

Superficial Deposits



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GeoIndex Onshore Data Sources: NERC, Natural England, English Heritage and Ordnance Survey

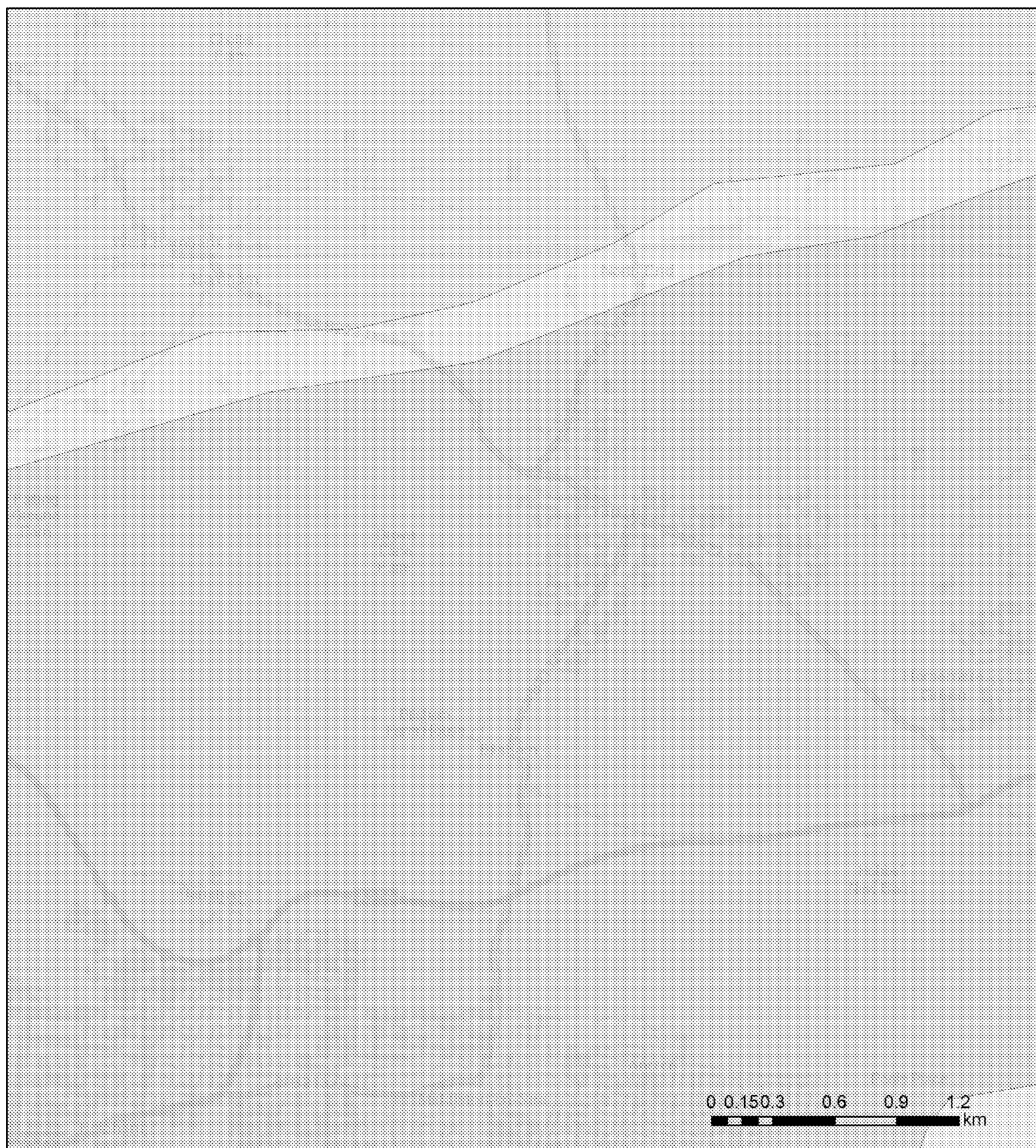
Map Key

Superficial deposits 1:50,000 scale

	<u>ALLUVIUM - CLAY, SILT, SAND AND GRAVEL</u>
	<u>RAISED MARINE DEPOSITS - CLAY, SILT, SAND AND GRAVEL</u>
	<u>HEAD - CLAY, SILT, SAND AND GRAVEL</u>
	<u>RIVER TERRACE DEPOSITS (UNDIFFERENTIATED) - SAND, SILT AND CLAY</u>
	<u>RAISED BEACH DEPOSITS, 1 - SAND AND GRAVEL</u>
	<u>BEACH AND TIDAL FLAT DEPOSITS (UNDIFFERENTIATED) - CLAY, SILT, SAND AND GRAVEL</u>
	<u>BLOWN SAND - SAND</u>

Hydrogeology

GEOINDEX
ONSHORE



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GeoIndex Onshore Data Sources: NERC, Natural England, English Heritage and Ordnance Survey

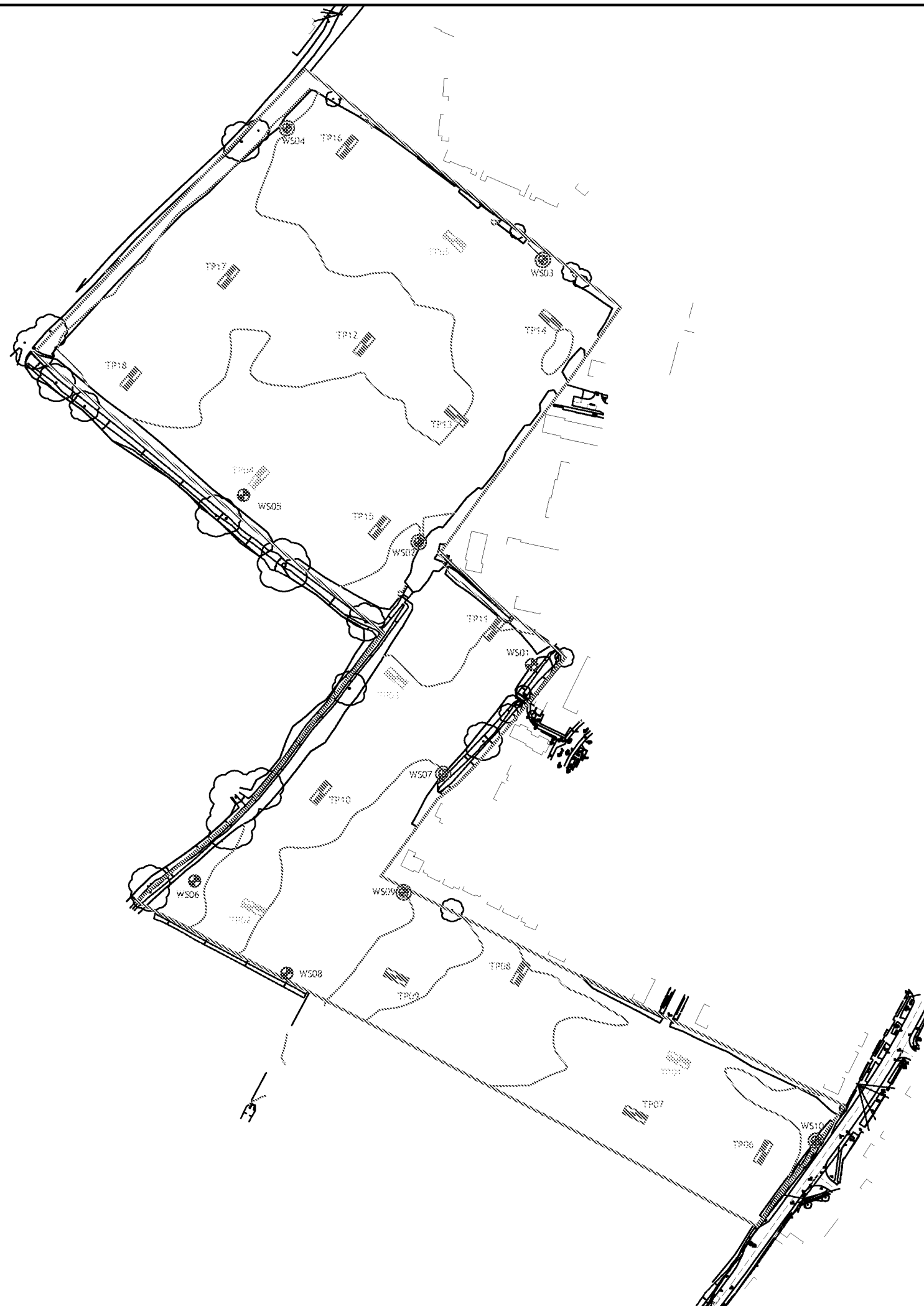
Map Key

Hydrogeology 1:625,000 scale

- Aquifers with significant intergranular flow
-  Highly productive aquifer
 -  Moderately productive aquifer
 -  Low productivity aquifer
- Aquifers in which flow is virtually all through fractures and other discontinuities
-  Highly productive aquifer
 -  Moderately productive aquifer
 -  Low productivity aquifer
 -  Rocks with essentially no groundwater

APPENDIX E

Groundwater Monitoring and Soakage Testing Results



KEY:

- BRD Windowless Sample Borehole (GPS Position)
- BRD Windowless Sample Borehole with Install (GPS Position)
- BRD Trial Pit (GPS Position)
- BRD Soakage Test Pit (GPS Position)
- Site Boundary (Approximate Position)

Drawing reproduced from Digital Terrain Surveys LLP 'Site Survey', Drawing ref. DTS170415-7Q0, Dated. April 2014.

Revision	Date	Description	Drawn	Approved
Drawing title				
EXPLORATORY POINT PLAN				
Project title				
LAND AT BILSHAM ROAD, YAPTON				
Client				
GLEESON DEVELOPMENTS				
Scale	Original drg. size/colour		Date	
1:2500	A3 / C		03/11/2017	
Drawn	Checked		Approved	
HKA	AP		BD	
Drawing Number				Rev
BRD2693-OD1				A
 BRD Environmental Ltd 01295 272244 info@brduk.com www.brduk.com				

TRIAL PIT RECORD

Client: Gleeson Developments Project Title: Land at Bilsham Road, Yapton Project No: BRD2693 Logged By: A Plant Date Completed: 17/10/2017 Method Used: 180° Backhoe excavator (JCB 3CX type)				Trial Pit No. TP02		
				Sheet 1 of 1		
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend
Depth	Type & No	Value				
0.10	J1		TOPSOIL: Friable, brown, light brown, slightly humic, sandy, silty topsoil. Sand is fine-sized.	0.30 (4.70)	TS	
0.50	SV	70 kPa	Firm, stiff, brown, light brown, slightly gravelly, slightly sandy, silty CLAY. Gravel is subrounded, fine-sized flint.			
0.80	SV D1	>140 kPa				
1.90	D2		1.50 m: Cobble of flint (90mm x 120mm x 180mm). 1.60 m: Increasing gravel and sand fractions to slightly sandy, slightly gravelly, silty CLAY. 1.70 m: Firm.	2 2.00 (3.00)	RIVER TERRACE DEPOSITS	
				3		
				4		
Pit Stability: Generally stable throughout Groundwater: Not encountered				Surface Elevation Level: 5.00 mAOD		
Plan of Trial Pit: 			General Remarks: Terminated at 2.00m bgl for soakage testing.			
			All dimensions in metres Log Scale 1:25 			
			Telephone: 01295 272244 Email: info@brduk.com			

TRIAL PIT RECORD

Client: Gleeson Developments Project Title: Land at Bilsham Road, Yapton Project No: BRD2693 Logged By: A Plant Date Completed: 17/10/2017 Method Used: 180° Backhoe excavator (JCB 3CX type)				Trial Pit No. TP04		
				Sheet 1 of 1		
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend
Depth	Type & No	Value				
0.10	J1		TOPSOIL: Friable, brown, slightly humic, sandy, silty topsoil.	0.25 (6.11)	TS	
1.00	SV	90 kPa	Firm, stiff, brown, orange brown, slightly sandy, silty CLAY. Sand is fine-sized.		RIVER TERRACE DEPOSITS	
1.90	D1		1.20 m: Becoming slightly gravelly, slightly sandy CLAY. Gravel fraction is fine, subangular flint and chalk.	2		2.00 (4.36)
				3		
				4		
Pit Stability: Generally stable throughout Groundwater: Not encountered					Surface Elevation Level: 6.36 mAOD	
Plan of Trial Pit: 			General Remarks: Terminated at 2.00m bgl for soakage testing.			
					All dimensions in metres Log Scale 1:25 Telephone: 01295 272244 Email: info@brduk.com	

TRIAL PIT RECORD

Client: Gleeson Developments Project Title: Land at Bilsham Road, Yapton Project No: BRD2693 Logged By: A Plant Date Completed: 17/10/2017 Method Used: 180° Backhoe excavator (JCB 3CX type)				Trial Pit No. TP09		
Sheet 1 of 1						
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend
Depth	Type & No	Value				
0.20	J1		TOPSOIL: Friable, brown, slightly humic, silty topsoil.	0.25 (5.03)	TS	
1.00	D1		Firm, stiff, brown, orange brown, silty CLAY.	1	RIVER TERRACE DEPOSITS	
			2.40 - 3.00 m: SAND AND GRAVEL pockets.	2		
				3 3.00 (2.28)		
				4		
Pit Stability: Generally stable throughout Groundwater: Not encountered					Surface Elevation Level: 5.28 mAOD	
Plan of Trial Pit: 			General Remarks: Terminated at 3.00m bgl.			All dimensions in metres Log Scale 1:25
			Telephone: 01295 272244 Email: info@brduk.com			

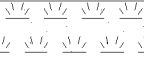
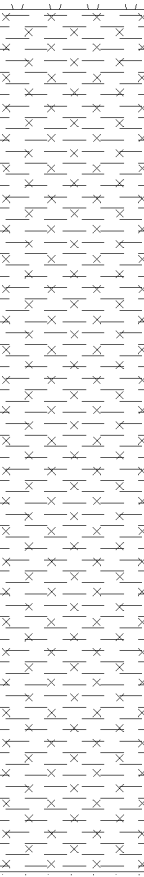
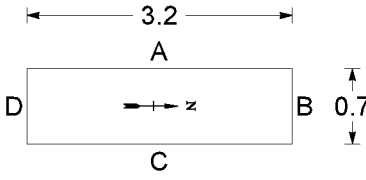
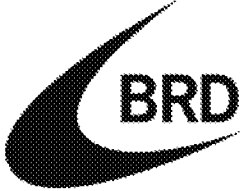
TRIAL PIT RECORD

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TRIAL PIT RECORD

Client: Gleeson Developments Project Title: Land at Bilsham Road, Yapton Project No: BRD2693 Logged By: A Plant Date Completed: 18/10/2017 Method Used: 180° Backhoe excavator (JCB 3CX type)				Trial Pit No. TP14		
Sheet 1 of 1						
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend
Depth	Type & No	Value				
0.20	J1	1.7	TOPSOIL: Friable, brown, slightly humic, sandy, silty topsoil. Sand is fine-sized. Firm, stiff, orange brown mottled brown, silty CLAY.	0.25 (5.75)	TS	
1.00	SV	120 kPa		1		
1.70	SV D1	65/60/50 kPa	Firm, stiff, light brown and light grey mottled orange brown, slightly sandy, slightly gravelly, silty CLAY. Gravel fraction is fine and medium-sized, subrounded flint. Local pockets of clayey SILT, possibly soft / loose sandy SILT.	1.70 (4.30)		
2.60	B1		Medium dense, light grey and light brown, off-white, chalky (silty), fine to coarse-sized SAND AND fine to coarse-sized, subangular to subrounded GRAVEL of flint and chalk.	2.50 (3.50)		
				3	3.00 (3.00)	
				4		
Pit Stability: Generally stable throughout Groundwater: Not encountered					Surface Elevation Level: 6.00 mAOD	
Plan of Trial Pit: 			General Remarks: Terminated at 3.00m bgl.			
All dimensions in metres Log Scale 1:25					Telephone: 01295 272244 Email: info@brduk.com	

TRIAL PIT RECORD

Client: Gleeson Developments Project Title: Land at Bilsham Road, Yapton Project No: BRD2693 Logged By: A Plant Date Completed: 18/10/2017 Method Used: 180° Backhoe excavator (JCB 3CX type)				Trial Pit No. TP15		
				Sheet 1 of 1		
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend
Depth	Type & No	Value				
0.10	J1		TOPSOIL: Friable, brown, slightly humic, silty topsoil.	0.25 (5.92)	TS	
			Firm, stiff, orange brown mottled brown, silty CLAY.			
0.90 1.00	SV J2 D1	100 kPa		1	RIVER TERRACE DEPOSITS	
				2		
			2.50 m: Becoming slightly gravelly, silty CLAY. Gravel is fine-sized, subrounded flint and chalk.	3		
			Medium dense, off-white, chalky (silt) SAND AND fine to coarse-sized, subrounded GRAVEL of flint and chalk.	3.10 (3.07) 3.20 (2.97)		
				4		
Pit Stability: Generally stable throughout Groundwater: Not encountered				Surface Elevation Level: 6.17 mAOD		
Plan of Trial Pit: 			General Remarks: Terminated at 3.20m bgl.			All dimensions in metres Log Scale 1:25
			 Telephone: 01295 272244 Email: info@brduk.com			

TRIAL PIT RECORD

Client: Gleeson Developments Project Title: Land at Bilsham Road, Yapton Project No: BRD2693 Logged By: A Plant Date Completed: 18/10/2017 Method Used: 180° Backhoe excavator (JCB 3CX type)				Trial Pit No. TP18			
Sheet 1 of 1							
Samples & Tests			Description of Strata	Depth / (Level)	Geology	Legend	
Depth	Type & No	Value					
0.20	J1		TOPSOIL: Friable, brown, slightly humic, silty topsoil. Firm, stiff, orange brown, slightly sandy, silty CLAY. Sand is fine.	0.25 (6.34)	TS		
1.00	SV D1	110 kPa		1	RIVER TERRACE DEPOSITS		
1.50	SV	90 kPa					
1.70	SV	60 kPa					
2.00	SV D2	30 kPa	Firm, light brown, silty CLAY / locally soft clayey SILT.	2			
				3	3.00 (3.59)		
				4			
Pit Stability: Generally stable throughout Groundwater: Not encountered					Surface Elevation Level: 6.59 mAOD		
Plan of Trial Pit: 			General Remarks: Terminated at 3.00m bgl.				
All dimensions in metres Log Scale 1:25					 Telephone: 01295 272244 Email: info@brduk.com		



Groundwater Monitoring Record

Project: Land at Bilsham Road, Yapton
 Client: Gleeson Developments
 Project No: BRD2693

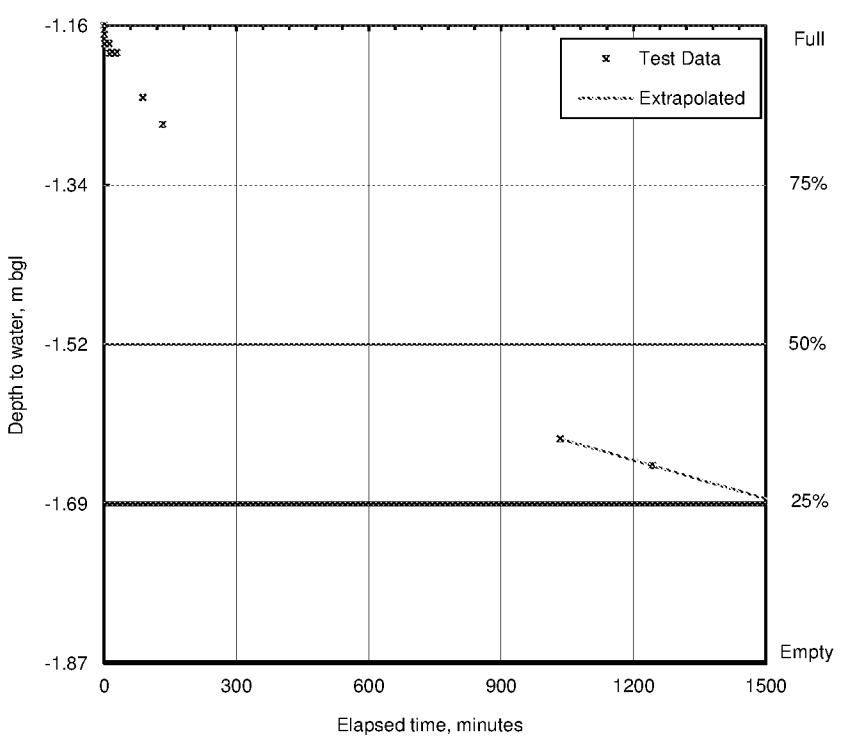
Borehole name	Date	Monitored by (initials)	Borehole depth (m)	Qty free product detected (mm)	Groundwater level below ground surface (m)	Groundwater level below top of standpipe (m)	Amount purged (l)	Post purge groundwater level below top of standpipe (m)	Comments
WS04	25/10/2017	AN	3.98	0.00	3.58	3.44	n/a	n/a	No odour noted on retrieval of interface meter.
WS03	25/10/2017	AN	4.01	0.00	2.94	2.79	n/a	n/a	No odour noted on retrieval of interface meter.
WS02	25/10/2017	AN	3.96	0.00	2.42	2.30	n/a	n/a	No odour noted on retrieval of interface meter.
WS07	25/10/2017	AN	3.89	0.00	1.69	1.54	n/a	n/a	No odour noted on retrieval of interface meter.
WS08	25/10/2017	AN	3.89	0.00	1.83	1.71	n/a	n/a	No odour noted on retrieval of interface meter. Borehole located immediately next to a dry ditch.
WS09	25/10/2017	AN	3.99	0.00	1.80	1.66	n/a	n/a	No odour noted on retrieval of interface meter.
WS10	25/10/2017	AN	3.00	0.00	2.03	1.88	n/a	n/a	No odour noted on retrieval of interface meter.



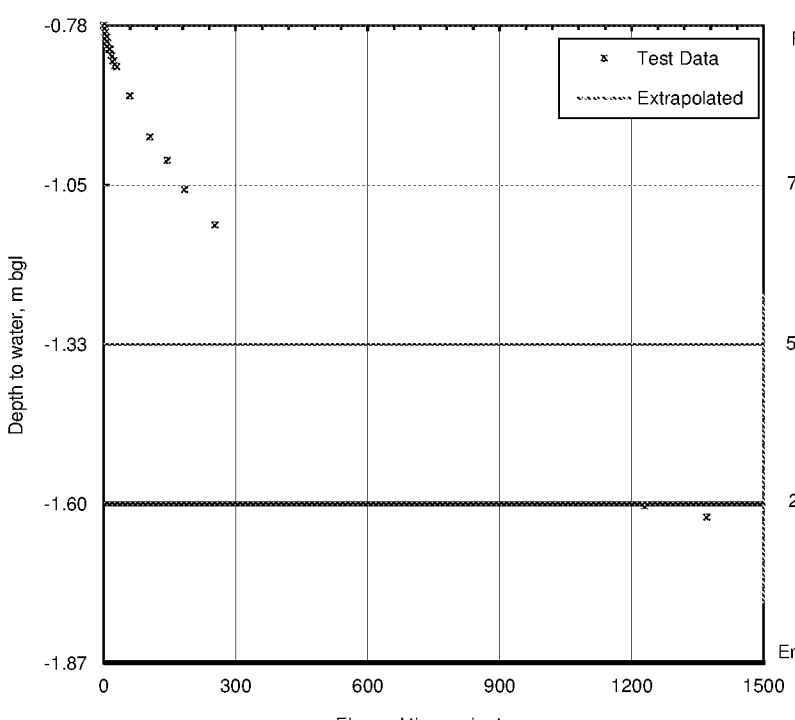
Groundwater Monitoring Record

Project: Land at Bilsham Road, Yapton Client: Gleeson Developments Project No: BRD2693									
Borehole name	Date	Monitored by (initials)	Borehole depth (m)	Qty free product detected (mm)	Groundwater level below ground surface (m)	Groundwater level below top of standpipe (m)	Amount purged (l)	Post purge groundwater level below top of standpipe (m)	Comments
WS04	31/10/2017	AN	3.97	0.00	3.63	3.51	n/a	n/a	No odour noted on retrieval of interface meter.
WS03	31/10/2017	AN	4.00	0.00	3.03	2.87	n/a	n/a	No odour noted on retrieval of interface meter.
WS02	31/10/2017	AN	3.95	0.00	2.52	2.40	n/a	n/a	No odour noted on retrieval of interface meter.
WS07	31/10/2017	AN	3.85	0.00	1.70	1.56	n/a	n/a	No odour noted on retrieval of interface meter.
WS08	31/10/2017	AN	3.89	0.00	1.88	1.75	n/a	n/a	No odour noted on retrieval of interface meter. Borehole located immediately next to a dry ditch.
WS09	31/10/2017	AN	3.99	0.00	1.84	1.71	n/a	n/a	No odour noted on retrieval of interface meter.
WS10	31/10/2017	AN	3.97	0.00	2.08	1.93	n/a	n/a	No odour noted on retrieval of interface meter.

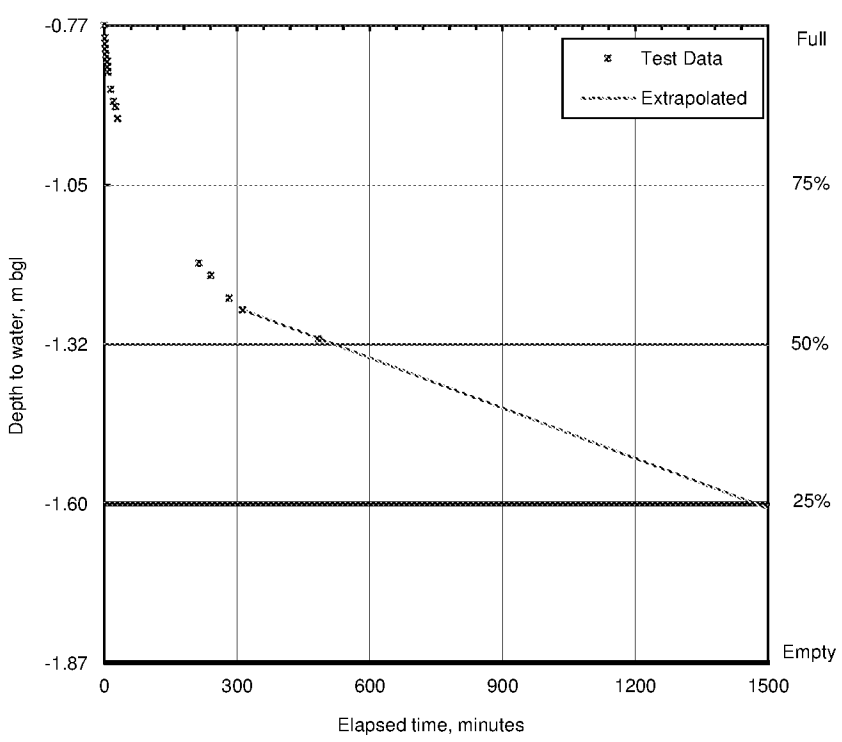
SOAKAGE TEST RECORD

SOIL INFILTRATION RATE (BRE Digest 365 : Soakaway Test)		
Client: Gleeson Developments Project Title: Land at Bilsham Road, Yapton Project No.: BRD2693		
Test Details		
Trial Pit Number Test Number Pit Depth Pit Length Pit Width Depth to groundwater prior to test Date of Test Logged by Description of Soil under Test	TP01 1 1.87 2.10 0.65 Dry 18/10/2017 S Raymundo	m m m m Firm, brown mottled orange brown, slightly sandy, silty CLAY. Sand is fine-sized.
Test Record		
Elapsed Time min	Depth to Water m	Plot of water level against elapsed time
0 1 2 3 4 5 6 7 8 9 11 13 15 17 19 21 23 25 27 29 88 133 1034 1243	1.16 1.17 1.18 1.18 1.18 1.18 1.18 1.18 1.18 1.18 1.19 1.19 1.19 1.19 1.19 1.19 1.19 1.19 1.19 1.19 1.24 1.27 1.62 1.65	
Summary of Calculations and Result		
Soil infiltration rate, f, is calculated from the time taken for the water to fall from 75% to 25% effective storage depth in the pit. $f = (V_{75}-V_{25})/A_{50}(T_{75}-T_{25})$ where, T_{75} (307 mins) is the time for the water level to fall to 75% effective depth (1.34m bgl) and T_{25} (1539* mins) is the time for the water level to fall to 25% effective depth (1.69m bgl) thus, $T_{75}-T_{25}$ is the time for the water level to fall from 75% to 25% effective depth: $T_{75}-T_{25} = 1232$ mins $V_{75}-V_{25}$ is the effective storage volume in the trial pit between 75% and 25% effective depth: $V_{75}-V_{25} = 0.48 \text{ m}^3$ and A_{50} is the internal surface area of the trial pit up to 50% effective depth and including the base area: $A_{50} = 3.32 \text{ m}^2$ Soil Infiltration Rate $f = 1.98 \times 10^{-6} \text{ m/s}$		
Comments Calculation based on extrapolated results. Use as a guide only.		

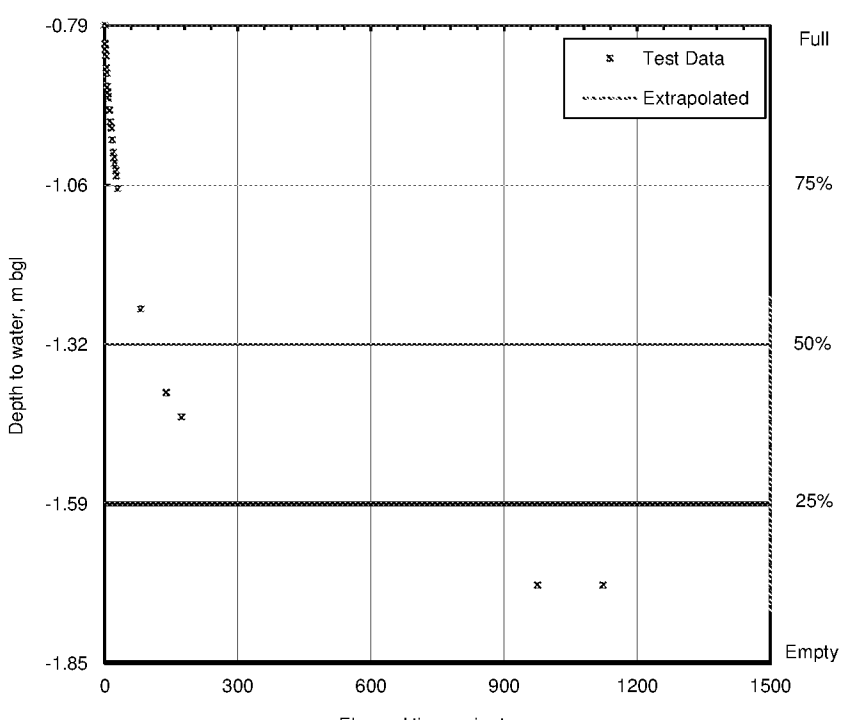
SOAKAGE TEST RECORD

SOIL INFILTRATION RATE (BRE Digest 365 : Soakaway Test)		
Client: Gleeson Developments Project Title: Land at Bilsham Road, Yapton Project No.: BRD2693		
Test Details		
Trial Pit Number Test Number Pit Depth Pit Length Pit Width Depth to groundwater prior to test Date of Test Logged by Description of Soil under Test	TP01 2 1.87 2.10 0.65 1.65 19/10/2017 S Raymundo	m m m m Firm, brown mottled orange brown, slightly sandy, silty CLAY. Sand is fine-sized.
Test Record		
Elapsed Time min	Depth to Water m	Plot of water level against elapsed time
0 1 2 3 4 5 6 7 8 9 11 13 15 17 19 21 23 25 29 59 105 144 185 253 1230 1371	0.78 0.78 0.79 0.79 0.79 0.80 0.80 0.80 0.81 0.81 0.82 0.82 0.82 0.83 0.83 0.84 0.84 0.85 0.85 0.90 0.97 1.01 1.06 1.12 1.60 1.62	
Summary of Calculations and Result		
Soil infiltration rate, f, is calculated from the time taken for the water to fall from 75% to 25% effective storage depth in the pit. $f = (V_{75}-V_{25})/A_{50}(T_{75}-T_{25})$ where, T_{75} (179 mins) is the time for the water level to fall to 75% effective depth (1.05m bgl) and T_{25} (1225 mins) is the time for the water level to fall to 25% effective depth (1.60m bgl) thus, $T_{75}-T_{25}$ is the time for the water level to fall from 75% to 25% effective depth: $T_{75}-T_{25} = 1046$ mins $V_{75}-V_{25}$ is the effective storage volume in the trial pit between 75% and 25% effective depth: $V_{75}-V_{25} = 0.74 \text{ m}^3$ and A_{50} is the internal surface area of the trial pit up to 50% effective depth and including the base area: $A_{50} = 4.36 \text{ m}^2$ Soil Infiltration Rate $f = 2.72 \times 10^{-6} \text{ m/s}$		
Comments		

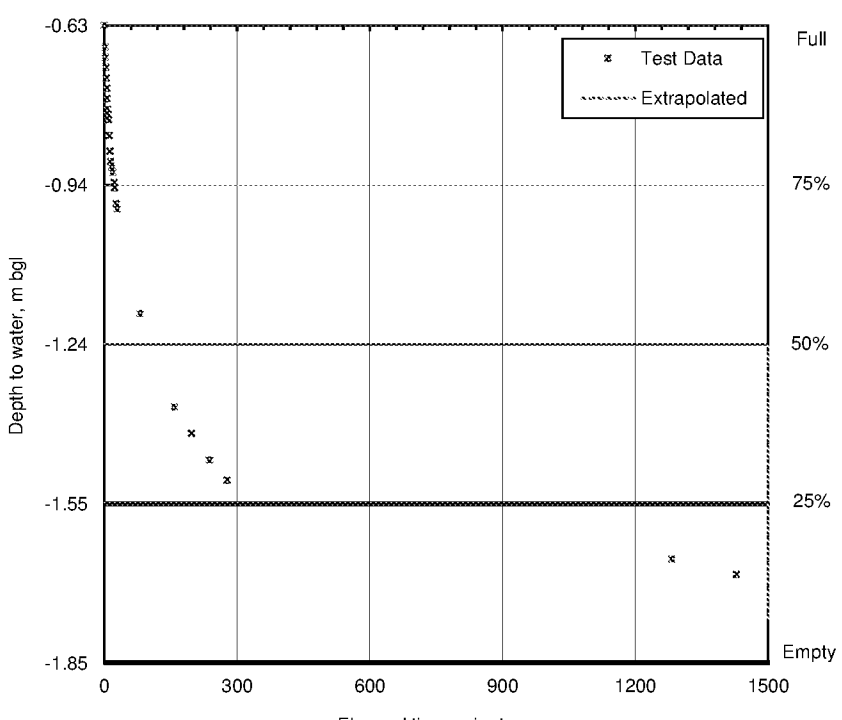
SOAKAGE TEST RECORD

SOIL INFILTRATION RATE (BRE Digest 365 : Soakaway Test)		
Client: Gleeson Developments Project Title: Land at Bilsham Road, Yapton Project No.: BRD2693		
Test Details		
Trial Pit Number Test Number Pit Depth Pit Length Pit Width Depth to groundwater prior to test Date of Test Logged by Description of Soil under Test	TP01 3 1.87 2.10 0.65 Dry 31/10/2017 S Raymundo	m m m m Firm, brown mottled orange brown, slightly sandy, silty CLAY. Sand is fine-sized.
Test Record		
Elapsed Time min	Depth to Water m	Plot of water level against elapsed time
0 1 2 3 4 5 6 7 8 9 10 15 20 25 30 214 240 281 312 485	0.77 0.79 0.80 0.81 0.82 0.82 0.83 0.83 0.84 0.85 0.85 0.88 0.90 0.91 0.93 1.18 1.20 1.24 1.26 1.31	
Summary of Calculations and Result		
Soil infiltration rate, f, is calculated from the time taken for the water to fall from 75% to 25% effective storage depth in the pit. $f = (V_{75}-V_{25})/A_{50}(T_{75}-T_{25})$ where, T_{75} (115 mins) is the time for the water level to fall to 75% effective depth (1.05m bgl) and T_{25} (1471* mins) is the time for the water level to fall to 25% effective depth (1.60m bgl) thus, $T_{75}-T_{25}$ is the time for the water level to fall from 75% to 25% effective depth: $T_{75}-T_{25} = 1356$ mins $V_{75}-V_{25}$ is the effective storage volume in the trial pit between 75% and 25% effective depth: $V_{75}-V_{25} = 0.75 \text{ m}^3$ and A_{50} is the internal surface area of the trial pit up to 50% effective depth and including the base area: $A_{50} = 4.39 \text{ m}^2$ Soil Infiltration Rate $f = 2.10 \times 10^{-6} \text{ m/s}$		
Comments Calculation based on extrapolated results. Use as a guide only.		

SOAKAGE TEST RECORD

SOIL INFILTRATION RATE (BRE Digest 365 : Soakaway Test)		
Client: Gleeson Developments Project Title: Land at Bilsham Road, Yapton Project No.: BRD2693		
Test Details		
Trial Pit Number Test Number Pit Depth Pit Length Pit Width Depth to groundwater prior to test Date of Test Logged by Description of Soil under Test	TP02 1 1.85 2.90 0.65 Dry 18/10/2017 S Raymundo	m m m m Firm, stiff, brown, light brown, slightly gravelly, slightly sandy, silty CLAY. Gravel is subrounded, fine-sized flint.
Test Record		
Elapsed Time min	Depth to Water m	Plot of water level against elapsed time 
0 1 2 3 4 5 6 7 8 9 11 13 15 17 19 21 23 25 27 29 81 139 173 976 1123	0.79 0.82 0.83 0.84 0.86 0.87 0.89 0.90 0.90 0.91 0.93 0.95 0.96 0.98 1.00 1.01 1.02 1.03 1.04 1.06 1.26 1.40 1.44 1.72 1.72	
Summary of Calculations and Result		
Soil infiltration rate, f , is calculated from the time taken for the water to fall from 75% to 25% effective storage depth in the pit. $f = (V_{75}-V_{25})/A_{50}(T_{75}-T_{25})$ where, T_{75} (29 mins) is the time for the water level to fall to 75% effective depth (1.06m bgl) and T_{25} (589 mins) is the time for the water level to fall to 25% effective depth (1.59m bgl) thus, $T_{75}-T_{25}$ is the time for the water level to fall from 75% to 25% effective depth: $T_{75}-T_{25} = 560 \text{ mins}$ $V_{75}-V_{25} \text{ is the effective storage volume in the trial pit between 75\% and 25\% effective depth:}$ $V_{75}-V_{25} = 1.00 \text{ m}^3$ and A_{50} is the internal surface area of the trial pit up to 50% effective depth and including the base area: $A_{50} = 5.65 \text{ m}^2$ Soil Infiltration Rate f = <u>5.26×10^{-6}</u> m/s		
Comments		

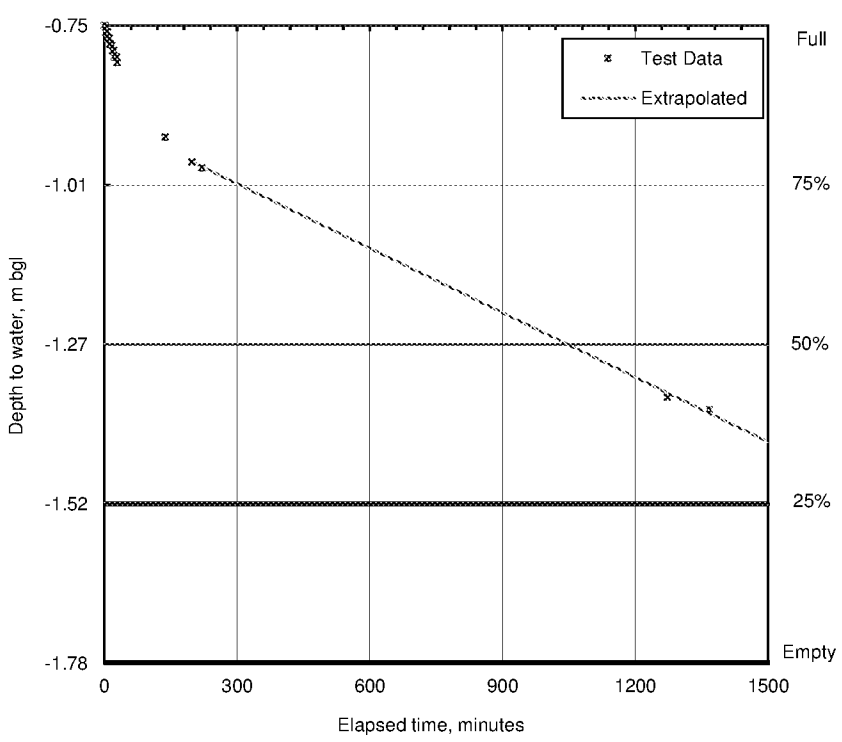
SOAKAGE TEST RECORD

SOIL INFILTRATION RATE (BRE Digest 365 : Soakaway Test)		
Client: Gleeson Developments Project Title: Land at Bilsham Road, Yapton Project No.: BRD2693		
Test Details		
Trial Pit Number Test Number Pit Depth Pit Length Pit Width Depth to groundwater prior to test Date of Test Logged by Description of Soil under Test	TP02 2 1.85 2.90 0.65 1.72 19/10/2017 S Raymundo	m m m m Firm, stiff, brown, light brown, slightly gravelly, slightly sandy, silty CLAY. Gravel is subrounded, fine-sized flint.
Test Record		
Elapsed Time min	Depth to Water m	Plot of water level against elapsed time
0 1 2 3 4 5 6 7 8 9 11 13 15 17 19 21 23 27 29 81 158 197 238 277 1283 1428	0.63 0.67 0.69 0.71 0.73 0.75 0.77 0.79 0.80 0.81 0.84 0.87 0.89 0.90 0.91 0.93 0.94 0.97 0.98 1.18 1.36 1.41 1.46 1.50 1.65 1.68	
Summary of Calculations and Result		
Soil infiltration rate, f, is calculated from the time taken for the water to fall from 75% to 25% effective storage depth in the pit. $f = (V_{75}-V_{25})/A_{50}(T_{75}-T_{25})$ where, T_{75} (22 mins) is the time for the water level to fall to 75% effective depth (0.94m bgl) and T_{25} (579 mins) is the time for the water level to fall to 25% effective depth (1.55m bgl) thus, $T_{75}-T_{25}$ is the time for the water level to fall from 75% to 25% effective depth: $T_{75}-T_{25} = 557$ mins $V_{75}-V_{25}$ is the effective storage volume in the trial pit between 75% and 25% effective depth: $V_{75}-V_{25} = 1.15 \text{ m}^3$ and A_{50} is the internal surface area of the trial pit up to 50% effective depth and including the base area: $A_{50} = 6.22 \text{ m}^2$ Soil Infiltration Rate $f = 5.54 \times 10^{-6} \text{ m/s}$		
Comments		

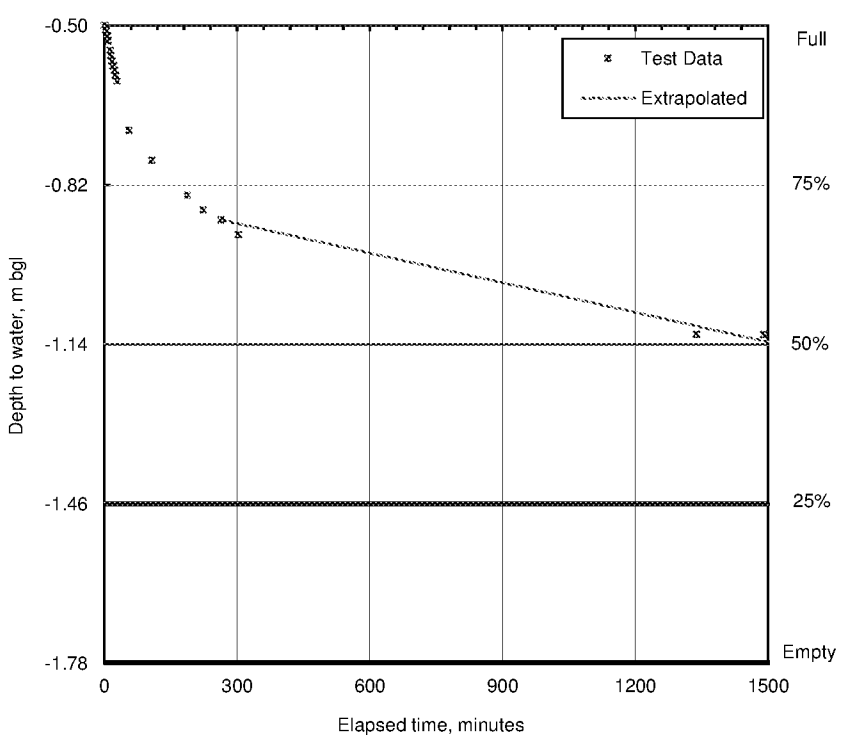
SOAKAGE TEST RECORD

SOIL INFILTRATION RATE (BRE Digest 365 : Soakaway Test)		
Client: Gleeson Developments Project Title: Land at Bilsham Road, Yapton Project No.: BRD2693		
Test Details		
Trial Pit Number Test Number Pit Depth Pit Length Pit Width Depth to groundwater prior to test Date of Test Logged by Description of Soil under Test	TP02 3 1.85 2.90 0.65 Dry 31/10/2017 S Raymundo	m m m m
Firm, stiff, brown, light brown, slightly gravelly, slightly sandy, silty CLAY. Gravel is subrounded, fine-sized flint.		
Test Record		
Elapsed Time min	Depth to Water m	Plot of water level against elapsed time
0 1 2 3 4 5 6 7 8 9 10 15 20 25 30 171 198 239 287 330	0.84 0.85 0.87 0.88 0.89 0.90 0.92 0.92 0.93 0.94 0.95 0.99 1.03 1.06 1.08 1.45 1.48 1.53 1.56 1.60	
Summary of Calculations and Result		
Soil infiltration rate, f , is calculated from the time taken for the water to fall from 75% to 25% effective storage depth in the pit. $f = (V_{75}-V_{25})/A_{50}(T_{75}-T_{25})$ where, T_{75} (35 mins) is the time for the water level to fall to 75% effective depth (1.09m bgl) and T_{25} (327 mins) is the time for the water level to fall to 25% effective depth (1.60m bgl) thus, $T_{75}-T_{25}$ is the time for the water level to fall from 75% to 25% effective depth: $T_{75}-T_{25} = 293 \text{ mins}$ $V_{75}-V_{25} \text{ is the effective storage volume in the trial pit between 75% and 25% effective depth:}$ $V_{75}-V_{25} = 0.95 \text{ m}^3$ and A_{50} is the internal surface area of the trial pit up to 50% effective depth and including the base area: $A_{50} = 5.47 \text{ m}^2$		
Soil Infiltration Rate f = <u>9.91×10^{-6}</u> m/s		
Comments		

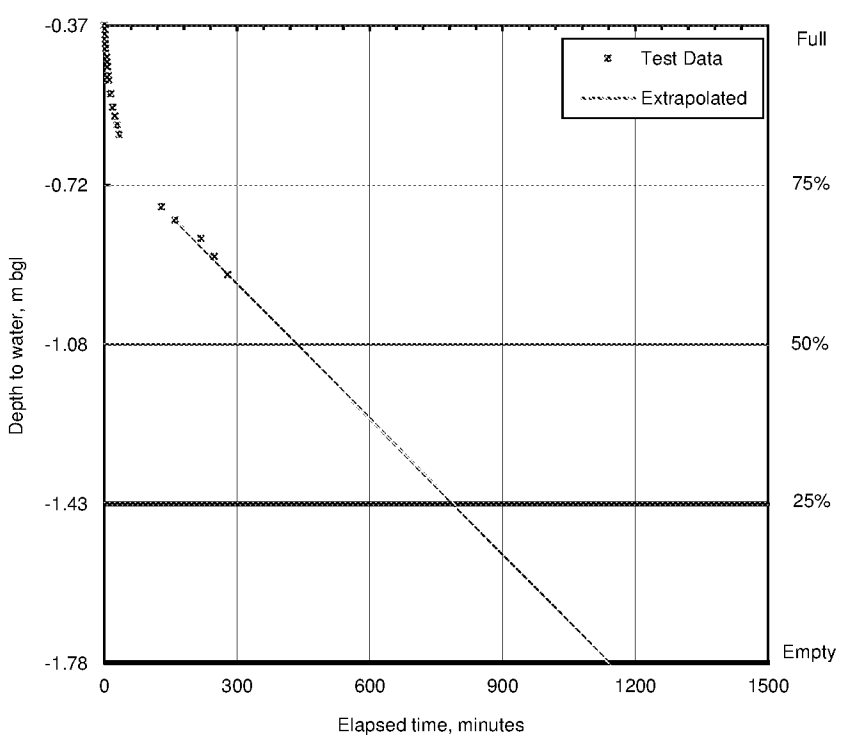
SOAKAGE TEST RECORD

SOIL INFILTRATION RATE (BRE Digest 365 : Soakaway Test)		
Client: Gleeson Developments Project Title: Land at Bilsham Road, Yapton Project No.: BRD2693		
Test Details		
Trial Pit Number Test Number Pit Depth Pit Length Pit Width Depth to groundwater prior to test Date of Test Logged by Description of Soil under Test	TP03 1 1.78 2.00 0.65 Dry 18/10/2017 S Raymundo	m m m m Firm, stiff, light brown and orange brown, slightly sandy, slightly gravelly, silty CLAY. Gravel is fine-sized, subangular to subrounded flint.
Test Record		
Elapsed Time min	Depth to Water m	Plot of water level against elapsed time
0 1 2 3 4 5 6 7 8 9 11 13 15 17 19 21 23 25 27 29 137 198 220 1272 1367	0.75 0.75 0.75 0.76 0.76 0.76 0.76 0.77 0.77 0.77 0.78 0.78 0.78 0.78 0.79 0.79 0.80 0.80 0.80 0.81 0.93 0.97 0.98 1.35 1.37	
Summary of Calculations and Result		
Soil infiltration rate, f, is calculated from the time taken for the water to fall from 75% to 25% effective storage depth in the pit. $f = (V_{75}-V_{25})/A_{50}(T_{75}-T_{25})$ where, T_{75} (298 mins) is the time for the water level to fall to 75% effective depth (1.01m bgl) and T_{25} (1789* mins) is the time for the water level to fall to 25% effective depth (1.52m bgl) thus, $T_{75}-T_{25}$ is the time for the water level to fall from 75% to 25% effective depth: $T_{75}-T_{25} = 1491$ mins $V_{75}-V_{25}$ is the effective storage volume in the trial pit between 75% and 25% effective depth: $V_{75}-V_{25} = 0.67 \text{ m}^3$ and A_{50} is the internal surface area of the trial pit up to 50% effective depth and including the base area: $A_{50} = 4.03 \text{ m}^2$ Soil Infiltration Rate $f = 1.86 \times 10^{-6} \text{ m/s}$		
Comments Calculation based on extrapolated results. Use as a guide only.		

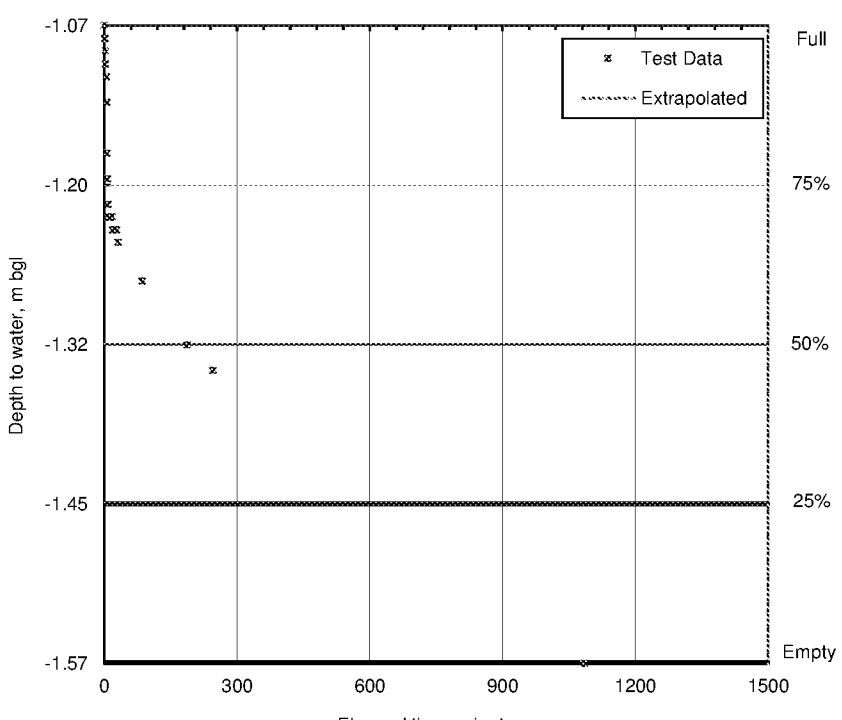
SOAKAGE TEST RECORD

SOIL INFILTRATION RATE (BRE Digest 365 : Soakaway Test)		
Client: Gleeson Developments Project Title: Land at Bilsham Road, Yapton Project No.: BRD2693		
Test Details		
Trial Pit Number Test Number Pit Depth Pit Length Pit Width Depth to groundwater prior to test Date of Test Logged by Description of Soil under Test	TP03 2 1.78 2.00 0.65 1.56 19/10/2017 S Raymundo	m m m m Firm, stiff, light brown and orange brown, slightly sandy, slightly gravelly, silty CLAY. Gravel is fine-sized, subangular to subrounded flint.
Test Record		
Elapsed Time min	Depth to Water m	Plot of water level against elapsed time
0 1 2 3 4 5 6 7 8 9 13 15 17 19 21 23 25 29 55 107 187 223 264 303 1338 1490	0.50 0.50 0.51 0.51 0.51 0.52 0.52 0.52 0.53 0.53 0.55 0.56 0.57 0.58 0.58 0.59 0.60 0.61 0.71 0.77 0.84 0.87 0.89 0.92 1.12 1.12	
Summary of Calculations and Result		
RESULT COULD NOT BE CALCULATED AS TEST PIT WOULD NOT REACH HALF EMPTY WITHIN 24 HOURS		
Comments		

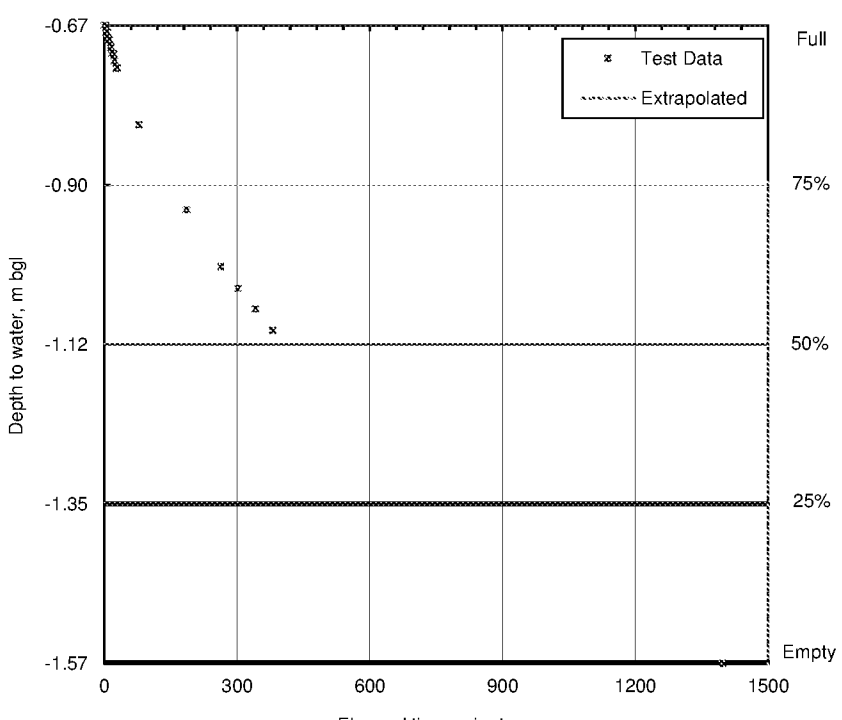
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SOIL INFILTRATION RATE (BRE Digest 365 : Soakaway Test)		
Client: Gleeson Developments Project Title: Land at Bilsham Road, Yapton Project No.: BRD2693		
Test Details		
Trial Pit Number Test Number Pit Depth Pit Length Pit Width Depth to groundwater prior to test Date of Test Logged by Description of Soil under Test	TP03 3 1.78 2.00 0.65 Dry 31/10/2017 S Raymundo	m m m m Firm, stiff, light brown and orange brown, slightly sandy, slightly gravelly, silty CLAY. Gravel is fine-sized, subangular to subrounded flint.
Test Record		
Elapsed Time min	Depth to Water m	Plot of water level against elapsed time
0 1 2 3 4 5 6 7 8 9 14 19 24 29 34 129 160 218 248 279	0.37 0.38 0.39 0.41 0.42 0.44 0.45 0.46 0.48 0.49 0.52 0.55 0.57 0.59 0.61 0.77 0.80 0.84 0.88 0.92	
Summary of Calculations and Result		
Soil infiltration rate, f, is calculated from the time taken for the water to fall from 75% to 25% effective storage depth in the pit. $f = (V_{75}-V_{25})/A_{50}(T_{75}-T_{25})$ where, T_{75} (101 mins) is the time for the water level to fall to 75% effective depth (0.72m bgl) and T_{25} (788* mins) is the time for the water level to fall to 25% effective depth (1.43m bgl) thus, $T_{75}-T_{25}$ is the time for the water level to fall from 75% to 25% effective depth: $T_{75}-T_{25} = 688$ mins $V_{75}-V_{25}$ is the effective storage volume in the trial pit between 75% and 25% effective depth: $V_{75}-V_{25} = 0.92 \text{ m}^3$ and A_{50} is the internal surface area of the trial pit up to 50% effective depth and including the base area: $A_{50} = 5.04 \text{ m}^2$ Soil Infiltration Rate $f = 4.41 \times 10^{-6} \text{ m/s}$		
Comments Calculation based on extrapolated results. Use as a guide only.		

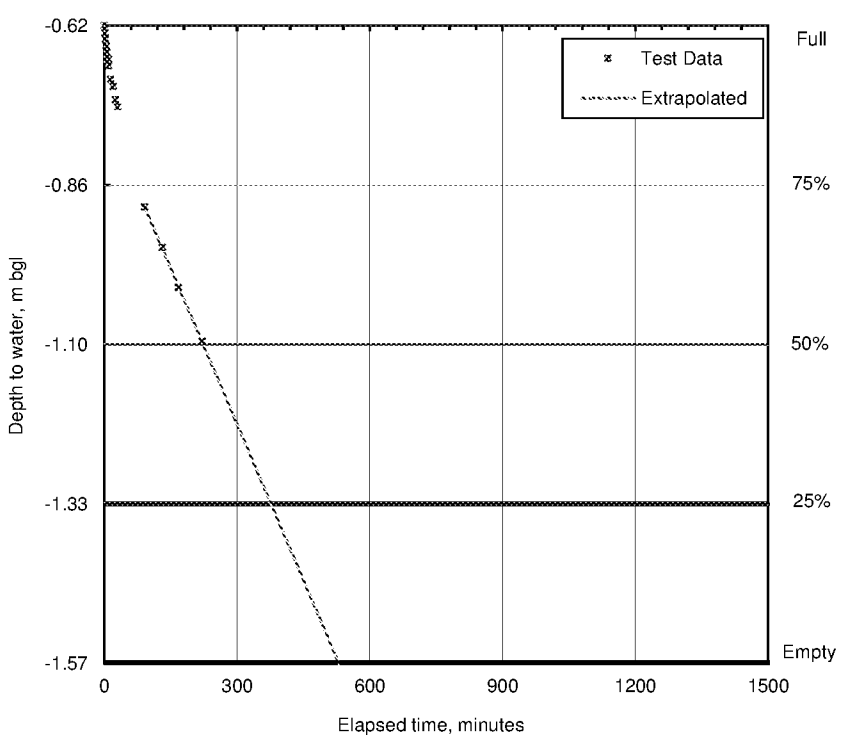
SOAKAGE TEST RECORD

SOIL INFILTRATION RATE (BRE Digest 365 : Soakaway Test)		
Client: Gleeson Developments Project Title: Land at Bilsham Road, Yapton Project No.: BRD2693		
Test Details		
Trial Pit Number Test Number Pit Depth Pit Length Pit Width Depth to groundwater prior to test Date of Test Logged by Description of Soil under Test	TP04 1 1.57 2.80 0.65 Dry 18/10/2017 S Raymundo	m m m m Firm, stiff, brown, orange brown, slightly sandy, silty CLAY. Sand is fine-sized.
Test Record		
Elapsed Time min	Depth to Water m	Plot of water level against elapsed time
0 1 2 3 4 5 6 7 8 9 11 13 15 17 19 21 23 25 27 31 86 187 245 1084	1.07 1.08 1.09 1.10 1.11 1.13 1.17 1.19 1.21 1.22 1.22 1.22 1.22 1.23 1.23 1.23 1.23 1.23 1.24 1.27 1.32 1.34 1.57	
Summary of Calculations and Result		
Soil infiltration rate, f, is calculated from the time taken for the water to fall from 75% to 25% effective storage depth in the pit. $f = (V_{75}-V_{25})/A_{50}(T_{75}-T_{25})$ where, T_{75} (7.3 mins) is the time for the water level to fall to 75% effective depth (1.20m bgl) and T_{25} (628 mins) is the time for the water level to fall to 25% effective depth (1.45m bgl) thus, $T_{75}-T_{25}$ is the time for the water level to fall from 75% to 25% effective depth: $T_{75}-T_{25} = 621$ mins $V_{75}-V_{25}$ is the effective storage volume in the trial pit between 75% and 25% effective depth: $V_{75}-V_{25} = 0.46 \text{ m}^3$ and A_{50} is the internal surface area of the trial pit up to 50% effective depth and including the base area: $A_{50} = 3.55 \text{ m}^2$ Soil Infiltration Rate $f = 3.45 \times 10^{-6} \text{ m/s}$		
Comments		

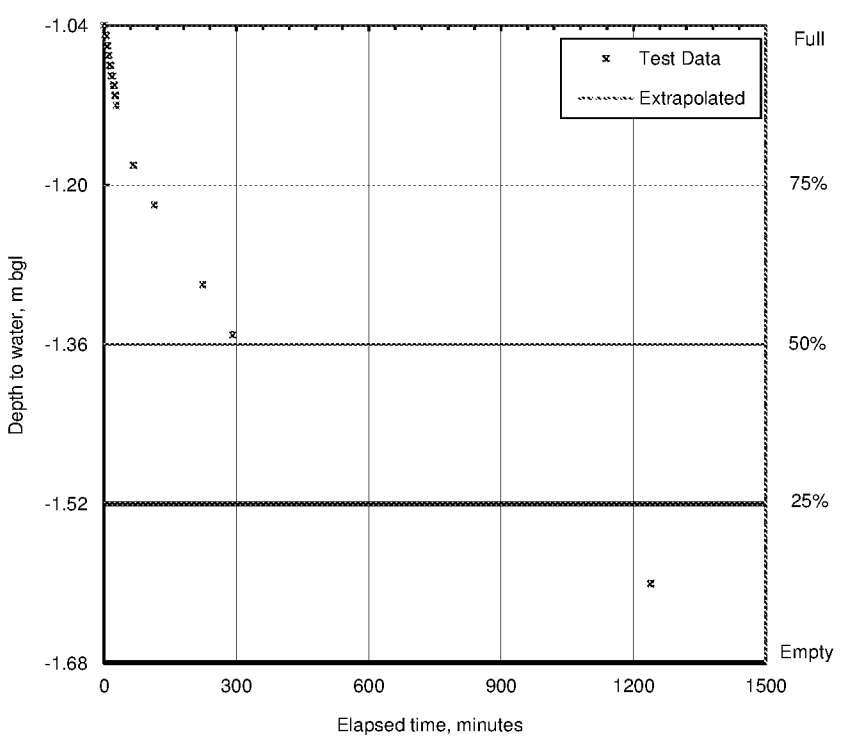
SOAKAGE TEST RECORD

SOIL INFILTRATION RATE (BRE Digest 365 : Soakaway Test)		
Client: Gleeson Developments Project Title: Land at Bilsham Road, Yapton Project No.: BRD2693		
Test Details		
Trial Pit Number Test Number Pit Depth Pit Length Pit Width Depth to groundwater prior to test Date of Test Logged by Description of Soil under Test	TP04 2 1.57 2.80 0.65 Dry 19/10/2017 S Raymundo	m m m m Firm, stiff, brown, orange brown, slightly sandy, silty CLAY. Sand is fine-sized.
Test Record		
Elapsed Time min	Depth to Water m	Plot of water level against elapsed time
0 1 2 3 4 5 6 7 8 9 11 13 15 17 19 21 23 27 29 78 186 264 302 342 380 1397	0.67 0.67 0.67 0.67 0.68 0.68 0.68 0.69 0.69 0.69 0.70 0.70 0.71 0.71 0.71 0.72 0.73 0.73 0.81 0.93 1.01 1.04 1.07 1.10 1.57	
Summary of Calculations and Result		
Soil infiltration rate, f, is calculated from the time taken for the water to fall from 75% to 25% effective storage depth in the pit. $f = (V_{75}-V_{25})/A_{50}(T_{75}-T_{25})$ where, T_{75} (155 mins) is the time for the water level to fall to 75% effective depth (0.90m bgl) and T_{25} (910 mins) is the time for the water level to fall to 25% effective depth (1.35m bgl) thus, $T_{75}-T_{25}$ is the time for the water level to fall from 75% to 25% effective depth: $T_{75}-T_{25} = 756$ mins $V_{75}-V_{25}$ is the effective storage volume in the trial pit between 75% and 25% effective depth: $V_{75}-V_{25} = 0.82 \text{ m}^3$ and A_{50} is the internal surface area of the trial pit up to 50% effective depth and including the base area: $A_{50} = 4.93 \text{ m}^2$ Soil Infiltration Rate $f = 3.67 \times 10^{-6} \text{ m/s}$		
Comments		

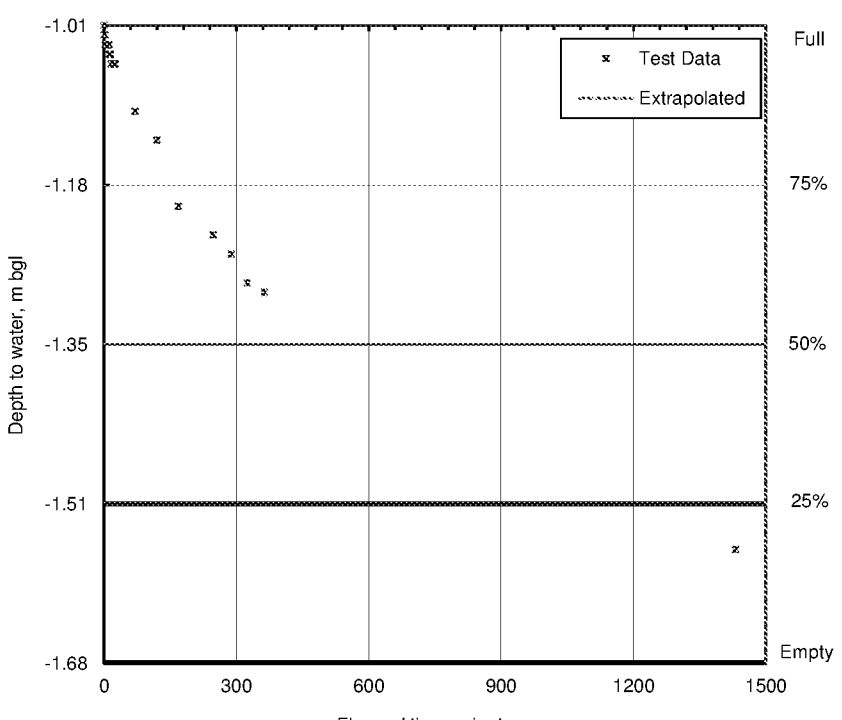
SOAKAGE TEST RECORD

SOIL INFILTRATION RATE (BRE Digest 365 : Soakaway Test)		
Client: Gleeson Developments Project Title: Land at Bilsham Road, Yapton Project No.: BRD2693		
Test Details		
Trial Pit Number Test Number Pit Depth Pit Length Pit Width Depth to groundwater prior to test Date of Test Logged by Description of Soil under Test	TP04 3 1.57 2.80 0.65 Dry 31/10/2017 S Raymundo	m m m m Firm, stiff, brown, orange brown, slightly sandy, silty CLAY. Sand is fine-sized.
Test Record		
Elapsed Time min	Depth to Water m	Plot of water level against elapsed time
0 1 2 3 4 5 6 7 8 9 10 15 20 25 30 91 131 167 221	0.62 0.63 0.63 0.64 0.65 0.66 0.66 0.67 0.67 0.67 0.68 0.70 0.71 0.73 0.74 0.89 0.95 1.01 1.09	
Summary of Calculations and Result		
Soil infiltration rate, f, is calculated from the time taken for the water to fall from 75% to 25% effective storage depth in the pit. $f = (V_{75}-V_{25})/A_{50}(T_{75}-T_{25})$ where, T_{75} (78 mins) is the time for the water level to fall to 75% effective depth (0.86m bgl) and T_{25} (377* mins) is the time for the water level to fall to 25% effective depth (1.33m bgl) thus, $T_{75}-T_{25}$ is the time for the water level to fall from 75% to 25% effective depth: $T_{75}-T_{25} = 299$ mins $V_{75}-V_{25}$ is the effective storage volume in the trial pit between 75% and 25% effective depth: $V_{75}-V_{25} = 0.86 \text{ m}^3$ and A_{50} is the internal surface area of the trial pit up to 50% effective depth and including the base area: $A_{50} = 5.10 \text{ m}^2$ Soil Infiltration Rate $f = 9.44 \times 10^{-6} \text{ m/s}$		
Comments Calculation based on extrapolated results. Use as a guide only.		

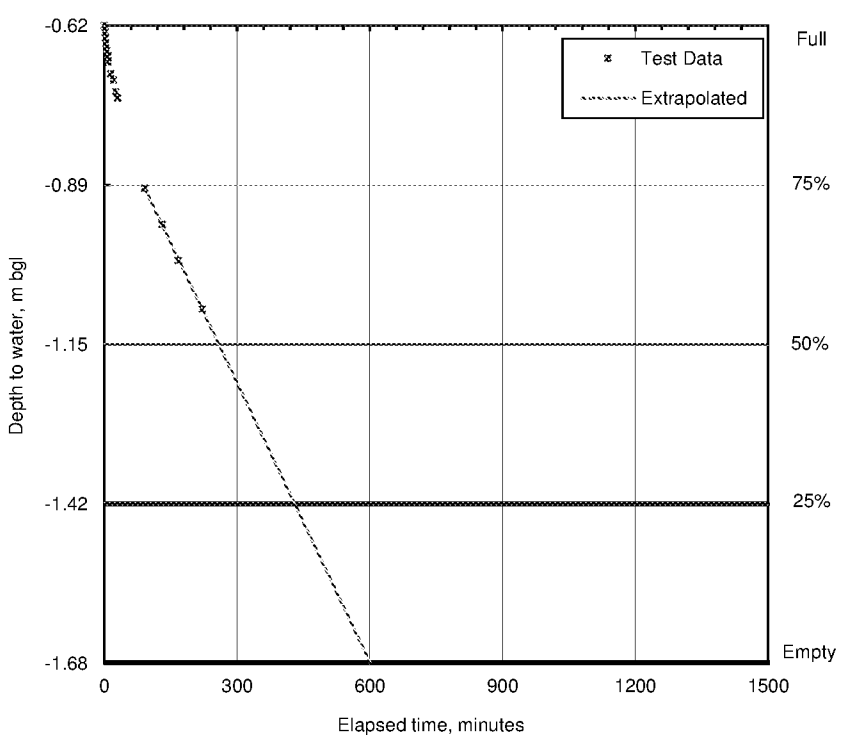
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SOIL INFILTRATION RATE (BRE Digest 365 : Soakaway Test)		
Client: Gleeson Developments Project Title: Land at Bilsham Road, Yapton Project No.: BRD2693		
Test Details		
Trial Pit Number Test Number Pit Depth Pit Length Pit Width Depth to groundwater prior to test Date of Test Logged by Description of Soil under Test	TP05 1 1.68 2.30 0.65 Dry 18/10/2017 S Raymundo	m m m m Firm, stiff, orange brown and mottled light brown and brown, silty CLAY.
Test Record		
Elapsed Time min	Depth to Water m	Plot of water level against elapsed time
0 1 2 3 4 5 6 7 8 9 11 13 15 17 19 21 23 25 27 29 67 115 225 292 1240	1.04 1.04 1.05 1.05 1.05 1.06 1.06 1.06 1.06 1.07 1.08 1.08 1.09 1.09 1.10 1.10 1.11 1.11 1.12 1.18 1.22 1.30 1.35 1.60	
Summary of Calculations and Result		
Soil infiltration rate, f, is calculated from the time taken for the water to fall from 75% to 25% effective storage depth in the pit. $f = (V_{75}-V_{25})/A_{50}(T_{75}-T_{25})$ where, T_{75} (91 mins) is the time for the water level to fall to 75% effective depth (1.20m bgl) and T_{25} (937 mins) is the time for the water level to fall to 25% effective depth (1.52m bgl) thus, $T_{75}-T_{25}$ is the time for the water level to fall from 75% to 25% effective depth: $T_{75}-T_{25} = 846$ mins $V_{75}-V_{25}$ is the effective storage volume in the trial pit between 75% and 25% effective depth: $V_{75}-V_{25} = 0.48 \text{ m}^3$ and A_{50} is the internal surface area of the trial pit up to 50% effective depth and including the base area: $A_{50} = 3.38 \text{ m}^2$ Soil Infiltration Rate $f = 2.79 \times 10^{-6} \text{ m/s}$		
Comments		

SOAKAGE TEST RECORD

SOIL INFILTRATION RATE (BRE Digest 365 : Soakaway Test)		
Client: Gleeson Developments Project Title: Land at Bilsham Road, Yapton Project No.: BRD2693		
Test Details		
Trial Pit Number Test Number Pit Depth Pit Length Pit Width Depth to groundwater prior to test Date of Test Logged by Description of Soil under Test	TP05 2 1.68 2.30 0.65 1.60 19/10/2017 S Raymundo	m m m m Firm, stiff, orange brown and mottled light brown and brown, silty CLAY.
Test Record		
Elapsed Time min	Depth to Water m	Plot of water level against elapsed time
0 1 2 3 4 5 6 7 8 9 11 13 15 17 19 21 23 25 71 120 169 247 288 325 363 1431 1584	1.01 1.02 1.02 1.03 1.03 1.03 1.03 1.03 1.03 1.03 1.04 1.04 1.05 1.05 1.05 1.05 1.10 1.13 1.20 1.23 1.25 1.28 1.29 1.56 1.58	
Summary of Calculations and Result		
Soil infiltration rate, f, is calculated from the time taken for the water to fall from 75% to 25% effective storage depth in the pit. $f = (V_{75}-V_{25})/A_{50}(T_{75}-T_{25})$ where, T_{75} (153 mins) is the time for the water level to fall to 75% effective depth (1.18m bgl) and T_{25} (1243 mins) is the time for the water level to fall to 25% effective depth (1.51m bgl) thus, $T_{75}-T_{25}$ is the time for the water level to fall from 75% to 25% effective depth: $T_{75}-T_{25} = 1090$ mins $V_{75}-V_{25}$ is the effective storage volume in the trial pit between 75% and 25% effective depth: $V_{75}-V_{25} = 0.50 \text{ m}^3$ and A_{50} is the internal surface area of the trial pit up to 50% effective depth and including the base area: $A_{50} = 3.47 \text{ m}^2$ Soil Infiltration Rate $f = 2.21 \times 10^{-6} \text{ m/s}$		
Comments		

SOAKAGE TEST RECORD

SOIL INFILTRATION RATE (BRE Digest 365 : Soakaway Test)		
Client: Gleeson Developments Project Title: Land at Bilsham Road, Yapton Project No.: BRD2693		
Test Details		
Trial Pit Number Test Number Pit Depth Pit Length Pit Width Depth to groundwater prior to test Date of Test Logged by Description of Soil under Test	TP05 3 1.68 2.30 0.65 Dry 31/10/2017 S Raymundo	m m m m Firm, stiff, orange brown and mottled light brown and brown, silty CLAY.
Test Record		
Elapsed Time min	Depth to Water m	Plot of water level against elapsed time
0 1 2 3 4 5 6 7 8 9 10 15 20 25 30 91 131 167 221	0.62 0.63 0.63 0.64 0.65 0.66 0.66 0.67 0.67 0.67 0.68 0.70 0.71 0.73 0.74 0.89 0.95 1.01 1.09	
Summary of Calculations and Result		
Soil infiltration rate, f, is calculated from the time taken for the water to fall from 75% to 25% effective storage depth in the pit. $f = (V_{75}-V_{25})/A_{50}(T_{75}-T_{25})$ where, T_{75} (89 mins) is the time for the water level to fall to 75% effective depth (0.89m bgl) and T_{25} (430* mins) is the time for the water level to fall to 25% effective depth (1.42m bgl) thus, $T_{75}-T_{25}$ is the time for the water level to fall from 75% to 25% effective depth: $T_{75}-T_{25} = 341$ mins $V_{75}-V_{25}$ is the effective storage volume in the trial pit between 75% and 25% effective depth: $V_{75}-V_{25} = 0.79 \text{ m}^3$ and A_{50} is the internal surface area of the trial pit up to 50% effective depth and including the base area: $A_{50} = 4.62 \text{ m}^2$ Soil Infiltration Rate $f = 8.37 \times 10^{-6} \text{ m/s}$		
Comments Calculation based on extrapolated results. Use as a guide only.		

APPENDIX F

Environment Agency (EA) Data and Correspondence



**PROPOSED RESIDENTIAL DEVELOPMENT
LAND WEST OF BILSHAM ROAD, YAPTON**

Fluvial Flood Study Report

**Report No. 14-111-05
July 2016**

**PROPOSED RESIDENTIAL DEVELOPMENT
LAND WEST OF BILSHAM ROAD, YAPTON**

Fluvial Flood Study Report

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**Project No. 14-111
July 2016**

DOCUMENT CONTROL SHEET

REV	ISSUE PURPOSE	AUTHOR	CHECKED	REVIEWED	APPROVED	DATE
-	Draft for comment	JH	GG	GG	BAC	1/7/2016

TABLE OF CONTENTS

1	Introduction	5
2	Input Data	9
3	Modelling Methodology	11
4	Model Proving	16
5	Model Results	18
6	Conclusions and Recommendations.....	22
	Appendices.....	23

Appendix A Hydrology

Appendix B DVD with Hydraulic Model Files and Channel Survey

1 INTRODUCTION

1.1 Appointment and Brief

- 1.1.1 Odyssey Markides was commissioned by Gleeson Strategic Land to assess flood risk associated with the Bilsham Ditch for a proposed residential development in Yapton, West Sussex. Refer to Figure 1.1 below for the site location plan.
- 1.1.2 The Environment Agency (EA) flood map shows parts of site as being located within Flood Zone 3 (High Risk) and the EA do not hold suitable flood levels for the area to inform a Flood Risk Assessment for the site. It was therefore necessary to carry out hydraulic modelling of the Bilsham Ditch within the site's vicinity to determine flood levels and the resulting flood extents. Once agreed this data can then be used to inform the sequential approach within the site and therefore confirming the land available for development as well as informing any proposed flood mitigation options. Please see Table 1.1 below for the project summary;

TABLE 1-1 PROJECT SUMMARY

Project name:	Land West of Bilsham Road, Yapton.
Project type:	Hydraulic modelling of the Bilsham Ditch at the site and its immediate surroundings.
What is being modelled?	Bilsham Ditch
What existing modelling exists?	No hydraulic modelling currently exists.
What modelling has been undertaken and why was that approach chosen?	Flood Modeller Pro -TUFLOW as detailed 1D (1-dimensional) -2D (2-dimensional) modelling package.
What hydrological analysis exists?	No hydrological analysis is available for the watercourses at the site.
What hydrological analysis has been undertaken?	Peak flow estimates and hydrographs for the 20%, 5%, 1%, 1% plus climate change and 0.1% Annual Exceedance Probability (AEP) scenarios.
What outputs have been produced?	Flood maps and levels for the 20%, 5%, 1%, 1% plus climate change and 0.1% Annual Exceedance Probability (AEP) scenarios.

1.2 Scope of Works

- 1.2.1 The primary aim of the modelling study is to identify the pre-development flood levels and floodplain extents in order to determine the land area available for different land uses. The resulting model will also be used to test any proposed flood mitigation options.
- 1.2.2 The flood levels and floodplain extents were therefore established for the following scenarios:
- 20% AEP (1 in 5 year);
 - 5% AEP (1 in 20 year);

- 1% AEP (1 in 100 year);
- 1% AEP plus climate change allowance (1 in 100 year + 45% and 105%); and
- 0.1% AEP (1 in 1000 year).

1.2.3 The scope of works for the fluvial hydraulic modelling includes the following tasks:

- Prepare a Specification for a Topographical Survey of the Bilsham Ditch and structures;
- Download available LiDAR data;
- Undertake hydrological analysis in order to obtain peak flows and hydrographs for the 20%, 5%, 1%, 1% plus climate change and 0.1% Annual Exceedance Probability (AEP) scenarios;
- Process the cross-sectional, topographical and structural survey data required to construct the hydraulic model;
- Construct computational grid with sufficient detail and prepare bathymetric map based on the LiDAR data (bare-earth) and site topographical survey to form the basis of the 2D TUFLOW model;
- Construct a 1D-2D Flood Modeller Pro - TUFLOW hydraulic model using ground model, surveyed watercourse sections and hydraulic structure data;
- Assess the model performance against historical flooding if available and undertake a calibration of the model;
- Run the baseline Flood Modeller Pro -TUFLOW model for the 20%, 5%, 1%, 1% plus climate change and 0.1% Annual Exceedance Probability (AEP) scenarios to assess flood depth, velocity and flow routes associated with the watercourses in the vicinity of the site;
- Carry out sensitivity testing of the model (for parameters such as Mannings roughness, blockage scenarios and structure coefficients);
- Map the baseline 20%, 5%, 1%, 1% plus climate change and 0.1% Annual Exceedance Probability (AEP) flood plain extents within the vicinity of the site;
- Prepare modelling report. Submit model and modelling report to the Environment Agency; and
- Once approved, the hydraulic model will be used to define the Flood Zone classification at the site and test any possible flood mitigation options required.

1.3 Project Limitations

- 1.3.1 Odyssey Markides hydraulic modelling is based on best practice and guidance current at the time of undertaking the project.
- 1.3.2 The baseline modelling undertaken assesses flood risk for an existing site/area in its current state. Any increase in flood risk caused by any alterations or future works to the area which are not modelled in the post-development scenarios are not included in this assessment.
- 1.3.3 The modelling undertaken is based on the interpretation and assessment of data provided by third parties. Odyssey Markides cannot be held responsible for the accuracy of the third party data and the

conclusions and findings of this report may change if the data is amended or updated after the date of consultation.

- 1.3.4 The conclusions of the modelling report are based on the data gathered for the purpose of the project and therefore are limited in their accuracy in proportion to the validity of the dataset. The data gathered in turn has been based on an agreed scope of works. Odyssey Markides cannot guarantee that the data used is the best available at the time of the modelling, but it is the best available data that could be gathered within the scope of the agreed instruction.

1.4 Site Description

- 1.4.1 The site is located in Yapton, approximately 4km to the west of Littlehampton in West Sussex. Refer to Figure 1.1 below for the site location map and Table 1-2 below for a summary.

TABLE 1-2 Site Description Summary

Site National Grid Reference:	The Ordnance Survey (OS) grid reference at the centre of the site is (497538, 103081) and the nearest post code is BN18 0HB.
Site area:	The total site area is approximately 1.2 hectares and has potential for c.300 residential dwellings.
Current use:	The site is a greenfield site currently occupied as agricultural land.
Wider setting:	The site is bounded by open agricultural fields to the south and west and Bilsham Road to the east. Existing residential development fronting the Mill View Road, The Millers and Gladstone Road constitute the northern and north eastern boundaries.
Existing water bodies:	The Bilsham Ditch is culverted through most of Yapton. It emerges at the edge of the site and flows in a southern direction before entering another culvert at the site estimated to be 190m long and 600mm in diameter. The Bilsham Ditch is classified as 'Main River' by the Environment Agency. Other unnamed ditches classified as 'Ordinary Watercourses' run in a south eastern direction before flowing south, parallel to the Bilsham Ditch.
Existing flood defences:	There are no known formal flood defences currently protecting the site.
Any other important comments:	No.

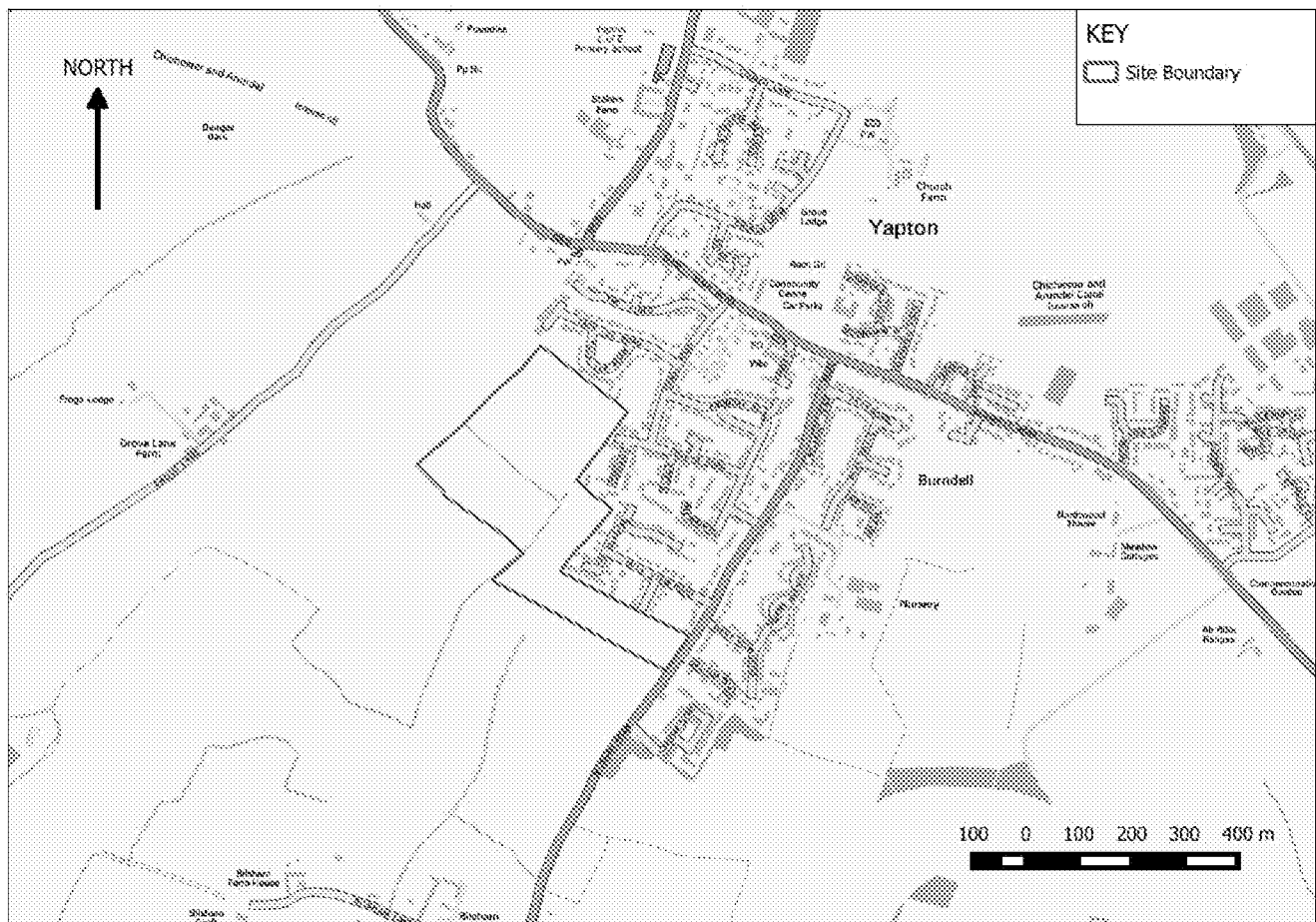


Figure 1:1 Site location

2 INPUT DATA

2.1 Key Input Data

- 2.1.1 Various sources of information have been utilised for this project with some of the relevant data sets listed in Table 2-1 below.

TABLE 2-1 Dataset Utilised

Dataset	Source	Date	Use	Quality ¹
Channel survey	Digital Terrain Surveys LLP	Surveyed in May 2016	Provides cross section and structure details for the modelled watercourses.	1
Topographical Survey	Digital Terrain Surveys LLP	Surveyed in April 2014	Provides ground level data at the site.	1
LiDAR (Light Detection And Ranging)	Environment Agency LiDAR	2011 and 2009	Forms basis of ground level data for the 2D component of the hydraulic model outside the site.	1-2
Existing flood defences:	None			
Hydrometric data	None			
Any other important comments:	None			

¹ Data quality scoring taken from Multi-Coloured Manual (Flood Hazard Research Centre, 2005) – 1 = best possible, 2 = data with known deficiencies, 3 = gross assumptions, 4 = heroic assumptions

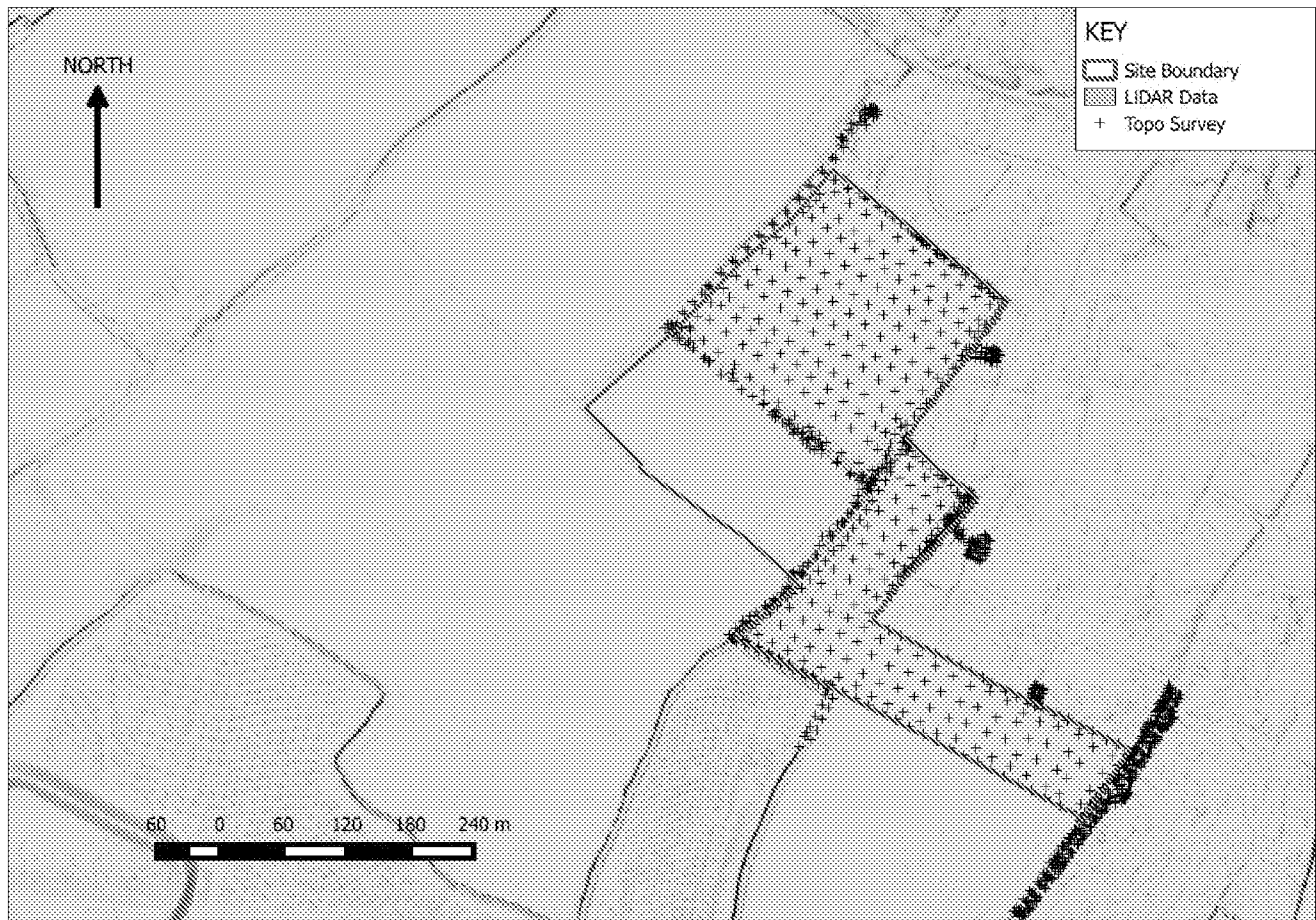


Figure 2:1 LiDAR data and topographical survey coverage

3 MODELLING METHODOLOGY

3.1 Hydrological Analysis

- 3.1.1 A full hydrological analysis was undertaken in order to derive the peak flow and hydrographs for the hydraulic model as described in Table 3.1 below. Refer to Appendix A for the full hydrological analysis.

TABLE 3-1 Hydrological Analysis

Summary of hydrological analysis required:	Design flow hydrographs for input into the hydraulic model.
Number and location of flood estimation points:	One flow estimation point at; • NGR 497700,102150
Peak flows, hydrographs or hyetographs?	Hydrographs
Return periods:	1 in 5, 20, 100 and 1 in 1000 year (20%, 5%, 1%, 0.1% AEP respectively).
Climate change estimation?	1% AEP (1 in 100 year) increased by 45% and 105%.
Choice of approach?	Revitalised Flood Hydrographs (ReFH) scaled to Statistical Method peak flows.
Reason for approach:	The statistical method for estimating flood flows is favoured as it is based on a much larger dataset of flood events, and has been more directly calibrated to reproduce flood frequency on UK catchments giving it a greater confidence in deriving the index flood (QMED).
Comparison against other approaches undertaken?	Yes – ReFH peak flows.
How flows were incorporated into the hydraulic model?	ReFH hydrographs scaled to fit statistical method peak flows and incorporated within the IED files in Flood Modeller Pro.

- 3.1.2 The key catchment descriptors for all the catchments assessed in the hydrological analysis are in Table 3-2 below;

TABLE 3-2 Key Catchment Characteristics

Catchment:	Reach A
EASTING (m)	497700
NORTHING (m)	102150
AREA (ha)	0.5
FARL:	1
PROPWET:	0.34
BFIHOST:	0.646
DPLBAR (km):	1.39
DPSBAR (m/km):	2.5
SAAR (mm):	747
SPRHOST:	34.74
URBEXT1990	0.1658
URBEXT2000	0.1634
FPEXT:	0.8317
Pumped watercourse?	No
Any unusual catchment features? In particular is BFIHOST>0.65, SPRHOST<0.20, URBEXT>0.125, FARL<0.90 or high FPEXT?	No

- 3.1.3 The final peak flow estimates for the above catchments were calculated using the FEH Statistical Analysis method, and summarised in Table 3-3 below. Refer to Appendix A for the full hydrological analysis.

TABLE 3-3 Summary of Peak Flows

Catchment:	Reach A (m³/s)
20% AEP (1 in 5 year)	0.19
5% AEP (1 in 20 year)	0.24
1% AEP (1 in 100 year)	0.30
0.1% AEP (1 in 1000 year)	0.69

3.2 Baseline Hydraulic Modelling

3.2.1 The process undertaken in the baseline hydraulic modelling is detailed in Table 3-4 below.

TABLE 3-4 Hydrological Analysis

Summary of hydrological analysis required:	Design flow hydrographs.
What existing modelling exists?	There are no existing hydraulic models for the area.
What modelling has been undertaken and why was that approach chosen?	Flood Modeller Pro -TUFLOW combines an accurate, very stable 1D channel solver, able to model channels and culverted networks with a 2D floodplain model based on a finite grid approach. The two solvers are dynamically linked, such that water can flow from the channel to the floodplain, and vice-versa.
What software version(s) have been used?	Flood Modeller Pro – v4.1.5742 TUFLOW – v2013-12-AE-iSP-w64
How have watercourse channels been represented?	The watercourse geometry was constructed using Flood Modeller Pro and based on the surveyed cross sections. Where appropriate, sections were trimmed to ensure no double counting of the floodplain. Refer to Figure 3.1 below for the hydraulic model schematic.
How have watercourse channel structures been represented?	In Flood Modeller Pro, the relevant key structure types were selected depending on the structure being modelled. They were parameterised in line with the Flood Modeller Pro manual recommendations. One bridge has been modelled as an orifice unit to aid model stability.
How have sewer networks been represented?	No sewer networks were modelled as part of the above proposals.
How has the floodplain/ground surface been represented?	The 2D domain was constructed using TUFLOW and based upon the site topographical survey and filtered LiDAR data. A grid size of 2m was chosen to allow for detailed modelling of the overland flow paths. Refer to Figure 3.1 below for the hydraulic model schematic.
How have different models been linked?	The boundary between the 1D and 2D models was chosen, as appropriate, for each individual cross section. An HX boundary (Head-eXchange or Head from eXternal source) was used for the link in TUFLOW, which takes the water level from Flood Modeller Pro and applies it along the boundary to allow flow into the 2D domain. The area between the 1D-2D boundary (HX lines) was set to 'inactive' in the 2D model to ensure that flow was not double-counted. Care was also taken to ensure that the width of the 1D element was reflected in the width of the inactive cells.

Have any adjustments to the raw DTM been made?	To ensure a better and more accurate link between the two models, a thick Z line (a 3D polyline) was snapped along the boundary based on surveyed levels (and where needed LiDAR) to ensure that the 2D domain levels match the Flood Modeller Pro model.																						
How have flood defences been represented?	There are no known formal flood defences along the modelled watercourses.																						
What boundary conditions have been used?	A normal depth boundary condition has been applied on the most downstream cross section.																						
What roughness values have been used?	Channel and floodplain roughness were represented within the model by using Manning's n values for roughness. Parameters were chosen with reference to standard values, using site visit photographs and engineering judgement. <table> <tr> <th>ISIS</th><th>Manning's n</th></tr> <tr> <td>In-channel – normal bed</td><td>n = 0.04</td></tr> <tr> <th>TUFLOW</th><th>Manning's n</th></tr> <tr> <td>Grass</td><td>0.04</td></tr> <tr> <td>Woodland</td><td>0.1</td></tr> <tr> <td>Roads</td><td>0.02</td></tr> <tr> <td>Buildings</td><td>1.0</td></tr> <tr> <td>Inland Water</td><td>0.03</td></tr> <tr> <td>Roadside</td><td>0.02</td></tr> <tr> <td>Paths</td><td>0.03</td></tr> <tr> <td>Rail</td><td>0.03</td></tr> </table>	ISIS	Manning's n	In-channel – normal bed	n = 0.04	TUFLOW	Manning's n	Grass	0.04	Woodland	0.1	Roads	0.02	Buildings	1.0	Inland Water	0.03	Roadside	0.02	Paths	0.03	Rail	0.03
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Buildings	1.0																						
Inland Water	0.03																						
Roadside	0.02																						
Paths	0.03																						
Rail	0.03																						
What structure coefficients have been used?	No changes to default parameters.																						
Are there any changes to default model or run parameters? Why?	The number of iterations in the run file increased to 11 to improve model stability.																						
What timestep has been used?	A 2.0 second 1D Flood Modeller Pro time step was used for the different model runs. A 1.0 second 2D TUFLOW time step was used for the model runs. This is in accordance with the recommendations that the 2D time step should be no smaller than a quarter of the 2D grid size and 1D time step should be no smaller than half the 2D time step.																						