Thomas Consulting

P5875/16/1

DRAINAGE STRATEGY REPORT

AT
CLITHEROE ROAD, BARROW,
(PHASE 2)

FOR

REILLY DEVELOPMENT

ISO 9001
ISO 14001
OHSAS 18001
Certificate Number 14272

REPORT VERIFICATION

Site Address	Clitheroe Road, Barrow (Phase 2)

Document Reference	P5875/16/01 Supplementary flood risk Assessment and Drainage Strategy Report
Version	02
Date released	25 August 2016
Originator	John Moxham BEng(Hons)
Checked	Kieron Hounslow BEng(Hons) CEng MIStructE
Verified	Kieron Hounslow BEng(Hons) CEng MIStructE

Issue no	Date	Status	Report version	Issued by
01	16-08-16	Final	01	KDH
02	25-08-16	Revised	02	KDH

SUPPLEMENTARY FLOOD RISK ASSESSMENT AND DRAINAGE STRATEGY REPORT

CLITHEROE ROAD, BARROW (PHASE 2)

CONTENTS

SUPPLEMENTARY FLOOD RISK ASSESSMENT AND DRAINAGE STRATEGY REPORT

CLITHEROE ROAD, BARROW (PHASE 2)

1.0 INTRODUCTION

1.1 Project Scope

1.1.1 Thomas Consulting Ltd have been commissioned by Reilly Developments to provide a supplementary flood risk assessment and drainage strategy for its proposed development at Clitheroe Road, Barrow (Phase 2).

1.1.2 The report has been prepared to address issues raised by the Flood Risk Management Team at Lancashire County Council.

1.1.3 This report must be read in conjunction with Thomas Consulting reports T17379 – Flood Risk Assessment and P5142 – Outline Drainage Strategy.

1.2 Limitations.

1.2.1 The opinions expressed within this review make use of sourced documentation currently available and information provided by the client. Thomas Consulting have not undertaken any special investigations, including opening up of covered areas or quantitative assessments.

1.2.2 The report utilises current guidance and therefore may require revision to incorporate any future changes in guidance or legislation.

2.0 SITE CHARARTERISTICS

2.1 Existing Site Characteristics and Location

2.1.1 The site is located off Clitheroe Road, Barrow, Lancashire. The approximate Ordnance Survey (OS) grid reference for the site is 373625, 437800 and the location of the site is shown on Figure 1.

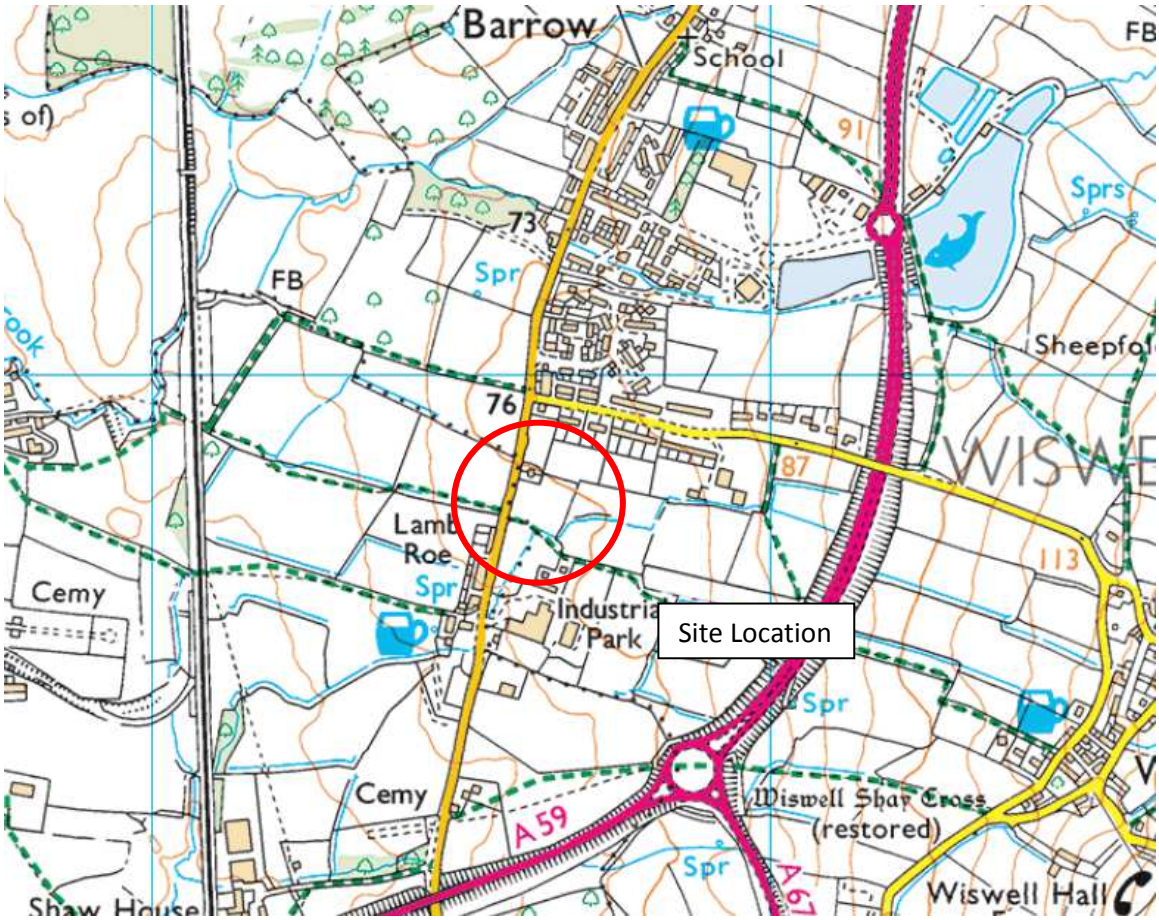


Figure 1: Site location plan (Source: Ordnance Survey, 2016)

2.1.2 The site covers a total area of approximately 0.73 ha and is located approximately 0.5km south of Barrow village.

2.1.3 The site is comprised of open fields, located immediately to the east of Clitheroe Road between the villages of Barrow and Whalley, south of Clitheroe in the Ribble Valley, Lancashire.

2.1.4 The site is bounded as follows:-

- North – Trees and open fields beyond
- South – Access track with residential property and open land beyond
- East – Trees with open land beyond
- West – Clitheroe Road

2.1.5 The site slopes gently from north to south with average ground levels of between 75 and 72.5m AOD. An existing open watercourse runs is present beyond the south east corner of the site.

2.1.6 A copy of the topographical survey is contained in Appendix A.

2.2 Site Proposals

2.2.1 It is the Client's intention to build 9 residential properties with associated infrastructure. Details of the proposed development are shown on PWL's drawing numbered 1152-PL-03. A copy of the proposed layout is contained in Appendix A.

3.0 SURFACE WATER MANAGEMENT PLAN

3.1 Overview

3.1.1 As a statutory consultee of the planning process, Lancashire County Council has sought clarification on the management of surface water run-off from the development and measures to ensure that the risk of flooding is not increased.

3.1.2 This supplementary flood risk assessment and drainage strategy report aims to examine the current site and its context in terms of any existing drainage regimes.

3.1.3 On the basis of this information and paying due regard to any Environmental / Topographical constraints associated with the site, examination of available options for the satisfactory disposal of surface water flows.

3.1.4 Based on these investigations a preferred Surface Water Management Plan is to be developed for later detailed design development.

4.0 EXISTING SURFACE WATER DRAINAGE ARRANGEMENTS

4.1 Drainage Overview

4.1.1 The drainage strategy for Phases 1 & 2 has been taken forward by the developer to provide surface water attenuation in Phase 1, which allows for a future restricted discharge connection from Phase 2.

4.1.2 The detailed drainage design for phase 1 was undertaken by Wavin and provided for a restricted discharge of 3l/s from Phase 2. The volume of attenuation provided on Phase 1 was 50.54m^3 in the form of its Aquacell units.

4.1.3 Attenuation calculations provided by Wavin include impermeable driveways. This avoids any potential of the attenuation system being overloaded if permeable paving had been converted to impermeable at a future date.

4.1.4 A copy of the Phase 1 drainage design is contained in Appendix B.

5.0 PROPOSED DRAINAGE ARRANGEMENTS

5.1 Proposed Surface Water Drainage Arrangements

5.1.1 The current site area is 0.73ha of which 100% constitutes as green field. The development proposal is comprised of 63% of landscaped permeable area and 37% of hard surface equivalent to 0.27ha. Hence, the development proposals for the site will result in a significant increase in impermeable area and therefore an increase in the peak surface water run-off rates and volume from the site.

5.1.2 The XP Solutions WinDes software package has been used to calculate the volume of surface water attenuation required on Phase 2. This has been calculated at 158m^3 for the 1 in 100 year + 30% climate change event.

5.1.3 Surface water run-off from Phase 2 is restricted to 3l/s by the use of a flow control.

5.1.4 As with Phase 1, and noted in item 4.1.3 above, the surface water attenuation on Phase 2 has catered for impermeable driveways.

5.1.5 A copy of the calculations is contained in Appendix C.

5.1.6 Preliminary drainage proposals to show the potential location for the surface water attenuation are shown on drawing number TC_P5875_16_001 – Preliminary Surface Water Atteunuation. A copy of the drawing is contained in Appendix D.

6.0 FLOOD RISK

6.1 Historic Flooding

6.1.1 Lancashire County Council has reported that the general area of the site experienced flooding over the Christmas period of December 2015. It has been confirmed by the developer that the site was not subject to flooding during this period.

6.1.2 From local knowledge it is understood that the area around Catlow Terrace, in Barrow, was flooded from the effect of Barrow Brook overflowing.

6.2 Culverted Watercourse

6.2.1 Beyond the proposed Phase 2 development and approximately 50m to the south of Phase 1, the open watercourse becomes culverted. From correspondence with the client, the watercourse is approximately 440mm diameter (nominal 450mm). It is also understood that water flows during the Christmas period of 2015 were contained within the banks of the watercourse. No further investigation has been undertaken for this watercourse / culvert.

6.2.2 Flows from the combined Phase 1-2 development have been restricted to 5l/s to minimise the flood risk to the area.

7.0 CONCLUSIONS

7.1 Surface Water Drainage

7.1.1 By restricting the surface water run-off from Phase 2 to 3 l/s and connecting into the Phase 1 attenuation, the development proposals do not represent an increased flood risk to others. The rate of discharge to the watercourse will not increase the flow rate discharging from Phase 1 of 5 l/s.

7.1.2 Subject to the above, the development proposals should be considered satisfactory in respect of the disposal surface water run-off from the development.

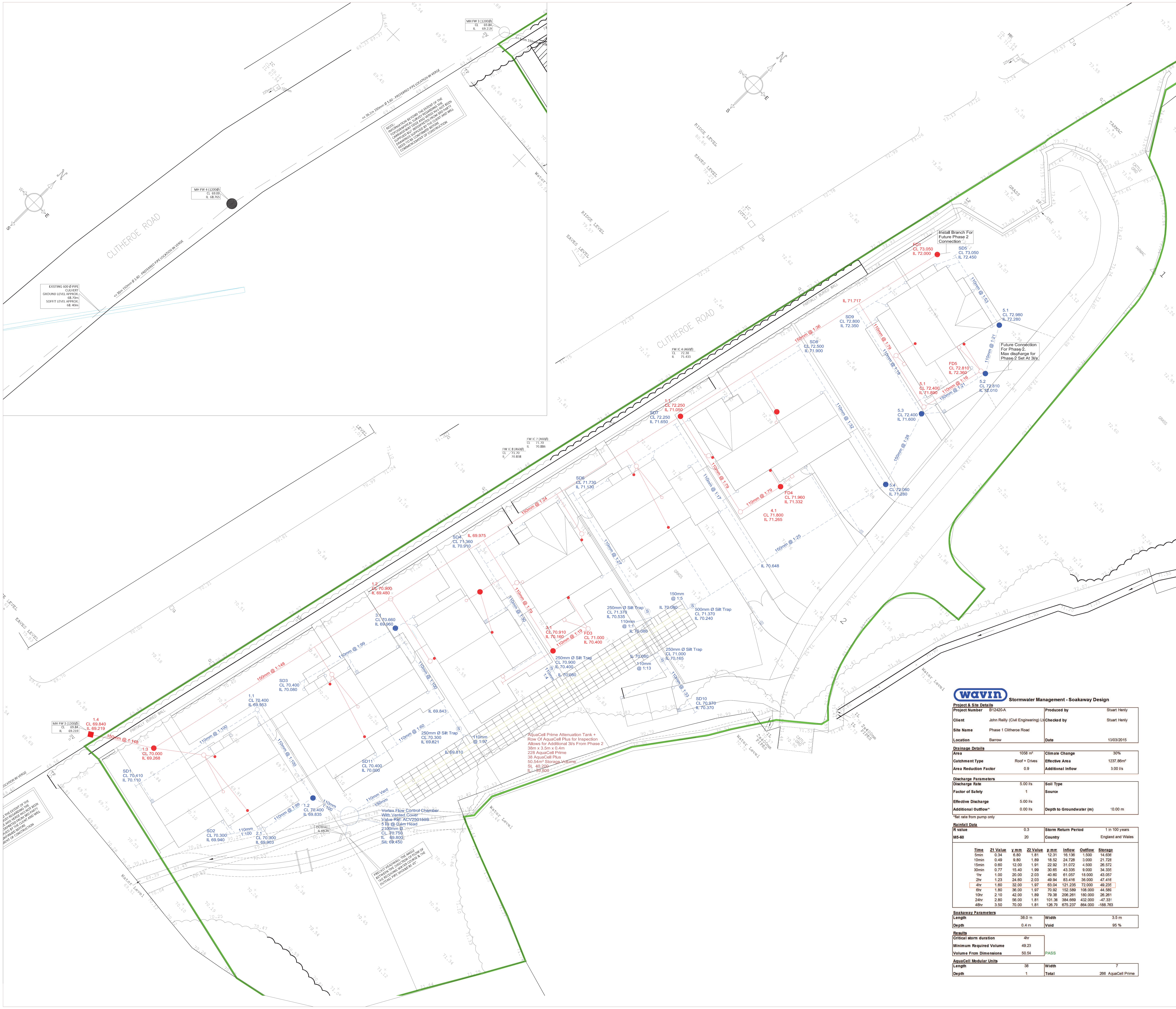
APPENDIX A

Existing and Proposed Layouts

Project
Proposed Development a
Clitheroe Road, Barrow –
Title
Proposed Site L
PWL
ARCHITECTS
The Studio 29 Bent Lane Leyland
Tel 01772 467404 E Mail in
Scale
1:200@A1
Date
April 2016
Drawn
PL
Drwg No
1152-PL-03
0
4m
8m
12m
16m
Materials:
block paving parking areas
tarmac to adopted highway standards
lawned private garden
paving flags
lawned private garden
1800mm high close boarded timber fence between plots.
existing established planting to boundary to be retained where possible
refer to specialist details for landscaping proposals
2.1m stone wall to rear garden
5m wide road with 2m footway / service strip
0.9m stone wall to site frontage
new site entrance
existing lamp post
4 x 60m visibility splay
CLITHEROE ROAD
new footpath to site frontage constructed to adoptable standards
existing low level stone wall
defined right of way
bins
garage
150mm
225mm
1
2
3
4
5
6
7
8
9
N

APPENDIX B

Phase 1 Drainage Plan



OsmaDrain

Notice: This drawing and accompanying schedule are provided subject to the following:-

The layout drawing and the accompanying schedule of products have been prepared only as an illustration.

The layout drawing illustrates a drainage system using Wavin's products. The schedule of products is merely an estimate of the Wavin products that might be needed to construct a drainage system in accordance with the layout drawing. The layout drawing should not be used for any other purpose. In particular, it should not be used as a plan for construction without further consultation with Wavin.

Wavin makes no warranty, guarantee or representation in relation to the suitability of the layout drawing for a particular scheme and accepts no responsibility for any use of the layout drawing other than for the purpose for which it was prepared, save where Wavin have expressly consented to such use.

OsmaDrain Key

- SHALLOW INSPECTION CHAMBER (Max 600mm deep)
- UNIVERSAL INSPECTION CHAMBER (Max 1.2m deep)
- NON-ENTRY INSPECTION CHAMBER (Max 3m deep)
- RANGE 600 INSPECTION CHAMBER (Max 5m deep)
- TRADITIONAL MANHOLE
- FOUL WATER DRAIN
- SURFACE WATER DRAIN
- FOUL WATER SEWER
- SURFACE WATER SEWER
- SILT TRAP
- RODDING POINT
- RWP
- GULLY
- WC/STUB WASTE INTERNALLY - VENT PIPE EXT.
- SOIL AND VENT PIPE

MANHOLE SCHEDULE ABBREVIATIONS :

RDP	RODDING POINT
SIC	SHALLOW INSP. CHAMBER
UIC	UNIVERSAL INSP. CHAMBER
NIC	NON ENTRY INSPECTION CHAMBER
TRA	TRADITIONAL MANHOLE
WAJ	WAVIN ACCESS JUNCTION
SAJ	SEALED ACCESS JUNCTION

ALL DRAINAGE PIPEWORK TO BE 110mm Ø OSMADRAIN UNLESS OTHERWISE STATED

Stormwater Management - Soakaway Design

Project & Site Details

Project Number	B12420-A	Produced by	Stuart Henly
Client	John Reilly (Civil Engineering) Lt	Checked by	Stuart Henly
Site Name	Phase 1 Clitheroe Road		
Location	Barrow	Date	13/03/2015

Drainage Details

Area	1058 m²	Climate Change	30%
Catchment Type	Roof + Drives	Effective Area	1237.86m²
Area Reduction Factor	0.9	Additional Inflow	3.00 l/s

Discharge Parameters

Discharge Rate	5.00 l/s	Soil Type	
Factor of Safety	1	Source	
Effective Discharge	5.00 l/s		
Additional Outflow*	0.00 l/s	Depth to Groundwater (m)	10.00 m

*flat rate from pump only

Rainfall Data

R value	0.3	Storm Return Period	1 in 100 years
M5-60	20	Country	England and Wales

Time	Z1 Value	y mm	Z2 Value	p mm	Inflow	Outflow	Storage
5min	0.34	6.80	1.81	12.31	16.136	1.500	14.636
10min	0.49	9.80	1.89	18.52	24.728	3.000	21.728
15min	0.60	12.00	1.91	22.92	31.072	4.500	26.572
30min	0.77	15.40	1.99	30.65	43.335	9.000	34.335
1hr	1.00	20.00	2.03	40.60	61.057	18.000	43.057
2hr	1.23	24.60	2.03	49.94	83.416	36.000	47.416
4hr	1.60	32.00	1.97	63.04	121.235	72.000	49.235
6hr	1.80	36.00	1.97	70.92	152.589	108.000	44.589
10hr	2.10	42.00	1.89	79.38	206.261	180.000	26.261
24hr	2.80	56.00	1.81	101.36	384.669	432.000	-47.331
48hr	3.50	70.00	1.81	126.70	675.237	864.000	-188.763

Soakaway Parameters

Length	38.0 m	Width	3.5 m
Depth	0.4 m	Void	95 %

Results

Critical storm duration	4hr
Minimum Required Volume	49.23
Volume From Dimensions	50.54

PASS

AquaCell Modular Units

Length	38	Width	7
Depth	1	Total	266 AquaCell Prime

Rev	By	Description	Date

Technical Design Department
Parsonage Way
Chippenham
SN15 5PN
Tel (01249) 766655
Fax (01249) 766653

Project	Phase 1 Clitheroe Road Barrow
Client	John Reilly (Civil Engineering)Ltd Chorley PR7 6AE

Drawing No	Revision	Scale
B12420-A	-	1:200

Drawn by	Checked by	Date completed	Sheet no
S.Henly		13/03/2015	1

APPENDIX C

Phase 2 Surface Water Calculations

Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	72.285	0.067	1.6	13.2	O K
30 min Summer	72.304	0.086	2.1	17.2	O K
60 min Summer	72.323	0.105	2.5	21.0	O K
120 min Summer	72.341	0.123	2.6	24.5	O K
180 min Summer	72.351	0.133	2.7	26.5	O K
240 min Summer	72.356	0.138	2.7	27.4	O K
360 min Summer	72.358	0.140	2.7	28.0	O K
480 min Summer	72.357	0.139	2.7	27.7	O K
600 min Summer	72.354	0.136	2.7	27.1	O K
720 min Summer	72.350	0.132	2.7	26.4	O K
960 min Summer	72.342	0.124	2.6	24.7	O K
1440 min Summer	72.326	0.108	2.5	21.5	O K
2160 min Summer	72.311	0.093	2.3	18.6	O K
2880 min Summer	72.301	0.083	2.0	16.6	O K
4320 min Summer	72.289	0.071	1.7	14.0	O K
5760 min Summer	72.281	0.063	1.4	12.5	O K
7200 min Summer	72.276	0.058	1.3	11.5	O K
8640 min Summer	72.272	0.054	1.1	10.7	O K
10080 min Summer	72.269	0.051	1.0	10.1	O K
15 min Winter	72.292	0.074	1.8	14.8	O K
30 min Winter	72.315	0.097	2.3	19.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	28.172	0.0	13.2	21
30 min Summer	19.178	0.0	18.3	34
60 min Summer	12.800	0.0	25.2	60
120 min Summer	8.412	0.0	33.2	92
180 min Summer	6.562	0.0	38.9	128
240 min Summer	5.468	0.0	43.3	162
360 min Summer	4.212	0.0	50.1	232
480 min Summer	3.501	0.0	55.5	298
600 min Summer	3.033	0.0	60.2	364
720 min Summer	2.699	0.0	64.3	430
960 min Summer	2.245	0.0	71.3	554
1440 min Summer	1.728	0.0	82.3	796
2160 min Summer	1.332	0.0	95.7	1152
2880 min Summer	1.109	0.0	106.2	1524
4320 min Summer	0.853	0.0	122.2	2232
5760 min Summer	0.706	0.0	135.5	2944
7200 min Summer	0.610	0.0	146.3	3672
8640 min Summer	0.541	0.0	155.7	4408
10080 min Summer	0.487	0.0	163.2	5144
15 min Winter	28.172	0.0	14.9	21
30 min Winter	19.178	0.0	20.6	34

Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	72.337	0.119	2.6	23.8	O K
120 min Winter	72.356	0.138	2.7	27.6	O K
180 min Winter	72.366	0.148	2.7	29.4	O K
240 min Winter	72.369	0.151	2.7	30.1	O K
360 min Winter	72.368	0.150	2.7	29.8	O K
480 min Winter	72.362	0.144	2.7	28.8	O K
600 min Winter	72.355	0.137	2.7	27.4	O K
720 min Winter	72.348	0.130	2.7	25.9	O K
960 min Winter	72.334	0.116	2.6	23.1	O K
1440 min Winter	72.314	0.096	2.3	19.2	O K
2160 min Winter	72.298	0.080	1.9	15.8	O K
2880 min Winter	72.288	0.070	1.7	13.9	O K
4320 min Winter	72.277	0.059	1.3	11.7	O K
5760 min Winter	72.271	0.053	1.1	10.4	O K
7200 min Winter	72.266	0.048	0.9	9.6	O K
8640 min Winter	72.263	0.045	0.8	8.9	O K
10080 min Winter	72.261	0.043	0.8	8.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	12.800	0.0	28.2	60
120 min Winter	8.412	0.0	37.2	98
180 min Winter	6.562	0.0	43.7	138
240 min Winter	5.468	0.0	48.6	176
360 min Winter	4.212	0.0	56.2	250
480 min Winter	3.501	0.0	62.3	320
600 min Winter	3.033	0.0	67.5	388
720 min Winter	2.699	0.0	72.1	454
960 min Winter	2.245	0.0	79.9	578
1440 min Winter	1.728	0.0	92.2	820
2160 min Winter	1.332	0.0	107.2	1172
2880 min Winter	1.109	0.0	119.0	1532
4320 min Winter	0.853	0.0	137.0	2252
5760 min Winter	0.706	0.0	151.7	2936
7200 min Winter	0.610	0.0	163.8	3744
8640 min Winter	0.541	0.0	174.4	4416
10080 min Winter	0.487	0.0	182.9	5112

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.300	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.267

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.133	4	8	0.134

Model Details

Storage is Online Cover Level (m) 73.650

Tank or Pond Structure

Invert Level (m) 72.218

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	200.0	0.400	200.0	0.800	200.0	0.801	0.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0082-3000-1000-3000
Design Head (m)	1.000
Design Flow (l/s)	3.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	82
Invert Level (m)	72.218
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	3.0
Flush-Flo™	0.299	3.0
Kick-Flo®	0.621	2.4
Mean Flow over Head Range	-	2.6

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.4	1.200	3.2	3.000	5.0	7.000	7.4
0.200	2.9	1.400	3.5	3.500	5.3	7.500	7.7
0.300	3.0	1.600	3.7	4.000	5.7	8.000	7.9
0.400	2.9	1.800	3.9	4.500	6.0	8.500	8.1
0.500	2.8	2.000	4.1	5.000	6.3	9.000	8.3
0.600	2.5	2.200	4.3	5.500	6.6	9.500	8.6
0.800	2.7	2.400	4.5	6.000	6.9		
1.000	3.0	2.600	4.7	6.500	7.2		

Summary of Results for 30 year Return Period (+10%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	72.398	0.180	2.8	35.9	O K
30 min Summer	72.459	0.241	2.9	48.1	O K
60 min Summer	72.521	0.303	3.0	60.5	O K
120 min Summer	72.576	0.358	3.0	71.4	O K
180 min Summer	72.596	0.378	3.0	75.4	O K
240 min Summer	72.604	0.386	3.0	77.1	O K
360 min Summer	72.611	0.393	3.0	78.6	O K
480 min Summer	72.611	0.393	3.0	78.4	O K
600 min Summer	72.606	0.388	3.0	77.5	O K
720 min Summer	72.598	0.380	3.0	75.9	O K
960 min Summer	72.579	0.361	3.0	72.2	O K
1440 min Summer	72.537	0.319	3.0	63.8	O K
2160 min Summer	72.478	0.260	3.0	52.0	O K
2880 min Summer	72.431	0.213	2.9	42.4	O K
4320 min Summer	72.366	0.148	2.7	29.5	O K
5760 min Summer	72.330	0.112	2.6	22.4	O K
7200 min Summer	72.314	0.096	2.3	19.0	O K
8640 min Summer	72.303	0.085	2.1	17.0	O K
10080 min Summer	72.296	0.078	1.9	15.4	O K
15 min Winter	72.420	0.202	2.9	40.4	O K
30 min Winter	72.489	0.271	3.0	54.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	75.891	0.0	37.0	21
30 min Summer	51.790	0.0	50.8	36
60 min Summer	33.892	0.0	67.4	64
120 min Summer	21.483	0.0	85.5	122
180 min Summer	16.223	0.0	96.9	180
240 min Summer	13.255	0.0	105.6	210
360 min Summer	9.958	0.0	119.1	274
480 min Summer	8.116	0.0	129.4	342
600 min Summer	6.920	0.0	137.9	410
720 min Summer	6.072	0.0	145.3	480
960 min Summer	4.936	0.0	157.4	616
1440 min Summer	3.681	0.0	176.0	882
2160 min Summer	2.739	0.0	197.1	1260
2880 min Summer	2.219	0.0	212.8	1616
4320 min Summer	1.649	0.0	236.9	2332
5760 min Summer	1.336	0.0	256.7	3000
7200 min Summer	1.136	0.0	272.6	3680
8640 min Summer	0.994	0.0	286.3	4408
10080 min Summer	0.889	0.0	298.3	5144
15 min Winter	75.891	0.0	41.6	21
30 min Winter	51.790	0.0	57.0	35

Summary of Results for 30 year Return Period (+10%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	72.561	0.343	3.0	68.5	O K
120 min Winter	72.626	0.408	3.0	81.5	O K
180 min Winter	72.652	0.434	3.0	86.8	O K
240 min Winter	72.664	0.446	3.0	89.1	O K
360 min Winter	72.668	0.450	3.0	89.8	O K
480 min Winter	72.665	0.447	3.0	89.2	O K
600 min Winter	72.655	0.437	3.0	87.4	O K
720 min Winter	72.642	0.424	3.0	84.8	O K
960 min Winter	72.610	0.392	3.0	78.4	O K
1440 min Winter	72.542	0.324	3.0	64.6	O K
2160 min Winter	72.452	0.234	2.9	46.8	O K
2880 min Winter	72.388	0.170	2.8	34.0	O K
4320 min Winter	72.322	0.104	2.5	20.7	O K
5760 min Winter	72.303	0.085	2.1	16.8	O K
7200 min Winter	72.292	0.074	1.8	14.6	O K
8640 min Winter	72.284	0.066	1.5	13.2	O K
10080 min Winter	72.280	0.062	1.4	12.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	33.892	0.0	75.5	64
120 min Winter	21.483	0.0	95.8	120
180 min Winter	16.223	0.0	108.6	176
240 min Winter	13.255	0.0	118.3	232
360 min Winter	9.958	0.0	133.4	296
480 min Winter	8.116	0.0	145.0	372
600 min Winter	6.920	0.0	154.5	448
720 min Winter	6.072	0.0	162.7	524
960 min Winter	4.936	0.0	176.4	672
1440 min Winter	3.681	0.0	197.2	944
2160 min Winter	2.739	0.0	220.8	1324
2880 min Winter	2.219	0.0	238.4	1672
4320 min Winter	1.649	0.0	265.5	2292
5760 min Winter	1.336	0.0	287.5	2992
7200 min Winter	1.136	0.0	305.3	3736
8640 min Winter	0.994	0.0	320.8	4416
10080 min Winter	0.889	0.0	334.3	5120

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.300	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+10

Time Area Diagram

Total Area (ha) 0.267

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.133	4	8	0.134

Model Details

Storage is Online Cover Level (m) 73.650

Tank or Pond Structure

Invert Level (m) 72.218

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	200.0	0.400	200.0	0.800	200.0	0.801	0.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0082-3000-1000-3000
Design Head (m)	1.000
Design Flow (l/s)	3.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	82
Invert Level (m)	72.218
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	3.0
Flush-Flo™	0.299	3.0
Kick-Flo®	0.621	2.4
Mean Flow over Head Range	-	2.6

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.4	1.200	3.2	3.000	5.0	7.000	7.4
0.200	2.9	1.400	3.5	3.500	5.3	7.500	7.7
0.300	3.0	1.600	3.7	4.000	5.7	8.000	7.9
0.400	2.9	1.800	3.9	4.500	6.0	8.500	8.1
0.500	2.8	2.000	4.1	5.000	6.3	9.000	8.3
0.600	2.5	2.200	4.3	5.500	6.6	9.500	8.6
0.800	2.7	2.400	4.5	6.000	6.9		
1.000	3.0	2.600	4.7	6.500	7.2		

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	72.497	0.279	3.0	55.6	O K
30 min Summer	72.598	0.380	3.0	75.8	O K
60 min Summer	72.706	0.488	3.0	97.4	O K
120 min Summer	72.808	0.590	3.0	118.0	O K
180 min Summer	72.856	0.638	3.0	127.6	O K
240 min Summer	72.882	0.664	3.0	132.7	O K
360 min Summer	72.903	0.685	3.0	136.8	O K
480 min Summer	72.903	0.685	3.0	136.8	O K
600 min Summer	72.898	0.680	3.0	135.9	O K
720 min Summer	72.890	0.672	3.0	134.3	O K
960 min Summer	72.870	0.652	3.0	130.2	O K
1440 min Summer	72.815	0.597	3.0	119.2	O K
2160 min Summer	72.728	0.510	3.0	101.8	O K
2880 min Summer	72.649	0.431	3.0	86.1	O K
4320 min Summer	72.522	0.304	3.0	60.8	O K
5760 min Summer	72.438	0.220	2.9	43.8	O K
7200 min Summer	72.383	0.165	2.8	33.0	O K
8640 min Summer	72.349	0.131	2.7	26.0	O K
10080 min Summer	72.327	0.109	2.5	21.7	O K
15 min Winter	72.531	0.313	3.0	62.6	O K
30 min Winter	72.645	0.427	3.0	85.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	116.002	0.0	57.0	22
30 min Summer	79.998	0.0	78.9	36
60 min Summer	52.662	0.0	104.9	66
120 min Summer	33.322	0.0	132.9	124
180 min Summer	24.998	0.0	149.5	184
240 min Summer	20.313	0.0	162.0	242
360 min Summer	15.144	0.0	181.2	360
480 min Summer	12.271	0.0	195.8	438
600 min Summer	10.413	0.0	207.7	498
720 min Summer	9.099	0.0	217.8	562
960 min Summer	7.345	0.0	234.4	694
1440 min Summer	5.419	0.0	259.2	964
2160 min Summer	3.986	0.0	287.0	1344
2880 min Summer	3.200	0.0	307.2	1732
4320 min Summer	2.349	0.0	337.9	2460
5760 min Summer	1.888	0.0	362.8	3120
7200 min Summer	1.594	0.0	382.9	3816
8640 min Summer	1.389	0.0	400.2	4496
10080 min Summer	1.237	0.0	415.4	5152
15 min Winter	116.002	0.0	63.9	22
30 min Winter	79.998	0.0	88.4	36

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	72.769	0.551	3.0	110.0	O K
120 min Winter	72.890	0.672	3.0	134.2	O K
180 min Winter	72.945	0.727	3.0	145.3	O K
240 min Winter	72.976	0.758	3.0	151.4	O K
360 min Winter	73.005	0.787	3.0	157.3	O K
480 min Winter	73.010	0.792	3.0	158.2	O K
600 min Winter	73.002	0.784	3.0	156.7	O K
720 min Winter	72.990	0.772	3.0	154.3	O K
960 min Winter	72.964	0.746	3.0	149.0	O K
1440 min Winter	72.892	0.674	3.0	134.6	O K
2160 min Winter	72.749	0.531	3.0	106.1	O K
2880 min Winter	72.624	0.406	3.0	81.1	O K
4320 min Winter	72.450	0.232	2.9	46.3	O K
5760 min Winter	72.361	0.143	2.7	28.4	O K
7200 min Winter	72.321	0.103	2.5	20.4	O K
8640 min Winter	72.307	0.089	2.2	17.7	O K
10080 min Winter	72.298	0.080	1.9	15.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	52.662	0.0	117.5	64
120 min Winter	33.322	0.0	148.8	122
180 min Winter	24.998	0.0	167.5	180
240 min Winter	20.313	0.0	181.5	238
360 min Winter	15.144	0.0	203.0	350
480 min Winter	12.271	0.0	219.4	458
600 min Winter	10.413	0.0	232.6	560
720 min Winter	9.099	0.0	243.9	586
960 min Winter	7.345	0.0	262.5	736
1440 min Winter	5.419	0.0	290.3	1054
2160 min Winter	3.986	0.0	321.5	1468
2880 min Winter	3.200	0.0	344.1	1844
4320 min Winter	2.349	0.0	378.6	2512
5760 min Winter	1.888	0.0	406.3	3168
7200 min Winter	1.594	0.0	428.8	3744
8640 min Winter	1.389	0.0	448.3	4416
10080 min Winter	1.237	0.0	465.4	5136

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.300	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 0.267

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.133	4	8	0.134

Model Details

Storage is Online Cover Level (m) 73.650

Tank or Pond Structure

Invert Level (m) 72.218

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	200.0	0.400	200.0	0.800	200.0	0.801	0.0

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0082-3000-1000-3000
Design Head (m)	1.000
Design Flow (l/s)	3.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	82
Invert Level (m)	72.218
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	3.0
Flush-Flo™	0.299	3.0
Kick-Flo®	0.621	2.4
Mean Flow over Head Range	-	2.6

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.4	1.200	3.2	3.000	5.0	7.000	7.4
0.200	2.9	1.400	3.5	3.500	5.3	7.500	7.7
0.300	3.0	1.600	3.7	4.000	5.7	8.000	7.9
0.400	2.9	1.800	3.9	4.500	6.0	8.500	8.1
0.500	2.8	2.000	4.1	5.000	6.3	9.000	8.3
0.600	2.5	2.200	4.3	5.500	6.6	9.500	8.6
0.800	2.7	2.400	4.5	6.000	6.9		
1.000	3.0	2.600	4.7	6.500	7.2		

APPENDIX D

Proposed Phase 2 Surface Water Attenuation Plan

KEY

Symbol	Description
65.700 / (65.700)	FW / SW Drainage with invert levels
	Proposed Flow Control Chamber (Private)
RE (65.000)	Rodding Eye with Invert Level
DC	Linear Drainage Channel
G	Road Gully (Private)
G	Yard Gully
RWP	Rain Water Pipe
BIG	Back Inlet Gully
TFG	Trapped Floor Gully
DP	Discharge Pipe
SVP/SS	Soil Vent Pipe / Stub Stack
65.700 / (65.700)	320Ø PPIC
65.700 / (65.700)	460Ø PPIC
65.700 / (65.700)	600Ø PPIC
65.700 / (65.700)	Demarcation Chamber

Private Drainage Notes

1. All house drains to be 100mmØ or 150mmØ Clay pipes to BS EN 295, or 110mmØ or 160mmØ PVC-u pipes to BS4660.
2. All RWPs to discharge to Roddable Trapped Gullies. All foul gullies to be trapped back inlet type.
3. Inspection chambers in driveways to have class B125 cover and frame.
4. All pipe work and fittings to be installed in accordance with manufacturers instructions.
5. All drainage to comply with relevant British Standards, current Building Regulations Part H and NHBC Standards.
6. Limestone pipe bedding will not be permitted in acidic ground water conditions.
7. All dimensions to be in millimetres.

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ITEM	HAZARD IDENTIFICATION
1	HAZARD DESCRIPTION...

REVISIONS

REV	DATE	DESCRIPTION	DRAWN BY	CHECKED BY

DRAWING STATUS:
DRAWING STATUS

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CLIENT:
REILLY DEVELOPMENTS

PROJECT:
CLITHEROE ROAD, BARROW (PHASE 2)

DRAWING TITLE:
PRELIMINARY SURFACE WATER ATTENUATION

DATE CREATED:	DRAWING SCALE:	DRAWN BY:	CHECKED BY:	QA CATEGORY:
16.08.2016	1:200	JGM	INT	QA1

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