials include pea gravel, sand, shingle, concrete, bentonite, cement grout and uncontaminated rock. There are also a range of recycled products, like crushed glass, on the market that are designed for use in boreholes

IMPORTANT - Never use backfill materials that can cause pollution.

You should also consider the geochemical environment into which these materials will be placed, as the behaviour of materials may change under different environmental conditions (for example, iron-rich sands may contaminate the aquifer; phenol contamination may prevent bentonite grouts curing).

Aggregates (pea gravel, shingle, sand etc) should be selected such that they have a grain size that allows easy delivery into the borehole and should be introduced in a controlled manner to ensure that accidental 'bridging' does not occur within the borehole. Concrete and grouts that are introduced in a liquid form should be introduced through an appropriate delivery pipe (e.g. tremie pipe), to ensure that voids do not form. **Note:** It is good practice to monitor the volume of backfill material that is being emplaced, compared to that calculated at the design stage, to check if bridging within the borehole, or loss to the formation is occurring.

Boreholes that penetrate highly fissured aquifers, such as some limestones and gypsum bearing units, present additional problems. Liquid grouts (particularly those injected under pressure), or fine-grained aggregates (e.g. sand) may be transported out of the borehole into the body of the aquifer through fissures. Careful monitoring of the process is required if these techniques are used, and in these cases it may be more appropriate to use coarser aggregates such as gravel as a backfill.

Deep and large diameter boreholes/wells

When dealing with very deep or large diameter boreholes and wells (note, this does not apply to mine shafts), the volume of the hole may be considerable. In such circumstances it may be appropriate to adopt an alternative approach to completely backfilling the void, as long as this will not prejudice any of the design objectives.

Provided that the long-term structural stability of the borehole can be demonstrated, it may be possible to place a permanent bridging seal within the borehole and then to infill above this level using the approach summarised above (see Fig. 1(D)). The bridging seal should ideally be positioned below the lowest aquifer horizon. However, where this is not possible, it is important that the open borehole beneath the bridging seal penetrates no more than a single aquifer unit, thereby preventing the flow of groundwater between different aquifers.

The material commonly used as a bridging seal is cement, although a combination of a mechanical plug (packer) and cement can be used. Cement seals must be allowed to set (cure) in place before backfilling is continued and completed.

Again, this is a specialist area of work that requires high standards of design and workmanship to ensure an effective permanent seal is achieved.

Artesian boreholes

For artesian boreholes, the decommissioning process should aim to confine the groundwater to the aquifer from which it came – in order to prevent loss of confining pressure and the loss of water resources to the surface or other formations.

The first step is to control the artesian flow. There are a number of ways to accomplish this depending, in part, on the water pressure in the confined aquifer and the depth to which the water level must be lowered. These include:

- Pumping the borehole to produce the necessary drawdown.
- Pumping nearby boreholes.
- Extending the casing above ground level beyond the elevation to which water will rise in the borehole. (the potentiometric or piezometric surface).
- Introducing dense, non-polluting fluids into the borehole.
- Introducing a pre-cast plug at an appropriate level within the hole.
- Using an inflatable packer and pressure grouting the void space below it.

In aquifers that have large seasonal fluctuations in water level, decommissioning artesian boreholes is likely to be easiest in late summer, when groundwater levels and artesian flows are at their lowest.

The importance of the potential pathways in and around the casing should also be considered.

Decommissioning artesian boreholes is a specialist job and requires expert advice.

Step 4 - Sealing the top of the borehole

The backfilled borehole/well should be completed with an impermeable plug and cap to prevent entry of potentially contaminated surface run-off or other liquids. The top two metres should be filled with cement, concrete or bentonite grout. A concrete cap of suitable strength, with a diameter at least one metre greater than the width of the backfilled borehole (see Fig. 2), should then be installed. The exact finished depth of this cap will depend on the setting and planned afteruse of the site. It should be at least 2 metres below plough depth in agricultural areas and at least 1 metre below formation level for sites proposed for redevelopment. Never build structures directly onto well caps or linings.

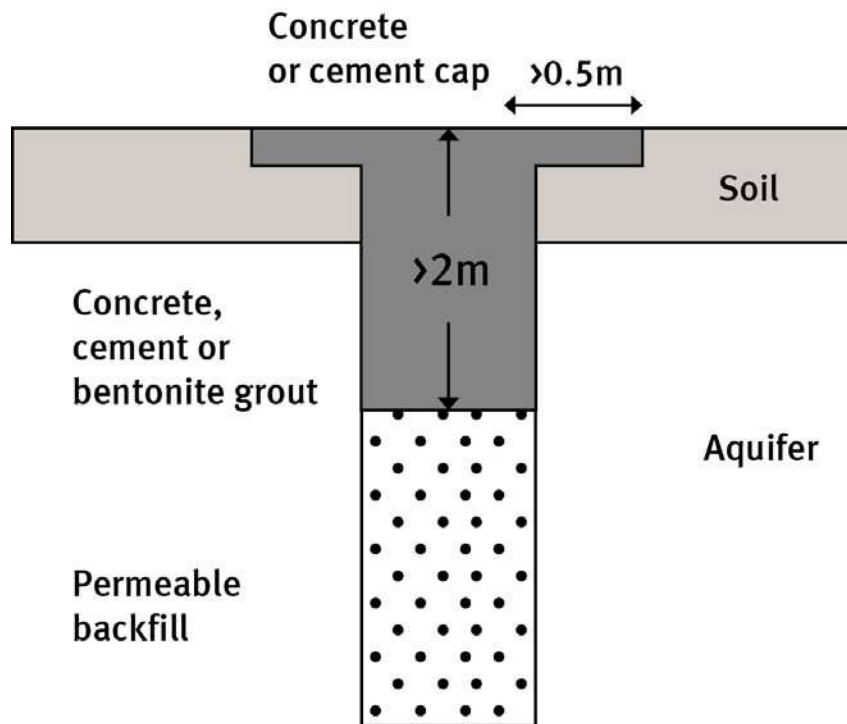


Figure 2: Schematic diagram for borehole seal and cap

Step 5 - Recording details and informing others

You should keep an accurate record of the abandonment details for future reference, including:

- The reasons for abandonment (for example water quality problems).
- Measurement of groundwater level prior to backfilling.
- The depth and position of each layer of backfilling and sealing materials.
- The type and quantity of backfilling and sealing materials used.
- Any changes made to the borehole/well during the abandonment (for example casing removal).
- Any problems encountered during the abandonment procedure.

The location of abandoned borehole and wells should be clearly marked on site records. This is essential where any part of the well has not been filled.

It is also very good practice to mark or deeply inscribe well caps with the word "WELL". Even if done crudely it can avoid considerable risk, delay or uncertainty in the event of the structure being discovered during excavation by others in the future, who may not otherwise know what the feature is.

Always notify the Environment Agency and British Geological Survey of the abandoned well location and structure.

Conversion to soakaways

Wells and boreholes should not be converted to soakaways, as these allow the direct discharge of pollutants into groundwater without any potential for attenuation, and will often result in groundwater pollution. The direct discharge of hazardous substances to groundwater, via a borehole, is effectively prohibited by the Environmental Permitting (England & Wales) Regulations 2010, and the pollution risk from any direct discharge of non-hazardous pollutants, such as sewage effluent, is so great as to make it highly unlikely to be acceptable.

Further advice and guidance

It is recommended that the advice of a specialist well contractor should always be sought, Details can be obtained from:

- **The British Drilling Association.** Wayside, London End, Upper Boddington, Daventry, Northamptonshire, NN11 6DP. Tel: 01327 264 622, email: office@britishdrillingassociation.co.uk

The Environment Agency cannot provide an advisory service on decommissioning individual boreholes and wells but your local Groundwater & Contaminated Land team may have some generic advice to help you; and would appreciate a copy of your abandonment details. They can be contacted via our National Customer Contact Centre (NCCC)

- **Environment Agency NCCC** Tel: 03708 506 506

The British Geological Survey are the national custodian of water well records in addition to other borehole records and geological information. They may have a record of the borehole or well you are dealing with, and will be interested in the abandonment details

- **British Geological Survey. National Geosciences Data Centre (NGDC)**, Keyworth, Nottingham, NG12 5GG. Tel: 0115 936 3143.

Useful references

- Environment Agency GP3 (Groundwater Protection Principles and Practice)
<http://www.environment-agency.gov.uk/research/library/publications/40741.aspx>
- American Society for Test and Materials (ASTM) D5299 - 99(2005) Standard Guide for Decommissioning of Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities
- Driscoll, F.G., 1986. Groundwater and Wells. Second Edition, Johnson Division.

Note: *This guidance supersedes the document ' Good practice for decommissioning redundant boreholes and wells' produced by our former National Groundwater and Contaminated Land Centre*

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