

07 November 2016

Philip O'Toole
AKSWard Ltd
116 High Street
Southampton
SO14 2AA

Our Ref: 416.06656.00001
Your Ref: Yapton

Dear Philip

RE: YAPTON RESIDENTIAL DEVELOPMENT – BESPOKE RISK ASSESSMENT FOR PACKAGE TREATMENT PLANT DISCHARGE – STAGE 1

SLR Consulting Ltd (SLR) was commissioned by AKSWard Ltd in October 2016 to carry out Stage 1 of a Bespoke Risk Assessment for the proposed package treatment plant discharge at Bonhams Field, Yapton, BN18 0DX. The site location is shown on Drawing 1.

1.0 BRIEF AND KEY ISSUES

The proposed development requires a bespoke risk assessment for the discharge to ground of a package treatment plant serving approximately 50 dwellings. The proposed infiltration drainage field is a 300m² area of land along the northwest boundary of the site. The site layout, proposed drainage field and relevant investigation locations are shown on Drawing 2.

The assessment is based on the premise that the waste water will not be raw sewage but will be treated via a package treatment plant. This level of pre-treatment is a prerequisite for discharge of treated sewage.

Prior to undertaking a detailed risk assessment, it is necessary to confirm that the ground conditions are appropriate for an infiltration system. As such the assessment has been developed as a 2-stage process:

Stage 1 – Screening of specific pre-requisite feasibility criteria; and

Stage 2 – Quantitative modelling of the discharge in the context of the physical and chemical properties of the soil and groundwater system, if the requirements of Stage 1 are met.

This letter report provides the results and conclusions of the Stage 1 assessment, specifically outlining the results of the field testing conducted on 25 and 26 October 2016 and an evaluation of the Stage 1 Prerequisite Criteria and published guidance¹.

2.0 PREREQUISITE CRITERIA

Before an application for a discharge consent may be submitted, the following Environment Agency (EA) stipulations apply as prerequisites to the assessment.

The discharge to an infiltration drainage field should not take place on land:

¹ BS 6297: 2007+A1:2008, Code of practice for the design and installation of drainage fields for use in wastewater treatment, 2008. British Standards Institute.

- within 10m of the nearest watercourse;
- within 50m of a well, spring, borehole or other source of water intended for human consumption;
- that's steeply sloping or waterlogged;
- where there's less than 1.2m depth to water table below the invert of the drainage pipes;
- where percolation rates fall outside an upper and lower range of values.

Percolation testing must be implemented in accordance with British Standard 6297:2007+A1:2008¹ to generate a percolation value (Vp). This generates a further set of criteria in which the percolation test must comply including:

- excavation of at least two holes 300mm square at least 300mm below the proposed invert level spaced along the proposed irrigation system;
- changes in soil characteristics and the position of the water table must be noted during excavation;
- initial priming of each pit comprises saturating the soil by filling with water to at least 300mm depth;
- If the water rapidly drains (within 10 minutes) the hole should be refilled up to a maximum of 10 times. If water continues to drain rapidly the ground can be considered unsuitable;
- Water must have soaked away completely within 6 hours; and,
- Calculated Vp values must be between 15 and 100.

The specified Vp value range ensures that:

- untreated effluent does not percolate too rapidly, which may result in groundwater pollution; and,
- the drainage field does not have inefficient soakage leading to ponding of wastewater.

3.0 SCOPE OF WORKS

The site itself is located on greenfield agricultural land, which is currently used for sheep grazing. During the field testing all animals were separated from the main hand pits in the southeast field by electric fencing. Access to the site was provided by the local farmer through a locked gate on southwest boundary.

Three hand pits (HP01 to HP03) were excavated to between 0.75m and 1.00m in the proposed infiltration zone. Ground conditions within the hand pits were logged in accordance with BS 5930:2015² by SLRs field engineer. The location of the soakaway pits is shown in Drawing 2.

Percolation testing in line with BS 6297:2007+A1:2008¹ was completed at each hand pit. Permeability testing (slug tests) was also undertaken in existing borehole locations. However, as one well was recorded dry, permeability testing was only completed on two locations.

A photolog of the works is presented in Appendix A.

² BS 5930: 2015, Code of Practice for Site Investigation, 2015. British Standards Institute

4.0 RESULTS AND ANALYSIS

4.1 Ground Conditions

A full record of the ground conditions encountered is provided in the hand pit logs as Appendix B, which also includes logs of the existing monitoring wells. Ground conditions remained largely consistent between hand pits comprising of light brown slightly gravelly very silty fine sand to sandy silt to approximately 0.5m bgl with flint gravel and rootlets.

HP01 encountered rare brick gravel within the top 0.5m and as such this has been recorded as fill. However, otherwise the material appeared consistent with the natural strata.

The proportion of clay appears to increase with underlying superficial deposits of stiff yellowish brown slightly sandy clayey silt with occasional flint gravel and rare cobbles. BGS geology data had recorded superficial deposits as River Terrace Deposits of sand, silt and clay in the area, which is also suggested from the excavated hand pits.

Previous investigation works undertaken at the site indicate that the superficial deposits extend to depth of between 2.4mbgl and greater than 5.0mbgl. The superficial deposits overly the Undifferentiated Chalk bedrock.

4.1.1 Groundwater Conditions

Groundwater was previously encountered at depths of approximately 4mbgl to 4.5mbgl with a resting water level present within the superficial deposits WS01 and the Chalk WS06. A third well WS05 was dry at 5.0mbgl during preliminary monitoring rounds undertaken in September 2016.

Groundwater was encountered at WS01 and WS06 at approximately 4.6mbgl and 5.2mbgl respectively, during the current investigation works in October 2016.

4.1.2 Percolation Field Test Analysis and Pre-requisite Screening

The specified prerequisites and criteria the field testing must meet can broadly be defined by location, groundwater conditions, and percolation testing results.

Location Criteria

Several EA stipulations can be considered as location criteria for the drainage field including ensuring the discharge to a drainage field does not take place on land:

- within 10m of the nearest watercourse;
- within 50m of a well, spring, borehole or other source of water intended for human consumption;
- that's steeply sloping or waterlogged.

The site walkover on 25th October 2016 confirmed the testing site and drainage field area was not within 10m of a watercourse. Further data from the previous desk study confirm the nearest water course is at least 100m away.

Although information provided by AKSWard Ltd suggested there is an abstraction well within 200m of the site, this was not identified on a site walkover. Published information on the EA indicates the nearest licensed groundwater abstraction is some 1.4km to the northeast. There was no evidence of a groundwater abstraction within 50m of the proposed infiltration area.

The initial site walkover confirmed the surrounding ground is not waterlogged or steeply sloping. The proposed infiltration area is located on the northwest boundary of the site in a shallow depression.

The selected location for the drainage field satisfies all the location criteria from EA stipulations.

Groundwater Conditions

The only EA pre-requisite stipulation specifically relating to groundwater condition is to ensure that the discharge to a drainage field does not take place on land:

- where there is less than 1.2m depth to water table below the invert of the drainage pipes.

In the absence of detailed design information for the package treatment plant drainage field, typical values of invert levels of 0.40m, 0.55m and 0.70m bgl were assigned for the assessment. These inverts require the water table to be below 1.90m bgl. No groundwater was encountered during the excavation of each hand pit and soil was found to be relatively dry. Previous groundwater monitoring recorded water depths at a shallowest level of 3.99m bgl.

Subsequently it can be assumed there is greater than 1.2m depth to water table below the invert of the drainage pipes in the proposed drainage field area.

Field Test Criteria

Methodology

The final EA stipulation relates to the field testing which requires that:

- Discharge to a drainage field should not take place of land where percolation rates fall outside an upper and lower range of values (Vp).

Vp value ranges have been specified by British Standard 6297:2007+A1:2008¹, in addition to generating a further set of criteria the percolation tests must satisfy:

- Excavated hand pits must be 300mm by 300mm square at least 300mm below the proposed invert level spaced along the proposed irrigation system;
- Initial assessment and priming of each pit comprises saturating the soil by filling with water to at least 300mm depth and allowing water to seep away completely;
- Water must not continue soak away rapidly (within 10 minutes) after being refilled up to a maximum of 10 times;
- Water must have soaked away completely within 6 hours; and,
- Calculated Vp values must be between 15 and 100.

Percolation rates can be calculated using the time in seconds for water to seep away 150mm from 75% full to 25% full. The percolation value can be defined as the time in seconds required for the water to drop by 1mm.

Hand pits were accurately located to ensure each pit was within the proposed area earmarked for the drainage field. As noted above, proposed invert levels of 0.40m, 0.55m and 1.00m bgl resulting in planned pit depths of 0.70m, 0.85m and 1.00m bgl. Excavation of each hand pit to 300mm by 300mm was completed by a subcontractor with the dimensions confirmed by SLR's field engineer.

The initial preparations were done in accordance with BS 6297:2007+A1:2008¹ to satisfy the following condition stating that:

- Excavated hand pits must be 300mm by 300mm square at least 300mm below the proposed invert level spaced along the proposed irrigation system.

Subsequently each of the hand pits was primed by filling with fresh water to a saturated depth of at least 300mm as specified for the initial assessment. Water level loggers were suspended from the surface to approximately 5cm above the base of the pit to record the water level at 5 second intervals during the test. The water level was dipped using a tape measure at the start of each test and at frequent intervals throughout the testing to complement and validate level logger data.

Hand pits were initially observed once filled to ensure that the pit could be refilled should water drain rapidly. The pits were left to seep away completely in order to satisfy the final two conditions set by the guidance stating:

- Water must have soaked away completely within 6 hours; and,
- Calculated Vp values must be between 15 and 100.

Table 1 Excavated hand pit depths and initial priming assessment

Hand Pit	Selected Drainage Invert Level (m bgl)	Proposed Depth of pit base (m bgl)	Excavated Depth (m bgl)	Initial Water Level (m bgl)	Saturated Zone (m)
HP01	0.55	0.85	0.85	0.55	0.30
HP02	0.70	1.00	1.00	0.70	0.30
HP03	0.40	0.70	0.75	0.45	0.30

Percolation Test Results

Full detail of the Percolation test results is provided in Appendix C. A summary of the test observations is provided below.

HP01

HP01 was filled to 0.55m bgl resulting in a saturated zone of 0.3m as shown in Table 1 Excavated hand pit depths and initial priming assessment above. Water did not soak away within 6 hours and subsequently the ground is not suitable. The pit was left overnight to continue draining and had not completely emptied 27 hours after the test began.

However water did seep from 75% and 25% of the initial saturated depth between 0.225m and 0.075m. Although not strictly applicable, as water did not seep away completely during the initial priming, a Vp value of 643.1 was calculated which is significantly above the upper limit of 100 specified.

HP02

HP02 was filled to 0.7m bgl resulting in a saturated zone of 0.3m required by the published guidance. The initial priming assessment was also unsuccessful as water failed to drain away within 6 hours indicating the ground as unsuitable for an infiltration system. The water did, however, soak away overnight, taking approximately 21 hours.

Level logger was suspended approximately 0.085m above the base of the pit. As a result the time taken for water level to seep away to the 25% level at 0.075m above the base of the pit

was extrapolated using dipped levels. The initial priming Vp value for HP02 is 257 which is significantly above the upper limit specified by British Standards.

HP03

HP03 was filled to 0.45m bgl resulting in the saturated zone of 0.3m required by the published guidance. Similarly to the first two hand pits, the water did not seep away within 6 hours and the ground is therefore indicated to be unsuitable. When left overnight water in the shallowest pit did not completely drain away or reach the 25% level after 27 hours.

Data recorded from the suspended level logger was extrapolated to provide a Vp value of 960, which is an order of magnitude higher than the limits specified by British Standards.

The calculated percolation values are summarised in Table 2 below.

Table 2 Percolation Test Results and Calculated Vp

Hole No.	Start Date	End Date	Test No.	Start time	Finish time	Elapsed Time			Vp (s/mm)
						Hours/ Mins	Mins	Secs	Secs divided by 150mm
1	25.10.16	26.10.16	Initial Assessment	10:25	14:08	26hrs 48mins	1608	96465	643
2	25.10.16	26.10.16	Initial Assessment	10:49	08:20	10hrs 43mins	643	38550	257
3	25.10.16	26.10.16	Initial Assessment	11:14	14:32	40hrs*	2400*	144050*	960*

* Vp value based on extrapolated time

A further test was completed on HP02 to collect further data, although the initial assessment indicated the ground is unsuitable. The hole was refilled to a depth of 300mm and was left to drain over 6.5 hours. A further percolation rate could not be calculated as water only drained approximately 60mm over this time period.

4.1.3 Aquifer Permeability Testing

While not specifically required for the Stage 1 assessment, in-situ permeability testing was completed on the existing monitoring wells WS1 and WS6. The purpose of the permeability tests was to establish the permeability of the underlying aquifer(s) to inform the Stage 2 assessment and also to provide supporting and contextual information to the percolation testing results. The location of each monitoring well is shown on Drawing 2.

Each well was tested 3 times over the 2 days using a suspended level logger near to the base of the well and displacing groundwater with a cylindrical solid plastic 'slug' of known volume. The implementation of the test causes a near instantaneous change in water level in the well and the recovery rate (falling head test) of the water level to equilibrium conditions is dictated by the permeability of the formation. Once the water level has returned to pre-test conditions the slug may be removed and a rising head test completed.

Due to the low permeability of the strata, it was only possible to undertake falling head tests on the two wells as the water levels did not return to equilibrium conditions.

The timings of the tests were undertaken as set out in Table 3 below.

Table 3 Timings of Permeability Testing

Monitoring Well	Test 1	Test 2	Test 3
WS01	25/10/16 13:06-13:53	26/10/16 09:34-10:50	26/10/16 12:06-13:36
WS06	25/10/16 14:25-15:49	26/10/16 10:15-11:20	26/10/16 12:55-13:52

There was no evidence of any existing down-hole monitoring equipment present in any of the monitoring wells visited on site.

A summary of the permeability test results for the two monitoring wells tested are summarised below in Table 4, with full details provided in Appendix C.

Table 4 Permeability Test Results

Monitoring Well	Response Zone Lithology	Falling Head 1	Falling Head 2	Falling Head 3	Geomean K [m/d]
		K [m/d]	K [m/d]	K [m/d]	
WS01	Superficial deposits (silty/sandy/gravelly clays)	0.0081	0.0059	0.0061	0.0066
WS06	Chalk (weathered chalk)	0.113	0.071	0.059	0.0779

Both wells indicated relatively low permeability results. The results for WS01 indicated that the superficial clays have a low permeability as expected given the results of the percolation test data.

The weathered Chalk bedrock was also shown to have a relatively low permeability, though an order of magnitude higher than the superficial deposits.

The permeability test results are within the ranges anticipated based on the lithology of each response zone encountered within WS01 and WS06.

5.0 CONCLUSIONS

5.1 Stage 1 Pre-requisite Assessment

The location of the proposed drainage field and the current depth to groundwater are both acceptable for a sewage discharge. Field testing confirmed that, in accordance with BS6297:2007+A1:2008, the ground is unsuitable for infiltration drainage fields for the discharge of sewage waste under a discharge consent. This is due to:

- Vp values fall significantly outside the upper allowable limit of 100 (257 to 960 recorded); and,
- Preliminary assessment of each hole indicated infiltration was not feasible as water did not drain within the stipulated 6 hour period (the minimum drainage time was 21 hours).

Pits were excavated to 0.75m, 0.85m and 1.00m as a means to represent likely invert levels of the infiltration drainage field. Borehole logs from previous site investigations suggest that the River Terrace Deposits are slightly variable with locally more sandy or gravelly bands. However, the formation is predominantly of clay and silt and it is considered likely that similar percolation values would be established across the site throughout the 2.4-5m thickness sequence.

Given the results of the testing and the likelihood of obtaining similar results across the site, it is deemed that a discharge of treated sewage effluent via an infiltration drainage field is

not feasible. The very poor infiltration capacity of the ground and the size of the proposed development mean that it is highly unlikely that an effective drainage field could be established and gain consent from the Environment Agency.

5.2 Permeability Testing

Permeability testing in two of the installed wells measured very low permeability within the superficial deposits. However, the results corroborate the outcomes of the percolation testing in that the superficial deposits have a low permeability and are unlikely to facilitate drainage of domestic sewage discharge to ground.

The underlying Chalk aquifer also appears to have relatively low permeability. This is likely due to the weathered nature at shallow depths. The permeability of the chalk is however an order of magnitude higher than the overlying superficial deposits.

6.0 RECOMMENDATIONS

Given the conclusions of the field testing, discharge of domestic sewage via a package treatment plant and infiltration drainage field is considered unsuitable. There are currently no foreseeable temporary storage or buffering capacity solutions that could mitigate the poor infiltration rates, and it is considered unlikely that the Environment Agency would grant consent for a infiltration discharge based on the percolation test results.

In the absence of a suitable nearby public sewer, the only feasible solution foreseeable at this time would be to add additional tertiary treatment to the package treatment plant and subsequently discharge to a nearby surface water course. This possible solution would be subject to further feasibility assessment and permitting requirements dictated by the Environment Agency.

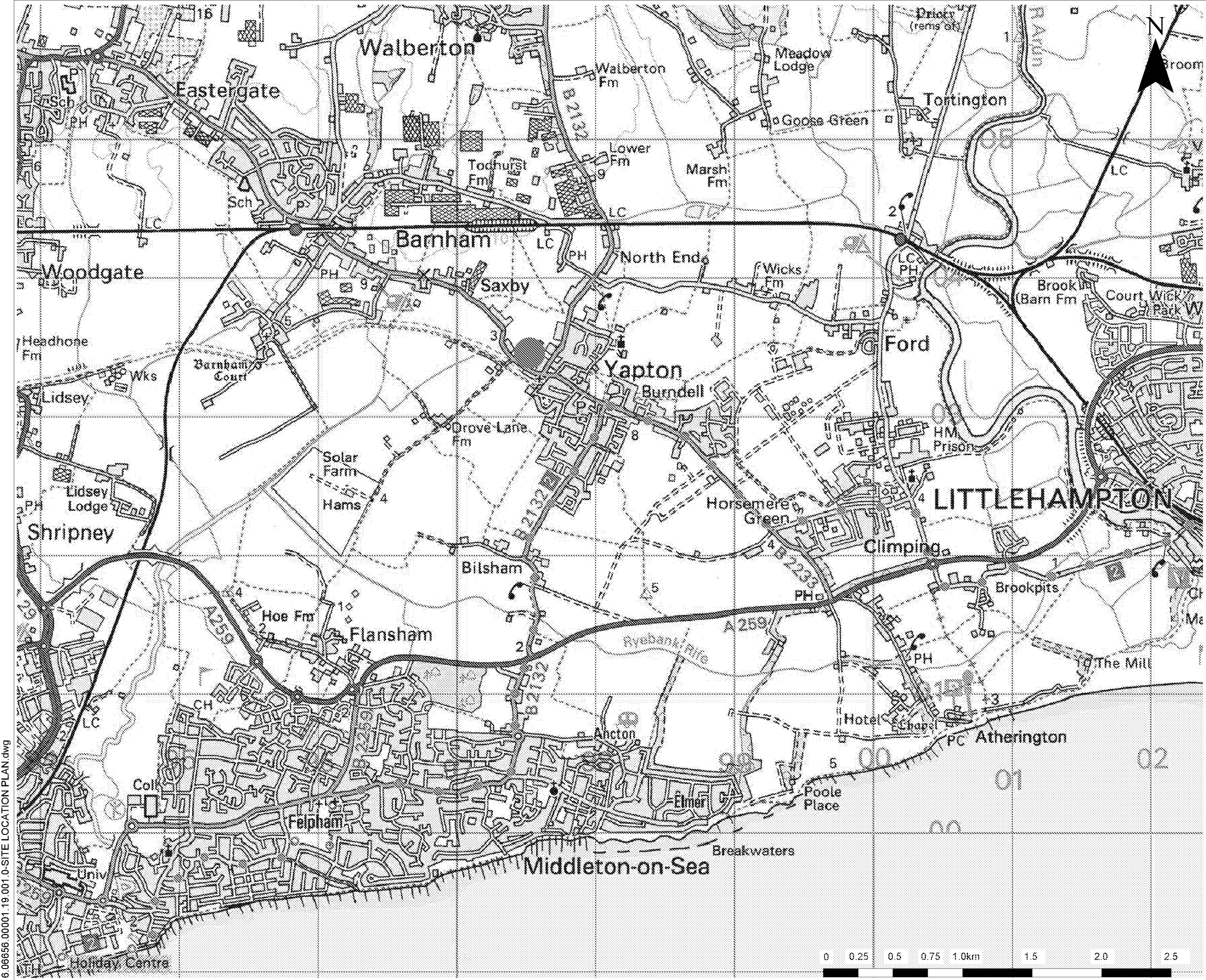
Yours sincerely
SLR Consulting Limited

Alice Wenborn
Geotechnical Engineer

Duncan Cartwright
Principal Hydrogeologist

Enc	Drawing 1	Site Location Plan
	Drawing 2	Site Layout Plan
	Appendix A	Photo Log
	Appendix B	Hand Pit Logs and Existing Borehole Logs
	Appendix C	Percolation Test Results
	Appendix D	Permeability (Slug) Test Results

416.06656.00001.19.001.0-SITE LOCATION PLAN.dwg



LEGEND



SITE LOCATION



SLR
global environmental solutions

LANGFORD LODGE
109 PEMBROKE ROAD
CLIFTON, BRISTOL
BS8 3EU
T: 01179 064280
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BONHAMS FIELD,
YAPTON

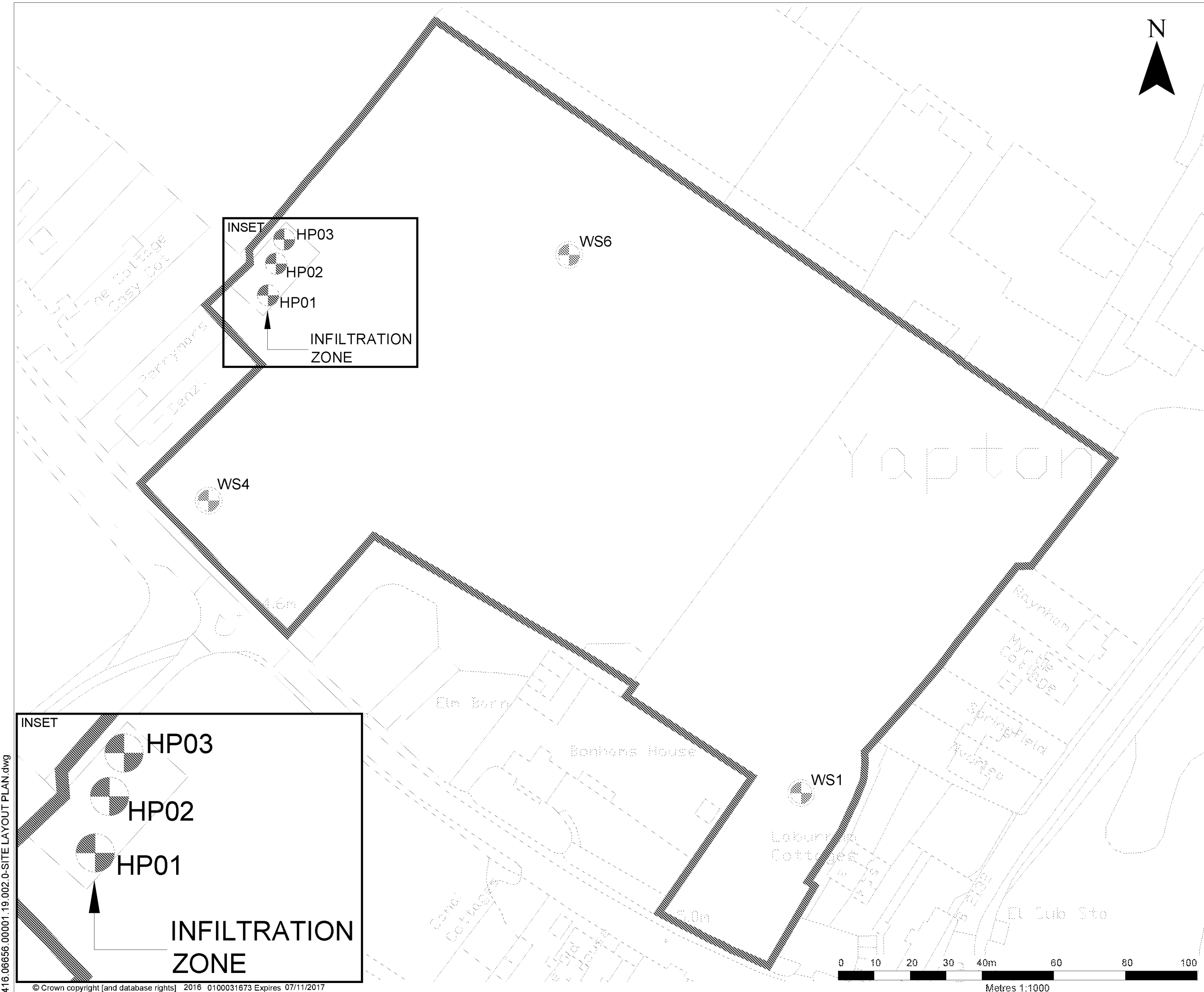
SITE LOCATION PLAN

416.06656.00001.19.001.0

Scale
AS SHOWN

Date
NOVEMBER 2016

416.06656.00001.19.002.0-SITE LAYOUT PLAN.dwg



LEGEND

SITE BOUDNARY

WS1

TEC DYNAMIC SAMPLE
BOREHOLE WITH INSTALLATION
LOCATION

HP01

HAND PITS WITHIN THE
INFILTRATION ZONE

global environmental solutions

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BONHAMS FIELD,
YAPTON

SITE LAYOUT PLAN

416.06656.00001.19.002.0

Scale
1:1000 @A3

Date
NOVEMBER 2016

APPENDIX A – Photo Log



Figure 1 Panoramic view of Bonhams Field, Yapton from site access.



Figure 1 View of access to site facing northeast



Figure 2 View of infiltration zone prior to excavation of hand pits facing west



Figure 3 View of infiltration zone during hand pitting facing west



Figure 4 View of completed hand pits facing south with suspended level loggers (HP03 near, HP01 furthest).



Figure 5 Spoil from hand pit 01 grading from slightly gravelly sandy silt to clayey silt.



Figure 6 Initial assessment of hand pit 01 using suspended level logger.



Figure 7 Hand pit 01 after approx. 27 hours from start of initial assessment.



Figure 9 Restored hand pit 01 and surrounding area facing west



Figure 10 Spoil from hand pit 02 grading from slightly gravelly very silty fine sand to clayey silt (left to right).

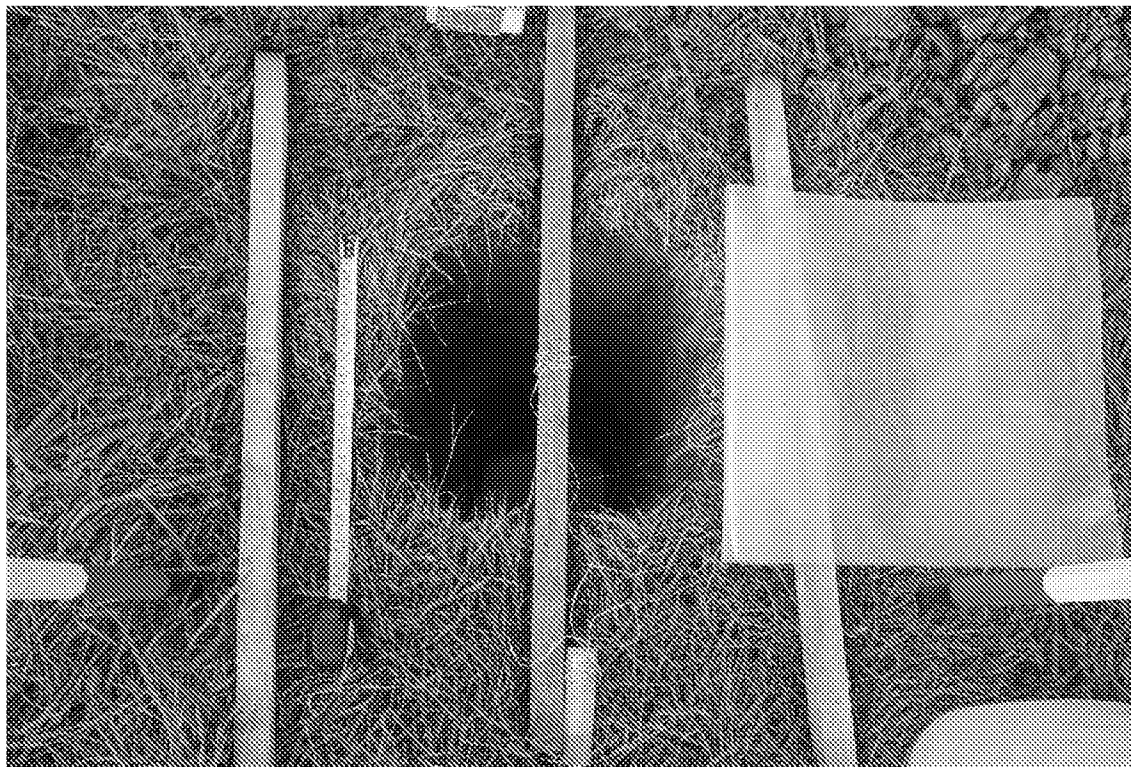


Figure 11 Configuration of initial assessment of hand pit 02 using suspended level logger showing dimensions of hand pit.



Figure 12 Configuration showing hand pits left safely overnight with visible poles. The field is not accessible to public and all animals were fenced in a separate field.



Figure 13 Photograph showing hand pit 02 drained completely after being left overnight during initial assessment.



Figure 14 Restored hand pit 02 and surrounding area facing southwest



Figure 15 Spoil from hand pit 03 grading from slightly gravelly very silty fine sand to clayey silt with rare flint gravel (left to right).



Figure 18 Configuration of initial assessment of hand pit 03 using suspended level logger showing dimensions of hand pit.



Figure 17 Photograph showing hand pit 03 approx. 27 hours after beginning the initial assessment. Level logger is approx. 5cm from base of 0.75m pit.



Figure 18 Restored hand pit 02 and surrounding area facing north.



Figure 19 WS01 viewed from top left clockwise: north; east; south; west.



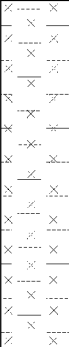
Figure 20 WS04 viewed from top left clockwise: north; east; south; west.



Figure 21 WS06 viewed from left to right: northeast; and southwest.

APPENDIX B – Hand Pit Logs and Existing Borehole Logs

HAND PIT LOG				HAND PIT No HP01	
Client: AKSWARD LTD					
Project: BONHAMS FIELD, YAPTON					
Project No: 416.06656.00001	Date: 25/10/16	Ground Level:	Co-ordinates:	Sheet: 1 of 1	

SAMPLES & TESTS				Water	STRATA			Instrument/ Backfill	
Depth	Type No	Test Type	Test Result		Reduced Level	Legend	Depth (Thick-ness)		DESCRIPTION
0.2							(0.50)	Light brown slightly gravelly sandy SILT with occasional roots. Gravel comprises angular to subangular fine to coarse flint and brick.	
0.4							0.50		
0.6						(0.35)	Stiff yellowish brown fine sandy clayey SILT with rare gravel comprising angular fine flint.		
0.8						0.85			
1.0							Hand Dug Pit complete at 0.85m		

GENERAL REMARKS: 1. Surface footprint 0.4mx0.3m	Hand Pit Dimensions: $\longleftrightarrow$ 0.3 $\longleftrightarrow$ $\updownarrow$ 0.3 $\updownarrow$
KEY: V = Hand Vane Shear Strength PP = Pocket Penetrometer Shear Strength J = Jar Sample D = Small Disturbed Sample B = Large Bulk Sample HS = Head Space Measurement	

All dimensions in metres Scale 1:7.5	Contractor : Oakley Soils Plant:	Method: Hand Dug Pit	Logged By: AW	Approved By:
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Form SLR AGS3 UK HP File 161027_416.06656.00001_BONHAMS FIELD YAPTON HAND PIT LOG 03-11-16

HAND PIT LOG				HAND PIT No HP02	
Client: AKSWARD LTD					
Project: BONHAMS FIELD, YAPTON					
Project No: 416.06656.00001	Date: 25/10/16	Ground Level:	Co-ordinates:	Sheet: 1 of 1	

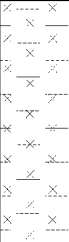
SAMPLES & TESTS				Water	STRATA			Instrument/ Backfill	
Depth	Type No	Test Type	Test Result		Reduced Level	Legend	Depth (Thick-ness)		DESCRIPTION
0.2							(0.55)	Light brown slightly gravelley very silty fine sand with frequent roots. Gravel is subangular and occasionally subrounded fine to coarse predominantly flint.	
0.4							0.55		
0.6							(0.45)	Stiff yellowish brown slightly sandy clayey SILT with rare subrounded to subangular coarse, and less frequent medium to fine flint gravel and rare cobbles.	
0.8							1.00		
1.0								Hand Dug Pit complete at 1.00m	

GENERAL REMARKS: 1. Surface footprint 0.4mx0.4m	Hand Pit Dimensions: $\longleftrightarrow$ 0.3 $\longleftrightarrow$ $\updownarrow$ 0.3 $\updownarrow$
KEY: V = Hand Vane Shear Strength PP = Pocket Penetrometer Shear Strength J = Jar Sample D = Small Disturbed Sample B = Large Bulk Sample HS = Head Space Measurement	

All dimensions in metres Scale 1:7.5	Contractor : Oakley Soils Plant:	Method: Hand Dug Pit	Logged By: AW	Approved By:
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Form SLR AGS3 UK HP File 161027_416.06656.00001_BONHAMS FIELD YAPTON HAND PITSGPJ 03-11-16

HAND PIT LOG				HAND PIT No HP03	
Client: AKSWARD LTD					
Project: BONHAMS FIELD, YAPTON					
Project No: 416.06656.00001		Date: 25/10/16	Ground Level:	Co-ordinates:	Sheet: 1 of 1

SAMPLES & TESTS				Water	STRATA			Instrument/ Backfill	
Depth	Type No	Test Type	Test Result		Reduced Level	Legend	Depth (Thick-ness)		DESCRIPTION
0.2							(0.50)	Light brown slightly gravelly very silty fine sand with occasional rootlets. Gravel comprises subangular to subrounded predominantly fine to medium white, dark grey and grey flint. Gravel is very rarely coarse.	
0.4							0.50 (0.25)	Stiff yellowish brown slightly sandy clayey SILT with occasional rootlets and rare subangular fine flint gravel.	
0.6							0.75	Hand Dug Pit complete at 0.75m	
0.8									
1.0									

GENERAL REMARKS: 1. Target depth = 0.7m 2. Surface footprint 0.3mx0.3m	Hand Pit Dimensions:
KEY: V = Hand Vane Shear Strength PP = Pocket Penetrometer Shear Strength J = Jar Sample D = Small Disturbed Sample B = Large Bulk Sample HS = Head Space Measurement	

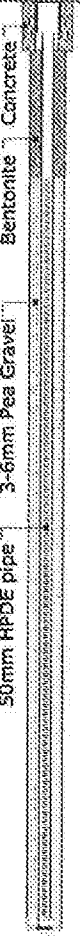
All dimensions in metres Scale 1:7.5	Contractor : Oakley Soils Plant:	Method: Hand Dug Pit	Logged By: AW	Approved By:
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DYNAMIC SAMPLING RECORD		 TWEEDIE EVANS CONSULTING www.tecon.co.uk info@tecon.co.uk
Project Title: Bonhams Field, Yapton	Borehole: WS1	
Project No: 1608013.001	Dates: 5th September 2016	
Client: Seaward Properties Ltd		

Depth (m)	Description	Legend	Sample Details	Depth (m)	SPT Results		Remarks/ Data	Installation
					Blow Count	N Value		
0.00	Ground Surface			0.0				
0.50	MADE GROUND Soft brown clay with frequent rootlets.							
	MADE GROUND Stiff brown silty clay with occasional gravel of sub-rounded chert and rare black carbonaceous material.							
1.00	Firm to stiff high strength orangish brown slightly sandy CLAY with frequent bioturbation holes.		T	1.0	(2, 2) 2, 2, 2, 2.	8	HSV @ 0.8m = 150, 150, 160 kPa	Concrete Bentonite 3-5mm Pea Gravel 50mm HDPE pipe
1.20	Firm medium to high strength orangish brown slightly sandy CLAY.						HSV @ 1.1m = 85, 90, 75 kPa	
	Soft to firm low to medium strength very sandy CLAY		T				HSV @ 1.5m = 60, 65, 55 kPa	
2.00				2.0	(2, 2) 2, 2, 3, 3.	16		
2.25	Firm locally soft locally gravelly sandy CLAY with gravel of fine sub-angular to sub-rounded chalk and fine to coarse sub-rounded to angular flint.							
2.60	Soft orangish brown sandy CLAY							
3.00	Soft to firm locally gravelly sandy CLAY with gravel of fine sub-angular to sub-rounded chalk and fine to coarse sub-rounded to angular flint.		T	3.0	(2, 4) 4, 5, 5, 6.	20		
	Firm to stiff white and creamish brown gravelly sandy CLAY. Frequent gravel of fine to coarse sub-angular to sub-rounded chalk and occasional gravel of fine to coarse sub-angular to sub-rounded flint.							
				4.0	(5, 5) 5, 6, 6, 6.	23		
			T					
5.00	Borehole Terminated			5.0				

Notes:	Plant: Archway Competitor Dart
A: 250ml and 60ml Amber Glass Jars	Water observations: No groundwater was encountered.
T: Plastic Tub (1Kg)	
SPT: Standard Penetration Test	General remarks:
HSV: Hand Shear Vane	
PP: Pocket Penetrometer	
PID: Photo-Ionisation Detector	
Logged by: MB	Checked by: CH
	Approved by: RE

DYNAMIC SAMPLING RECORD		 TWEEDIE EVANS CONSULTING www.tecon.co.uk info@tecon.co.uk
Project Title: Bonhams Field, Yapton	Borehole: WS4	
Project No: 1608013.001	Dates: 5th September 2016	
Client: Seaward Properties Ltd		

Depth (m)	Description	Legend	Sample Details	Depth (m)	SPT Results		Remarks/ Data	Installation
					Blow Count	N Value		
0.00	Ground Surface			0.0				
0.10	MADE GROUND Dark brown clayey silt with frequent rootlets.		A					
0.30	MADE GROUND Brown silt with rare fine gravel of red brick and chalk.							
0.60	MADE GROUND Dark brown slightly sandy silt with occasional gravel of chalk and rare gravel of red brick.							
1.30	Firm locally stiff orangish brown slightly clayey SILT with occasional fine gravel of chalk and rare fine gravel of sub-angular flint. Rare rootlets.		T	1.0	(2, 2) 2, 2, 3, 3.	10	PP @ 1.2m = 2.25, 2.25, 2.5, 3.5, 2.5 kg/cm2	
1.60	Firm to stiff medium to high strength orangish brown slightly sandy slightly silty CLAY. Rare gravel of fine angular flint and rare coarse sand of chalk.						HSV @ 1.5m = 70, 85, 80 kPa	
	Firm to stiff cream gravelly sandy CLAY. Gravel of fine to medium sub-angular chalk and rare sub-angular flint.			2.0	(2, 3) 3, 2, 2, 2.	9		
2.45			T				HSV @ 2.5m = 45, 45, 45 kPa	
2.80	Soft to firm low to medium strength creamish brown very sandy CLAY with rare fine gravel of sub-angular chalk.							
3.00	Firm cream slightly sandy gravelly CLAY with gravel of fine angular to sub-rounded chalk and rare cobbles of flint.			3.0	(7, 7) 7, 7, 8, 14.	36		
3.70	Structureless CHALK composed of cream gravelly sandy SILT. Clasts are weak, medium density, white with localised orange staining and occasional black specks. With occasional locally frequent cobbles of flint. (Grade Dm)		T					
					(12, 15/60) 14, 16, 16, 4/10.	>50	SPT refusing on flints.	
	Borehole Terminated			4.0				
				5.0				

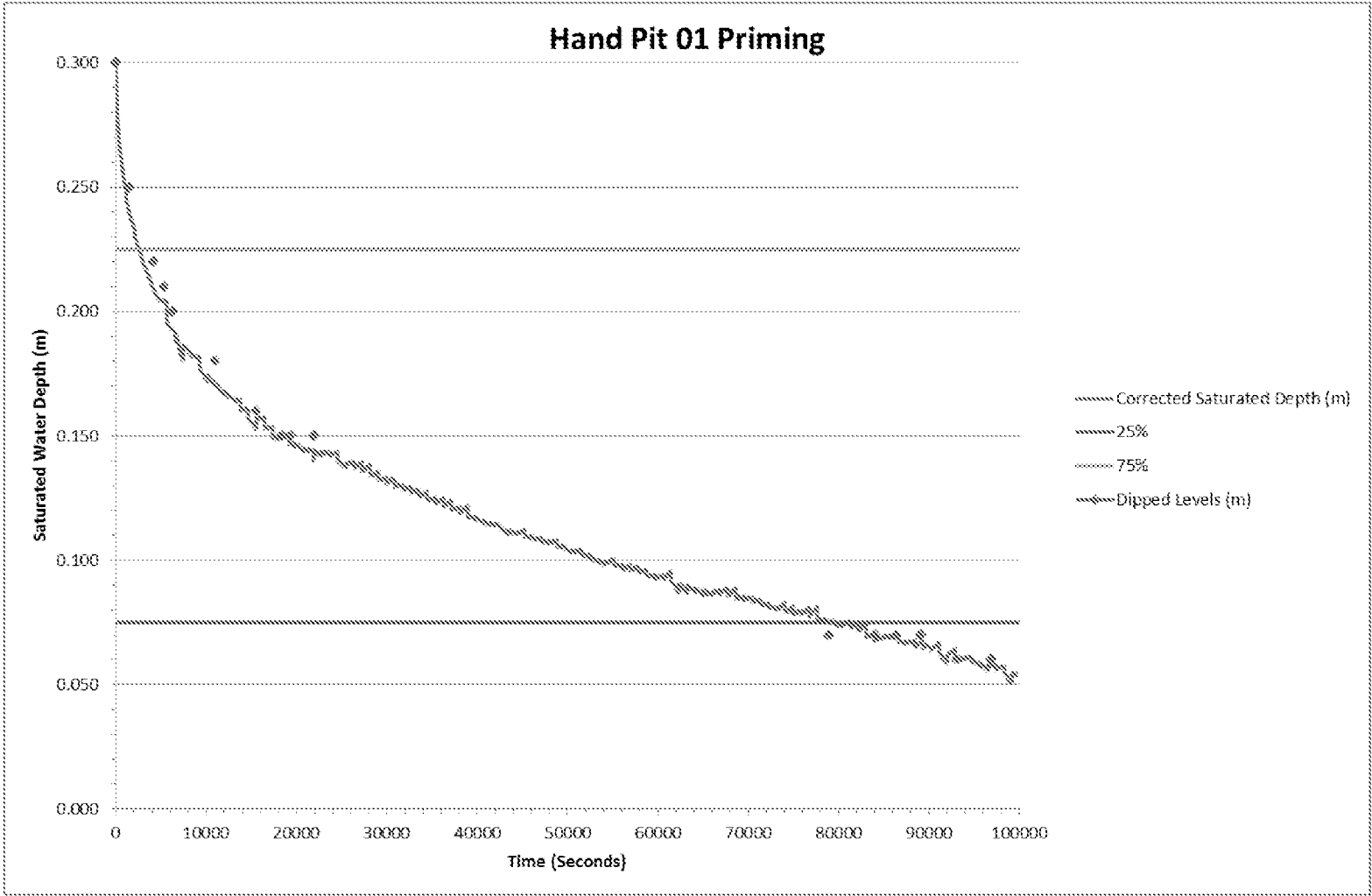
Notes: A: 250ml and 60ml Amber Glass Jars T: Plastic Tub (1Kg) SPT: Standard Penetration Test HSV: Hand Shear Vane PP: Pocket Penetrometer PID: Photo-Ionisation Detector	Plant: Archway Competitor Dart		
	Water observations: No groundwater was encountered.		
	General remarks:		
	Logged by: MB	Checked by: CH	Approved by: RE

DYNAMIC SAMPLING RECORD		 TEC TWEEDE EVANS CONSULTING www.tecon.co.uk info@tecon.co.uk
Project Title: Bonhams Field, Yapton	Borehole: WS6	
Project No: 1608013.001	Dates: 5th September 2016	
Client: Seaward Properties Ltd		

Depth (m)	Description	Legend	Sample Details	Depth (m)	SPT Results		Remarks/ Data	Installation
					Blow Count	N Value		
0.00	Ground Surface			0.0				
0.10	MADE GROUND / NEAR SURFACE MATERIALS Dark brown silty clay with many rootlets. Stiff light brown slightly sandy clayey SILT with a friable texture and frequent bioturbation holes and occasional rootlets.		T				PP @ 0.5m = >5, >5, >5, >5, >5 kg/cm2	 Concrete Bentonite 3-6mm Pea Gravel 50mm HPDE pipe
0.90	Firm to stiff high strength orangish brown slightly sandy silty CLAY with occasional black organic relics.		T	1.0	(1, 1) 2, 2, 2, 2.	8	HSV @ 0.9m = 110, 110, 125 kPa HSV @ 1.2m = 85, 100, 125 kPa	
1.80	Stiff cream and orangish brown sandy very gravelly CLAY with gravel of fine to coarse sub-angular chalk.			2.0	(3, 3) 5, 6, 6, 6.	23		
				3.0	(2, 2) 4, 4, 4, 4.	16		
3.60	Structureless CHALK composed of cream sandy clayey GRAVEL. Clasts are extremely weak to very weak, low to medium density, white with localised orange staining and occasional black specks. With occasional flint cobbles. (Grade Dc)			4.0	(4, 3) 4, 7, 9, 9.	29		
4.60	Weak, medium dense CHALK white with localised orange staining. Occasional flint cobbles.							
5.00	Borehole Terminated			5.0	(7, 9) 9, 12, 14, 14.	49		

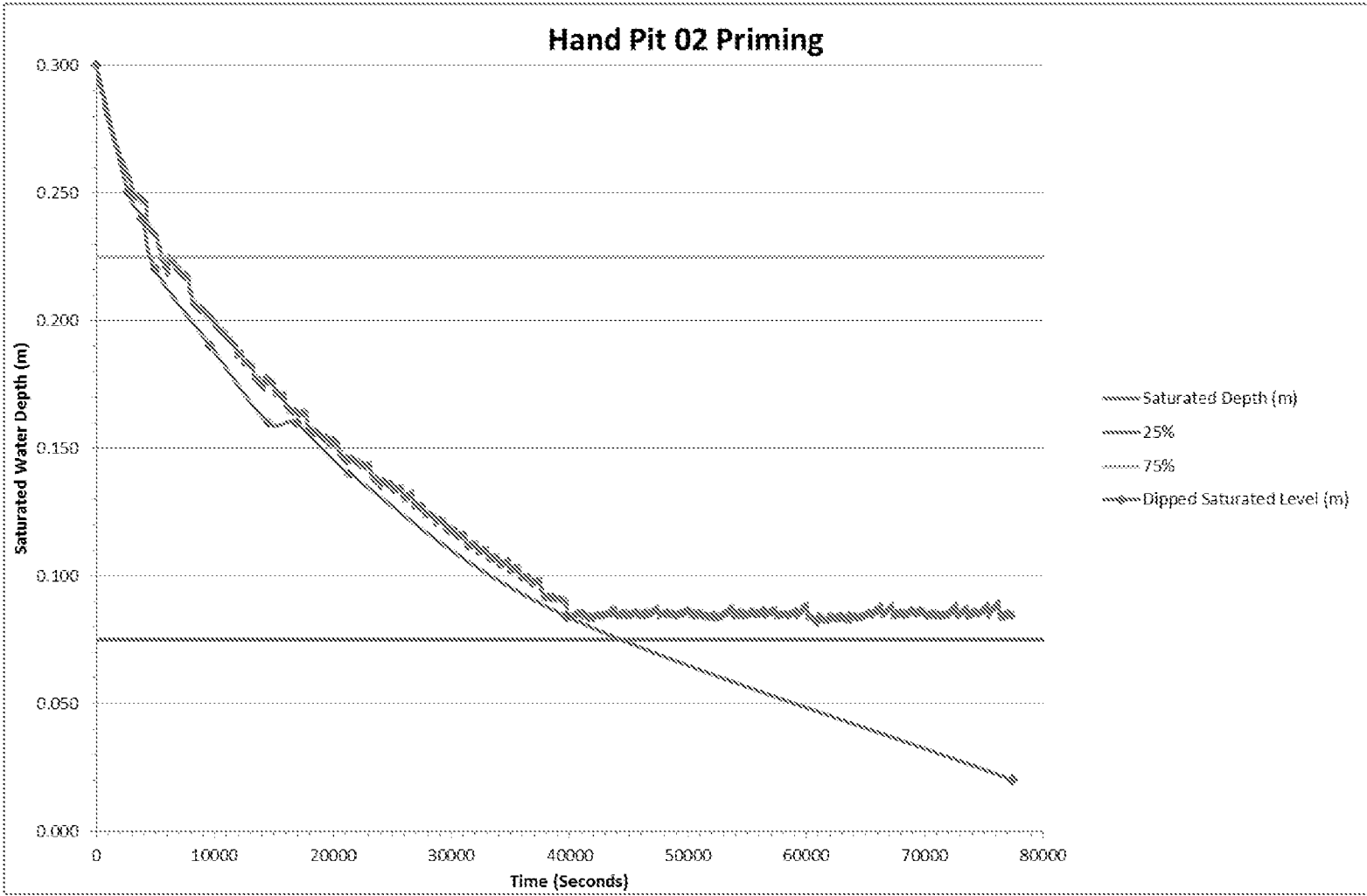
Notes: A: 250ml and 60ml Amber Glass Jars T: Plastic Tub (1Kg) SPT: Standard Penetration Test HSV: Hand Shear Vane PP: Pocket Penetrometer PID: Photo-Ionisation Detector	Plant: Archway Competitor Dart Water observations: No groundwater was encountered. General remarks: Logged by: MB Checked by: CH Approved by: RE
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APPENDIX C – Percolation Test Results



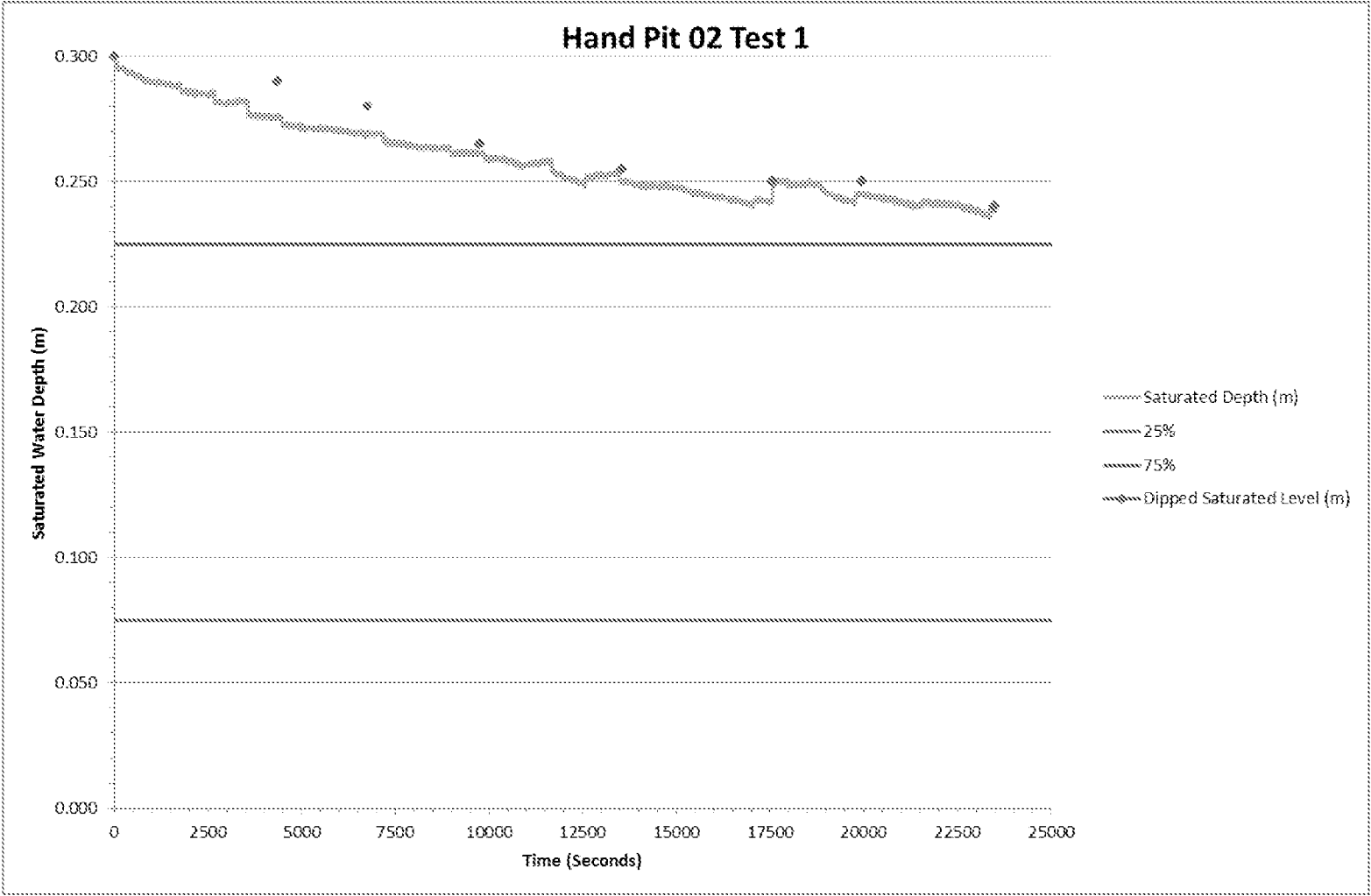
HP01

Calculation sheet for initial assessment in hand pit 01.



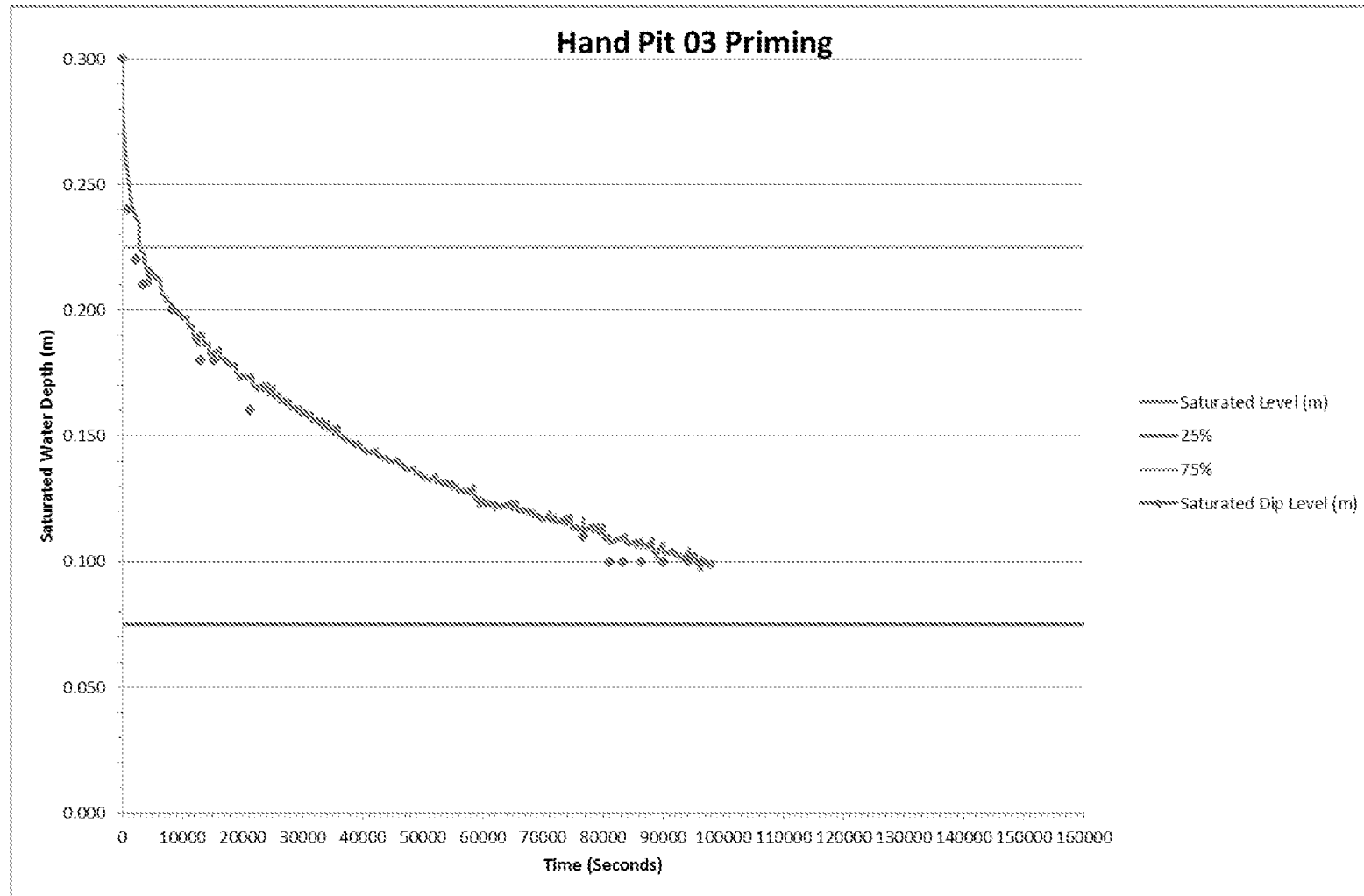
HP02

Calculation sheet for initial assessment in hand pit 02.



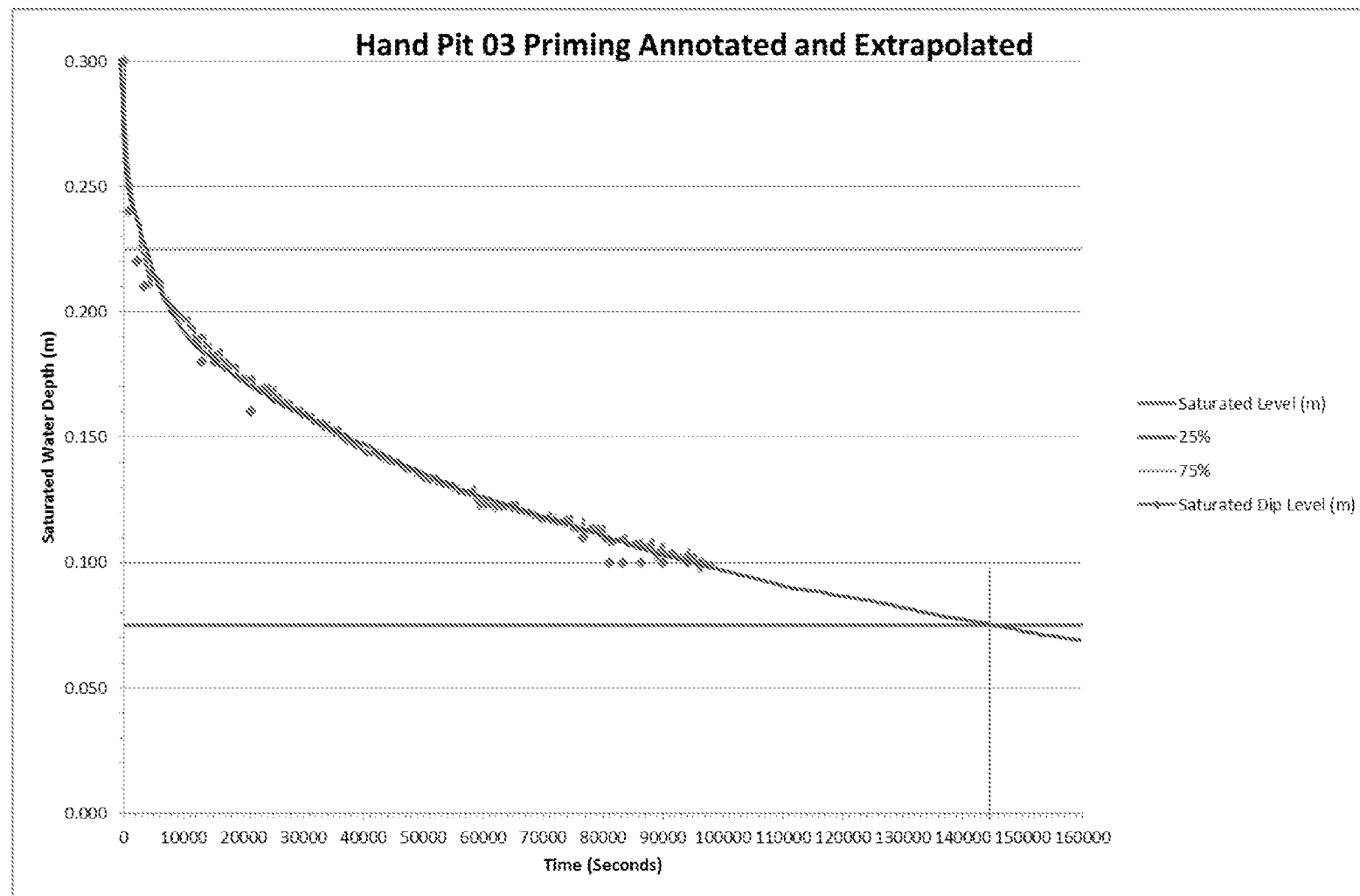
HP02

Calculation sheet for initial assessment in hand pit 03.



HP03

Calculation sheet for initial assessment in hand pit 03.



HP03

Calculation sheet for initial assessment in hand pit 03.

Hand Pit 01 Priming		
	HP01	
Width (m)	0.300	
Length (m)	0.300	
Depth (m)	0.850	
Data Logger (m) from top of pit	0.800	
Initial Water Level (m bgl)	0.550	
Initial Saturated Depth (m)	0.300	
Saturated Depth (m)	25%	0.075
Saturated Depth (m)	75%	0.225
Saturated Volume (m3)	0.027	
Saturated Volume 25-75% (m3)	0.0135	
Saturated Depth @ 50% (m)	0.15	
Internal surface area up to 50% effective depth (m2)	0.108	
75% Time	2505	
25% Time	98970	
time from 25% to 75% based on graphs	96465 seconds	
time from 25% to 75% based on graphs	1607.75 minutes	
time from 25% to 75% based on graphs	26.80 hours	
Vp value	643.1	
infiltration rate (m/s)		1.29581E-06

HP01 Calculation sheet for initial assessment in hand pit 01.

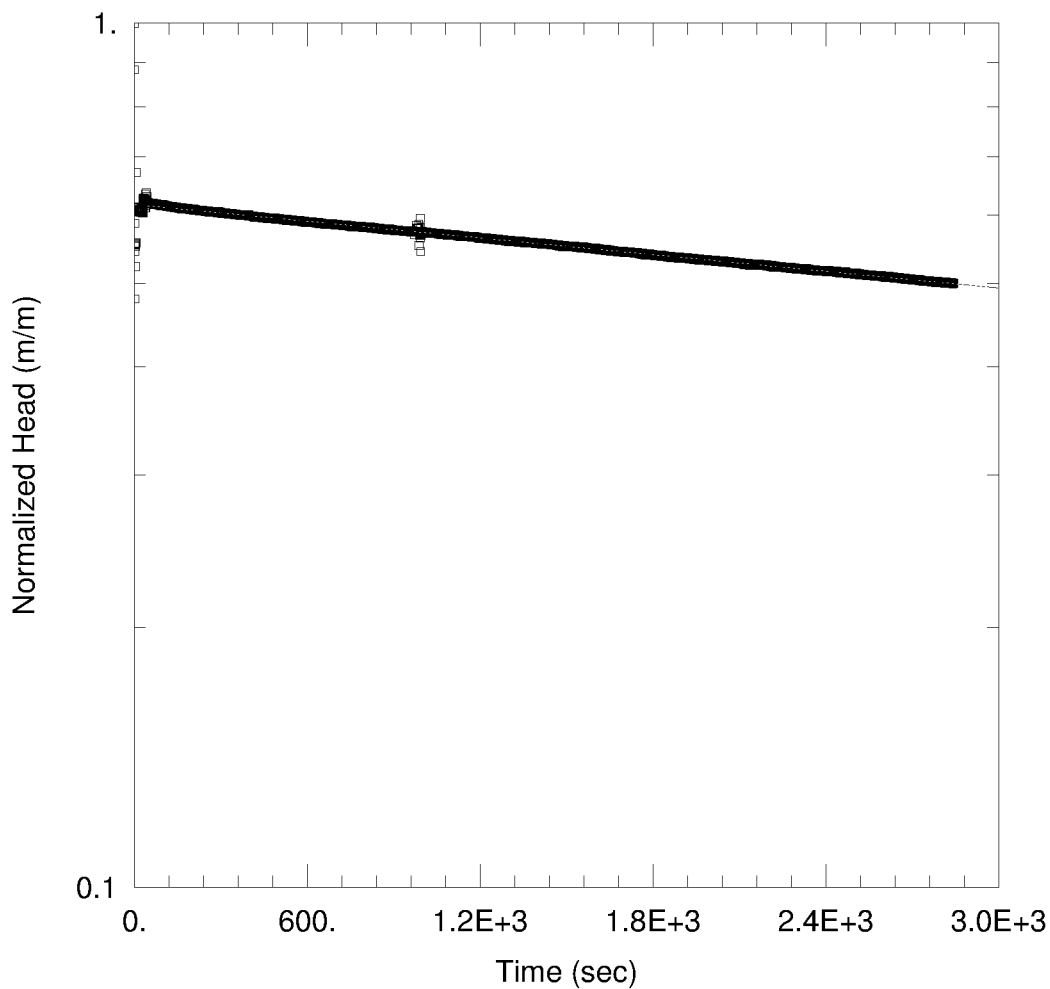
Hand Pit 02 Priming		
	HP02	
Width (m)	0.300	
Length (m)	0.300	
Depth (m)	1.000	
Data Logger (m) from top of pit	0.085	
Initial Water Level (m bgl)	0.700	
Initial Saturated Depth (m)	0.300	
Saturated Depth (m)	25%	0.075
Saturated Depth (m)	75%	0.225
Saturated Volume (m3)	0.027	
Saturated Volume 25-75% (m3)	0.0135	
Saturated Depth @ 50% (m)	0.15	
Internal surface area up to 50% effective depth (m2)	0.108	
75% Time	5450	
25% Time	44000	
time from 25% to 75% based on graphs	38550	seconds
time from 25% to 75% based on graphs	642.50	minutes
time from 25% to 75% based on graphs	10.71	hours
Vp value	257	
infiltration rate (m/s)		3.24254E-06

HP02 Calculation sheet for initial assessment in hand pit 02.

Hand Pit 03 Priming		
	HP03	
Width (m)	0.300	
Length (m)	0.300	
Depth (m)	0.750	
Data Logger (m) from top of pit	0.700	
Initial Water Level (m bgl)	0.450	
Initial Saturated Depth (m)	0.300	
Saturated Depth (m)	25%	0.075
Saturated Depth (m)	75%	0.225
Saturated Volume (m3)	0.027	
Saturated Volume 25-75% (m3)	0.0135	
Saturated Depth @ 50% (m)	0.15	
Internal surface area up to 50% effective depth (m2)	0.108	
75% Time	5450	
25% Time	149500	EXTRAPOLATED
time from 25% to 75% based on graphs	144050	seconds
time from 25% to 75% based on graphs	2400.83	minutes
time from 25% to 75% based on graphs	40.01	hours
Vp value	960.33333	
infiltration rate (m/s)		8.67754E-07

HP03 Calculation sheet for initial assessment in hand pit 03.

APPENDIX D – Permeability (Slug) Test Results



WELL TEST ANALYSIS

Data Set: C:\Users\dcartwright\Documents\06656 - AKSWard\Slug Tests\WS01 FH1.aqt
 Date: 11/03/16 Time: 16:27:49

PROJECT INFORMATION

Company: SLR
 Client: AKSWard
 Project: 416.06656.00001
 Location: Yapton
 Test Well: WS01
 Test Date: 25/10/16

AQUIFER DATA

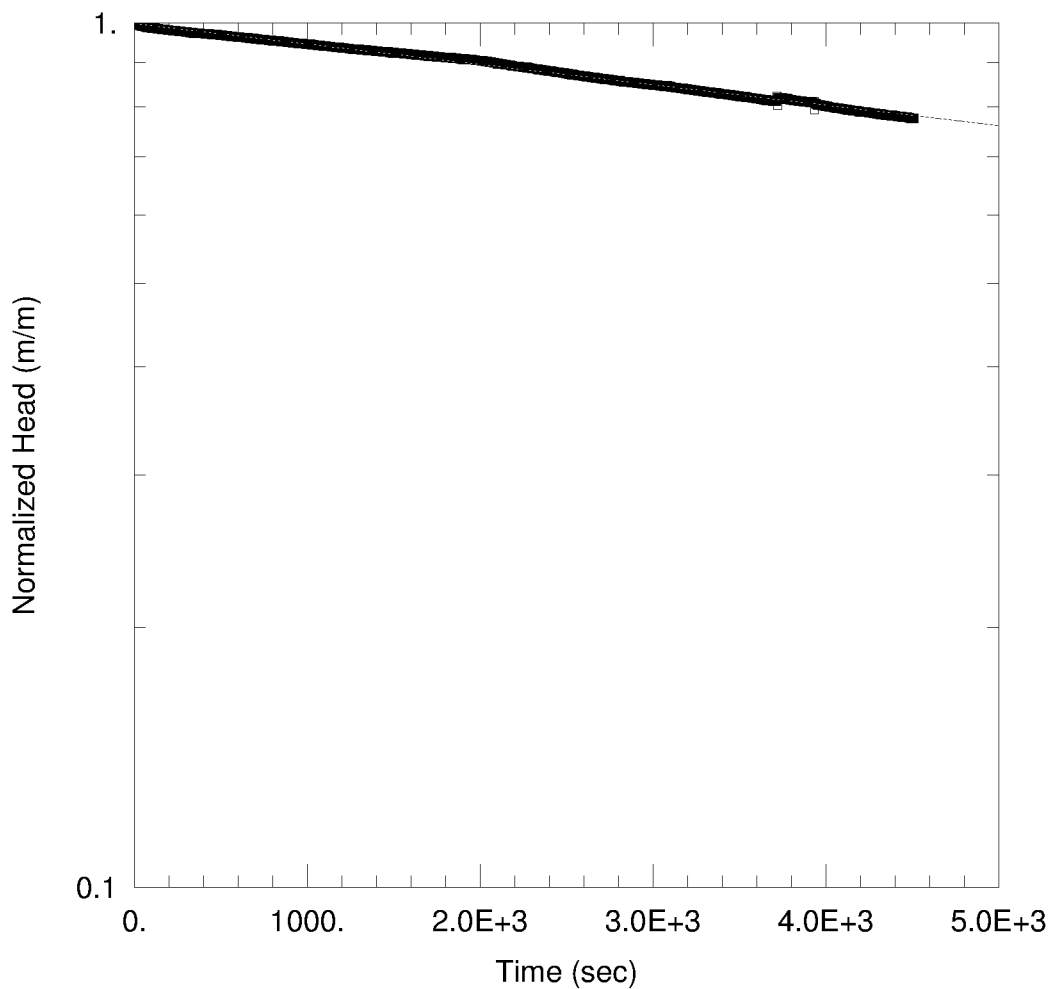
Saturated Thickness: 1. m Anisotropy Ratio (K_z/K_r): 0.1

WELL DATA (WS01)

Initial Displacement: 0.3303 m Static Water Column Height: 0.82 m
 Total Well Penetration Depth: 0.82 m Screen Length: 0.82 m
 Casing Radius: 0.025 m Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice
 $K = 0.00807$ m/day $y_0 = 0.2037$ m



WELL TEST ANALYSIS

Data Set: C:\Users\dcartwright\Documents\06656 - AKSWard\Slug Tests\WS01 FH2.aqt
 Date: 11/03/16 Time: 16:29:09

PROJECT INFORMATION

Company: SLR
 Client: AKSWard
 Project: 416.06656.00001
 Location: Yapton
 Test Well: WS01
 Test Date: 25/10/16

AQUIFER DATA

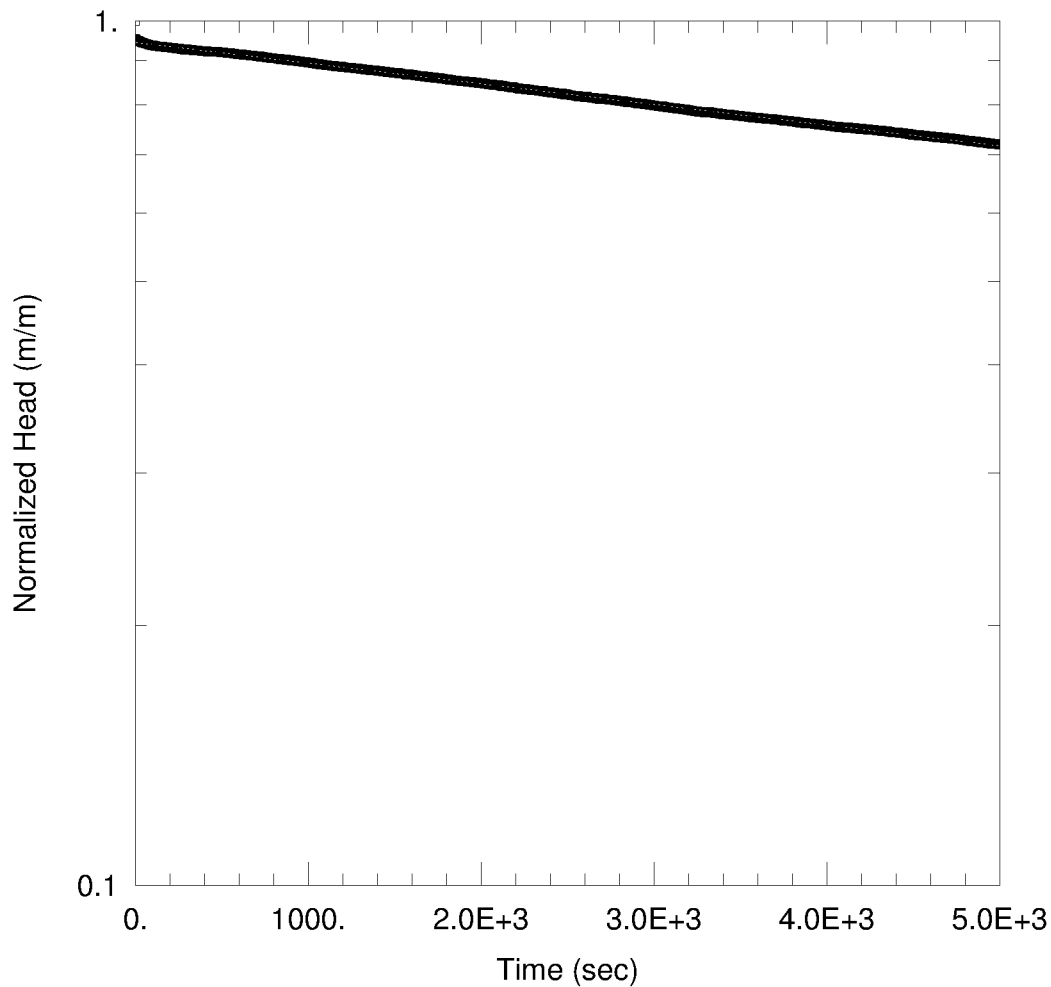
Saturated Thickness: 1. m Anisotropy Ratio (K_z/K_r): 0.1

WELL DATA (WS01)

Initial Displacement: 0.26 m Static Water Column Height: 0.82 m
 Total Well Penetration Depth: 0.82 m Screen Length: 0.82 m
 Casing Radius: 0.025 m Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice
 $K = 0.005911$ m/day $y_0 = 0.2597$ m



WELL TEST ANALYSIS

Data Set: C:\Users\dcartwright\Documents\06656 - AKSWard\Slug Tests\WS01 FH3.aqt
 Date: 11/03/16 Time: 16:26:40

PROJECT INFORMATION

Company: SLR
 Client: AKSWard
 Project: 416.06656.00001
 Location: Yapton
 Test Well: WS01
 Test Date: 25/10/16

AQUIFER DATA

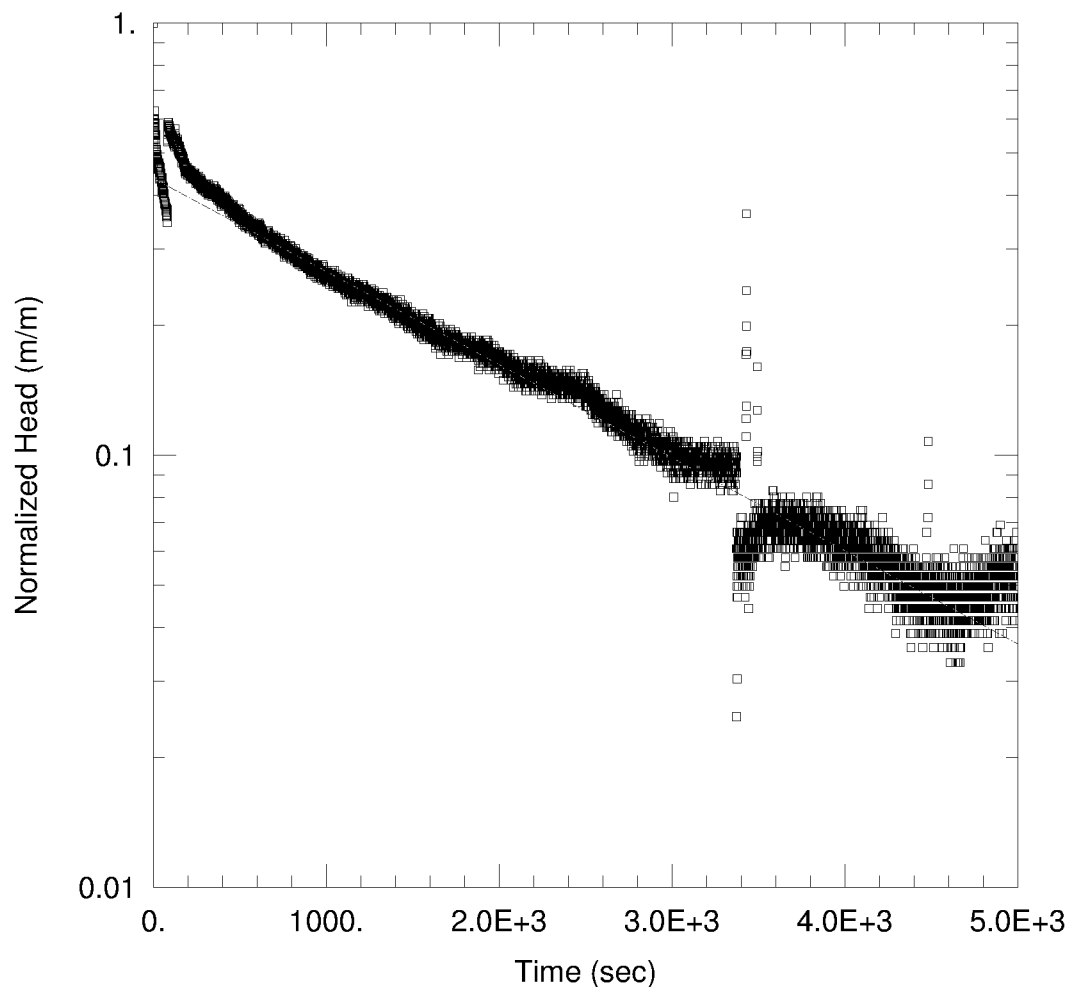
Saturated Thickness: 1. m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (WS01)

Initial Displacement: 0.2682 m Static Water Column Height: 0.82 m
 Total Well Penetration Depth: 0.8 m Screen Length: 0.8 m
 Casing Radius: 0.025 m Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice
 K = 0.006092 m/day y0 = 0.2534 m



WELL TEST ANALYSIS

Data Set: C:\Users\dcartwright\Documents\06656 - AKSWard\Slug Tests\WS06 FH1.aqt
 Date: 11/03/16 Time: 16:51:33

PROJECT INFORMATION

Company: SLR
 Client: AKSWard
 Project: 416.06656.00001
 Location: Yapton
 Test Well: WS06
 Test Date: 25/10/16

AQUIFER DATA

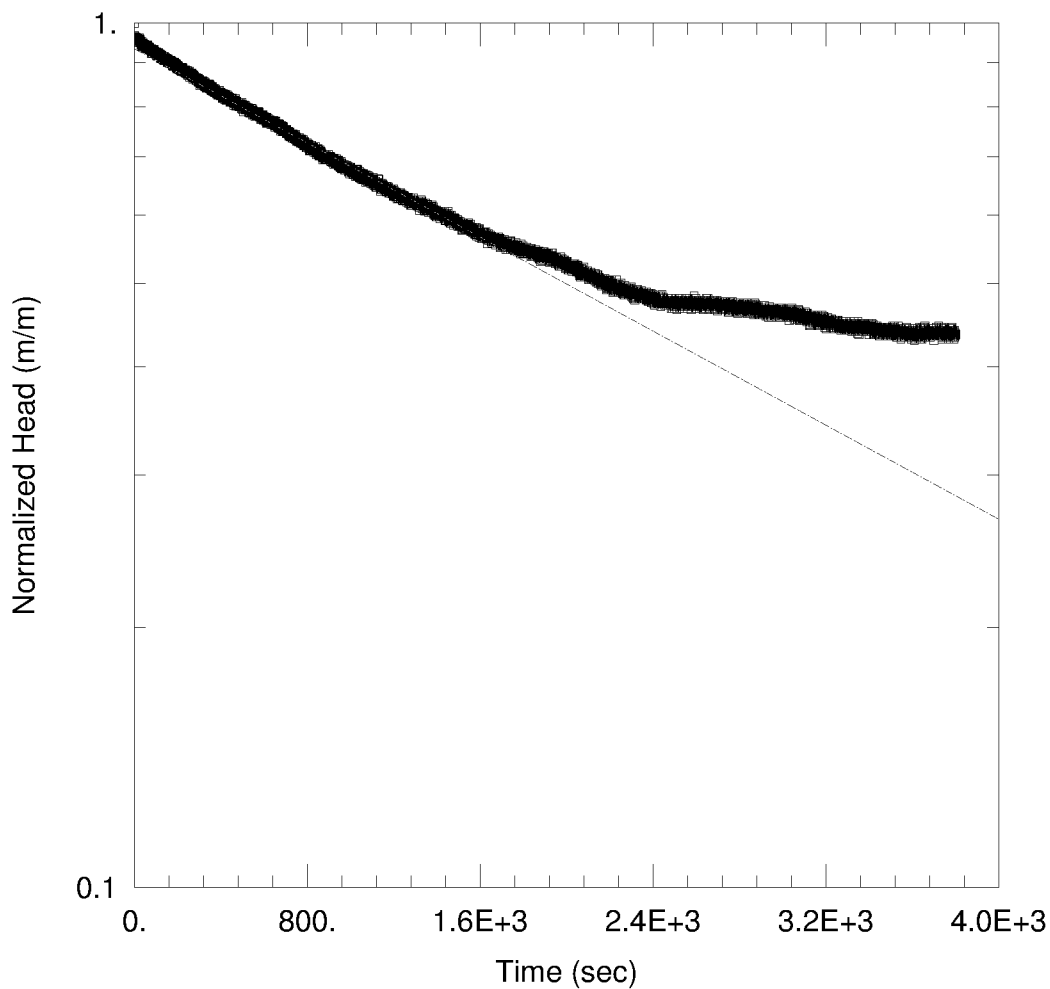
Saturated Thickness: 50. m Anisotropy Ratio (K_z/K_r): 0.1

WELL DATA (WS06)

Initial Displacement: 0.0362 m Static Water Column Height: 0.25 m
 Total Well Penetration Depth: 0.25 m Screen Length: 0.25 m
 Casing Radius: 0.025 m Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice
 $K = 0.1129$ m/day $y_0 = 0.01583$ m



WELL TEST ANALYSIS

Data Set: C:\Users\dcartwright\Documents\06656 - AKSWard\Slug Tests\WS06 FH2.aqt
 Date: 11/03/16 Time: 16:59:13

PROJECT INFORMATION

Company: SLR
 Client: AKSWard
 Project: 416.06656.00001
 Location: Yapton
 Test Well: WS06
 Test Date: 25/10/16

AQUIFER DATA

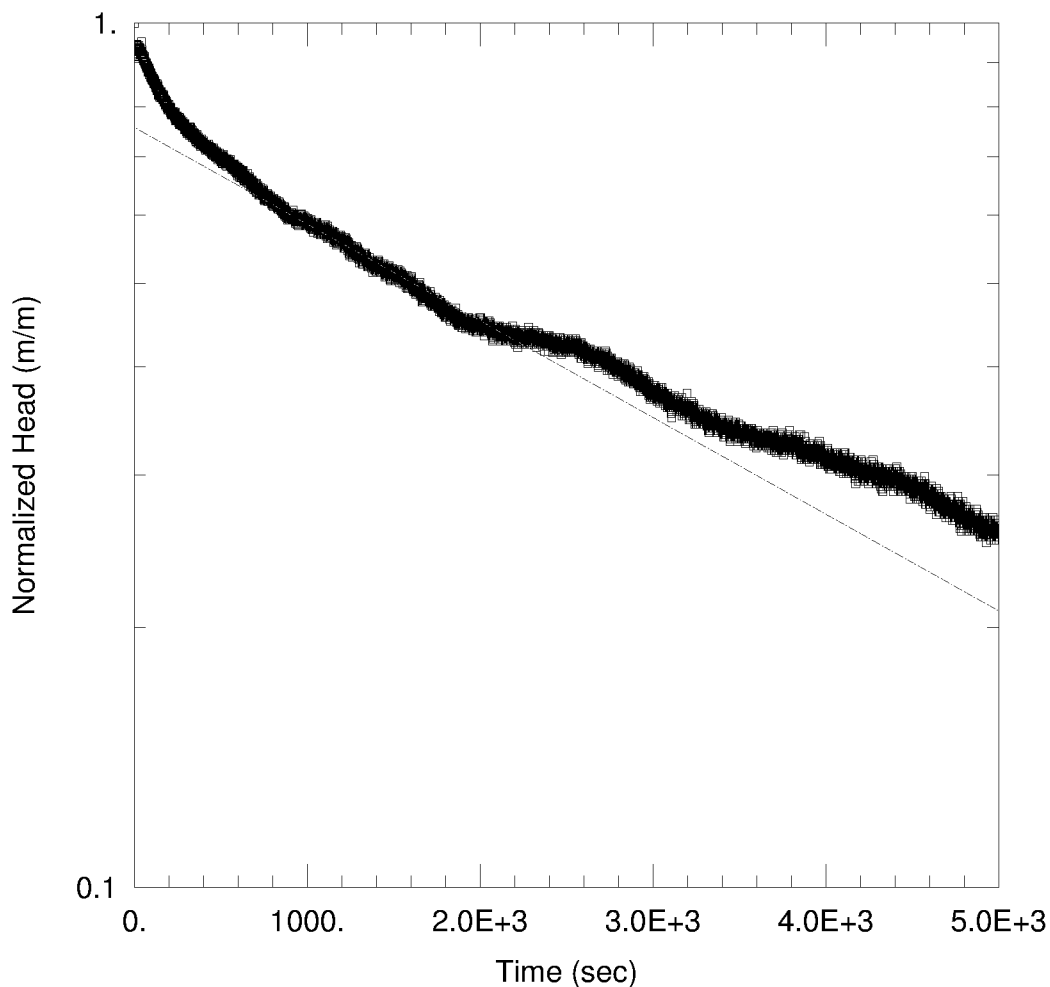
Saturated Thickness: 50. m Anisotropy Ratio (K_z/K_r): 0.1

WELL DATA (WS06)

Initial Displacement: 0.0596 m Static Water Column Height: 0.25 m
 Total Well Penetration Depth: 0.25 m Screen Length: 0.25 m
 Casing Radius: 0.025 m Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice
 $K = 0.07134$ m/day $y_0 = 0.05567$ m



WELL TEST ANALYSIS

Data Set: C:\Users\dcartwright\Documents\06656 - AKSWard\Slug Tests\WS06 FH3.aqt
 Date: 11/03/16 Time: 17:05:42

PROJECT INFORMATION

Company: SLR
 Client: AKSWard
 Project: 416.06656.00001
 Location: Yapton
 Test Well: WS06
 Test Date: 25/10/16

AQUIFER DATA

Saturated Thickness: 50. m Anisotropy Ratio (K_z/K_r): 0.1

WELL DATA (WS06)

Initial Displacement: 0.0515 m Static Water Column Height: 0.25 m
 Total Well Penetration Depth: 0.25 m Screen Length: 0.25 m
 Casing Radius: 0.025 m Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice
 $K = 0.05865$ m/day $y_0 = 0.03901$ m