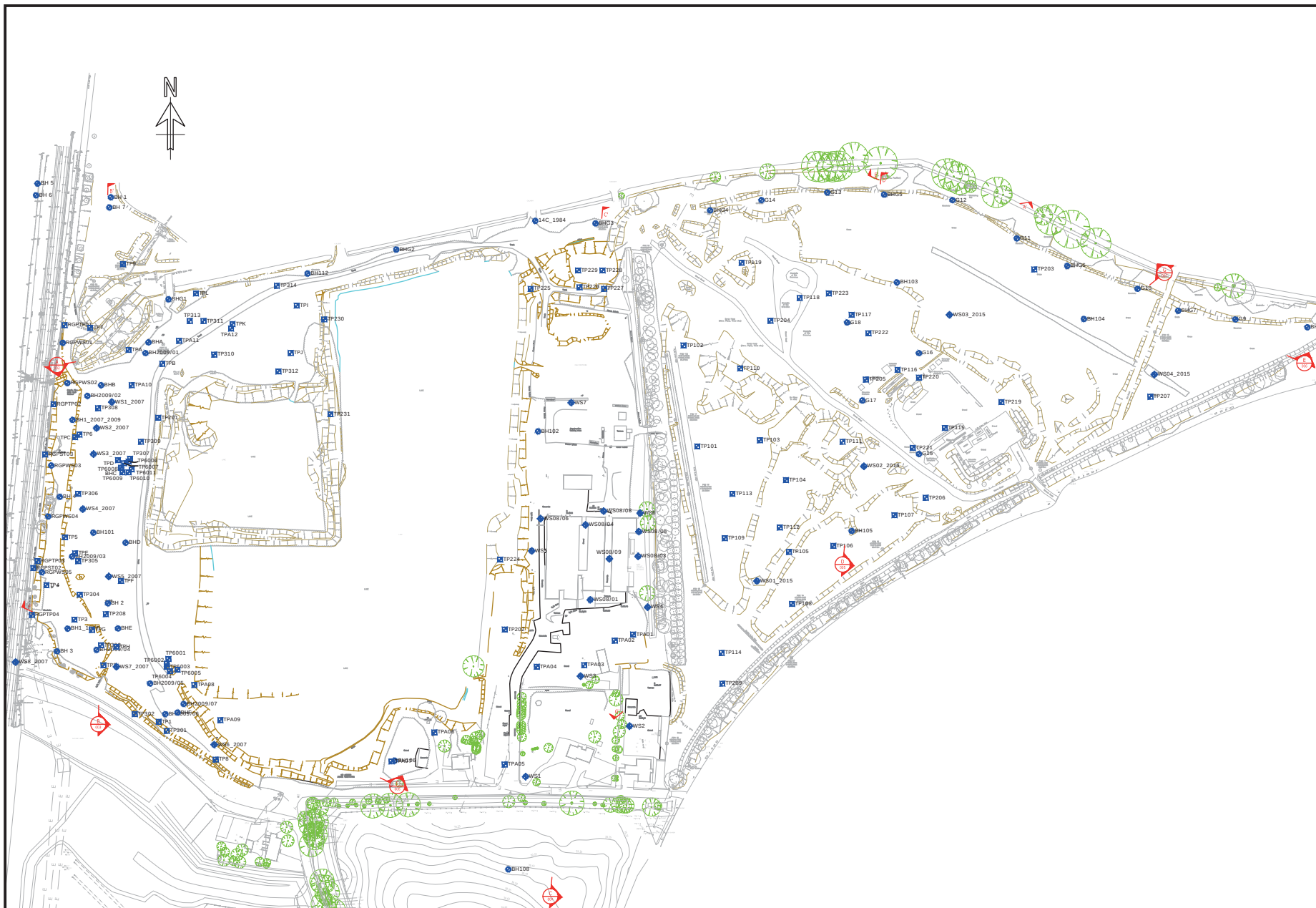


APPENDIX 1

EXPLORATORY HOLE LOCATIONS AND GEOLOGICAL SECTIONS



NOTES:

- DO NOT SCALE FROM THIS DRAWING.
- ALL DIMENSIONS ARE MILLIMETRES U.N.O.
- ALL LEVELS ARE IN METRES ABOVE ORDNANCE DATUM U.N.O.
- THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS AND ENGINEERS DRAWINGS AND SPECIFICATIONS.
- ALL EXPLORATORY HOLE LOCATION ARE INDICATIVE ONLY AND SHOULD NOT BE SCALED.
- FOR STRATA DETAILS REFER TO EXPLORATORY HOLE LOGS

KEY

- HISTORICAL BOREHOLE LOCATION
- HISTORICAL WINDOW SAMPLE LOCATION
- HISTORICAL TRIAL PIT LOCATION



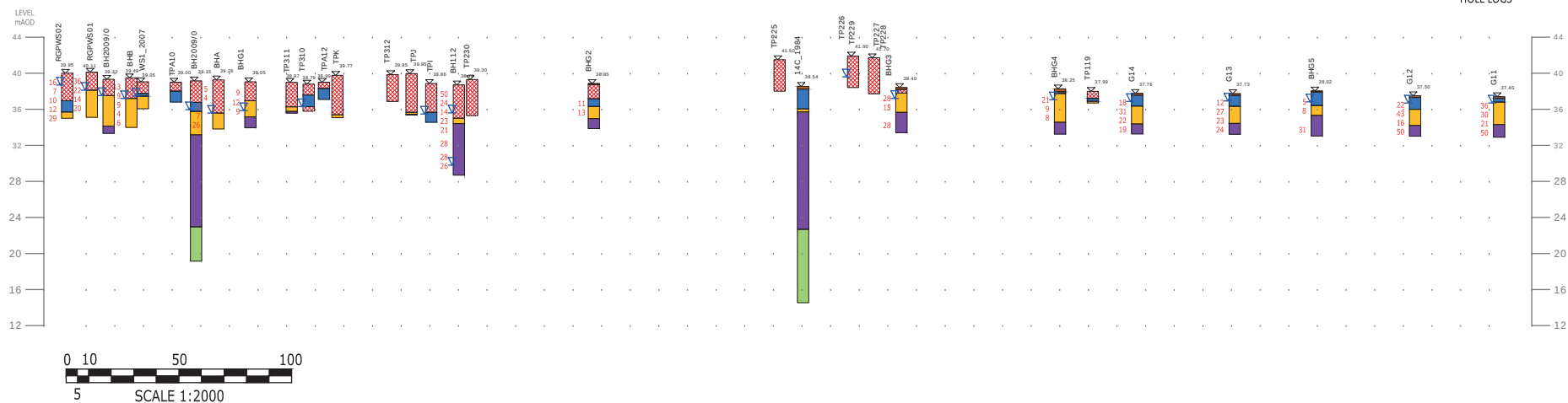
tel 023 8081 7500 fax 023 8081 7600 southampton@ramboll.co.uk
www.ramboll.co.uk

GREEN PARK VILLAGE READING

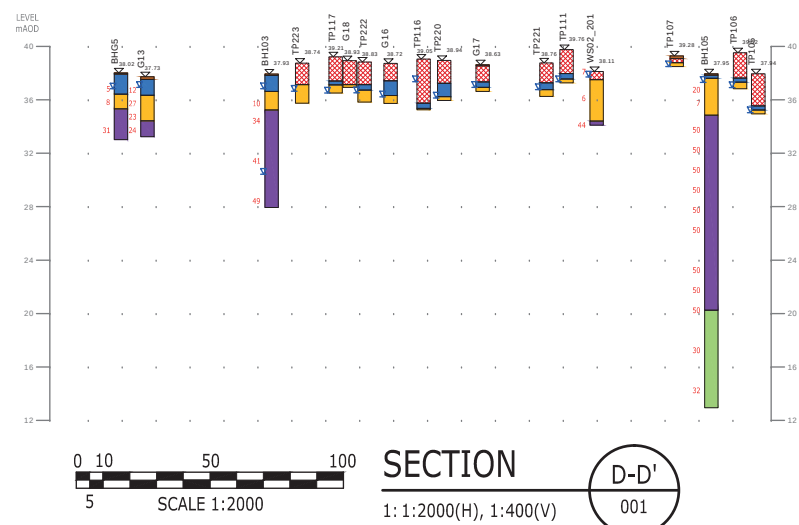
EXPLORATORY HOLE LOCATION PLAN

Rev	Description	Date	By Chk	App
FOR INFORMATION				
Project No:	Scale (@A3):	Drawn:	Date:	
1620000492	1:2500	SKH	FEB.16	
Drawing No:	Rev:			
RAM-GDR-00-DR-CG-001	I01			

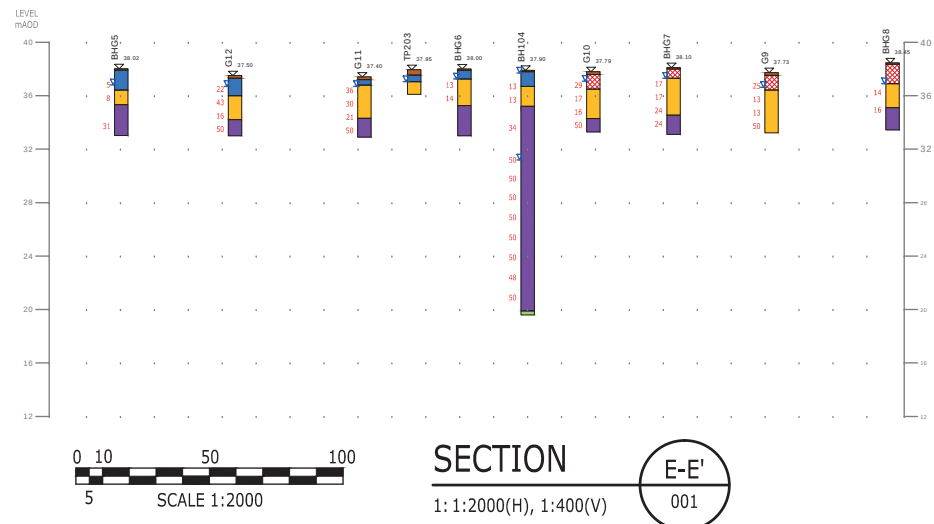
- NOTES:
1. DO NOT SCALE FROM THIS DRAWING.
 2. ALL DIMENSIONS ARE MILLIMETRES U.N.O.
 3. ALL LEVELS ARE IN METRES ABOVE ORDINANCE DATUM U.N.O.
 4. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS AND ENGINEERS DRAWINGS AND SPECIFICATIONS.
 5. ALL EXPLORATORY HOLE LOCATION ARE INDICATIVE ONLY AND SHOULD NOT BE SCALED.
 6. FOR STRATA DETAILS REFER TO EXPLORATORY HOLE LOGS



- NOTES:
- 1. DO NOT SCALE FROM THIS DRAWING.
 - 2. ALL DIMENSIONS ARE MILLIMETRES U.N.O.
 - 3. ALL LEVELS ARE IN METRES ABOVE ORDNANCE DATUM U.N.O.
 - 4. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS AND ENGINEERS DRAWINGS AND SPECIFICATIONS.
 - 5. ALL EXPLORATORY HOLE LOCATION ARE INDICATIVE ONLY AND SHOULD NOT BE SCALED.
 - 6. FOR STRATA DETAILS REFER TO EXPLORATORY HOLE LOGS



- KEY
- TOPSOIL
 - MADE GROUND
 - ALLUVIUM
 - RIVER TERRACE DEPOSITS
 - LAMBETH GROUP
 - CHALK
 - 'N' SPT 'N' VALUE
 - WATERSTRIKE

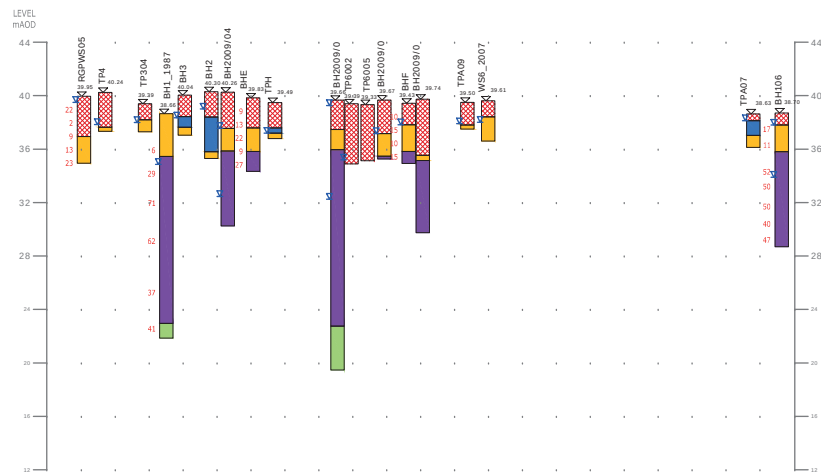


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GREEN PARK VILLAGE
READING

GEOLOGICAL SECTION D-D' & E-E'

Rev	Description	Date	By Chk	App
FOR INFORMATION				
Project No: 1620000492		Scale (@A3): AS SHOWN	Drawn: SKH	Date: FEB.16
Drawing No: RAM-GDR-XX-DR-CG-004			Rev: I01	

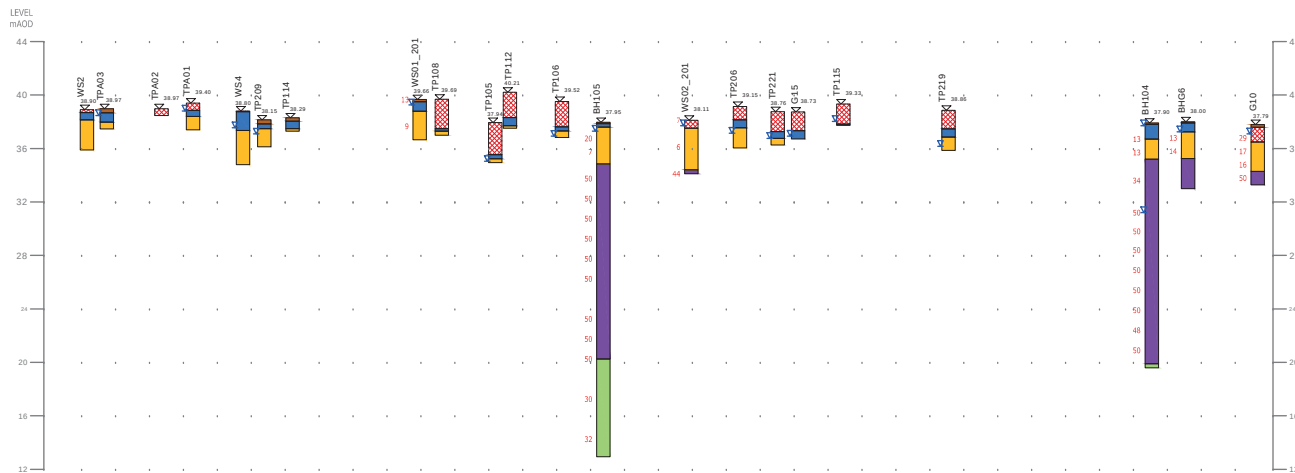


0 10 50 100
5 SCALE 1:2000

SECTION

1: 1:2000(H), 1:400(V)

F-F'
001



0 10 50 100
5 SCALE 1:2000

SECTION

1: 1:2000(H), 1:400(V)

G-G'
001

NOTES:

- DO NOT SCALE FROM THIS DRAWING.
- ALL DIMENSIONS ARE MILLIMETRES U.N.O.
- ALL LEVELS ARE IN METRES ABOVE ORDNANCE DATUM U.N.O.
- THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS AND ENGINEERS DRAWINGS AND SPECIFICATIONS.
- ALL EXPLORATORY HOLE LOCATION ARE INDICATIVE ONLY AND SHOULD NOT BE SCALED.
- FOR STRATA DETAILS REFER TO EXPLORATORY HOLE LOGS

KEY

- TOPSOIL
- MADE GROUND
- ALLUVIUM
- RIVER TERRACE DEPOSITS
- LAMBETH GROUP
- CHALK
- 'N' SPT 'N' VALUE
- WATERSTRIKE



tel 023 8081 7500 fax 023 8081 7600 southampton@ramboll.co.uk
www.ramboll.co.uk

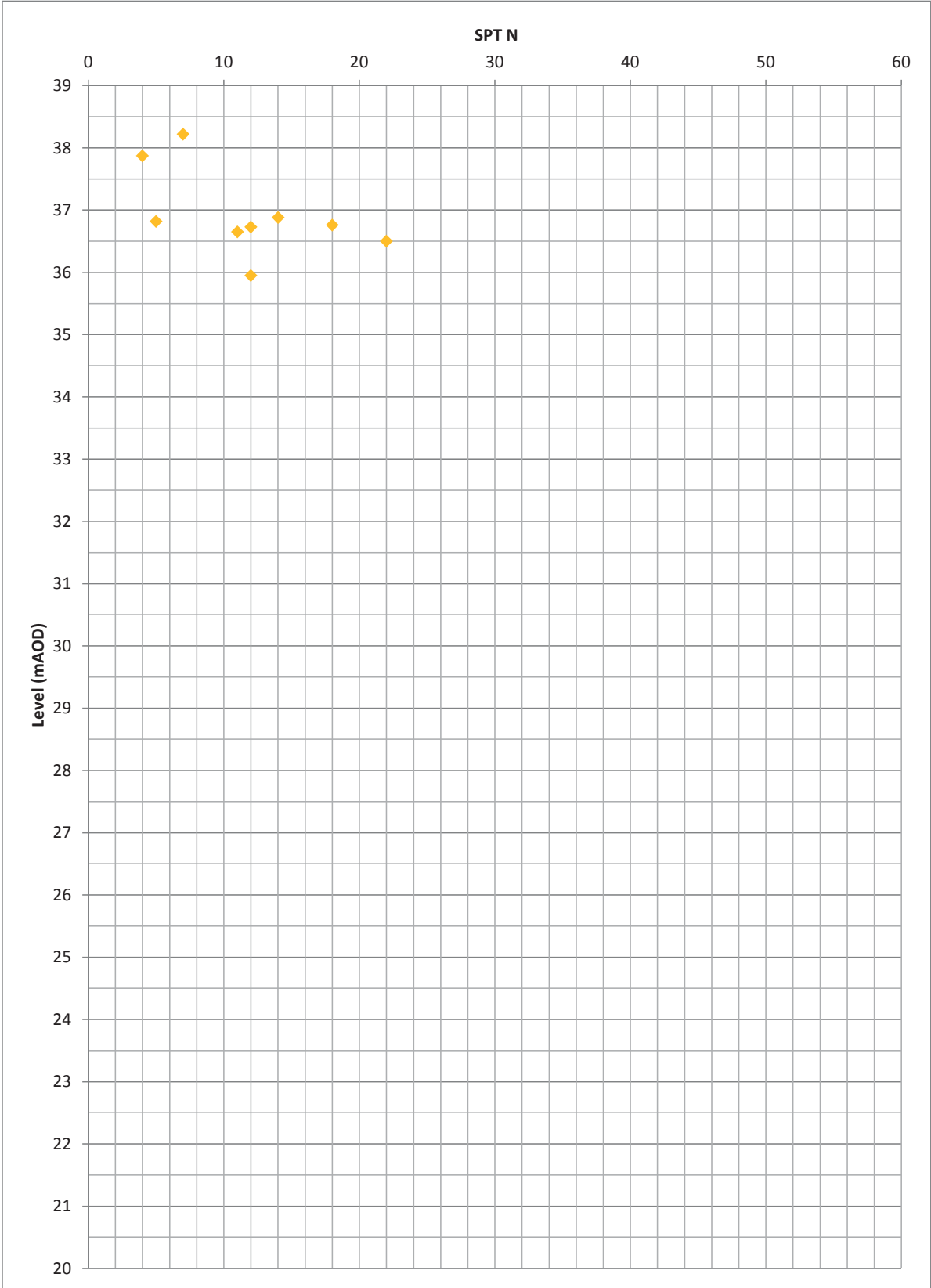
GREEN PARK VILLAGE READING

GEOLOGICAL SECTION F-F' & G-G'

Rev	Description	Date	By Chk	App
FOR INFORMATION				
Project No:	Scale (@A3):	Drawn:	Date:	
1620000492	AS SHOWN	SKH	FEB.16	
Drawing No:	Rev:			
RAM-GDR-XX-DR-CG-005	I01			

APPENDIX 2

DATA PLOTS FOR GEOTECHNICAL TESTS

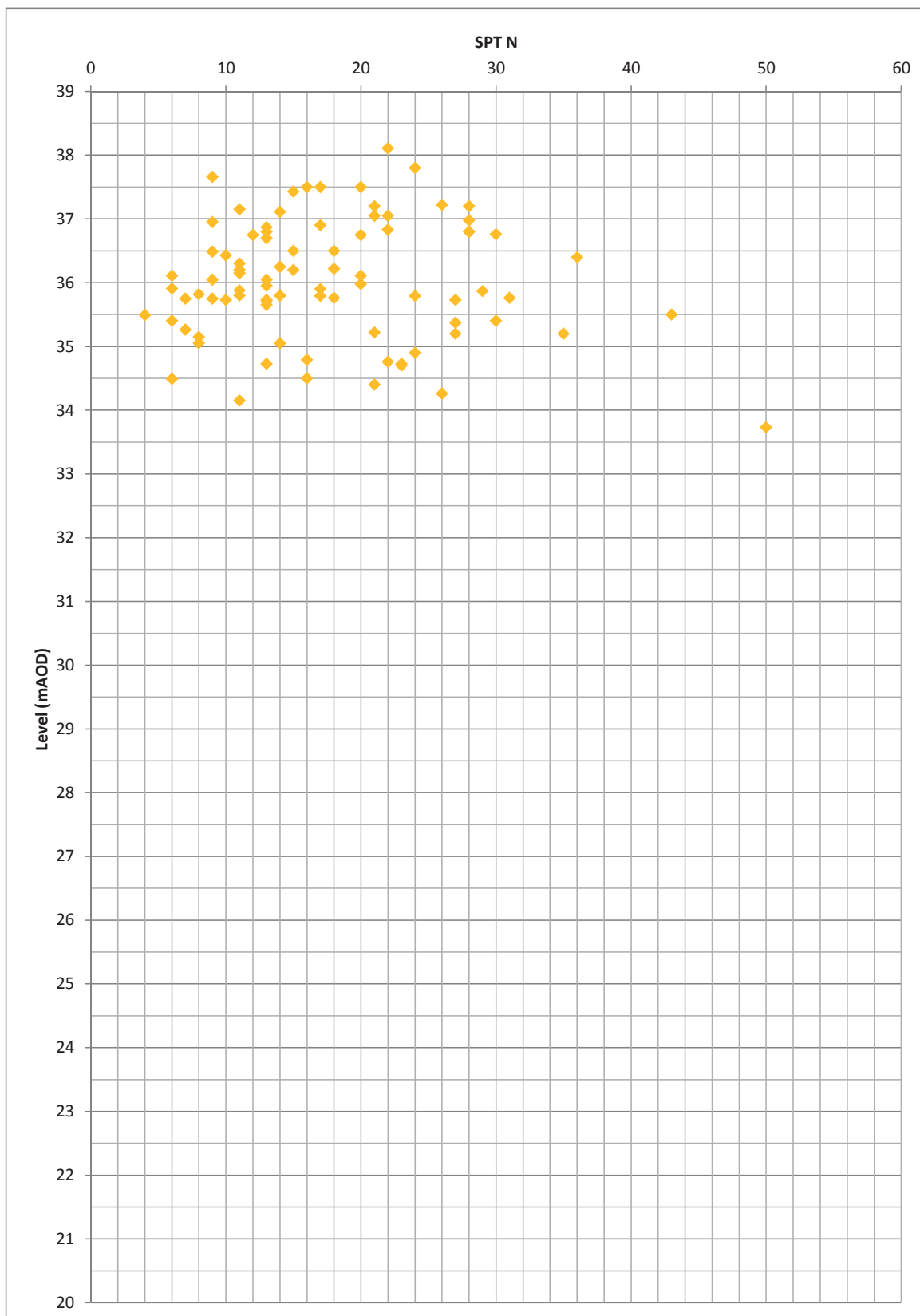


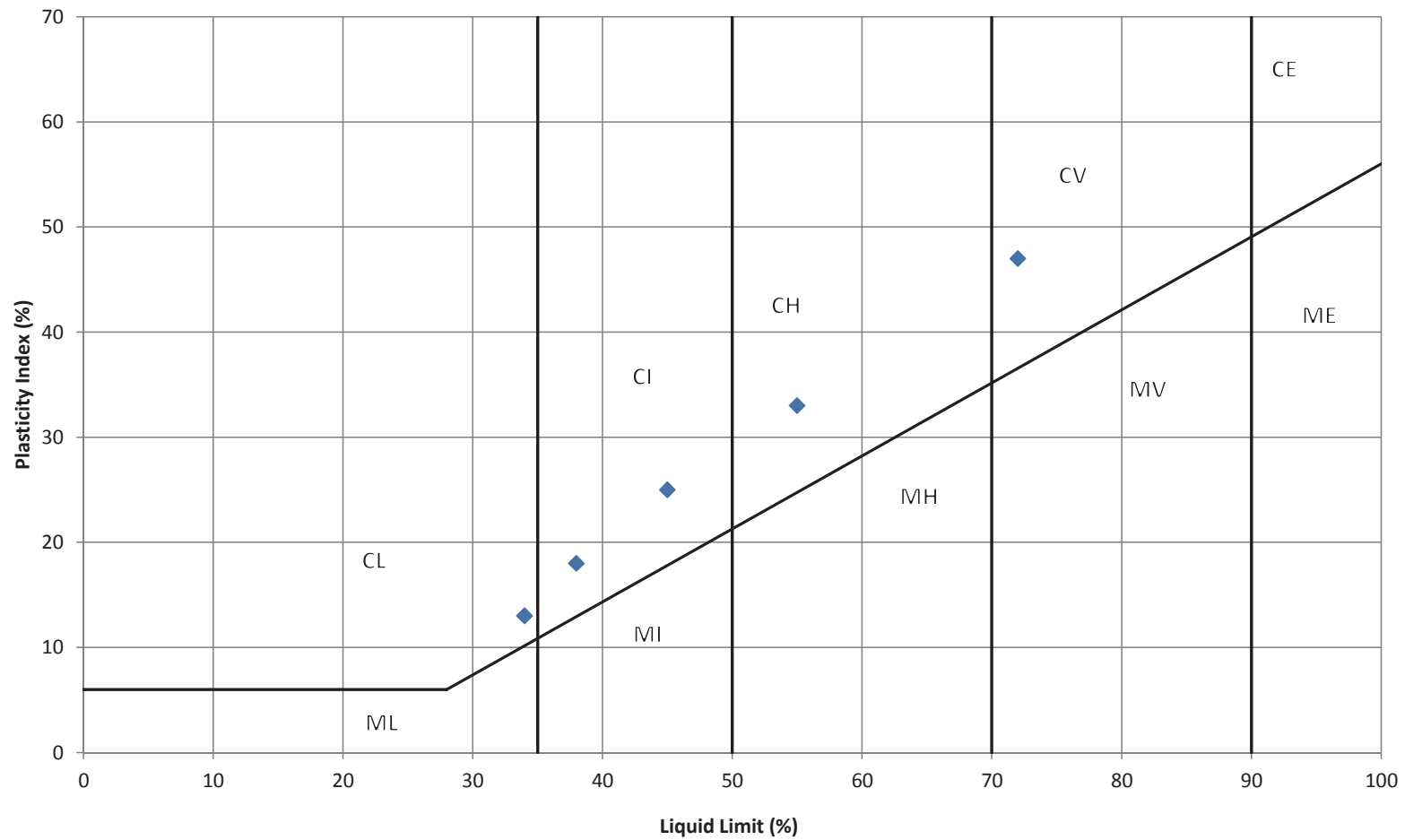
Green Park Village

1620000492

Alluvium SPT N vs Reduced Level

1



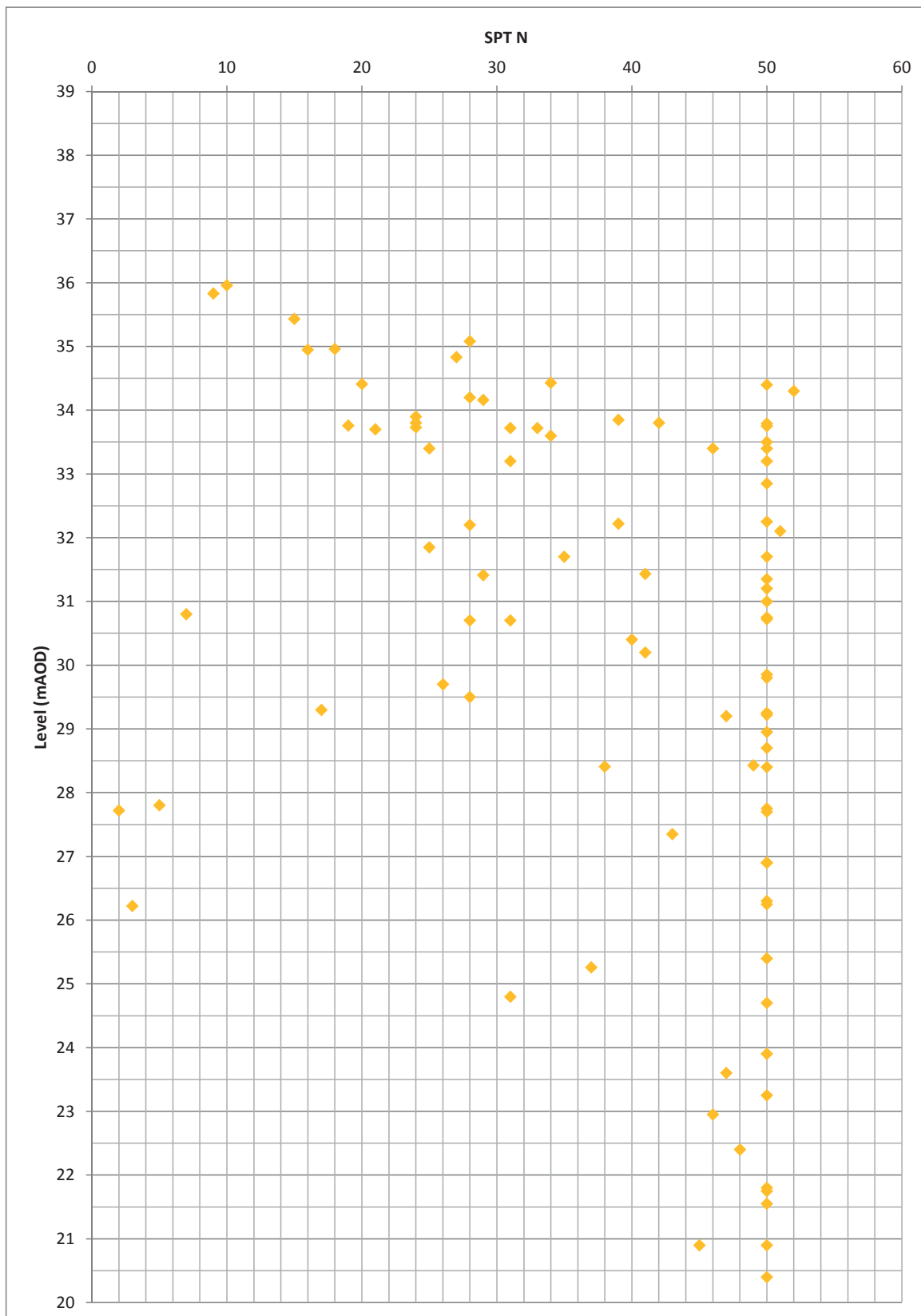


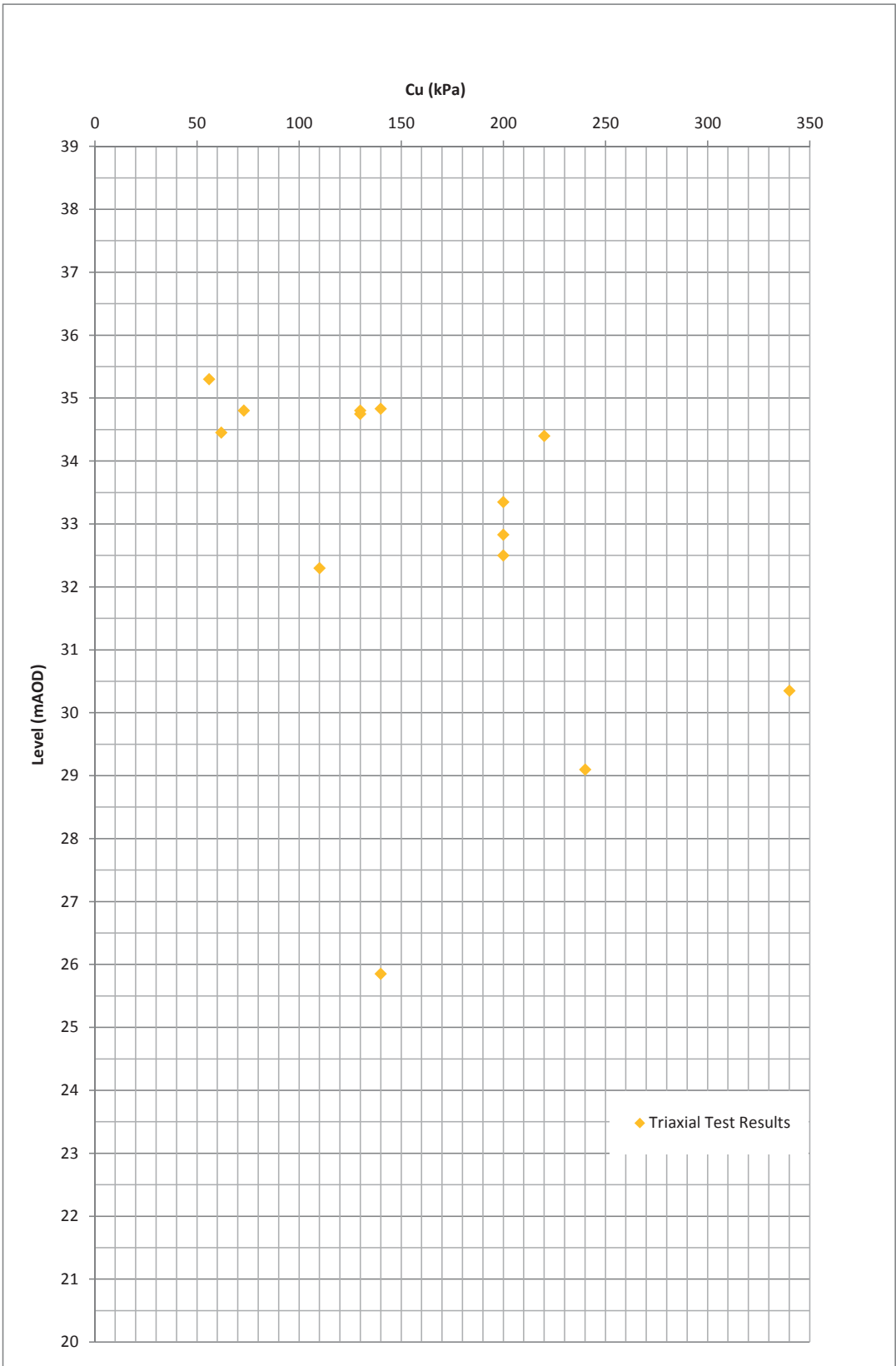
Green Park Village

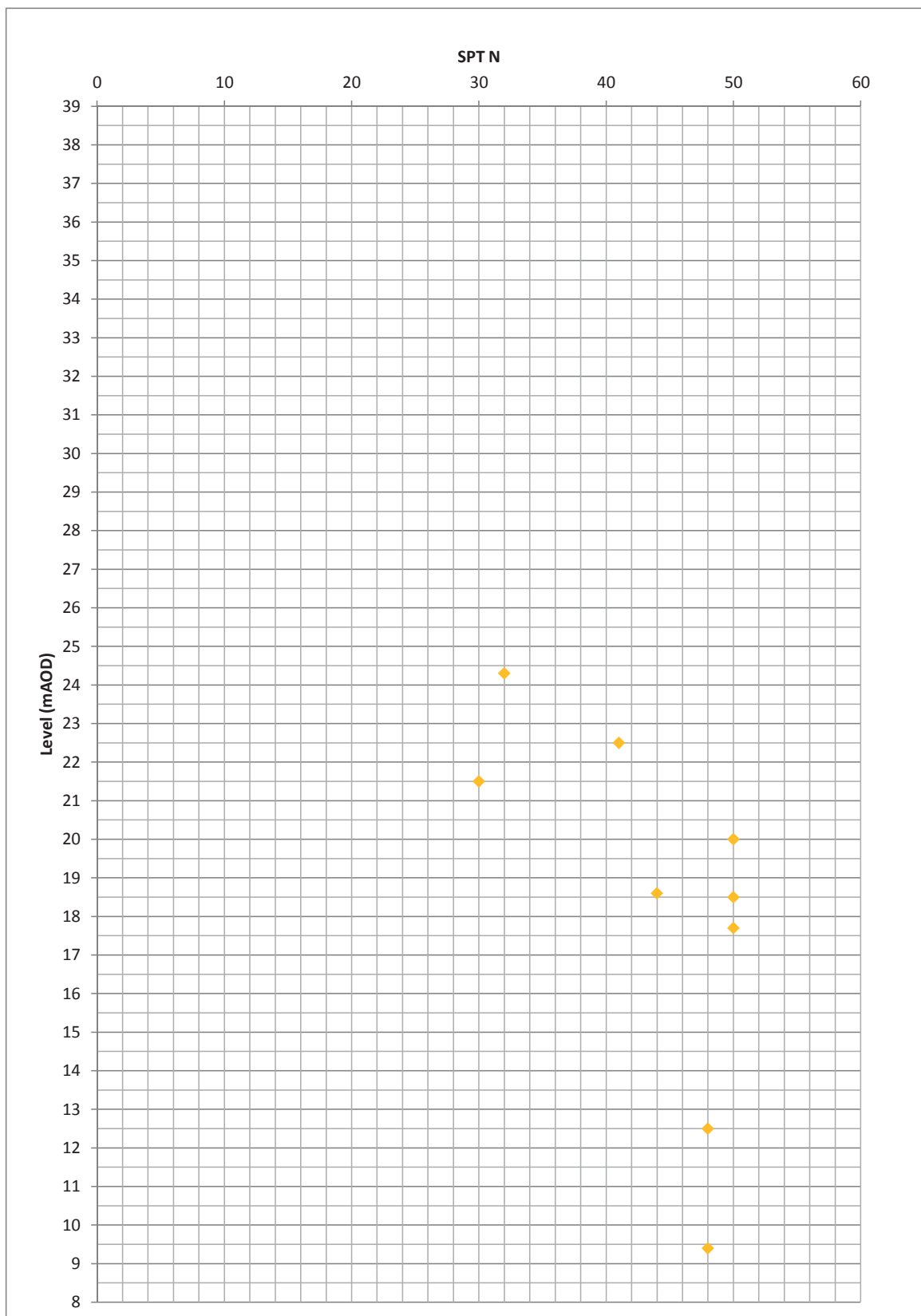
1620000492

Atterberg Limits - Lambeth Group

3





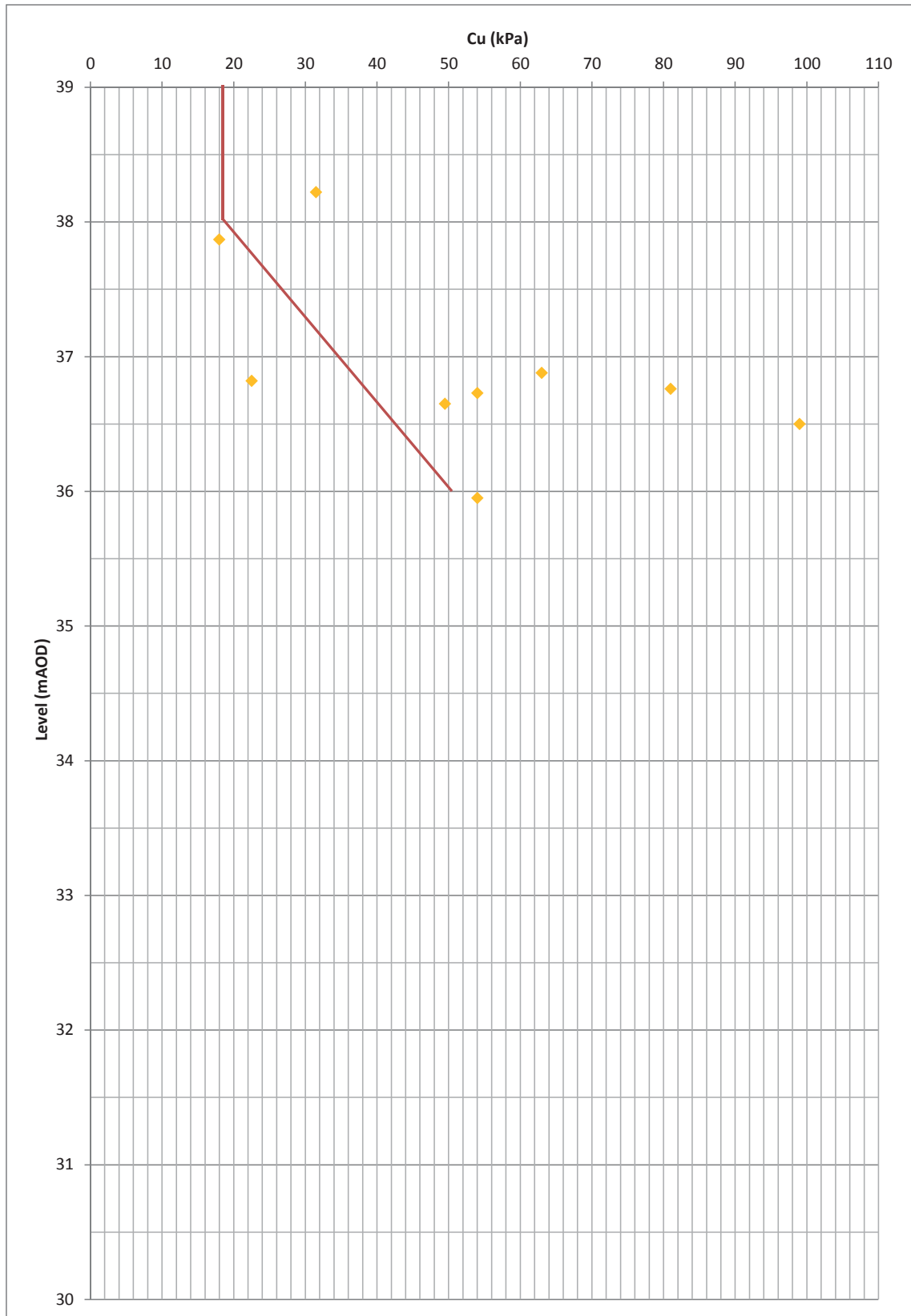


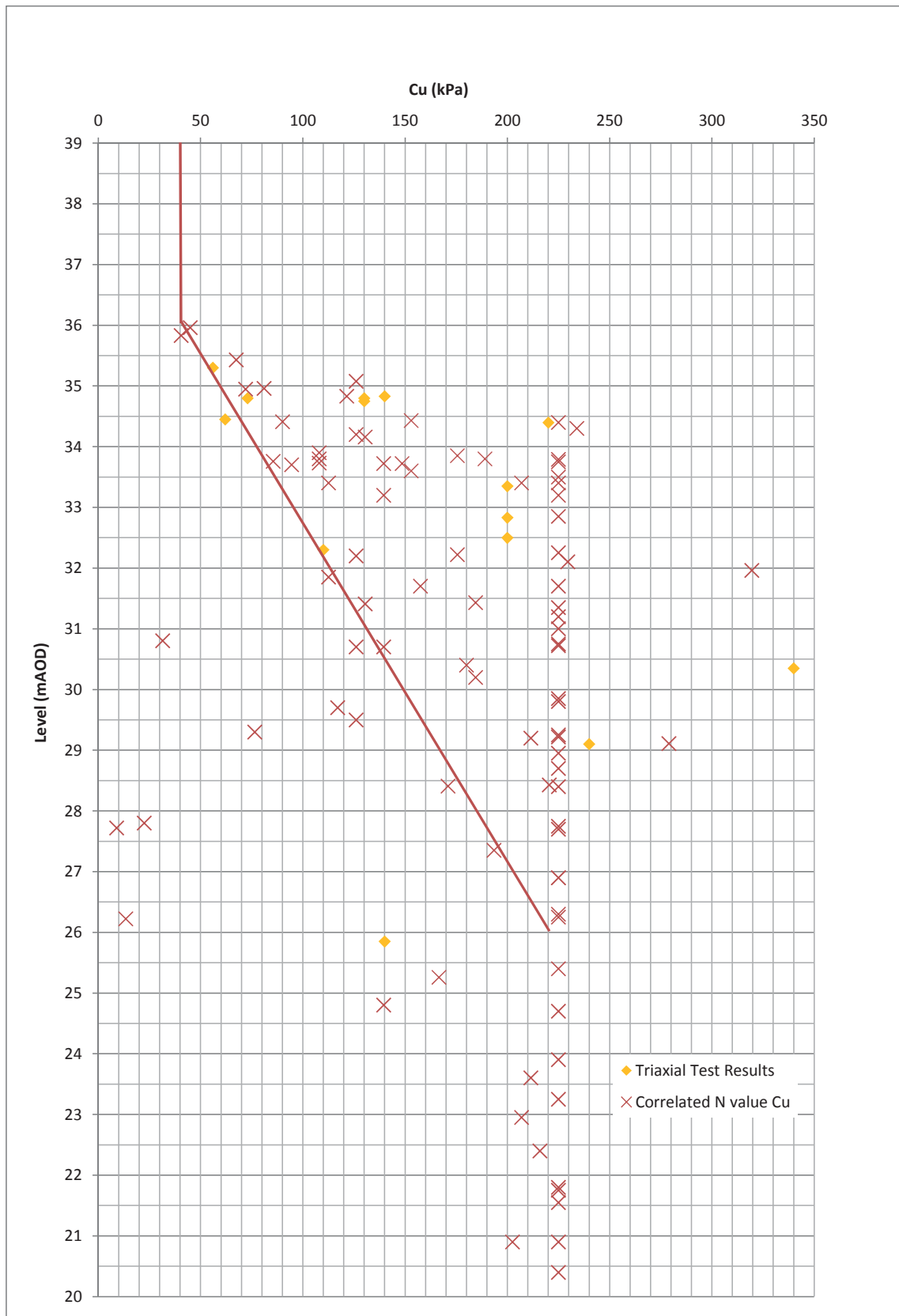
Green Park Village

1620000492

Chalk Formation SPT N vs Reduced Level

6





APPENDIX 3

TEST RESULTS FOR EXISTING FILL MATERIAL

PAGE:	JOB 3700	PLASTICITY INDEX
DATE:18.02.15	GREEN PARK VILLAGE, READING	

LIQUID AND PLASTIC LIMIT RESULTS

To BS 1377: Part 2 Methods 4.6 & 5.3 Air dried sample.

SAMPLE NUMBER	BRIEF SOIL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX NORMAL	% PASSING MODIFIED 425 SIEVE
V 3700/TP4 D.....	Silty CLAY [Alluvium].....	53.....	39.....	14.....	13..... 90.7%
	Clay fraction category:Undetermined				Sample moisture content 26.4%
	Classification to BS 5930				SILT of high plasticity. Subgroup: MH
	NHBC volume change potential:				LOW Minimum recommended depth of foundations 0.75m.
V 3700/TP6 D.....	Gravelly clayey SILT [FILL]....	41.....	26.....	15.....	9..... 62.6%
	Clay fraction category:Undetermined				Sample moisture content 17.8%
	Classification to BS 5930				SILT of intermediate plasticity. Subgroup: MI
	NHBC Classification:				NON SHRINKABLE.
V 3700/TP3 D..	Gravelly sandy clayey SILT [FILL].	38.....	28.....	10.....	9..... 86.5%
	Clay fraction category:Assumed 30-59%				Sample moisture content 21.5%
	Classification to BS 5930				SILT of intermediate plasticity. Subgroup: MI
	NHBC Classification:				NON SHRINKABLE.
V 3700/TP4 D..	Slightly sandy clayey SILT [FILL].	55.....	40.....	15.....	14..... 91.3%
	Clay fraction category:Assumed 30-59%				Sample moisture content 34.1%
	Classification to BS 5930				SILT of high plasticity. Subgroup: MH
	NHBC volume change potential:				LOW Minimum recommended depth of foundations 0.75m.

V = Visual description only.

NOTE: Based on the NHBC Chapter 4.2 'Building near Trees' 2006.

Modified PI = Normal PI x fraction passing 425 micron sieve.

For the modified PI to be used "sufficient sample should be taken to provide confidence that the test results are representative of the soil volume change potential for the site. If in doubt use the higher value of volume change potential". (NHBC Building near trees, Chapter 4.2D5(b)).

Foundation depths given are based on the foundations being outside the influence of existing and newly planted trees and shrubs.

PAGE:	JOB 3700	PLASTICITY INDEX
DATE:18.02.15	GREEN PARK VILLAGE, READING	

LIQUID AND PLASTIC LIMIT RESULTS

To BS 1377: Part 2 Methods 4.6 & 5.3 Air dried sample.

SAMPLE NUMBER	BRIEF SOIL DESCRIPTION	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX NORMAL	% PASSING MODIFIED 425 SIEVE
V 3700/TP5 D...	Very gravelly silty CLAY [FILL]..	50.....	25.....	25.....	21..... 85.2%
	Clay fraction category:Assumed >60%				Sample moisture content 24.7%
	Classification to BS 5930 CLAY of high plasticity. Subgroup: CH				
	NHBC volume change potential: MEDIUM Minimum recommended depth of foundations 0.90m.				
V 3700/TP3 D.....	Silty Clay [Alluvium].....	67.....	47.....	20.....	19..... 97.4%
	Clay fraction category:Undetermined				Sample moisture content 50.1%
	Classification to BS 5930 SILT of high plasticity. Subgroup: MH				
	NHBC volume change potential: LOW Minimum recommended depth of foundations 0.75m.				
V 3700/TP5 D..	Gravelly silty CLAY [Alluvium]....	39.....	28.....	11.....	9..... 84.6%
	Clay fraction category:Undetermined				Sample moisture content 26.6%
	Classification to BS 5930 SILT of intermediate plasticity. Subgroup: MI				
	NHBC Classification: NON SHRINKABLE.				
V 3700/Layer2 D.	Gravelly sandy clayey SILT [FILL].	40.....	29.....	11.....	9..... 86.1%
	Clay fraction category:Assumed 30-59%				Sample moisture content 19.1%
	Classification to BS 5930 SILT of intermediate plasticity. Subgroup: MI				
	NHBC Classification: NON SHRINKABLE.				
V 3700/Layer3 D.	Gravelly sandy silty CLAY [FILL].	47.....	30.....	17.....	13..... 78.8%
	Clay fraction category:Assumed >60%				Sample moisture content 15.9%
	Classification to BS 5930 SILT of intermediate plasticity. Subgroup: MI				
	NHBC volume change potential: LOW Minimum recommended depth of foundations 0.75m.				

V = Visual description only.

NOTE: Based on the NHBC Chapter 4.2 'Building near Trees' 2006.
Modified PI = Normal PI x fraction passing 425 micron sieve.
For the modified PI to be used "sufficient sample should be taken to provide confidence that the test results are representative of the soil volume change potential for the site. If in doubt use the higher value of volume change potential". (NHBC Building near trees, Chapter 4.2D5(b)).

Foundation depths given are based on the foundations being outside the influence of existing and newly planted trees and shrubs.

SUMMARY OF CHEMICAL TESTS ON SOIL

[illegible]

Analysis Performed by: i2 Analytical Ltd, 7 Woodshots Meadow, Croxley Green, Watford, WD18 8YS

Checked and Approved by

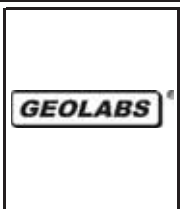
JS

J Sturges (Ops Mgr)

Date: 18/03/2015

Project Number:	GEO / 22299
Project Name:	Green Park Village Project Ref.: 30158

Project Number:	GEO / 22299
Project Name:	Green Park Village Project Ref.: 30158



Determination of Dry Density / Moisture Content Relationship

TP No.: TP 101
 Sample Ref.: -
 Depth (m): 0.90 - 1.10

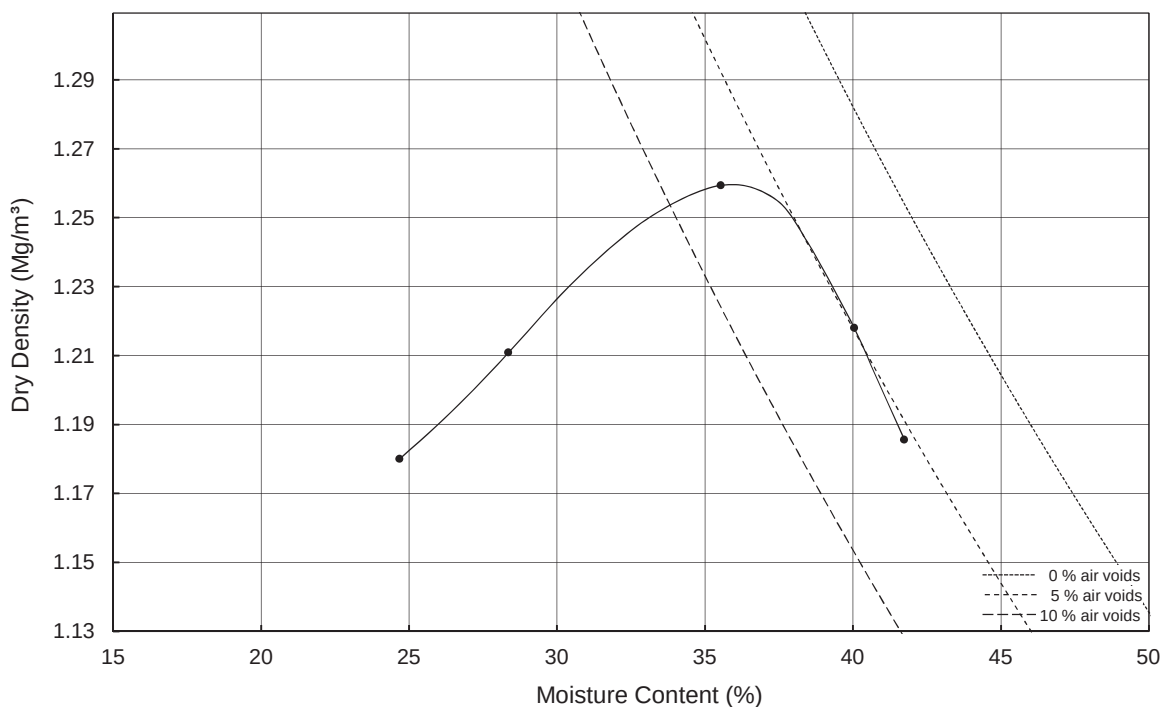
Description:
 Dark brown and brown peaty silty CLAY with rare fine gravel

BS1377 : Part 4 : Clause 3.3.4.1 : 1990 2.5 kg Compaction Test

Sample preparation: Material was air dried. Single sample.
 No particles were removed.
 Particle Density: 2.65 (assumed)

Material retained on 37.5 mm test sieve (%): 0
 Material retained on 20 mm test sieve (%): 0

Compaction (Dry Density/Moisture Content)



Point	1	2	3	4	5	
Moisture Content	25	28	36	40	42	%
Dry Density	1.18	1.22	1.26	1.22	1.19	Mg/m³

Maximum Dry Density **1.26 Mg/m³**
 Optimum Moisture Content **36 %**

Checked and Approved by

JS

J Sturges (Ops Mgr)

Date: 18/03/2015

Project Number:

GEO / 22299

Project Name:

**Green Park Village
 Project Ref.: 30158**

GEOLABS



Determination of Dry Density / Moisture Content Relationship

TP No.: TP 101
 Sample Ref.: -
 Depth (m): 0.90 - 1.10

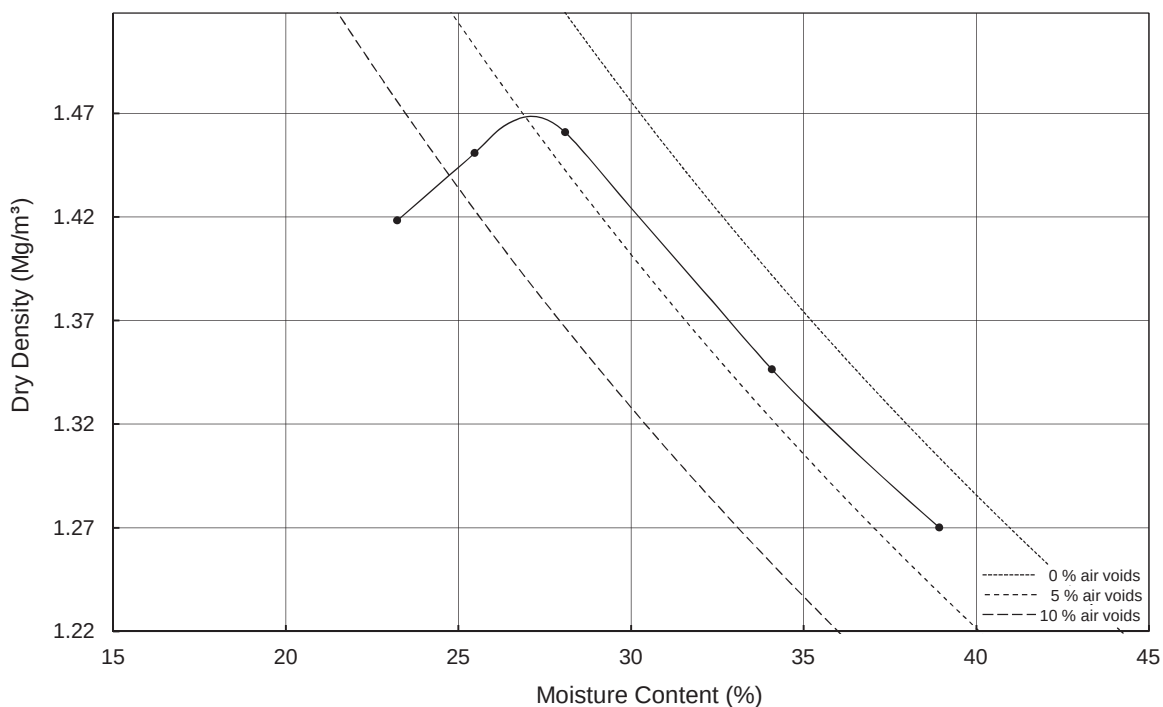
Description:
 Dark brown and brown peaty silty CLAY with rare fine gravel

BS1377 : Part 4 : Clause 3.5.4.1 : 1990 4.5 kg Compaction Test

Sample preparation: Material was air dried. Single sample.
 No particles were removed.
 Particle Density: 2.65 (assumed)

Material retained on 37.5 mm test sieve (%): 0
 Material retained on 20 mm test sieve (%): 0

Compaction (Dry Density/Moisture Content)



Point	1	2	3	4	5	
Moisture Content	23	25	28	34	39	%
Dry Density	1.42	1.45	1.46	1.35	1.27	Mg/m³

Maximum Dry Density **1.47 Mg/m³**
 Optimum Moisture Content **27 %**

Checked and Approved by

JS

J Sturges (Ops Mgr)

Date: 18/03/2015

Project Number:

GEO / 22299

Project Name:

**Green Park Village
 Project Ref.: 30158**

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Determination of Dry Density / Moisture Content Relationship

TP No.: TP 105
 Sample Ref.: -
 Depth (m): 1.20 - 1.50

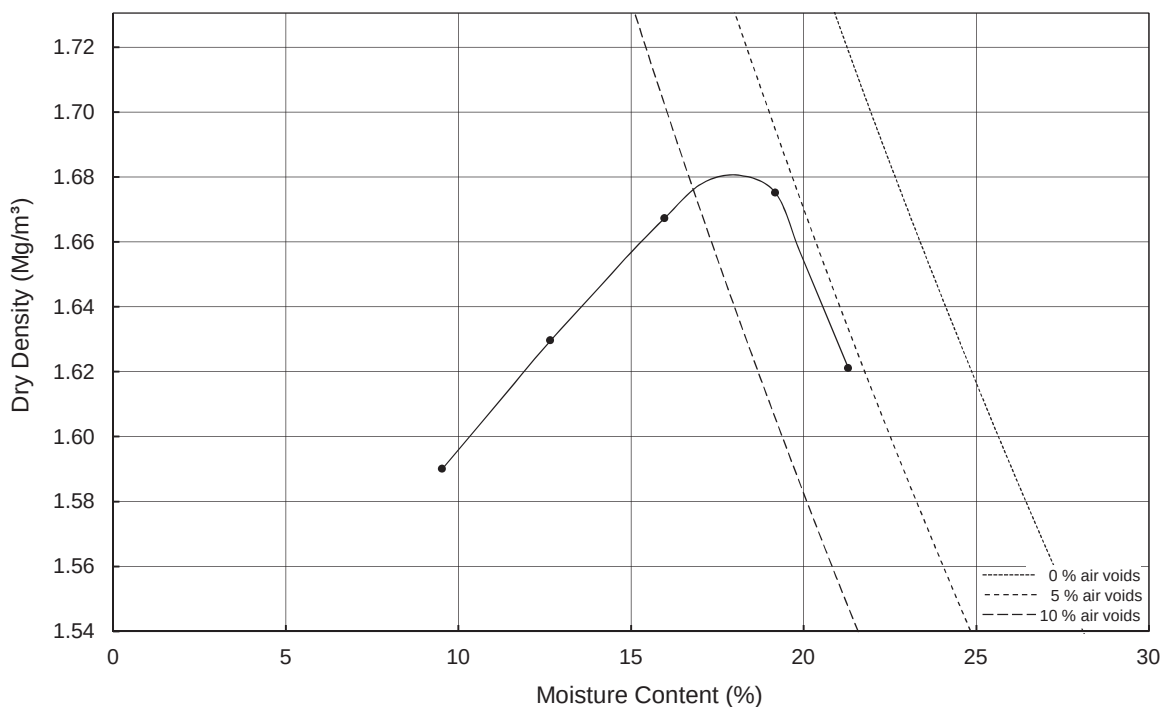
Description:
 Dark brown sandy silty gravelly CLAY. Gravel is fine to medium.

BS1377 : Part 4 : Clause 3.3.4.1 : 1990 2.5 kg Compaction Test

Sample preparation: Material was air dried. Single sample.
 No particles were removed.
 Particle Density: 2.70 (assumed)

Material retained on 37.5 mm test sieve (%): 0
 Material retained on 20 mm test sieve (%): 4

Compaction (Dry Density/Moisture Content)



Point	1	2	3	4	5	
Moisture Content	9.5	13	16	19	21	%
Dry Density	1.59	1.62	1.66	1.67	1.62	Mg/m³

Maximum Dry Density **1.68 Mg/m³**
 Optimum Moisture Content **18 %**

Checked and Approved by

JS

J Sturges (Ops Mgr)

Date: 18/03/2015

Project Number:

GEO / 22299

Project Name:

Green Park Village
Project Ref.: 30158

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Determination of Dry Density / Moisture Content Relationship

TP No.: TP 105
 Sample Ref.: -
 Depth (m): 1.20 - 1.50

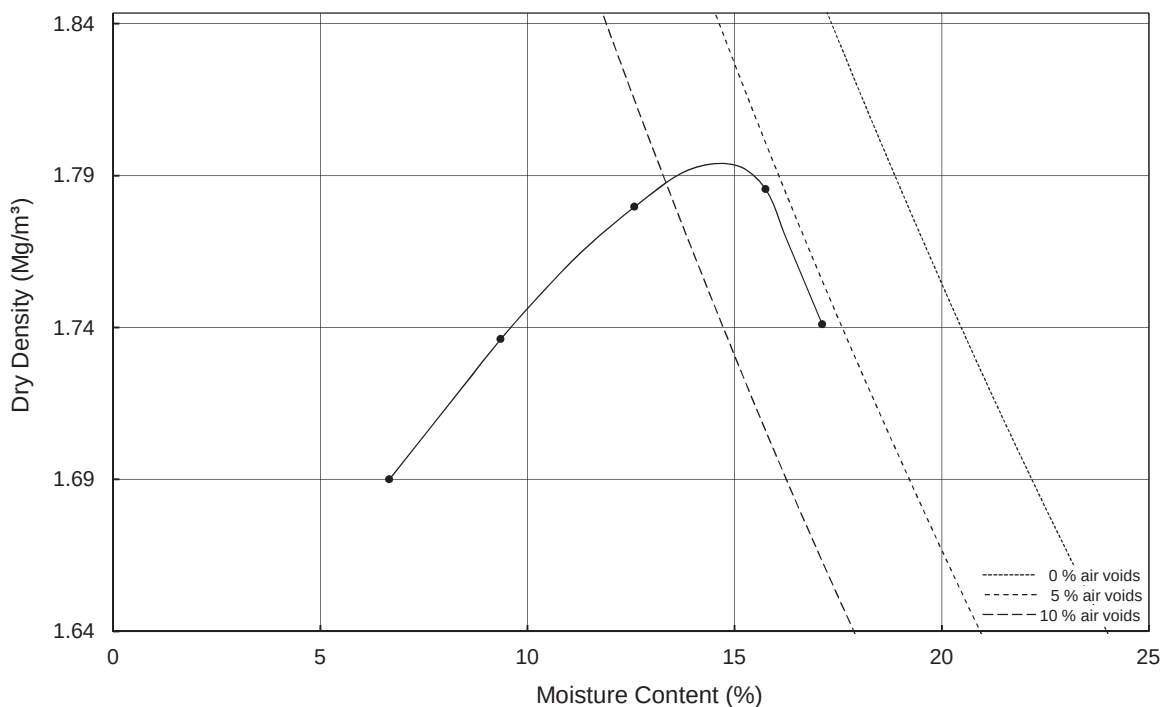
Description:
 Dark brown sandy silty gravelly CLAY. Gravel is fine to medium.

BS1377 : Part 4 : Clause 3.5.4.1 : 1990 4.5 kg Compaction Test

Sample preparation: Material was air dried. Single sample.
 No particles were removed.
 Particle Density: 2.70 (assumed)

Material retained on 37.5 mm test sieve (%): 0
 Material retained on 20 mm test sieve (%): 4

Compaction (Dry Density/Moisture Content)



Point	1	2	3	4	5	
Moisture Content	6.7	9.4	13	16	17	%
Dry Density	1.69	1.74	1.78	1.78	1.74	Mg/m³

Maximum Dry Density **1.79 Mg/m³**
 Optimum Moisture Content **15 %**

Checked and Approved by

JS

J Sturges (Ops Mgr)

Date: 18/03/2015

Project Number:

GEO / 22299

Project Name:

Green Park Village
Project Ref.: 30158

GEOLABS



Determination of Dry Density / Moisture Content Relationship

TP No.: TP 108
 Sample Ref.: -
 Depth (m): 0.20 - 0.40

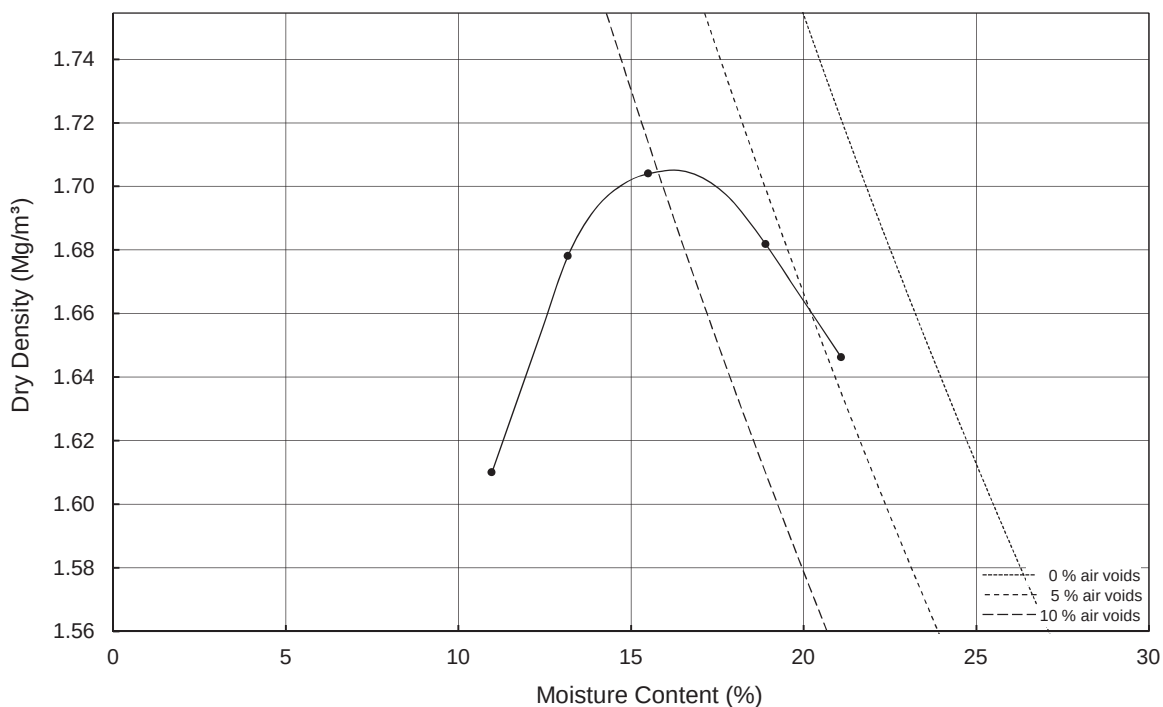
Description:
 Brown silty clayey SAND with lumps of greyish brown gravelly sandy silty CLAY. Gravel is fine to medium.

BS1377 : Part 4 : Clause 3.3.4.1 : 1990 2.5 kg Compaction Test

Sample preparation: Material was air dried. Single sample.
 No particles were removed.
 Particle Density: 2.70 (assumed)

Material retained on 37.5 mm test sieve (%): 0
 Material retained on 20 mm test sieve (%): 0

Compaction (Dry Density/Moisture Content)



Point	1	2	3	4	5	
Moisture Content	11	13	16	19	21	%
Dry Density	1.61	1.68	1.70	1.68	1.65	Mg/m³

Maximum Dry Density **1.70 Mg/m³**
 Optimum Moisture Content **17 %**

Checked and Approved by

JS

J Sturges (Ops Mgr)

Date: 18/03/2015

Project Number:

GEO / 22299

Project Name:

Green Park Village
Project Ref.: 30158

GEOLABS



Determination of Dry Density / Moisture Content Relationship

TP No.: TP 108
 Sample Ref.: -
 Depth (m): 0.20 - 0.40

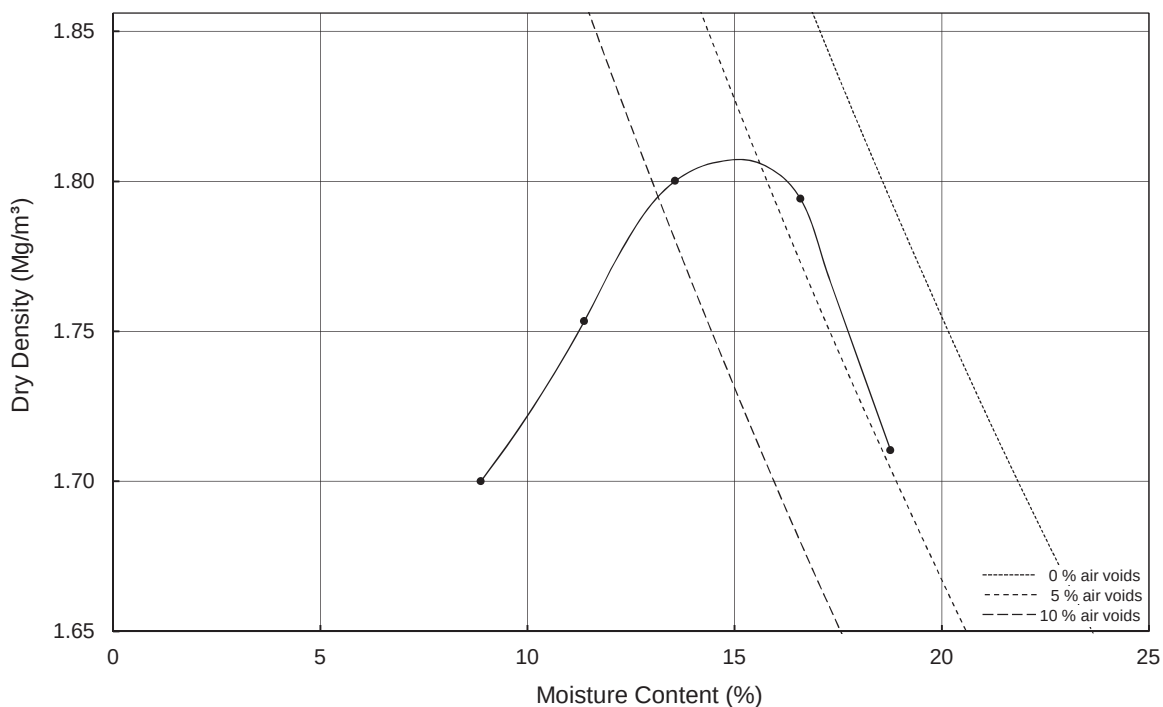
Description:
 Brown silty clayey SAND with lumps of greyish brown gravelly sandy silty CLAY> Gravel is fine to medium.

BS1377 : Part 4 : Clause 3.5.4.1 : 1990 4.5 kg Compaction Test

Sample preparation: Material was air dried. Single sample.
 No particles were removed.
 Particle Density: 2.70 (assumed)

Material retained on 37.5 mm test sieve (%): 0
 Material retained on 20 mm test sieve (%): 0

Compaction (Dry Density/Moisture Content)



Point	1	2	3	4	5	
Moisture Content	8.9	11	14	17	19	%
Dry Density	1.70	1.75	1.80	1.79	1.71	Mg/m³

Maximum Dry Density **1.80 Mg/m³**
 Optimum Moisture Content **16 %**

Checked and Approved by

JS

J Sturges (Ops Mgr)

Date: 18/03/2015

Project Number:

GEO / 22299

Project Name:

Green Park Village
Project Ref.: 30158

GEOLABS



Determination of Dry Density / Moisture Content Relationship

TP No.: TP 109
 Sample Ref.: -
 Depth (m): 1.50 - 1.70

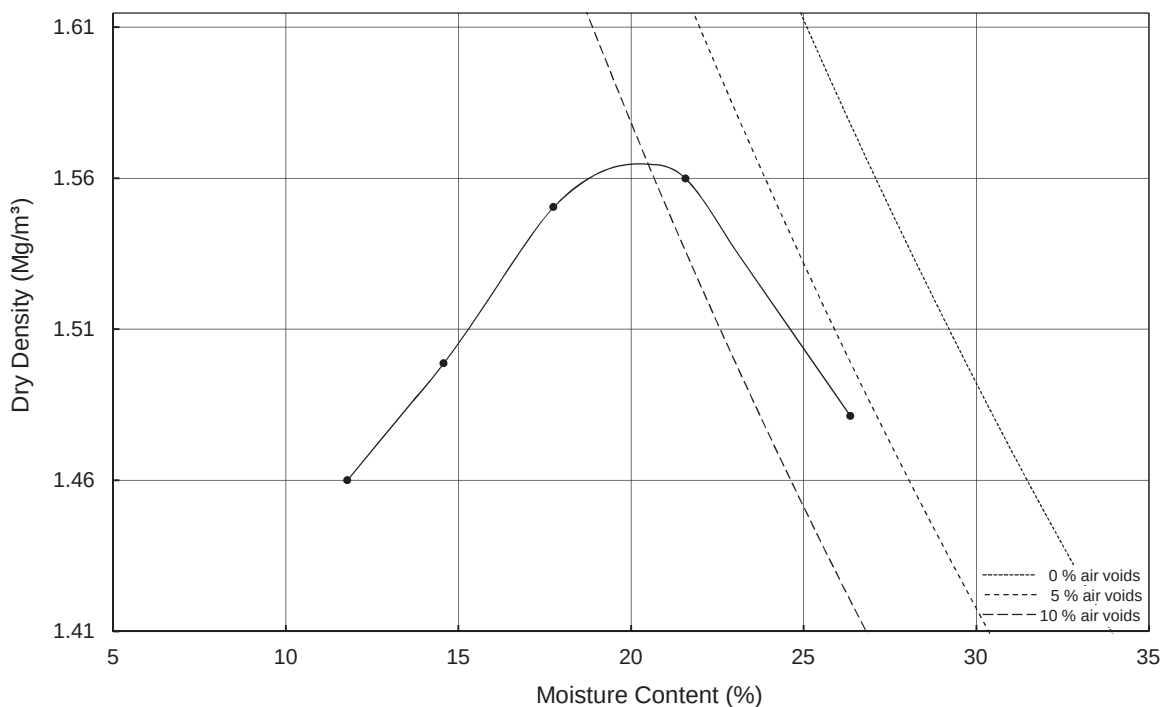
Description:
 Greyish brown gravelly sandy silty CLAY

BS1377 : Part 4 : Clause 3.3.4.1 : 1990 2.5 kg Compaction Test

Sample preparation: Material was air dried. Single sample.
 No particles were removed.
 Particle Density: 2.70 (assumed)

Material retained on 37.5 mm test sieve (%): 0
 Material retained on 20 mm test sieve (%): 3

Compaction (Dry Density/Moisture Content)



Point	1	2	3	4	5	
Moisture Content	12	15	18	22	26	%
Dry Density	1.46	1.50	1.55	1.56	1.48	Mg/m³

Maximum Dry Density **1.56 Mg/m³**
 Optimum Moisture Content **20 %**

Checked and Approved by

JS

J Sturges (Ops Mgr)

Date: 18/03/2015

Project Number:

GEO / 22299

Project Name:

**Green Park Village
 Project Ref.: 30158**

GEOLABS



Determination of Dry Density / Moisture Content Relationship

TP No.: TP 113
 Sample Ref.: -
 Depth (m): 1.10 - 1.30

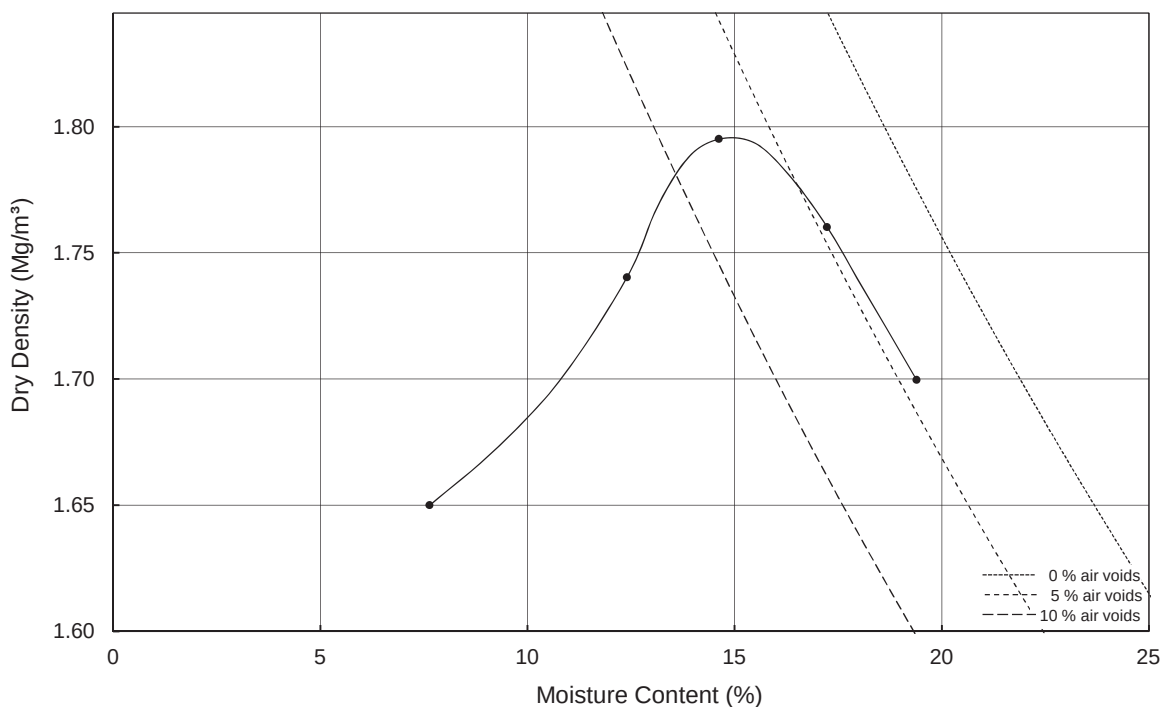
Description:
 Greyish brown gravelly sandy silty CLAY

BS1377 : Part 4 : Clause 3.3.4.1 : 1990 2.5 kg Compaction Test

Sample preparation: Material was air dried. Single sample.
 No particles were removed.
 Particle Density: 2.70 (assumed)

Material retained on 37.5 mm test sieve (%): 0
 Material retained on 20 mm test sieve (%): 2

Compaction (Dry Density/Moisture Content)



Point	1	2	3	4	5	
Moisture Content	7.6	12	15	17	19	%
Dry Density	1.65	1.74	1.79	1.76	1.70	Mg/m³

Maximum Dry Density **1.79 Mg/m³**
 Optimum Moisture Content **15 %**

Checked and Approved by

JS

J Sturges (Ops Mgr)

Date: 18/03/2015

Project Number:

GEO / 22299

Project Name:

Green Park Village
Project Ref.: 30158

GEOLABS



Determination of Dry Density / Moisture Content Relationship

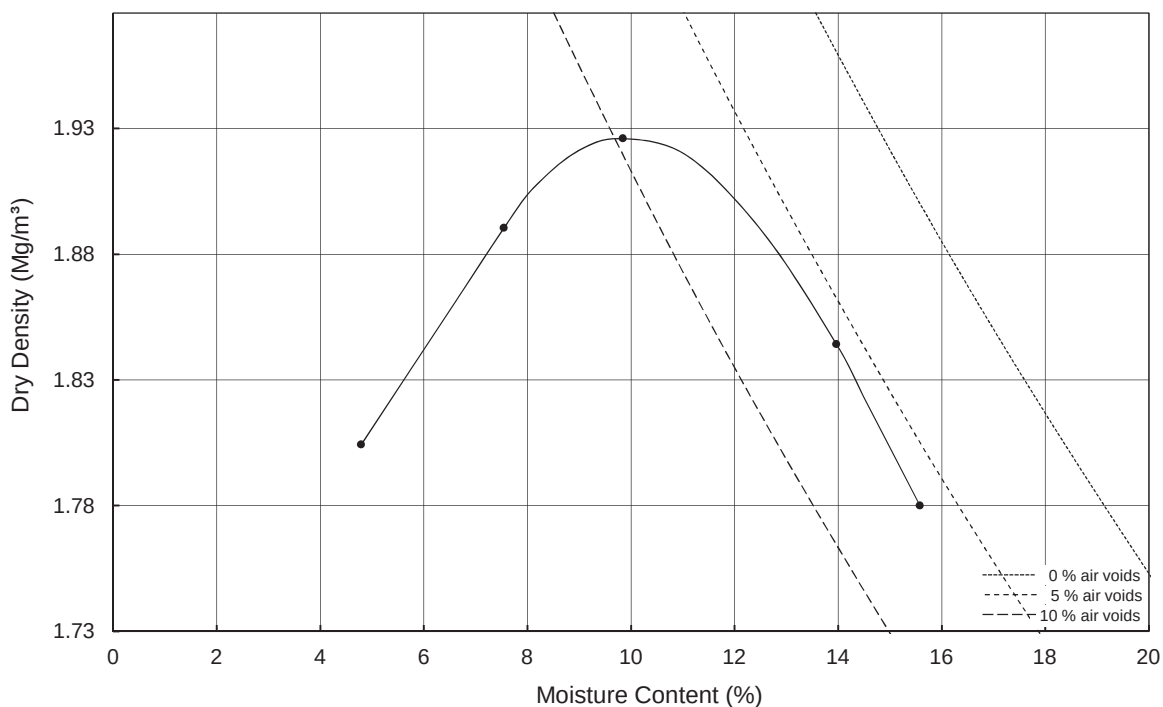
TP No.: TP 113
 Sample Ref.: -
 Depth (m): 1.90 - 2.10

Description:
 Greyish brown gravelly silty CLAY and SAND. Gravel includes brick and broken pipe.

BS1377 : Part 4 : Clause 3.6.4.1 : 1990 4.5 kg Compaction Test

Sample preparation: Material was air dried. Single sample.
 Particles greater than 37.5 mm were replaced by 20 to 37.5 mm material.
 Particle Density: 2.70 (assumed)
 Material retained on 37.5 mm test sieve (%): 5
 Material retained on 20 mm test sieve (%): 12

Compaction (Dry Density/Moisture Content)



Point	1	2	3	4	5	
Moisture Content	4.8	7.5	9.8	14	16	%
Dry Density	1.80	1.89	1.93	1.84	1.78	Mg/m³

Maximum Dry Density **1.93 Mg/m³**
 Optimum Moisture Content **9.8 %**

Checked and Approved by

JS

J Sturges (Ops Mgr)

Date: 18/03/2015

Project Number:

GEO / 22299

Project Name:

Green Park Village
Project Ref.: 30158

GEOLABS



SUMMARY OF GEOTECHNICAL TESTING

Sample details					Classification Tests				Density Tests		Unconfined Compressive Strength				Chemical Tests			Other tests and comments	
TP No.	Sample No.	Depth (m)	Type	Description	MC (%)	LL (%)	PL (%)	PI	<425 µm (%)	Bulk (Mg/m³)	Dry (Mg/m³)	N/A	N/A	UCS (kPa)	Failure Sketch	pH	2:1 W/S SO4 (g/L)		W/S Mg (mg/L)
TP 101	-	0.90 - 1.10	B	Dark brown and brown peaty silty CLAY with rare fine gravel	50	72	32	40	x										Particle Size Distribution, Chemical, 2.5kg Compaction, 4.5kg Compaction
TP 102	-	0.40 - 0.60	B		19	52	18	34	x										Particle Size Distribution
TP104	-	0.40 - 0.40	B		19	49	22	27	x										Particle Size Distribution
TP104	-	1.10 - 1.30	B	Dark brown silty sandy CLAY. Gravel includes concrete and mortar.	19	46	21	25	x										Particle Size Distribution, Chemical, 2.5kg Compaction
TP 105	-	0.30 - 0.50	B		13	NP	NP	NP	x										Particle Size Distribution. Atterberg is Non-plastic
TP 105	-	1.20 - 1.50	B	Brown silty clayey SAND with lumps of greyish brown gravelly sandy silty CLAY. Gravel is fine to medium.	26	43	19	24	x										Particle Size Distribution, Chemical, 2.5kg Compaction, 4.5kg Compaction
TP 108	-	0.20 - 0.40	B	Brown silty clayey SAND with lumps of greyish brown gravelly sandy silty CLAY. Gravel is fine to medium.	22	38	19	19	x										Particle Size Distribution, 2.5kg Compaction, 4.5kg Compaction
TP 109	-	1.50 - 1.70	B	Greyish brown gravelly sandy silty CLAY	34	52	25	27	x										Particle Size Distribution, Chemical, 2.5kg Compaction
TP 110	-	0.50 - 0.70	B		27	56	21	35	x										Particle Size Distribution
TP 112	-	0.40 - 0.60	B		25	32	14	18	x										Particle Size Distribution
TP 113	-	1.10 - 1.30	B	Greyish brown gravelly sandy silty CLAY	20	41	15	26	x										Particle Size Distribution, Chemical, 2.5kg Compaction
TP 113	-	1.90 - 2.10	B	Greyish brown gravelly silty CLAY and SAND. Gravel includes brick and broken pipe.	x														Particle Size Distribution, 4.5kg Compaction

Sample type: B (Bulk disturb.) BLK (Block) C (Core) D (Disturbed) LB (Large Bulk dist.) U (Undisturbed)

Checked and Approved by

Project Number:

Project Name:

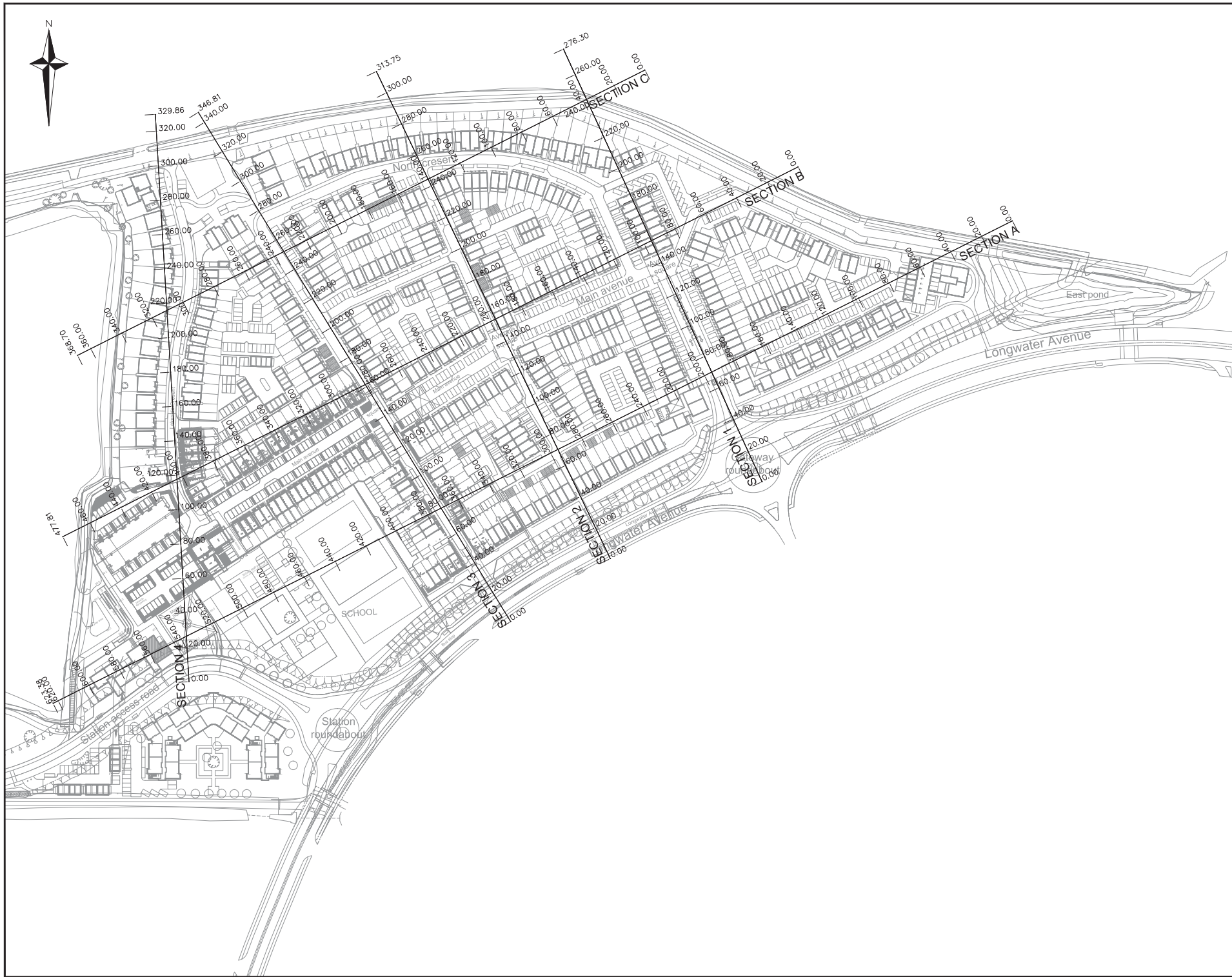
GEO / 22299

Green Park Village
Project Ref.: 30158



APPENDIX 4

GCL PLANS AND SECTIONS



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Rev	Description	Date	Chkd
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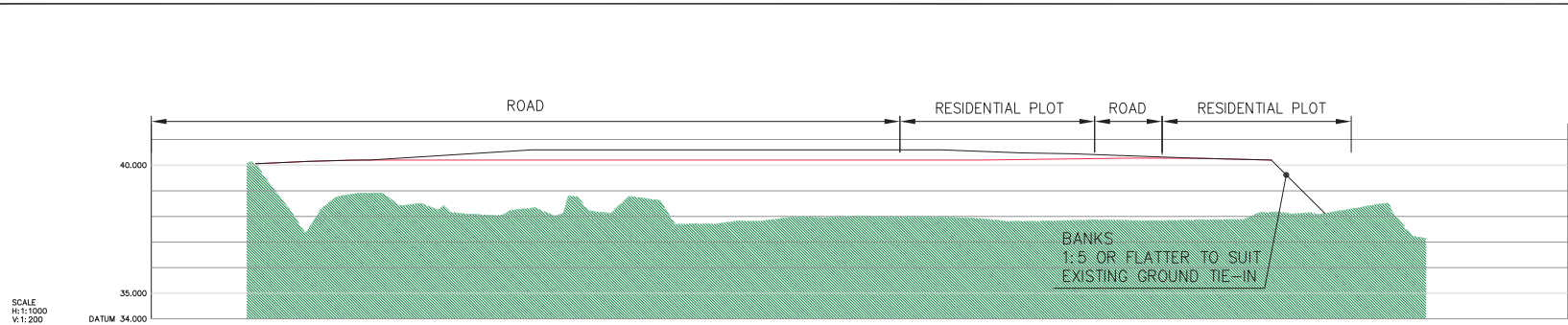


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Project : GREEN PARK VILLAGE READING

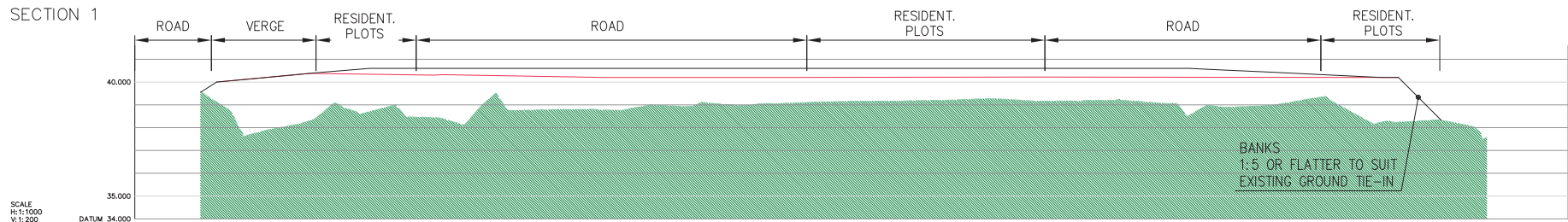
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Project Engineer :	MG	Scale :	1:1000 @ A1
Project Director :	HBG	Date :	JUNE 2015
Status :	PRELIMINARY		

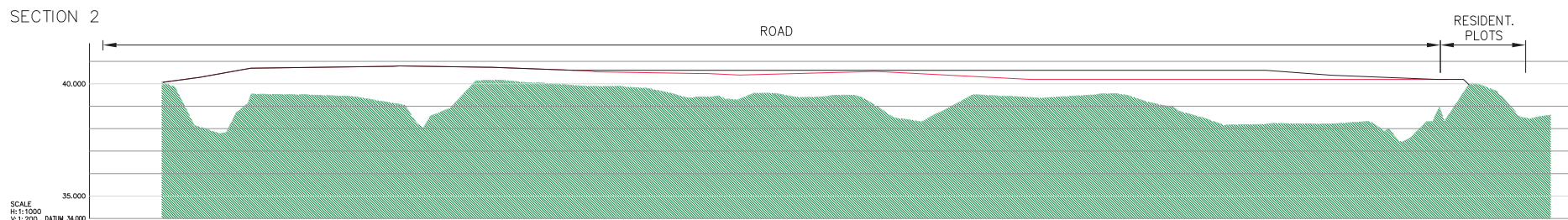
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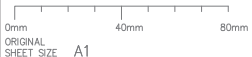
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KEY:

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- GLANVILLE EARTHWORKS LEVEL
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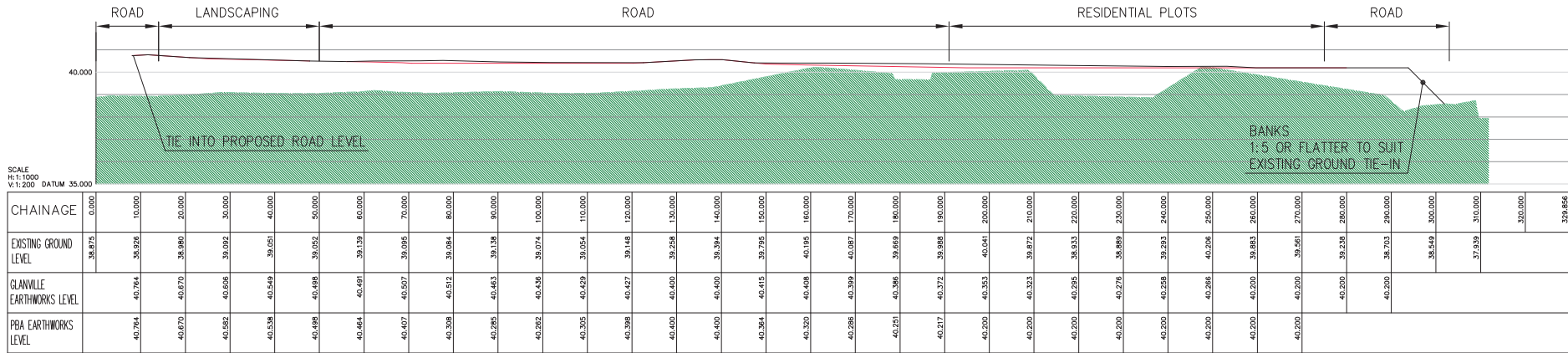


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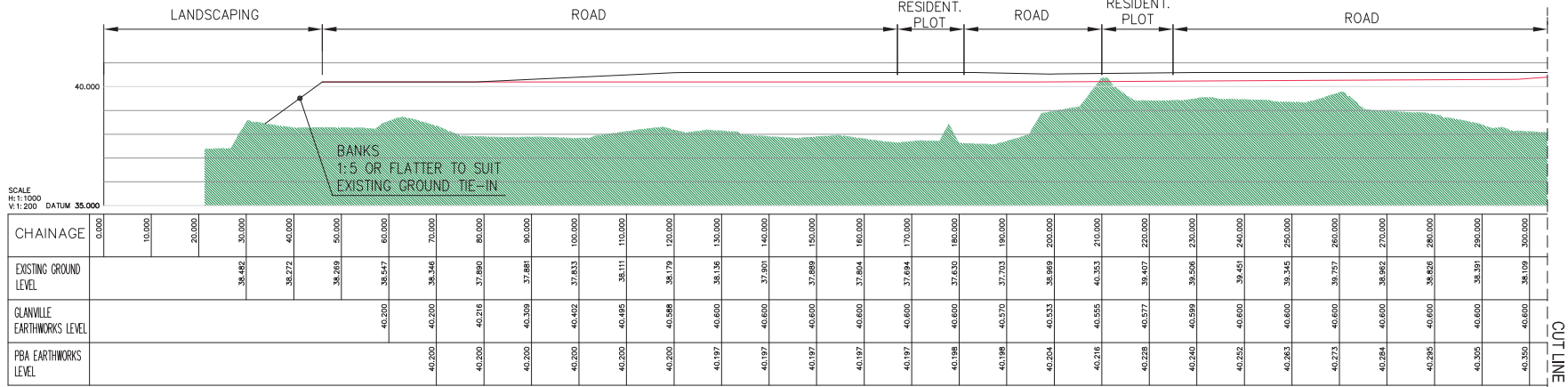
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Project Director : HBG Date : JUNE 2015
Status : PRELIMINARY

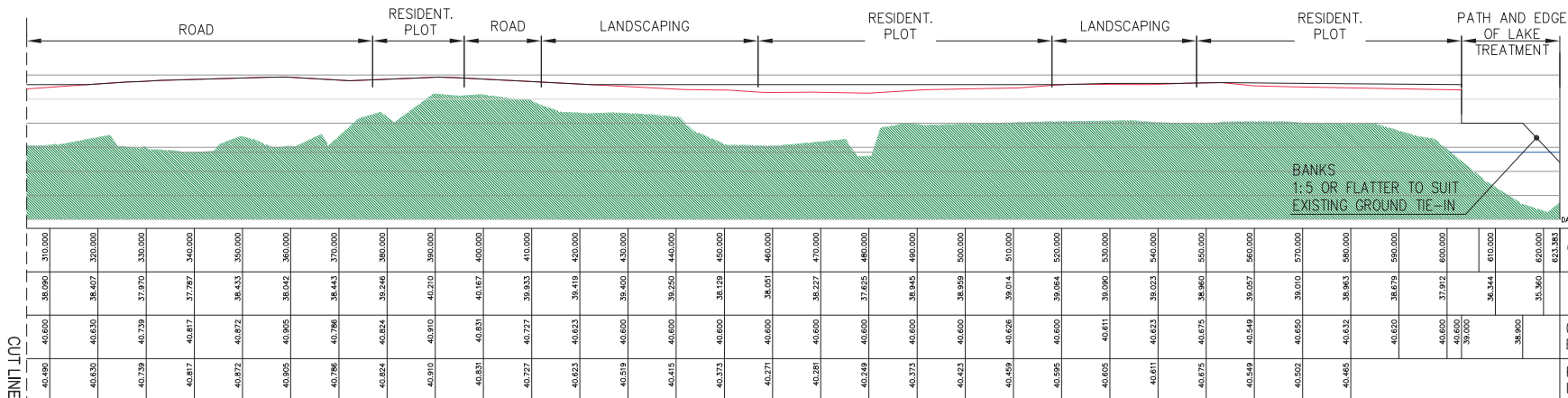
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SECTION 4



SECTION A-part 1



SECTION A-part 2

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Client: **Berkeley**

Project: **GREEN PARK VILLAGE READING**

Title: **PROPOSED LEVEL DEVELOPMENT SECTIONS SHEET 2 OF 3**

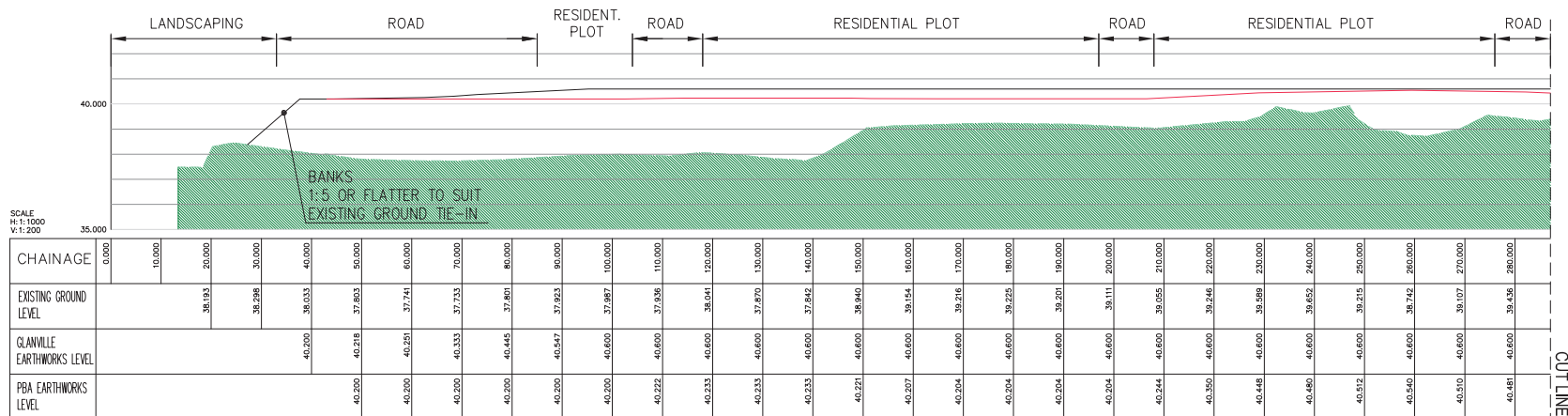
Project Engineer: MG Scale: AS SHOWN

Project Director: HBG Date: JUNE 2015

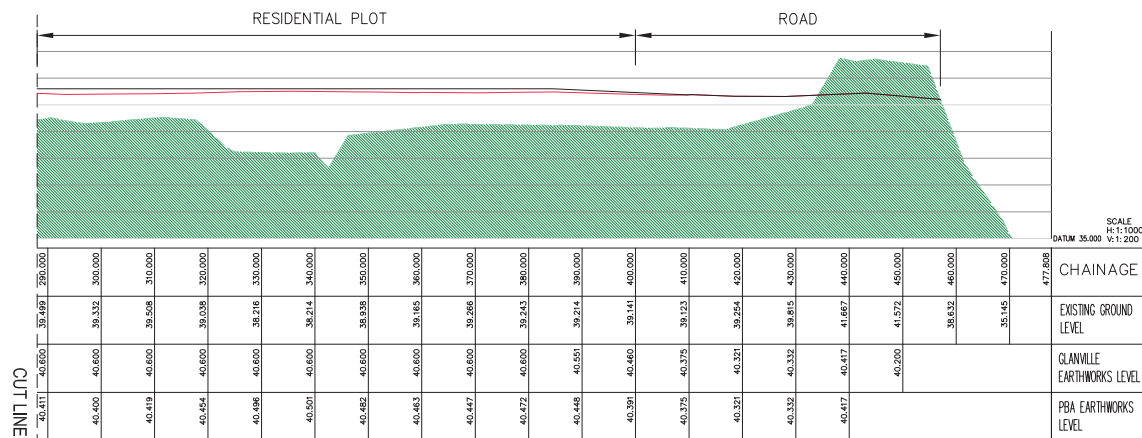
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Drawing No. 4140564-1103

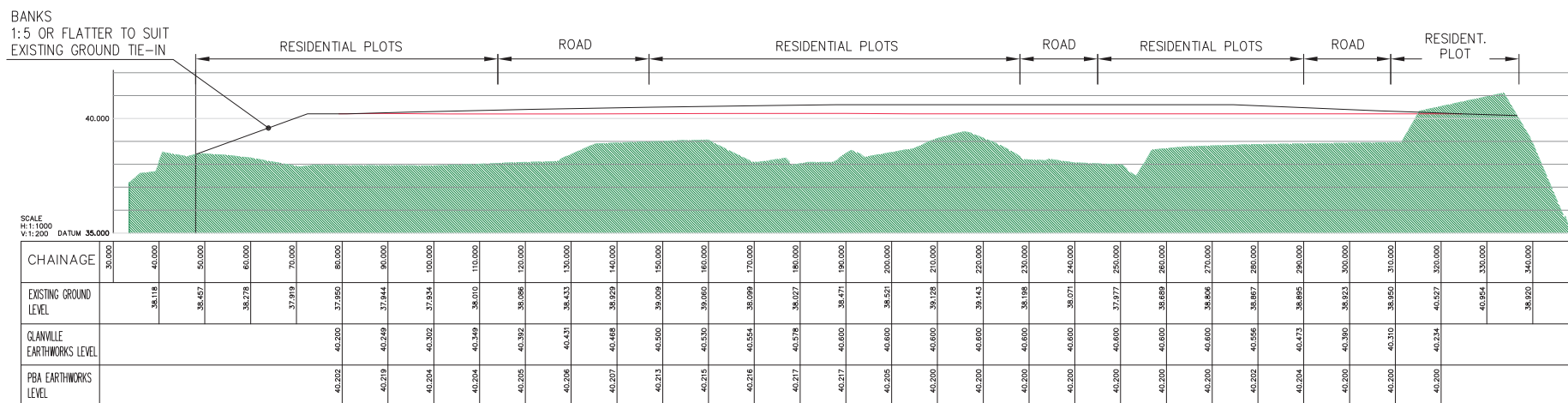
Rev P1



SECTION B-part 1



SECTION B-part 2



SECTION C

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- PBA EARTHWORKS LEVEL

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Rev.	Description	Date	Chld

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Client: **Berkeley**

Project: **GREEN PARK VILLAGE READING**

Title: **PROPOSED LEVEL DEVELOPMENT SECTIONS SHEET 3 OF 3**

Project Engineer: MG Scale: AS SHOWN
Project Director: HBG Date: JUNE 2015
Status: PRELIMINARY

Drawing No. 4140564-1104 Rev P1

APPENDIX 5 REPORT RELIANCE

Notwithstanding any other provisions of this report and in consideration of the sum of ten pounds (£10.00) paid by both St Edward Homes Limited, Berkeley Homes (Western) Limited and Berkeley Homes plc, we Ramboll UK Limited hereby acknowledge receipt of the aforementioned consideration and hereby irrevocably acknowledge and agree that St Edward Homes Limited, Berkeley Homes (Western) Limited and Berkeley Homes plc and any parties acquiring an interest in the works to be carried out at the site and/or the property/properties in respect of which this report has been carried out and/or the property and/or the land in respect of which this report has been carried out or any part or parts thereof (the **Project**) and/or any party providing finance and/or refinance in connection with the Project and any contractors involved in the development of the site/property to which this report relates and their assigns shall have relied and will continue to rely on the findings of this report and in so doing we acknowledge a duty of care to them provided that the duty of care shall be no greater in terms of obligation than that owed to the company/body who has commissioned the report from us as if the beneficiary had been named jointly with the company/body who have commissioned the report in such commission/appointment.

Appendix B:
Drainage Calculations

Appendix C:
Sewer Records

Appendix D:
PBA original FRA for Green Park Village



St. Edward Homes

Green Park Village

Flood Risk Assessment

Project Ref: 11321/2008

Doc Ref: R001/rev A

July 2010

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Document Control Sheet

Project Name: Green Park Village
Project Ref: 11321/2008
Report Title: Flood Risk Assessment
Doc Ref: R001/rev A
Date: July 2010

Name	Position	Signature	Date
C. Brown	Engineer		02.08.2010
D. Hayes	Associate		02.08.2010
J. Share	Principal Engineer		02.08.2010

For and on behalf of Peter Brett Associates LLP

Revision	Date	Description	Prepared	Reviewed	Approved
0	15.07.2010	Draft for comment	C. Brown	D. Hayes	J. Share
A	02.08.2010	Final	C. Brown	D. Hayes	J. Share

Peter Brett Associates LLP disclaims any responsibility to the Client and others in respect of any matters outside the scope of this report. This report has been prepared with reasonable skill, care and diligence within the terms of the Contract with the Client and generally in accordance with the appropriate ACE Agreement and taking account of the manpower, resources, investigations and testing devoted to it by agreement with the Client. This report is confidential to the Client and Peter Brett Associates LLP accepts no responsibility of whatsoever nature to third parties to whom this report or any part thereof is made known. Any such party relies upon the report at their own risk.

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Appendices

Appendix 1 – Site Location Plan
Appendix 2 – Topographic Survey
Appendix 3 – Proposed Site Layout
Appendix 4 – Environment Agency Flood Zone Mapping
Appendix 5 – Foudry Brook – Flood Storage Proposals, Lewin, Fryer & Partners, September 1985
Appendix 6 – Foudry Brook Proposed New Channel – M4 to River Kennet, PBA, May 1984
Appendix 7 – Green Park Flood Alleviation Scheme Overview
Appendix 8 – PBA/EA licence for Lower Kennet 2D Hydraulic Model
Appendix 9 – Model Node Location Plan
Appendix 10 – Level updates to Hydraulic Model
Appendix 11 – Key Structures
Appendix 12 – Comparison of Modelling Results
Appendix 13 – Dry Access Routes
Appendix 14 – RBC Correspondence, dated 26th June 2007

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1 Introduction

This Flood Risk Assessment (FRA) has been prepared in support of a planning application by St. Edward Homes for the proposed development of Green Park Village in Reading. A site location plan is contained in Appendix 1.

Government planning policy with respect to flood risk is contained within Planning Policy Statement 25: Development and Flood Risk (PPS25), which was revised in March 2010, and its accompanying practice guidance, issued in June 2008.

This report summaries the methodology and results of the site specific FRA for Green Park Village and has been prepared in consultation with the Local Planning Authority (LPA) and the Environment Agency (EA) and in accordance with PPS25.

The final decision with regard to any planning application lies with the LPA, Reading Borough Council. The EA is a designated statutory consultee and plays a key role in providing advice on development and flood risk issues to aid the LPA in forming its decision.

Peter Brett Associates LLP (PBA), Consulting Engineers are specialists in, amongst other areas, hydrology, flood defence and river engineering.

2 Proposed Development Site

2.1 Site Location and Plan

Green Park is an existing commercial business park situated in the south of Reading adjacent to the M4 and to the west of the A33. Construction on Phases 1 and 2 of the development commenced in 1995 and continues today. In total the development is set to provide 2.25M ft² of commercial office and retail space.

Green Park Village is located immediately to the west of Longwater Avenue in Green Park. The southern boundary is formed by Smallmead Road. The western boundary of the site is the Reading-Basingstoke railway line, and will be the location of the Green Park Reading Railway Station. The northern boundary of the site is formed by the northern ditch and open grassed land, which was a former waste refuse tip but is now capped and restored.

A site location plan is contained in Appendix 1.

The site covers an area of approximately 24ha of which 4ha (17%), is a lake that will largely be retained in its current configuration, while approximately 4.75ha of the site (around 20%) is brownfield and has either recently been, or is in, light industrial or waste recycling use. The remainder of the site is currently used for top soil storage, and has existing permissions that would raise the land out of the flood plain.

A copy of the Topographical Survey carried out in May 2007 by Longdin & Browning is contained in Appendix 2.

2.2 Development Proposals

This proposed redevelopment will provide:

- 737 new homes;
- An 80 unit Continuing Care Retirement Community (CCRC) scheme;
- 8 family homes for disabled persons designed in accordance with Housing Corporation guidelines;
- 16,000 sq m of B1 floorspace;
- A One Form Entry Primary School with sports pitches for dual use with the local community;
- Support facilities and recreation comprising a village hall, childcare facilities, local retail (including Class A1, A2, A3, A4 and A5); satellite health surgery and recreation facilities;
- A network of dedicated pedestrian and cycle routes; and,
- The provision of a high quality landscaped environment, open space, fully equipped children's play facilities (LEAPs).
- The provision of a waterside park around the existing lake.

A plan showing the proposed site layout is contained in Appendix 3.

3 Flood Risk Assessment

The scale of detail entered into in any Flood Risk Assessment (FRA) is dependent upon the scale and potential impact on the proposed development. In this case the FRA is to support a planning application for a 24ha mixed used residential and commercial development.

3.1 Strategic Flood Risk Assessment

PPS25 confirms that Regional Planning Bodies (RPBs) or Local Planning Authorities (LPAs) should prepare Strategic Flood Risk Assessments (SFRAs) in consultation with the Environment Agency (EA). The SFRA will then be used to refine information on areas that may flood, taking into account other sources of flooding and the impacts of climate change, in addition to the information on the EA Flood Zone Map.

Reading Borough Council (RBC) has undertaken an SFRA and this FRA has been compiled taking account of the information therein and correspondence with RBC's Planning Implementation Manager.

3.2 Flood Zone

The main risk to the site in terms of flooding is fluvial (river) flooding from either the Foudry Brook, Longwater Relief Channel or the River Kennet. The watercourses are hydraulically linked to the Lake and ditches that surround the proposed development site.

3.2.1 Environment Agency Flood Zone Mapping

The initial phase of identifying whether a site is potentially at risk of flooding is to consult the EA's Flood Zone Maps, available on the EA's website. However, these are (often) based on course scale modelling and provide only an initial indication of the flood risk on a site. More detailed modelled levels and topographical survey levels are then sought to confirm the probability of risk.

The EA Flood Zone Mapping for the site is contained in Appendix 4.

This mapping shows the site to lie within Flood Zones 2 and 3. However, due to a previous agreement to raise the level of the land throughout the Green Park development, as part of the Green Park Flood Alleviation Scheme as described in Section 3.2.2, and approval to the hydraulic modelling described in Section 3.2.2 the EA has advised that the site's Flood Zoning should be based on post-development levels. Therefore, the Green Park Village development will lie within Flood Zone 1.

PPS25 Table D.1: Flood Zones

Zone 1 Low Probability
Definition This zone comprises land assessed as having between a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).
Appropriate Uses All uses of land are appropriate in this zone.
FRA Requirements For development proposals on sites comprising one hectare or above the vulnerability of flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water run-off, should be incorporated in a FRA. This need only be brief unless the factors above or other local considerations require particular attention.
Policy Aims In this zone, developers and local authorities should seek opportunities to reduce the overall level of risk in the area through the layout and form of the development, and the appropriate application of sustainable drainage techniques.

3.2.2 Green Park Flood Alleviation Scheme

In order to facilitate the development of all of Green Park and alleviate an existing flooding problem in South Reading a floodplain management scheme was devised in the 1980's with the Rivers Division of the then Thames Water Authority (as predecessors of the EA) and RBC. The basis of this agreement is detailed within the report Foudry Brook - Flood Storage Proposals by Lewin, Fryer and Partners dated September 1985, a copy of which is contained in Appendix 5.

The scheme, which has been implemented during the first two phases of Green Park, removed a previous bottleneck caused by the raised landfill sites spanning the floodplain to the north of Green Park, on the Foudry Brook catchment, by constructing a new flood relief channel to the River Kennet, of which Longwater Flood Relief Channel is part. A copy of Foudry Brook Proposed New Channel - M4 to River Kennet by PBA which contains the specific details of the Flood Alleviation Scheme is contained in Appendix 6.

Comprising of the Longwater Flood Relief Channel and 16Ha of land reserved for dedicated flood storage across all of Green Park, the scheme is designed to reduce the flood risk associated with the

Foudry Brook whilst at the same time allowing further land raising to facilitate the entire Green Park development. The majority of the scheme has been implemented within previous construction contracts, the most recent being the land raising and works to Plot 8 within the southern sector of Green Park. The provisions of the scheme require that the Green Park Village application provides 4.06ha of flood storage at the 37.8m contour when ground levels are raised for development. The scheme also requires that any losses in flood storage within boundary ditches will be compensated for on an area for area basis at the 37.8m contour. A plan showing an overview of the Flood Alleviation Scheme is contained in Appendix 7.

As a consequence of the completion of the scheme so far, and in accordance with the aspirations of Thames Water Authority and RBC at the time, flood levels in this area of South Reading have been lowered providing relief to properties with historic flooding problems. During the interim years between the construction of the Longwater Flood Relief Channel and this phase of development, a period of betterment over that designed for has been experienced. This is because, effectively, the flood compensation for the ground raising was constructed in advance.

There have been previous consents for development on the Green Park Village site that acknowledge that the implemented floodplain management scheme allows development of the entire Green Park scheme. Most notably these include the Construction Skills Training Centre, which was consented in 2002 and is in operation on the site today. Consents have also been granted for the stockpiling of material within the Green Park Village development site.

The following section describes the hydrology and hydraulic modelling undertaken by PBA for the Green Park Village, Station and Interchange (GPVSI) planning application and approved by the EA.

3.2.3 Hydrology and hydraulic Modelling

Following consultation with the EA, PBA undertook hydraulic modelling to demonstrate the efficacy of the existing Green Park Flood Alleviation Scheme on the proposed Green Park Village, Station and Interchange (GPVSI) development in 2006 – 2007.

PBA was granted permission by the EA to use a preliminary version of the Lower Kennet 2D hydraulic model which was supplied by Jacobs in October 2006 and which superseded any previous 1D hydraulic models of the site. A copy of the license is contained in Appendix 8. PBA then increased the detail of the Lower Kennet model in and around the Green Park site for the purposes of the assessment.

Hydrological Analysis

Jacobs undertook a hydrological study of the River Kennet as part of the River Kennet Flood Study Stage 2 (Commission Ref TH 600). The results of which are reported separately in the project Interim Hydrology Report (November 2004). The Interim Hydrology Report details the results of the hydrological modelling undertaken and provides the design hydrographs that are used in the Lower Kennet 2D hydraulic model (Lower Kennet Flood Study: Final Hydraulic Modelling Report, May 2006).

Before utilising this hydraulic model PBA calibrated it to the recorded January 2003 flood event. Flood levels and flows for this event were available at Theale Gauging Station and Blakes Lock. However, with little or no reliable data available on the tributaries (including Foudry Brook) the main calibration point for the reach of the Kennet between Southcote and the Thames was at Blakes Lock.

The impact of the hydraulic changes to the Lower Kennet 2D hydraulic model made by this calibration were analysed by running the January 2003 event through the updated Lower Kennet model and the results compared to the original Environment Agency model. It was found that there was a negligible impact on flows and stage at Blakes Lock. Further calibration was therefore deemed not necessary and the hydrology in the hydraulic model was unaltered for the assessment of the impact of the proposed land raising required as part of the GPVSI development

Table 1: Comparison between Jacobs and PBA hydraulic models

Comparison Event	EA/Jacobs	PBA
Peak flows at Blakes Lock for the January 2003 modelled flood event	61.29 m ³ /s	61.20 m ³ /s
Peak stage at Blakes Lock for the January 2003 modelled flood event	36.86m AOD	36.86m AOD

Hydraulic Modelling – Baseline Conditions

The calibrated Lower Kennet 2D hydraulic model comprised two interlinked components:

- An ESTRY 1D hydraulic model of the main channels and ditches, and
- A 2D grid based hydraulic model of the floodplain topography

A node location plan is contained in Appendix 9.

A detailed review of the ESTRY 1D elements of the hydraulic model showed that a number of channels which provide vital storage, attenuation and conveyance had been excluded from the model. These were subsequently added to the baseline model. These included:

- Pingewood Road South ditch connecting Englefield (jet ski) Lake into the Foudry Brook including the culvert under Kybes Lane and twin culverts linking the ditch to Englefield Lake.
- South Oak Way culvert on the Foudry Brook immediately downstream of the M4.
- Smallmead Road ditch conveying water from the Smallmead lakes to Longwater (including the culvert under Longwater Avenue).
- The northern and southern inlets/outlets of the Smallmead lakes
- The Longwater Avenue road ditch running parallel with the eastern margin of the proposed GPVSI development site, and
- Ditches on the western and eastern sides of the railway on the proposed new railway station site.

Following a detailed topographical survey of the Green Park site in May 2007 the 2D elements of the model which were originally based upon LiDAR data that was swept in January 2005 were updated. This update included revisions to:

- The levels across Plots 8 and 17 which had undergone land raising since 2005,
- The final levels created by the restoration of the Cemex Aggregates Landfill area immediately to the north of the GPVSI site, and
- The contours of Lake within the GPVSI site itself.

The plans to which the hydraulic model were revised are contained in Appendix 10.

The existing 1D river channel cross sections were also checked in detail against the topographic survey and were subsequently adjusted in places where the bed or bank levels were contradictory to the PBA topographic survey. Structure dimensions and attributes were also checked against the

survey or design specification. A list of the key structures in the baseline model on the Green Park site and their locations can be found in Appendix 11.

The baseline model was therefore deemed to represent the existing conditions plus all existing consents on the site.

Hydraulic Modelling – Post Development

In order to assess the effects of the land raising proposed as part of the GPSI development amendments were made to both the 1D and 2D elements the newly created baseline model.

The 2D modifications to the site included raising the GPSI site levels to the minimum development platform level of 40.2m AOD and modelling a new flood storage lake within this developed area. The initial water level in the lake was estimated as being 37.2m AOD based on normal water level observations and groundwater monitoring results in the areas surrounding Smallmead Lake pre-restoration.

The modifications to the 1D network of the model included:

- Adding to the existing cross sections a 5m flat buffer zone rising up to the development platform level along the right bank of Cemex (Halls) ditch that runs west to east along the north side of the Green Park Village development site.
- Adjusting the weir connections at the northern and southern ends of the Green Park Village lake to 38.100mAOD and modelling the new channel cross section at the southern end of the lake into the Smallmead Road Ditch.
- Upgrading the existing culvert in the Longwater Avenue ditch that runs along the south-eastern margin of the site to a 20m long 2m² box culvert that will be built under the new Longwater Avenue roundabout structure that provides access near the north-eastern corner of the site.
- Diverting the eastern railway embankment toe-drain through a culvert over a length of approximately 50m. The culvert is required to pass under the proposed station plaza, and has been sized as 2m² box culvert.

A list of the key structures, their dimensions and their locations is contained in Appendix 11.

The following structures were not included in the post development model:

- There is a proposed left-in, left-out road connection between Longwater Avenue and the site over the upstream end of the Longwater Avenue Ditch, to the north-east of the proposed school. The structure will be a road bridge with a 10m long, 2m² box culvert under it to allow flow into the remaining upstream part of the ditch. For model stability reasons this culvert was not included. It was also assessed to provide no significant additional constriction to flow above that from the proposed 20m long 2m² box culvert under the roundabout crossing immediately downstream of this bridge.

Limitations to both Hydraulic Models

The EA/Jacobs model was initially produced for a Section 105 flood mapping exercise. The purpose of the flood risk mapping is to provide strategic scale flood risk maps, and as such the model will not include a high level of detail locally. This is reflected in the large grid size of 25m² in the 2D component of the model and the lack of structures such as bridges in the 1D model. Furthermore, reliable hydrological data for tributaries such as the Foudry Brook is sparse and where available the records

are short. Inflows into the Foudry Brook are therefore increasingly inaccurate towards the lower probability flood events.

Accounting for these limitations, absolute levels taken from the results should be treated with a degree of caution. However the model should perform better when assessing the land raising and flood alleviation scheme by looking at relative differences in levels between the baseline model and the proposed model. For example, the stated absolute accuracy of a model might be +/-100mm, but the relative accuracy would be lower, as the uncertainties arising from assumptions such as topographic survey or downstream boundary conditions are consistent across model runs. It is therefore a valid tool to be used in this flood risk assessment and provides the best available information. To account for the uncertainty in the absolute flood levels, a freeboard will be applied in designing mitigation measures in accordance with EA guidance. This is discussed further in Section 3.5

Analysis of the model results show that results may vary at the third decimal place throughout the model, following small changes. This is because any change to the model will alter the structure of the mathematical matrix, so there may be unexpected small changes in calculated levels although there would be no physical impact in reality. For example on the Draper's Osier Bed Stream, over 5km upstream of the site on the Kennet, at the 1 in 10 year flood event, flood levels may vary up to 8mm between the baseline model and the proposed model even though the changes in the proposed model clearly can not have any impact on flood levels through this area. Thus while the model may calculate water levels to 3 decimal places and therefore be precise to 1mm, the accuracy of the model will be less, for example an accuracy of +/-10mm might be expected. As such, changes to the third decimal place magnitude should be treated with caution and a model sensitivity of +/- 10mm should be expected.

Modelling Results

A full comparison of the results across the two models is contained in Appendix 12.

Tables 2 and 3 below show the results for the 1 in 100 year + 20% increase for climate change fluvial event at key nodes on and off the site. Reference is also made to the node location plan contained in Appendix 9.

Table 2: Comparison of On-Site Modelling Results

Node	Location	1 in 100 year + 20% Increase For Climate Change Inflows Scenarios		
		Baseline Condition Water Level	Post Development Water Level	Difference in Peak Flood Level
RCadded3.2	Longwater Flood Relief Channel	39.132	39.136	+0.004
001.019.1	Foudry Brook parallel with Brook Drive	39.106	39.110	+0.004
RC.003.2	Green Park Flood Relief Stream	39.121	39.123	+0.002
CLW.2.2	Smallmead Road Ditch	39.132	39.136	+0.004
northGP5.2	Cemex (Halls) Ditch	39.124	39.127	+0.003
Kybes8.2	Kybes Lane Ditch	39.135	39.145	+0.010
001.003.1	Foundry Brook at Junction of Kybes Lane and Pingewood Road South	39.405	39.408	+0.003

Table 3: Comparison of Off-Site Modelling Results

Node	Location	1 in 100 year + 20% Increase For Climate Change Inflows Scenarios		
		Baseline Condition Water Level	Post Development Water Level	Difference in Peak Flood Level
Rk.013.1	Kennet at the Oracle	38.225	38.227	+0.002
001.002.2	Confluence of Foudry Brook with the River Kennet	39.093	39.094	+0.001
RC.005.2	Confluence of Longwater Flood Relief Stream with River Kennet	39.119	39.121	+0.002
Ka.6.001.2	Kennet at Milkmaids Bridge	39.997	39.996	-0.001

As can be seen in Tables 2 and 3 above, the modelling results show that the land raising and proposed infrastructure associated with the Green Park Village development will have a negligible effect on fluvial flood risk. This conclusion has been agreed with the EA for the Green Park Village, Station and Interchange planning application.

3.3 Vulnerability

PPS25 Table D.2 confirms the 'Flood Risk Classification' of a site, depending upon the proposed usage. This classification is subsequently applied to PPS25 Table D.3 to determine whether:

- The proposed development is suitable for the Flood Zone in which it is located, and;
- Whether an Exception Test is required for the proposed development.

In this case the proposals consist of a mixed used residential and commercial development that includes a school and Continuing Care Retirement Community. Table D.2 confirms that these uses range from being classified as '*More Vulnerable*' to '*Less Vulnerable*'.

PPS25 Table D.2: Flood Risk Vulnerability Classification

More Vulnerable	Residential institutions such as residential care homes , children's homes, social services homes, prisons and hostels. Buildings used for: dwelling houses ; student halls of residence; drinking establishments; nightclubs; and hotels. Non-residential uses for health services , nurseries and educational establishments .
Less Vulnerable	Buildings used for: shops , financial, professional and other services; restaurants and cafes; hot food takeaways; offices ; general industry; storage and distribution; non-residential institutions not included in ' <i>more vulnerable</i> '; and assembly and leisure .

PPS25, Table D.3: Flood Risk Vulnerability and Flood Zone 'Compatibility', shows that no Exception Test is required for development proposed within Flood Zone 1 and the '*More Vulnerable*' and '*Less Vulnerable*' classifications.

PPS25 Table D.3: Flood Risk Vulnerability and Flood Zone 'Compatibility'

Flood Risk Vulnerability Classification (See Table D.2)		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone (Table D.1)	Zone 1	✓	✓	✓	✓	✓

3.4 Climate Change

Much has been said and written about the potential impacts of climate change. However, although general warming of the climate is occurring and will be likely to continue, the impact with respect to rainfall and flooding are less certain.

Annex B of PPS25 confirms that *'there is an increasing body of scientific evidence that the global climate is changing as a result of human activity'*.

Table B.2 from PPS25 provides precautionary ranges for peak rainfall intensities and peak river flows that should be used to compensate for climate change.

PPS25 Table B.2: Recommended National Precautionary Sensitivity Ranges for Peak Rainfall Intensities, Peak River Flows, Offshore Wind Speeds and Wave Heights.

Parameter	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Peak Rainfall Intensity	+5%	+10%	+20%	+30%
Peak River Flow	+10%	+20%		

In accordance with PPS25 Table B.2 the modelling carried out to determine the risk of fluvial (river) flooding to the permanent development included an allowance of 20% for climate change. Refer to Section 3.2.3

Also in accordance with PPS25 Table B.2 the proposed surface water drainage strategy for the development includes a 30% increase in rainfall intensities to take account of climate change.

3.5 Impact of Flood Level on the Site

Modelling carried out and detailed in Section 3.2.3 determined that the 1 in 100 year + 20% climate change fluvial (river) flood level for the site varies between 39.126m and 39.313m AOD. This value has been used to set the minimum development platform level for the proposed village development at 40.200m AOD, a minimum of 0.887m above the 1 in 100 year + 20% climate change fluvial flood level.

A review of ground levels surrounding the site also carried out as part of the modelling determined that safe dry access to local services and amenities was maintained during a 1 in 100 year + 20% climate change fluvial flood event. Levels on the local highway network vary between 39.470m and 40.460m AOD a minimum of 0.157m above the 1 in 100 year + 20% climate change fluvial flood level.

A plan showing the dry access route is contained in Appendix 13.

3.6 Impact of the Development on Site Permeability

Although the proposed development will result in an increase in the impermeability of the site, the proposed surface water drainage strategy will maintain the 1 in 100 year greenfield discharge rate. The use of Sustainable Drainage Systems (SuDS) will also provide a water quality benefit. Therefore, there will be no exacerbation of off-site flood risk as a result of the development.

3.7 The Sequential Test and Exception Test

PPS25 follows a sequential risk-based approach in determining the suitability of land for development in flood risk areas, with the intention of steering all new development to the lowest flood risk areas.

In correspondence dated the 26th June 2007 RBC stated that *'Green Park Village, including the proposed station is a unique proposal. The site has approval for works to raise the land which would put it in Flood Zone 1. Moreover, there are no reasonably available sites in Flood Zones 1 and 2 to*

accommodate the proposed development. Its development would therefore appear to satisfy the PPS25 Sequential Test. A copy of the letter is contained in Appendix 14.

PPS25 states that the local planning authority, as the principal decision maker, is responsible for applying the Sequential Test. Liaison has been undertaken with RBC regarding the Sequential Test. As detailed above the Council considers that there are no reasonably available sites in Flood Zone 1 or 2 that could accommodate the proposed development, and thus the development satisfies the PPS25 sequential test, provided that an FRA demonstrates that the development will be safe and there will be no increase in flood risk elsewhere.

As discussed previously in Section 3.3 - Vulnerability, PPS25 Table D.3: Flood Risk Vulnerability and Flood Zone 'Compatibility' shows that no Exception Test is required for development proposed within Flood Zone 1 and the 'More Vulnerable' and 'Less Vulnerable' classifications.

3.8 Managing Surface Water and SuDS

PPS25 Annex F states that:

'The effective disposal of surface water from development is a material planning consideration in determining proposals for the development and use of land.

Surface water arising from a developed area should as far as practicable, be managed in a sustainable manner to mimic the surface water flows arising from the site prior to the proposed development, while reducing the flood risk to the site itself and elsewhere, taking climate change into account. This should be demonstrated as part of the Flood Risk Assessment.'

3.8.1 Existing Surface Water Drainage

Although the site has previously been used for light industrial or waste recycling use, there are no formal surface water drainage networks currently on the site.

3.8.2 Building Regulations Surface Water Drainage Hierarchy

The Building Regulations H3 stipulates that *'rainwater from roofs and paved areas is carried away from the surface to discharge to one of the following in order of priority:*

- *An adequate soakaway or some other infiltration system,*
- *A watercourse, or where that is not practical,*
- *A sewer.'*

3.8.3 Sustainable Drainage Systems (SuDS)

Flood risk and other environmental damage can be managed by minimising changes in volume and rate of surface water runoff from development sites through the use of SuDS, this being complementary to the control of development within the floodplain. SuDS will not alleviate flooding in an area prone to flooding, however if properly designed SuDS have the potential to prevent the surface water runoff from new development increasing the off-site flood risk.

3.8.4 Proposed Surface Water Drainage Strategy

Details of the proposed surface water drainage strategy for the development are contained in the Green Park Drainage Strategy (11321/2008/R002/Rev0, July 2010) and were developed in consultation with the EA.

This strategy seeks to replicate the existing greenfield runoff situation by returning a significant proportion of rainfall runoff to ground via infiltration devices. It also acknowledges the risk to groundwater and maintains the EA's requirement for a 1m minimum unsaturated zone to groundwater level, which has been determined by site monitoring to be 37.800m AOD. Therefore, all of the proposed infiltration devices will maintain this clearance by setting their minimum invert level at 38.800m AOD.

These devices have been designed in accordance with BRE 365 to store a 1 in 10 year rainfall event below the invert level of the incoming pipe and half drain in 24 hours using an infiltration rate of 1×10^{-5} m/s, which will be the specified property of the imported fill. Where infiltration techniques are not considered suitable due to potential contamination SuDS systems are to be lined, with the attenuated discharge piped into the lake or surrounding ditch network.

The strategy proposes that surface water runoff from areas classed as having a higher contamination risk, such as the proposed highways and parking areas, will pass through permeable paving which provides a water quality benefit by removing hydrocarbons before discharging to ground via infiltration or to the Lake via a filter drain. Where this is prohibited by the proposed layout of the development, run-off generated by the highway network will be discharged via trapped gullies into the proposed surface water drainage networks. These networks will ultimately discharge into the Lake or surrounding ditch network via oil separators.

3.9 Mitigation Measures

As previously discussed the development will be constructed using a minimum development platform level of 40.200m AOD (0.887m above the 1 in 100 year + 20% climate change flood level).

The proposed surface water drainage strategy will manage surface water arising from the development utilising SuDS and attenuating the discharge to the 1 in 100 year greenfield runoff rate so as to ensure that there will be no exacerbation of off-site flood risk.

3.10 Residual Risks

It is impossible to completely guard against fluvial (river) or pluvial (rainfall) flooding since extreme events greater than the design standard events are always possible. However, it is possible to minimise the risk by ensuring that an appropriate minimum development level is set and by providing a surface water drainage regime which takes climate change into account.

4 Summary

EA mapping shows the site to lie in Flood Zones 2 and 3, however, modelling of the already implemented Green Park Flood Management Scheme, which includes an allowance for raising the site, has been approved previously as part of the larger Green Park development. Therefore, the EA has advised that the site's flood zoning should be based on post development levels, which places this the development in Flood Zone 1; *'land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%)'*.

PPS25, Table D.3: Flood Risk Vulnerability and Flood Zone 'Compatibility', shows that no Exception Test is required for development proposed within Flood Zone 1 and the 'More Vulnerable' and 'Less Vulnerable' classifications.

RBC has carried out a Sequential Test and has concluded that *'Green Park Village, including the proposed station is a unique proposal. The site has approval for works to raise the land which would put it in Flood Zone 1. Moreover, there are no reasonably available sites in Flood Zones 1 and 2 to accommodate the proposed development. Its development would therefore appear to satisfy the PPS25 Sequential Test.'*

The primary source of flooding to the site is from the Foudry Brook and/or Longwater Relief Channel which are tributaries of the River Kennet. Modelling of these watercourses has determined the 1 in 100 year + 20% climate change fluvial (river) flood level for the site and the minimum development platform level for the development has been set 0.887m above this to provide a freeboard.

Access to the site will be maintained during a 1 in 100 year + 20% climate change fluvial flood event as road levels along Longwater Avenue are also a minimum of 0.337m above this level.

The proposed surface water drainage strategy for Green Park Villages utilises SuDS, provides attenuation up to the 1 in 100 year + 30% (climate change) pluvial (rainfall) event and limits discharges to the sites calculated greenfield runoff rates therefore providing a betterment on the existing situation.

As a result the precautionary principle that PPS25 advocates to the uncertainties of flooding has been addressed satisfactorily and the site is considered suitable for its intended use.



St. Edward Homes

Green Park Village

Drainage Strategy

Project Ref: 11321/2008

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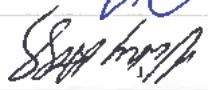
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For and on behalf of Peter Brett Associates LLP

Revision	Date	Description	Prepared	Reviewed	Approved
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Appendices

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Appendix 2 – Greenfield Run-off Calculations
Appendix 3 – Proposed Surface Water Drainage Layout
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Appendix 9 – MicroDrainage Calculations West Lakeside Development
Appendix 10 – MicroDrainage Calculations Surcharged Outfalls
Appendix 11 – Proposed Foul Drainage Layout

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1 Introduction

Peter Brett Associates LLP has been appointed by St. Edward Homes to prepare the surface water drainage strategy for Green Park Village.

This report describes the proposed scheme and any amendments to the previous consented strategy submitted for the site. This report encompasses two levels of detail; the main outline application for the site and the Phase 1 detailed application. Phase 1 is located in the east residential area of Green Park Village and is indicated on the proposed site layout (Appendix 1)

The surface water drainage scheme has been prepared in consultation with the Environment Agency (EA). The EA issued a response (reference dr10/00587/SCO dated 25th May 2010) in relation to the submitted Environmental Impact Assessment scoping report. This letter confirms that assuming no major changes are necessary a proposed drainage strategy would be based on the previous Flood Risk Assessment and Surface Water drainage concept, would be acceptable in terms of the application of Sustainable Drainage Systems (SuDS) techniques.

2 Site Location and Plan

The Green Park Village site is 24 hectares, and is located immediately to the west of Longwater Avenue in Green Park, Reading. The southern boundary is formed by Smallmead Road and the willows and stream which flows under Kybes Lane. The western boundary of the site is the Reading-Basingstoke railway line, and will be the location of the Green Park Reading Railway Station. The site is bounded to the north by the Northern ditch (formally Hall's ditch).

4 hectares of the site, about 17%, is a lake which will be largely retained in its current configuration and will form the focal point for a waterside park at the heart of Green Park Village, and also forms part of the Green Park Flood Alleviation Scheme that connects to Green Park.

About 4.75 hectares of the site, 20%, has either recently been or is in light industrial or waste recycling use, and effectively brownfield. These uses, including any contamination arising from them, will be removed to make way for the new railway station and the Green Park Village.

The remainder of the site is currently used for top soil storage, and has existing permissions that would raise the land out of the flood plain.

Appendix 1 includes the location plan and proposed site layout.

3 Surface Water Drainage

3.1 Greenfield Runoff Calculations

Due to a lack of information regarding the existing surface water drainage regime for the brownfield elements of the site, it has been decided that for the purpose of this surface water strategy that the site will be taken as 100% greenfield. The Consented Surface Water Drainage Strategy that accompanied the Green Park Village, Station and Interchange application calculated partial brownfield rates for the site. Therefore, the proposed strategy will provide a betterment in terms of the discharge rate at which surface water run-off from the development will enter the Lake and ditch network.

The Greenfield runoff rate for the site has been calculated using 'Preliminary Rainfall Runoff Management for Developments – Technical Report W5-074A/TR/1, Revision D, September 2005' (DEFRA) as recommended by the EA. The Greenfield runoff rate was calculated for a site area of 1ha, a pro-rata rate according to the individual site area (defined by the proposed topography of the site) was then calculated for the individual networks. This can be found in Appendix 2.

Table 3.1: Calculated Greenfield Run-off Rates

Rainfall Event	Greenfield Run-off Rate
1 in 1 year	3.16 l/s/ha
1 in 30 year	8.32 l/s/ha
1 in 100 year	11.85 l/s/ha

3.2 Consented Surface Water Drainage Strategy

A previous planning application was submitted for the site in July 2007. The principles of the drainage strategy, which formed an appendix of the Green Park Village, Station and Interchange Flood Risk Assessment (project ref. 11321/134, July 2007), have formed the basis for the proposed Green Park Village surface water drainage strategy, described in this report. Broadly these are as described in the following parts of this chapter taken from the original FRA.

Commercial Plots

- Clean roof run-off to be attenuated via underground cellular storage or dry ponds and discharge to Lake / ditches.
- Run-off from decked car parks to be discharge to ground via infiltration trench / filter drain or discharge to Lake /ditches via lined infiltration trench / filter drain.
- Run-off from surface car parks and plot access roads to be discharged via lined permeable paving or filter drains to lined cellular storage before discharging into the Lake / ditches.

School Plot

- Clean roof run-off discharged to Longwater Ditch via attenuation in underground cellular storage.
- Run-off from hard standing play area to be discharged to ground via infiltration or to Longwater Ditch via underground cellular storage.
- Run-off for the school car park to be discharged via infiltrating permeable paving.

Main residential Area to the East of the Lake

- Clean run-off from the front of houses to be discharged into the Lake / ditch network via attenuation in oversized pipes.
- Clean roof run-off from the rear of houses to be discharged to ground via infiltration devices located in car parking areas to the rear of properties.
- Clean roof runoff from houses that are located on the boundary of the development is discharged via infiltration trenches within the properties gardens.
- Run-off from private parking areas will discharge to ground via infiltrating permeable pavements. An emergency overflow will be connected to the proposed surface water drainage network which ultimately discharges into the Lake.
- The run-off from residential streets will be discharged to ground via infiltrating permeable paving located in the parking areas which front the properties. A high void sub-base in the parking bays and under the carriageway acts as storage during larger rainfall events.

Residential Development to the North West of the Lake Including Square

- Clean roof run-off to discharge to the Lake via attenuation in oversized pipes.
- Run-off from decked car parking to be discharged either to ground by infiltration or into the Lake.
- Run-off from residential streets to be discharged to ground via permeable paving and / or filter drains.
- Run-off from the public square is to be discharged to ground via permeable paving.

3.3 Proposed Surface Water Drainage Strategy

The proposed drainage strategy seeks to follow the drainage principles of the previous consented scheme (Section 3.2) and replicate the existing greenfield runoff situation by returning a significant proportion of rainfall runoff to ground via infiltration devices. It also acknowledges the risk to groundwater and maintains the EA's requirement for a 1m minimum unsaturated zone to groundwater level, which has been determined by site monitoring to be 37.800m AOD. Therefore, all of the proposed infiltration devices will maintain this clearance by setting their minimum invert level at 38.800m AOD.

All infiltration devices have been designed in accordance with BRE 365 to store a 1 in 10 year rainfall event below the invert level of the incoming pipe, and half drain in 24 hours. An infiltration rate of 1×10^{-5} m/s was used, which will be the specified property of the imported fill. Where infiltration techniques are not considered suitable due to potential contamination SuDS systems are to be lined, with the attenuated discharge piped into the lake or surrounding ditch network.

The strategy proposes that surface water runoff from areas classed as having a higher contamination risk, such as the proposed highways and parking areas, will pass through permeable paving which provides a water quality benefit by removing hydrocarbons before discharging to ground via infiltration or to the Lake via a filter drain. Where this is prohibited by the proposed layout of the development, run-off generated by the highway network will be discharged via trapped gullies into the proposed surface water drainage networks. These networks will ultimately discharge into the Lake or surrounding ditch network via oil separators.

Drawings showing the proposed surface water drainage strategy are contained in Appendix 3. The drawings have been broken down for clarity showing infiltrating drainage and positive drainage networks on separate sheets.

3.3.1 Main Residential Area to the East of the Lake

As per the consented surface water drainage strategy, roof run-off from the rear of residential properties will be discharged to ground via infiltration devices. Roof run-off from the front of properties will be discharged into the Lake / ditch network via one of the three proposed on-site surface water drainage networks. Where spatial constraints allow, the whole of the roof will be discharged to ground and in a few isolated cases the whole of the roof will discharge via the proposed networks.

All private car parks and private driveways will discharge run-off to ground via direct infiltration permeable pavements (permeable pavements which do not accept any additional run-off from neighbouring parts of the development).

Where possible, run-off from residential highways will pass through permeable paving located in the parking bays adjacent to the carriageway. The permeable paving in these bays is divided into infiltrating permeable paving (permeable pavements which act as soakaways) and lined (tanked) permeable paving, with the lined permeable paving utilised for storage and its water quality benefits. The boundary for the infiltrating permeable paving is 5m from any structures in accordance with current building Regulations. As previously discussed where this method of discharge is prohibited by the proposed development layout, the run-off generated by the highway will be discharged via trapped gullies and oil separators, in accordance with Pollution Prevention Guideline 3: Use and Design of Oil Separators in Surface Water Drainage (PPG3), into the Lake / ditch network.

The three proposed surface water drainage networks have been designed to attenuate the surface water discharge into the surrounding watercourses up to and including the 1 in 100 year + 30% climate change rainfall event below ground. The North and East Networks discharge into the Northern ditch via cellular storage devices located below equipped public open space, while the Phase 1 Network discharges into the Lake via cellular storage located under a car park.

All three networks have flow control devices located at the 1st manhole upstream of the outfall and flap valves (non-return valves) installed on the outfall itself to prevent water backing up the network in times of fluvial flood. This is discussed further in Section 3.4. However, the location of the controls ensures that should blockage of the device occur then the flood waters will be routed to the surrounding ditch network or Lake and away from highways and properties

Details of the proposed drainage strategy are shown on drawings 11321/2008/001 & 002 in Appendix 3.

Outline Design – Discharge rates

As previously discussed in Section 3.1, greenfield run-off rates for the site have been calculated and are contained in Appendix 2. In accordance with Planning Policy Statement 25: Development and Flood Risk (PPS25) an allowance for climate change of 30% has been added to the 1 in 100 year rainfall event.

For the North and East networks, comparison against the calculated greenfield 1 in 30 year and 1 in 100 year run-off rates has been undertaken. Comparison to the 1 in 1 year discharge rate will be made during the detail design stage. As can be seen in Tables 3.2 and 3.3 below a betterment has been achieved for each of the rainfall events. MicroDrainage Calculations for the North and East Networks are contained in Appendix 4 and 5 respectively.

Table 3.2: East Network – Existing and Proposed Discharge Rates

Rainfall event	Existing Discharge Rate	Proposed Discharge Rate
1 in 30 year	8.56 l/s	6.4 l/s
1 in 100 year	12.19 l/s	7.5 l/s
1 in 100 year + 30%	-	8.8 l/s

Table 3.3: North Network – Existing and Proposed Discharge Rates

Rainfall event	Existing Discharge Rate	Proposed Discharge Rate
1 in 30 year	8.55 l/s	7.7 l/s
1 in 100 year	12.18 l/s	8.9 l/s
1 in 100 year + 30%	-	10.4 l/s

Detail Design – Discharge Rates

For the Phase 1 network, comparison against the calculated greenfield 1 in 30 year and 1 in 100 year run-off rates has been undertaken. Assessment against the 1 in 1 year greenfield discharge rate has also been undertaken to ensure that the requirements of Code for Sustainable Homes (May 2010, Department for Communities and Local government) mandatory category 4 (SUR 1) are achieved by the development. As can be seen in Tables 3.4 below a betterment has been achieved for each of the rainfall events. MicroDrainage Calculations for the Phase 1 Network are contained in Appendix 6.

Table 3.4: Phase 1 – Existing and Proposed Discharge rates

Rainfall event	Existing Discharge Rate	Proposed Discharge Rate
1 in 1 year	3.11 l/s	3.0 l/s
1 in 30 year	8.19 l/s	5.8 l/s
1 in 100 year	11.66 l/s	7.2 l/s
1 in 100 year + 30%	-	9.0 l/s

Detail Design – Volume of Discharge

Also required under the Code for Sustainable Homes (May 2010, Department for Communities and Local government) mandatory category 4 (SUR 1) is the requirement to compare pre and post development discharge volumes. The Code requires that assessment of the 1 in 100year, 6 hour duration plus a 30% allowance for climate change is made and that any additional volume is managed on-site and made available for re-use or discharged at a reduced rate. It has been determined that the density of the proposed development will preclude the effective use of rainwater harvesting for the re-use of water. However, due to the level of infiltration proposed on the Green Park Village development, assessment for the Phase 1 Network has shown a reduction in discharge volumes. Refer to Table 3.5 below.

Table 3.5: Pre and Post Development Discharge Volumes.

Pre Development Volume	Post Development Volume	
	Summer	Winter
830.067m ³	262.535m ³	287.410m ³

3.3.2 School

All surface water runoff generated by the school buildings and areas of hard standing discharges to ground via infiltrating cellular storage. Parking areas are drained by direct infiltration permeable paving. The proposed strategy is shown on drawing 11321/2008/002, Appendix 3. MicroDrainage calculations for the school site are contained in Appendix 7.

3.3.3 Lake View Villas & Continuing Care Retirement Community (CCRC) Extra Care

The runoff generated by the Lake View Villa roofs is drained independently and discharged to ground via infiltrating cellular storage, which is located within the adjacent car park area. The car park itself is drained by direct infiltration permeable paving.

Similarly, the CCRC Extra Care Unit roof runoff is drained independently from other areas and all runoff discharges to ground via infiltrating cellular storage, which is located in the central courtyard area. Parking areas are drained by direct infiltration permeable paving.

The proposed strategy is shown on the drawing 11321/2008/2002 located in Appendix 2 and the MicroDrainage calculations are contained in Appendix 8.

3.3.4 Development to the West of the Lake

An area of potential contamination lies within part of this area of the development. Hence, we have not considered that infiltration techniques are suitable. However, SuDS have been used to provide a water quality benefit and outside this area infiltration devices have been utilised to discharge water to ground and reduce the discharge to the Lake. The boundary of the possible contamination and the proposed drainage strategy are shown on drawings 11321/2008/003 & 004 in Appendix 3.

Where possible clean roof run-off discharges to ground via infiltrating cellular devices located below car parks located outside the area of potential contamination. This is not always possible due to the recorded groundwater level and required 1m unsaturated zone. In this case the run-off is discharged into the Lake via a surface water drainage network including lined filter drains. In addition, two areas of green roof are also proposed which have the benefit of mimicking *'the predevelopment state of the building footprint'* and *'can reduce the volume and rate of run-off of rainfall'* (SuDS Manual CIRIA 697, 2007).

In areas outside the contamination boundary enclosed parking areas will discharge all run-off to ground via direct infiltration permeable paving. Parking areas within the contamination boundary will discharge into the Lake via lined permeable paving. This allows pollutants to be removed within the sub-base.

The run-off generated by the proposed highway will shed towards lined permeable paving in parking bays or parking areas. A surface water network then connects this storage to infiltrating cellular storage devices or discharge to the Lake. As such the run-off will benefit from treatment through the sub-base.

Discharge Rates

As previously discussed in Section 3.1 greenfield run-off rates for the site have been calculated and are contained in Appendix 2. In accordance with Planning Policy Statement 25: Development and Flood Risk (PPS25) an allowance for climate change of 30% has been added to the 1 in 100 year rainfall event.

As per the other outline design networks, East and North Networks, comparison against the calculated greenfield 1 in 30 year and 1 in 100 year run-off rates has been undertaken. Comparison to the 1 in 1 year discharge rate will be made during the detail design stage. As can be seen in Table 3.6 below a betterment has been achieved for each of the rainfall events. MicroDrainage Calculations for the West Lakeside Development Network are contained in Appendix 9.

Table 3.6: West Lakeside Network – Existing and Proposed Discharge Rates

Rainfall event	Existing Discharge Rate	Proposed Discharge Rate
1 in 30 year	3.33 l/s	3.1 l/s
1 in 100 year	4.74 l/s	3.6 l/s
1 in 100 year + 30%	-	4.4 l/s

3.4 Risk Analysis

As per the consented surface water drainage strategy, an assessment of the interaction between fluvial events of the Lake / ditch network and pluvial (rainfall) events has been undertaken on a risk basis.

All the proposed networks which ultimately discharge into the Lake have a minimum outfall level of 38.200m AOD as per the consented strategy, and flap valves to prevent water backing up the network during larger fluvial events.

In order to demonstrate that the precautionary principle that PPS25 advocates will be achieved by the proposed surface water drainage strategy, all networks which discharge to the Lake/ watercourse have been modelled with their outfalls surcharged to the 1 in 20 year level fluvial flood event (38.709m AOD). All of these networks have been shown to provide attenuation up to and including the 1 in 100 year + 30% increase for climate change rainfall event combined with a 1 in 20 year fluvial event below ground. MicroDrainage calculations for this assessment are contained in Appendix 10.

For details of the hydraulic modelling of the Lake and ditch network refer to the Green Park Flood Risk Assessment (11321/2008/R001/Rev 0, July 2010).

4 Proposed Foul Drainage Strategy

Effluent generated by the Green Park Village development will be discharged via two existing spurs into the private sewer which runs from west to east in Longwater Avenue. This in turn discharges into the adopted Thames Water Utilities sewer located in the A33 at its junction with Longwater Avenue. A pumping station is required to convey effluent generated from the development located to west of the Lake. A plan showing the proposed on-site foul drainage networks, 11321/2008/007, is contained in Appendix 11.

5 Summary

Table 5 below summaries this report and the proposed drainage strategy for the development.

Table 5: Summary

Location	Proposed drainage strategy
Main Residential Area to the East of the Lake	
Runoff from rear of houses	Soakaways in rear of garden or discharge to Lake/ ditch network if infiltration not available
Runoff from front of houses	Positive drainage network
Private car parks	Direct Infiltration permeable paving
Flats over Garages (FOGs)	Infiltrating cellular storage
Residential streets	Lined/ Infiltrating permeable paving in parking spaces adjacent to carriageway. Where none present, runoff is discharged to positive drainage network.
School and Lakeside Residential	
All drainage	Infiltrating cellular storage
West side	
Outside potential contamination zone	
Building roof runoff	Infiltrating cellular storage units within car parks
Car parks	Permeable paving connected to infiltrating cellular storage units.
Streets	Fall to adjacent permeable paving connected to infiltrating cellular storage units.
Within potential contamination zone	
Building roof runoff	Positive drainage networks discharging to lake via filter drain and cellular storage attenuation.
Car parks	Lined permeable paving connecting to positive drainage networks discharging to lake via filter drain and cellular storage attenuation
Streets	Fall to adjacent lined permeable paving connected to positive drainage networks discharging to lake via filter drain and cellular storage attenuation.



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