

VARIABLE HEAD PERMEABILITY TEST (STANDPIPE PIEZOMETER) TYPE OF TEST: **FALLING HEAD TEST**

Contract: **Forth Road Crossing** BH No: **CSR003A** Test No: **1**
 Date: **5-Feb-12**

Aquifer Unit: Sandstone		
Datum	0.35	mAGL
Depth of hole	5.85	mbd
Diameter of standpipe (d):	0.05	(m)
Screen Length	2.00	(m)
Diameter of filter (D):	0.1	(mm)
Rest water level	3.75	mbd on: 15-Feb-12

Formula (d) has been used for calculating shape factor. See Figure 6. Though the test section is not of infinite depth, this equation should still predict k to a good degree of accuracy as demonstrated in CIRIA Report 113.

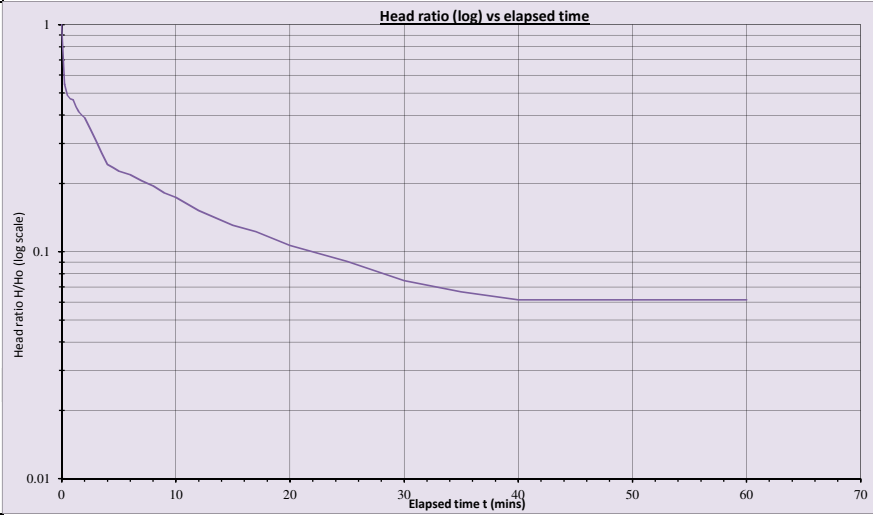
$F = 3.405978435$

$A = 0.001963495 \text{ (m}^2\text{)}$

$t_1 = 3.5$	$H_1 = 1.02$
$t_2 = 12$	$H_2 = 0.57$

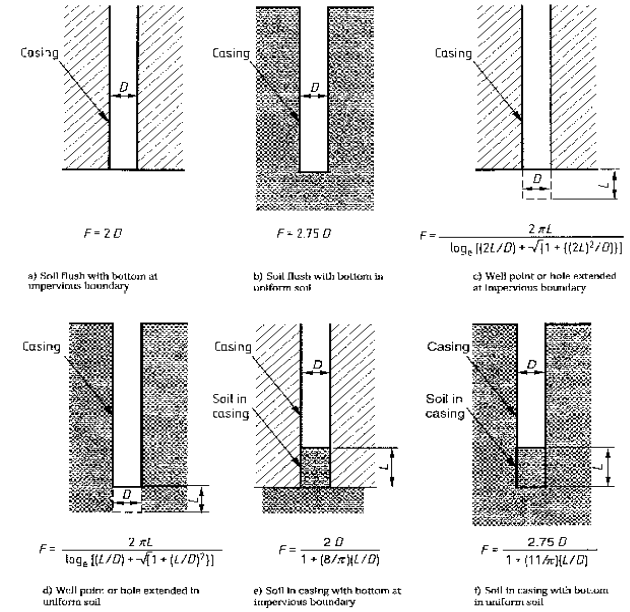
$k = 6.58E-07 \text{ m/sec}$
 $k = 0.0568 \text{ m/day}$

Elapsed Time (mins)	Water Level (m)	Head H (m)	Head ratio H/Ho
0	0.00	3.75	1
0.25	1.70	2.05	0.547
0.5	1.92	1.83	0.488
0.75	1.98	1.77	0.472
1	2.00	1.75	0.467
1.25	2.12	1.63	0.435
1.5	2.20	1.55	0.413
1.75	2.25	1.5	0.400
2	2.29	1.46	0.389
2.5	2.45	1.3	0.347
3	2.59	1.16	0.309
3.5	2.73	1.02	0.272
4	2.84	0.91	0.243
4.5	2.87	0.88	0.235
5	2.90	0.85	0.227
6	2.93	0.82	0.219
7	2.98	0.77	0.205
8	3.02	0.73	0.195
9	3.07	0.68	0.181
10	3.1	0.65	0.173
12	3.18	0.57	0.152
15	3.26	0.49	0.131
17	3.29	0.46	0.123
20	3.35	0.4	0.107
25	3.41	0.34	0.091
30	3.47	0.28	0.075
35	3.5	0.25	0.067
40	3.52	0.23	0.061
45	3.52	0.23	0.061
50	3.52	0.23	0.061
55	3.52	0.23	0.061
60	3.52	0.23	0.061



Check	$t_{37} = 2.2$
$k = 4.367E-06$	m/sec
$k = 0.3773356$	m/day

B55930-1999 Figure 6



NOTE 1 Expressions come from Hvorslev [57].
 NOTE 2 Values are for use primarily in tests carried out through the open ends of boreholes.
 NOTE 3 Case d) may be used for tests carried out using piezometer tips, but more accurate results are obtained by using Figure 7, especially for values of (L/D) > 2.
 NOTE 4 Cases e) and f) assume the permeability of the soil in the casing to be the same as that below it. Where this is not so, see [57].
 NOTE 5 Cases a) and b) tend to measure the mean permeability of the soil; c) and d) the vertical permeability; e) and f) the horizontal permeability. Where the horizontal permeability is much greater than the vertical permeability, all tests tend to measure the former.

VARIABLE HEAD PERMEABILITY TEST (STANDPIPE PIEZOMETER)

TYPE OF TEST: **FALLING HEAD TEST**

Contract: Forth Road Crossing BH No: CSRO03B Test No: 1
 Date: 5-Feb-12
 Aquifer Unit: Sandstone

Datum	0.34	mAGL
Depth of hole	6.34	mbd
Diameter of standpipe (d):	0.05	(m)
Screen Length	4.00	(m)
Diameter of filter (D):	0.1	(mm)
Rest water level	1.35	mbd on: 5-Feb-12

Formula (d) has been used for calculating shape factor. See Figure 6. Though the test section is not of infinite depth, this equation should still predict k to a good degree of accuracy as demonstrated in CIRIA Report 113.

F = 5.735210533

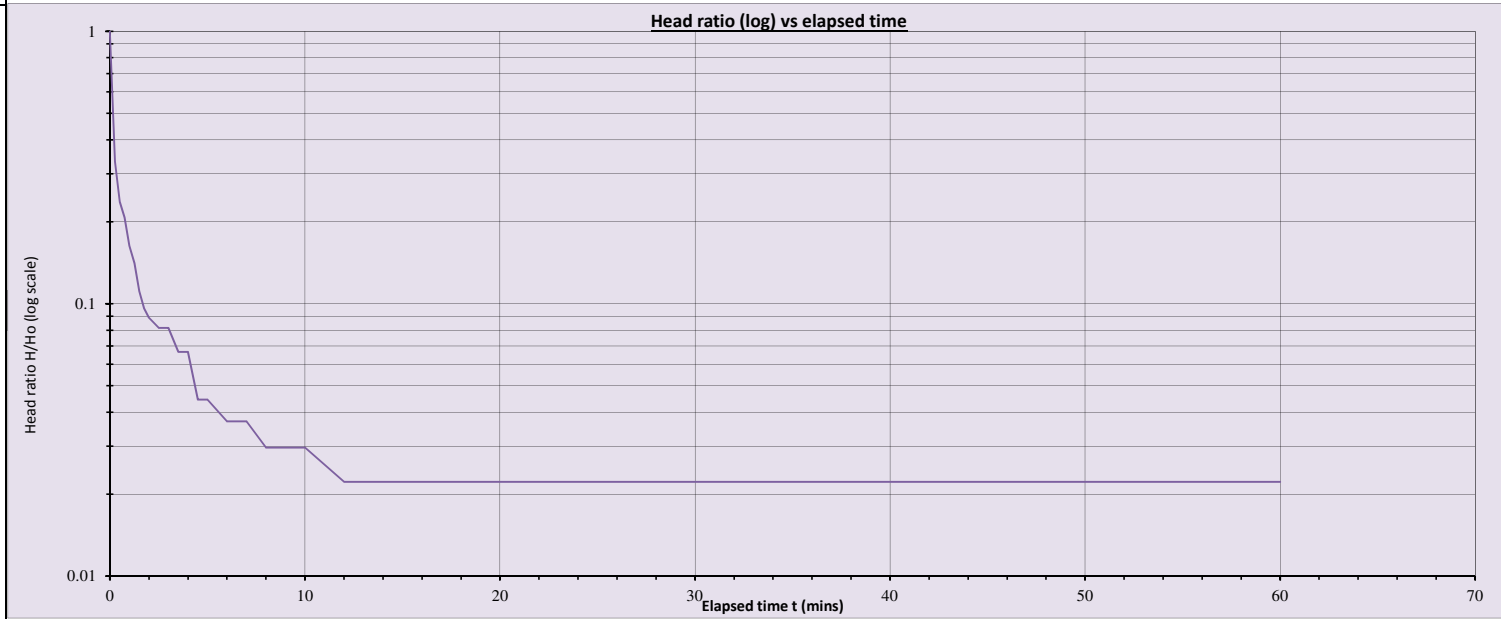
A = 0.001963495 (m²)

t ₁ =	0.5	H _{1e} =	0.32
t ₂ =	1.25	H _{2e} =	0.19

k = 3.97E-06 m/sec
k = 0.3427 m/day

Check	t37 =	0.25
k =	2.28E-05	m/sec
k =	1.9719823	m/day

Elapsed Time (mins)	Water Level (m)	Head (m)	Head ratio H/Ho
0	0.00	1.35	1
0.25	0.90	0.45	0.333
0.5	1.03	0.32	0.237
0.75	1.07	0.28	0.207
1	1.13	0.22	0.163
1.25	1.16	0.19	0.141
1.5	1.20	0.15	0.111
1.75	1.22	0.13	0.096
2	1.23	0.12	0.089
2.5	1.24	0.11	0.081
3	1.24	0.11	0.081
3.5	1.26	0.09	0.067
4	1.26	0.09	0.067
4.5	1.29	0.06	0.044
5	1.29	0.06	0.044
6	1.30	0.05	0.037
7	1.30	0.05	0.037
8	1.31	0.04	0.030
9	1.31	0.04	0.030
10	1.31	0.04	0.030
12	1.32	0.03	0.022
15	1.32	0.03	0.022
17	1.32	0.03	0.022
20	1.32	0.03	0.022
25	1.32	0.03	0.022
30	1.32	0.03	0.022
35	1.32	0.03	0.022
40	1.32	0.03	0.022
45	1.32	0.03	0.022
50	1.32	0.03	0.022
55	1.32	0.03	0.022
60	1.32	0.03	0.022



VARIABLE HEAD PERMEABILITY TEST (STANDPIPE PIEZOMETER)

TYPE OF TEST: **FALLING HEAD TEST**

Contract: Forth Road Crossing BH No: CSR004A Test No: 1
 Date: 5-Feb-12
 Aquifer Unit: Sand/sandstone (with interbedded mudstone)

Datum	0.25	mAGL
Depth of hole	10.25	mbd
Diameter of standpipe (d):	0.05	(m)
Screen Length	5.00	(m)
Diameter of filter (D):	0.1	(mm)
Rest water level	2.5	mbd on: 5-Feb-12

Formula (d) has been used for calculating shape factor. See Figure 6. Though the test section is not of infinite depth, this equation should still predict k to a good degree of accuracy as demonstrated in CIRIA Report 113.

F = 6.821733659

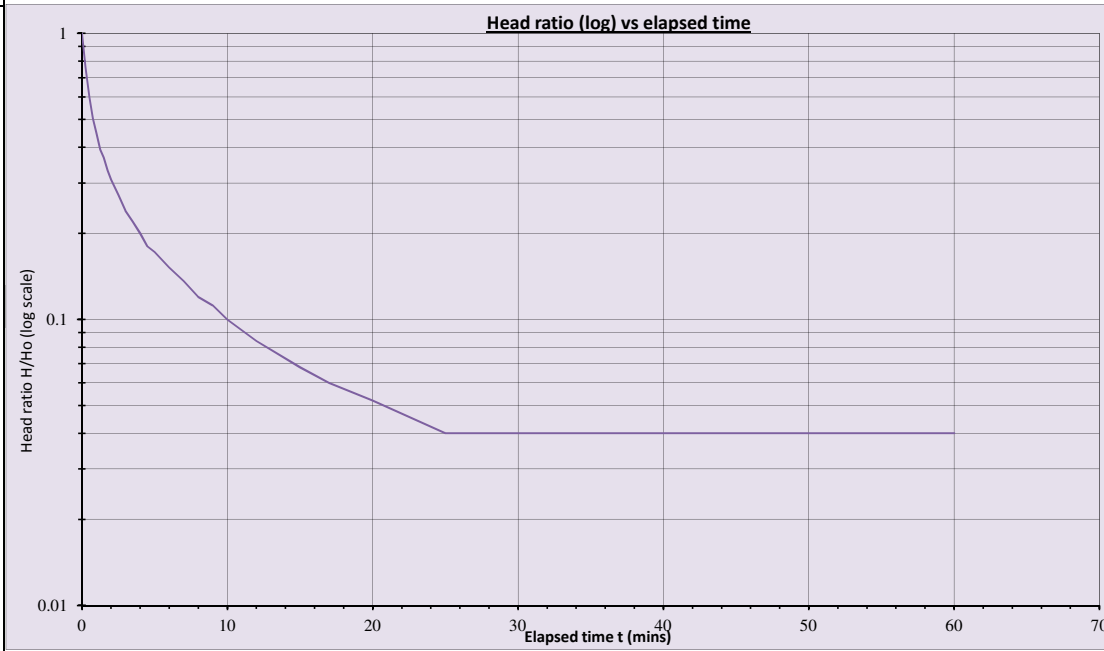
A = 0.001963495 (m²)

t₁ = 0.25 H₁ = 1.9
 t₂ = 4 H₂ = 0.5

k = 1.71E-06 m/sec
k = 0.1476 m/day

Check	t37 =	1.8
k =	2.67E-06	m/sec
k =	0.2302635	m/day

Elapsed Time (mins)	Water Level (m)	Head H (m)	Head ratio H/Ho
0	0.00	2.5	1
0.25	0.60	1.9	0.760
0.5	1.00	1.5	0.600
0.75	1.24	1.26	0.504
1	1.38	1.12	0.448
1.25	1.52	0.98	0.392
1.5	1.58	0.92	0.368
1.75	1.67	0.83	0.332
2	1.73	0.77	0.308
2.5	1.82	0.68	0.272
3	1.90	0.6	0.240
3.5	1.95	0.55	0.220
4	2.00	0.5	0.200
4.5	2.05	0.45	0.180
5	2.07	0.43	0.172
6	2.12	0.38	0.152
7	2.16	0.34	0.136
8	2.20	0.3	0.120
9	2.22	0.28	0.112
10	2.25	0.25	0.100
12	2.29	0.21	0.084
15	2.33	0.17	0.068
17	2.35	0.15	0.060
20	2.37	0.13	0.052
25	2.40	0.1	0.040
30	2.40	0.1	0.040
35	2.40	0.1	0.040
40	2.40	0.1	0.040
45	2.40	0.1	0.040
50	2.40	0.1	0.040
55	2.40	0.1	0.040
60	2.40	0.1	0.040



VARIABLE HEAD PERMEABILITY TEST (STANDPIPE PIEZOMETER)

TYPE OF TEST: **FALLING HEAD TEST**

Contract: Forth Road Crossing BH No: CSR005A Test No: 1
 Date: 5-Feb-12
 Aquifer Unit: Sandstone

Datum	0.25	mAGL
Depth of hole	13.55	mbd
Diameter of standpipe (d):	0.05	(m)
Screen Length	10.80	(m)
Diameter of filter (D):	0.1	(mm)
Rest water level	2	mbd on: 5-Feb-12

Formula (d) has been used for calculating shape factor. See Figure 6. Though the test section is not of infinite depth, this equation should still predict k to a good degree of accuracy as demonstrated in CIRIA Report 113.

F = 12.62411462

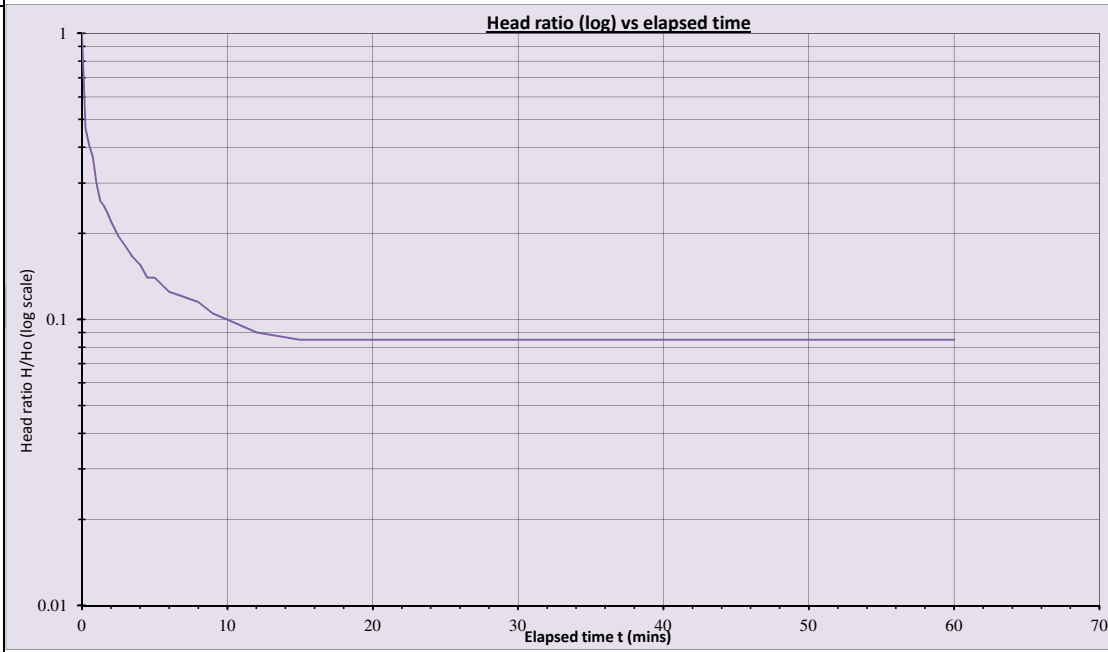
A = 0.001963495 (m²)

t₁ = 1.5 H₁ = 0.5
 t₂ = 4 H₂ = 0.31

k = 4.96E-07 m/sec
k = 0.0428 m/day

Check	t37 =	2
k =	1.30E-06	m/sec
k =	0.1119854	m/day

Elapsed Time (mins)	Water Level (m)	Head H (m)	Head ratio H/Ho
0	0.00	2	1
0.25	1.07	0.93	0.465
0.5	1.19	0.81	0.405
0.75	1.26	0.74	0.370
1	1.40	0.6	0.300
1.25	1.48	0.52	0.260
1.5	1.50	0.5	0.250
1.75	1.53	0.47	0.235
2	1.56	0.44	0.220
2.5	1.61	0.39	0.195
3	1.64	0.36	0.180
3.5	1.67	0.33	0.165
4	1.69	0.31	0.155
4.5	1.72	0.28	0.140
5	1.72	0.28	0.140
6	1.75	0.25	0.125
7	1.76	0.24	0.120
8	1.77	0.23	0.115
9	1.79	0.21	0.105
10	1.8	0.2	0.100
12	1.82	0.18	0.090
15	1.83	0.17	0.085
17	1.83	0.17	0.085
20	1.83	0.17	0.085
25	1.83	0.17	0.085
30	1.83	0.17	0.085
35	1.83	0.17	0.085
40	1.83	0.17	0.085
45	1.83	0.17	0.085
50	1.83	0.17	0.085
55	1.83	0.17	0.085
60	1.83	0.17	0.085



VARIABLE HEAD PERMEABILITY TEST (STANDPIPE PIEZOMETER)

TYPE OF TEST: **FALLING HEAD TEST**

Contract: Forth Road Crossing BH No: CSR006B Test No: 1
 Date: 7-Feb-12
 Aquifer Unit: Sandstone

Datum	0.32	mAGL
Depth of hole	4.32	mbd
Diameter of standpipe (d):	0.05	(m)
Screen Length	1.00	(m)
Diameter of filter (D):	0.1	(mm)
Rest water level	1.52	mbd on: 5-Feb-12

Formula (d) has been used for calculating shape factor. See Figure 6. Though the test section is not of infinite depth, this equation should still predict k to a good degree of accuracy as demonstrated in CIRIA Report 113.

F = 2.095636452

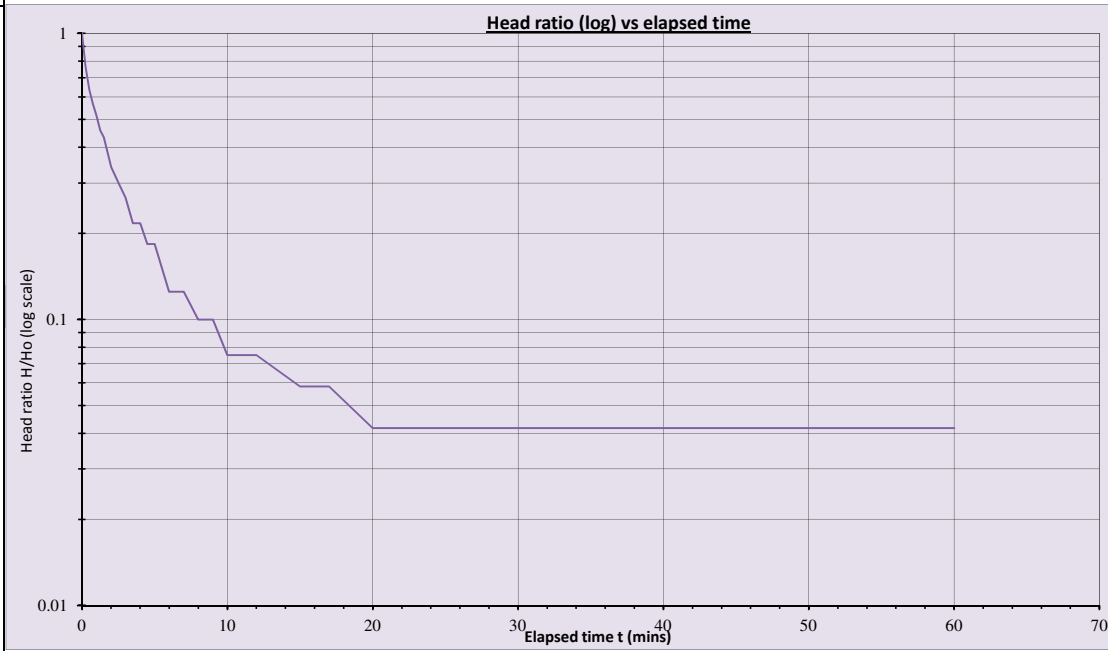
A = 0.001963495 (m²)

t₁ = 0.25 H₁ = 0.92
 t₂ = 3 H₂ = 0.32

k = 6.00E-06 m/sec
k = 0.5181 m/day

Check	t37 =	2
k =	7.81E-06	m/sec
k =	0.6746002	m/day

Elapsed Time (mins)	Water Level (m)	Head H (m)	Head ratio H/Ho
0	0.32	1.2	1
0.25	0.60	0.92	0.767
0.5	0.76	0.76	0.633
0.75	0.84	0.68	0.567
1	0.90	0.62	0.517
1.25	0.97	0.55	0.458
1.5	1.00	0.52	0.433
1.75	1.06	0.46	0.383
2	1.11	0.41	0.342
2.5	1.16	0.36	0.300
3	1.20	0.32	0.267
3.5	1.26	0.26	0.217
4	1.26	0.26	0.217
4.5	1.30	0.22	0.183
5	1.30	0.22	0.183
6	1.37	0.15	0.125
7	1.37	0.15	0.125
8	1.40	0.12	0.100
9	1.40	0.12	0.100
10	1.43	0.09	0.075
12	1.43	0.09	0.075
15	1.45	0.07	0.058
17	1.45	0.07	0.058
20	1.47	0.05	0.042
25	1.47	0.05	0.042
30	1.47	0.05	0.042
35	1.47	0.05	0.042
40	1.47	0.05	0.042
45	1.47	0.05	0.042
50	1.47	0.05	0.042
55	1.47	0.05	0.042
60	1.47	0.05	0.042



VARIABLE HEAD PERMEABILITY TEST (STANDPIPE PIEZOMETER)

TYPE OF TEST: **FALLING HEAD TEST**

Contract: Forth Road Crossing BH No: CSR007A Test No: 1
 Date: 7-Feb-12
 Aquifer Unit: Sandstone and interbedded mudstone

Datum	0.10	mAGL
Depth of hole	8.1	mbd
Diameter of standpipe (d):	0.05	(m)
Screen Length	1.50	(m)
Diameter of filter (D):	0.1	(mm)
Rest water level	0.9	mbd on: 7-Feb-12

Formula (d) has been used for calculating shape factor. See Figure 6. Though the test section is not of infinite depth, this equation should still predict k to a good degree of accuracy as demonstrated in CIRIA Report 113.

F = 2.770114203

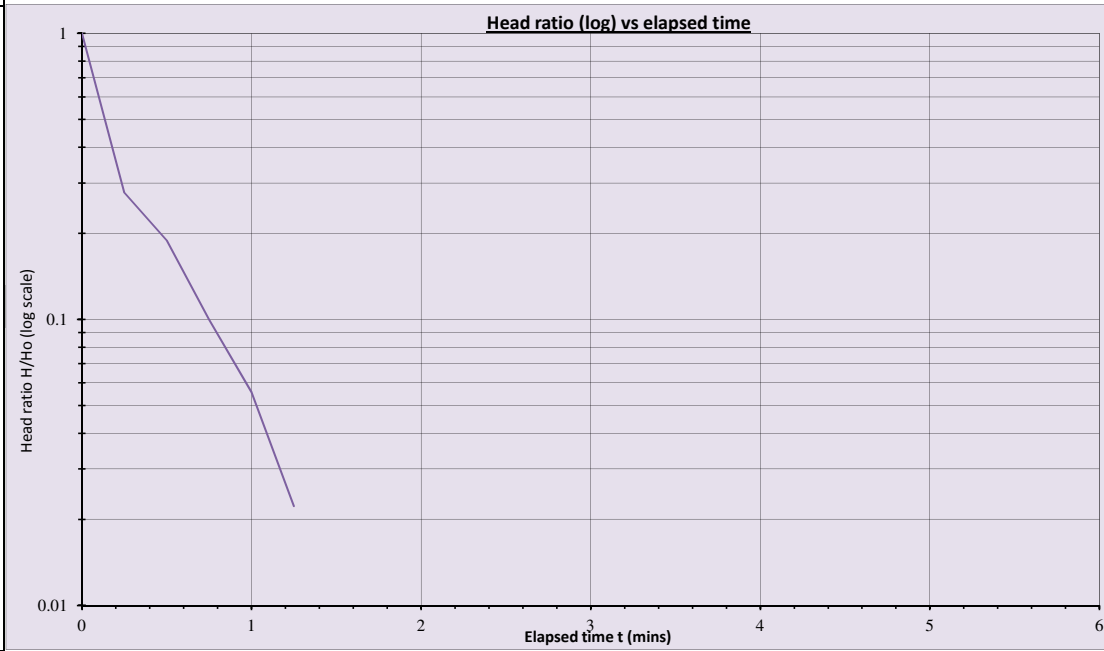
A = 0.001963495 (m²)

t₁ = 0.25 H₁ = 0.25
 t₂ = 0.75 H₂ = 0.09

k = 2.41E-05 m/sec
k = 2.0856 m/day

Check	t37 =	1
k =	1.18E-05	m/sec
k =	1.020692	m/day

Elapsed Time (mins)	Water Level (m)	Head H (m)	Head ratio H/Ho
0	0.00	0.9	1
0.25	0.65	0.25	0.278
0.5	0.73	0.17	0.189
0.75	0.81	0.09	0.100
1	0.85	0.05	0.056
1.25	0.88	0.02	0.022
1.5	0.90	0	0.000
1.75	0.90	0	0.000
2	0.90	0	0.000
2.5	0.90	0	0.000
3	0.90	0	0.000
3.5	0.90	0	0.000
4	0.90	0	0.000
4.5	0.90	0	0.000
5	0.90	0	0.000



VARIABLE HEAD PERMEABILITY TEST (STANDPIPE PIEZOMETER)

TYPE OF TEST: **FALLING HEAD TEST**

Contract: Forth Road Crossing BH No: CSRO07A Test No: 2
 Date: 7-Feb-12
 Aquifer Unit: Sandstone and interbedded mudstone

Datum	0.10	mAGL
Depth of hole	8.1	mbd
Diameter of standpipe (d):	0.05	(m)
Screen Length	1.50	(m)
Diameter of filter (D):	0.1	(mm)
Rest water level	0.9	mbd on: 7-Feb-12

Formula (d) has been used for calculating shape factor. See Figure 6. Though the test section is not of infinite depth, this equation should still predict k to a good degree of accuracy as demonstrated in CIRIA Report 113.

F = 2.770114203

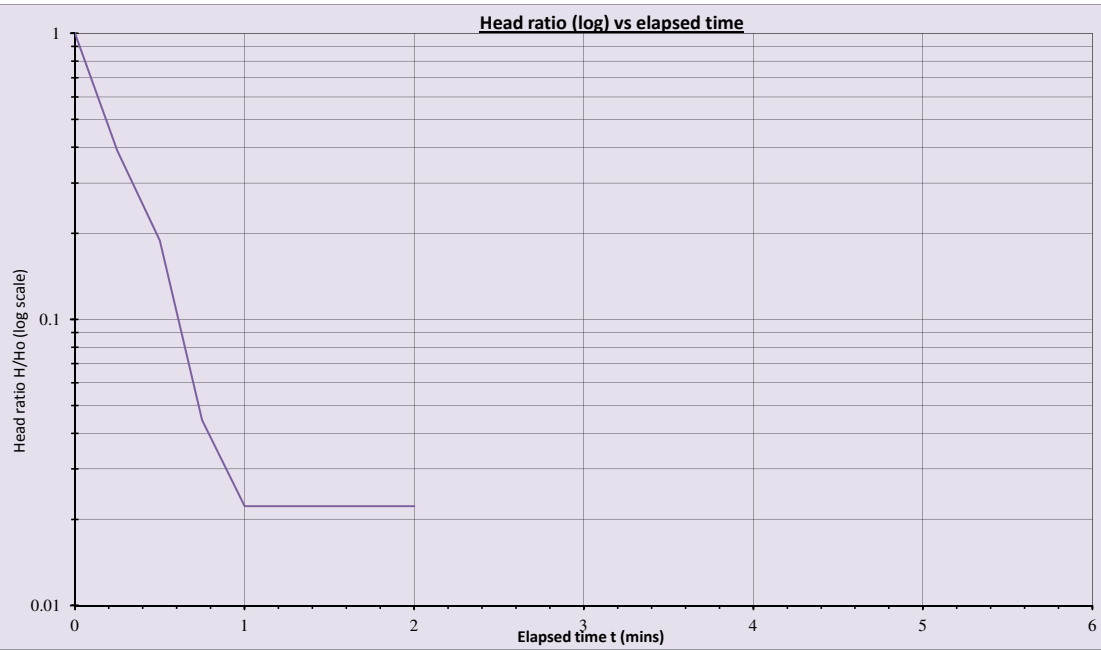
A = 0.001963495 (m²)

t₁ = 0.25 H₁ = 0.35
 t₂ = 1 H₂ = 0.02

k = 4.51E-05 m/sec
k = 3.8952 m/day

Check	t37 =	2.2
k =	5.37E-06	m/sec
k =	0.4639509	m/day

Elapsed Time (mins)	Water Level (m)	Head H (m)	Head ratio H/Ho
0	0.00	0.9	1
0.25	0.55	0.35	0.389
0.5	0.73	0.17	0.189
0.75	0.86	0.04	0.044
1	0.88	0.02	0.022
1.25	0.88	0.02	0.022
1.5	0.88	0.02	0.022
1.75	0.88	0.02	0.022
2	0.88	0.02	0.022
2.5	0.90	0	0.000
3	0.90	0	0.000
3.5	0.90	0	0.000
4	0.90	0	0.000
4.5	0.90	0	0.000
5	0.90	0	0.000



VARIABLE HEAD PERMEABILITY TEST (STANDPIPE PIEZOMETER)

TYPE OF TEST: **FALLING HEAD TEST**

Contract:	Forth Road Crossing	BH No:	CSRO09	Test No:	1
Date:	5-Feb-12				
Aquifer Unit:	Dark blue grey Mudstone				
Datum	0.30	mAGL			
Depth of hole	11.3	mbd			
Diameter of standpipe (d):	0.05	(m)			
Screen Length	3.00	(m)			
Diameter of filter (D):	0.1	(mm)			
Rest water level	1.8	mbd	on:	15-Feb-12	

Formula (d) has been used for calculating shape factor. See Figure 6. Though the test section is not of infinite depth, this equation should still predict k to a good degree of accuracy as demonstrated in CIRIA Report 113.

F = 4.603490845

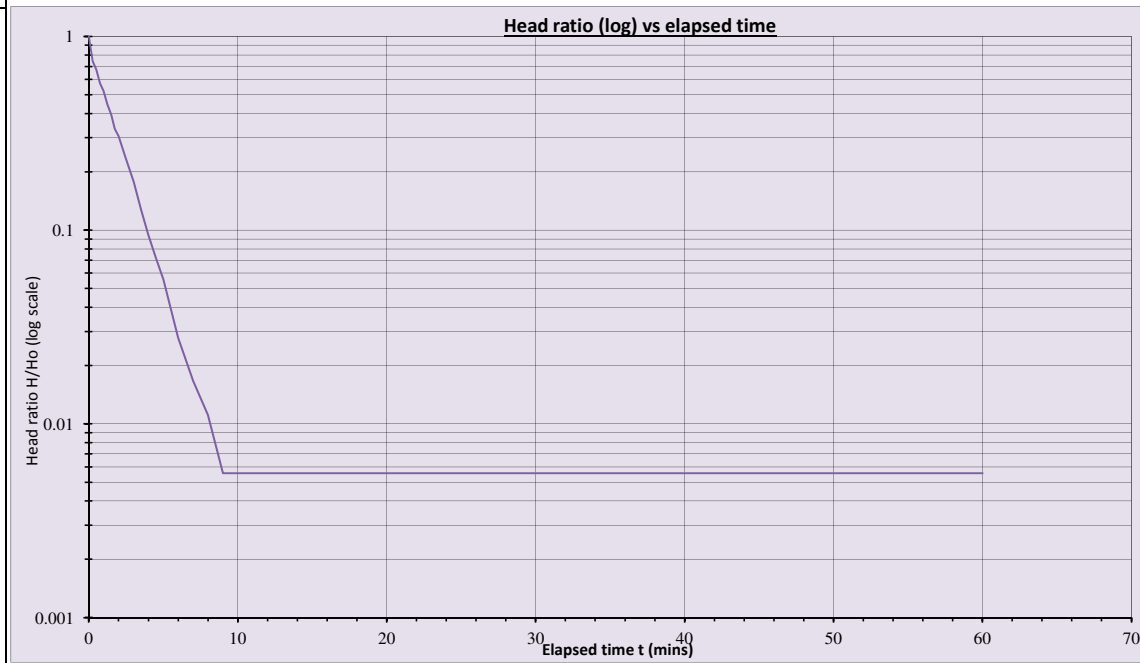
A = 0.001963495 (m²)

t ₁ =	2	H ₁ =	0.55
t ₂ =	3.5	H ₂ =	0.23

k=	4.13E-06 m/sec
k=	0.357 m/day

Check	t37=	1.8
k=	3.95E-06	m/sec
k=	0.3412185	m/day

Elapsed Time (mins)	Water Level (m)	Head H (m)	Head ratio H/Ho
0	0.00	1.8	1
0.25	0.46	1.34	0.744
0.5	0.58	1.22	0.678
0.75	0.77	1.03	0.572
1	0.86	0.94	0.522
1.25	1.00	0.8	0.444
1.5	1.09	0.71	0.394
1.75	1.20	0.6	0.333
2	1.25	0.55	0.306
2.5	1.38	0.42	0.233
3	1.48	0.32	0.178
3.5	1.57	0.23	0.128
4	1.63	0.17	0.094
4.5	1.67	0.13	0.072
5	1.70	0.1	0.056
6	1.75	0.05	0.028
7	1.77	0.03	0.017
8	1.78	0.02	0.011
9	1.79	0.01	0.006
10	1.79	0.01	0.006
12	1.79	0.01	0.006
15	1.79	0.01	0.006
17	1.79	0.01	0.006
20	1.79	0.01	0.006
25	1.79	0.01	0.006
30	1.79	0.01	0.006
35	1.79	0.01	0.006
40	1.79	0.01	0.006
45	1.79	0.01	0.006
50	1.79	0.01	0.006
55	1.79	0.01	0.006
60	1.79	0.01	0.006



VARIABLE HEAD PERMEABILITY TEST (STANDPIPE PIEZOMETER)

TYPE OF TEST: **FALLING HEAD TEST**

Contract: Forth Road Crossing BH No: CSRO09A Test No: 1
 Date: 6-Feb-12
 Aquifer Unit: Dolerite

Datum	0.20	mAGL
Depth of hole	4.7	mbd
Diameter of standpipe (d):	0.05	(m)
Screen Length	2.10	(m)
Diameter of filter (D):	0.1	(mm)
Rest water level	1.17	mbd on: 6-Feb-12

Formula (d) has been used for calculating shape factor. See Figure 6. Though the test section is not of infinite depth, this equation should still predict k to a good degree of accuracy as demonstrated in CIRIA Report 113.

F = 3.529656511

A = 0.001963495 (m²)

t ₁ =	0.25	H ₁ =	0.3
t ₂ =	1.25	H ₂ =	0.02

k = 2.51E-05 m/sec
k = 2.1693 m/day

Check	t37=	0.2
k=	4.64E-05	m/sec
k=	4.0052529	m/day

Elapsed Time (mins)	Water Level (m)	Head H (m)	Head ratio H/Ho
0	0.00	1.17	1
0.25	0.87	0.3	0.256
0.5	1.06	0.11	0.094
0.75	1.11	0.06	0.051
1	1.13	0.04	0.034
1.25	1.15	0.02	0.017
1.5	1.16	0.01	0.009
1.75	1.16	0.01	0.009
2	1.16	0.01	0.009
2.5	1.16	0.01	0.009
3	1.16	0.01	0.009
3.5	1.16	0.01	0.009
4	1.16	0.01	0.009
4.5	1.16	0.01	0.009
5	1.16	0.01	0.009
6	1.16	0.01	0.009
7	1.16	0.01	0.009
8	1.16	0.01	0.009
9	1.16	0.01	0.009
10	1.16	0.01	0.009
12	1.16	0.01	0.009
15	1.16	0.01	0.009
17	1.16	0.01	0.009
20	1.16	0.01	0.009
25	1.16	0.01	0.009
30	1.16	0.01	0.009
35	1.16	0.01	0.009
40	1.16	0.01	0.009
45	1.16	0.01	0.009
50	1.16	0.01	0.009
55	1.16	0.01	0.009
60	1.16	0.01	0.009

