Outline Surface Water Drainage Design Report

for the

New Poultry Unit

on land at

Poplar Farm, Hagnaby Lane,

Keal Cotes, Spilsby,

Lincolnshire,

PE23 4AH.

Prepared for

Wright Eggs Ltd

Issue 01

Sept 2024

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Date	:	24th September 2024

1.0 INTRODUCTION

1.1 Planning Approval S/204/00755/24 was obtained for the erection of a free range egg production poultry unit with ancillary structures and hardstanding for a site at Poplar Farm, Hagnaby Lane, Keal Cotes, Lincolnshire PE23 4AH.

1.2 Condition 5 of the Planning Approval states that:

The permitted development shall be undertaken in accordance with a surface water drainage scheme which shall first have been approved in writing by the Local Planning Authority. The scheme shall:

- *be based on sustainable drainage principles and an assessment of the hydrological and hydrogeological context of the development;*
- *provide flood exceedance routing for storm event greater than 1 in 100 year;*
- *provide details of how run-off will be safely conveyed and attenuated during storms up to and including the 1 in 100 year critical storm event, with an allowance for climate change, from all hard surfaced areas within the development into the existing local drainage infrastructure and watercourse system without exceeding the run-off rate for the undeveloped site;*
- *provide attenuation details and discharge rates;*
- *provide details of the timetable for and any phasing of implementation for the drainage scheme; and*
- *provide details of how the scheme shall be maintained and managed over the lifetime of the development, including any arrangements for adoption by any public body or Statutory Undertaker and any other arrangements required to secure the operation of the drainage system throughout its lifetime.*

No part of the development shall be occupied until the approved scheme has been completed or provided on the site in accordance with the approved phasing. The approved scheme shall be retained and maintained in full, in accordance with the approved details.

1.3 In addition Planning Condition 3 states that

a Construction Plan and Method Statement be approved prior to commencing construction and requires it to include

- *strategy stating how surface water run off on and from the development will be managed during construction and protection measures for any sustainable drainage features. This should include drawing(s) showing how the drainage systems (temporary or permanent) connect to an outfall (temporary or permanent) during construction.*

1.4 George Shuttleworth Ltd (GSL) has been appointed on behalf of the applicant to design the surface water drainage in sufficient detail to allow discharge of of Planning Condition.4

1.5 This report contains information on the design of the proposed surface water drainage system to allow discharge of the planning condition. The report also contains information on surface water management during construction which can be used by others to produce a Construction Plan and Method Statement to discharge Planning Condition 3..

2.0 SUSTAINABLE DRAINAGE SYSTEMS

2.1 Sustainable Drainage Systems (SuDS) have been considered for this development.

2.2 Following the preferred hierarchy of drainage stated in Part H of the Building Regulations and The Suds Manual the following disposal routes were considered

a) Disposal via Infiltration

b) Disposal to a Watercourse

c) Disposal to Surface Water Sewer

2.3 The existing site contours and key drainage features are shown on Drawing 805-001 contained in Appendix 1.

2.4 No site-specific site investigation information is available for the site but a Desktop Geotechnical Study was undertaken.

Desktop Geotechnical Study

2.5 From the HR Wallingford Greenfield run-off Calculation Tool available on their web-site, the tool identifies the site as having Soil Type 2 on the Winter Rainfall Acceptance Potential (WRAP) Map. Soil Type 2 has relatively good drainage characteristics and is normally suitable for infiltration drainage systems. A copy of the Greenfield Run-off Calculation Sheet is provided in Appendix 1.

2.6 A search of the borehole records on the BGS web-site revealed that there are no freely available four boreholes scans within 1km of the site.

2.7 There are a number of drainage ditches and dykes which provide surface water drainage in the area. The ditches and dykes are shown on Drawing 805-001 contained in Appendix 1.

2.8 The applicant has provided details of an extensive land drainage system which was installed to drain the fields to the surrounding ditches. Copies of the land drainage plans are provided in Appendix 1.

2.9 From this Desk Top Study, it is concluded that any infiltration systems installed would inevitably drain to a large extent ditches through existing the land drainage system, This may have a detrimental effect on the existing land drainage system and as such it would be preferably to have a controlled discharge direct to the watercourse.

Disposal to a Watercourse

2.10 Following the hierarchy of drainage, the next preferred solution is disposal to a watercourse. Therefore, a surface water drainage system, discharging to the watercourse to the west of the site adjacent to Hagnaby Lane, at a controlled rate, is proposed.

2.11 It is proposed that the maximum discharge is restricted to 5.0 l/s, which is the minimum practical size for a discharge control device.

2.12 It is understood that this watercourse discharges to a pipe that connects to a culvert draining the runway at the former RAF East Kirkby site. It is understood that the culvert discharges to Hagnaby Beck, which eventually discharges to the East Fen Catchwater Drain

2.13 The East Fen Catchwater Drain is operated and maintained by the Witham Fourth Internal Drainage Board and permission will be required to discharge into their extended area,

3.0 PROPOSED SURFACE WATER DRAINAGE SYSTEM

3.1 The intention of this report is to demonstrate that it is practical to provide a surface water drainage system that meets the requirements of the LLFA. The detailed design of the system will need to be undertaken before Building Regulations submission stage and follow the principles contained in this report.

3.2 An outline of the proposed surface water drainage system is shown on Drawing 805-002 contained in Appendix 1.

Surface Water Run-Off Generation

3.3 The proposed new poultry unit will create the following artificial surfaces potentially generating surface water run-off

a) 2790m2 of new roofs

b) 906m2 of new concrete hardstandings

3.4 The concrete hardstanding will be accessed via an existing compacted stone access track from the public road will not be positively drained.

3.5 A compacted stone access track, nominally 3.0m wide, shall be constructed around the building. It shall not be positively drained and will not contribute to surface water run-off.

Operational Restrictions

3.6 The Developer needs to consider the risk of avian flu. Open, normally wet attenuation basins are considered too high risk. Underground crated storage reduces the risk but the costs of providing such storage are relatively high.

3.7 Normally dry open attenuation basins can be used, supplemented with protective netting, if required.

3.8 Due to the proposed free range site operations, any attenuation provided is required to be located as far as practical away from the poultry units.

3.9 In addition, potentially muddied areas such as swales or drainage grips running parallel to the building can cause issues with the birds health and transporting mud etc, into the unit. Therefore buried pipework is required to transport the surface water away from the building.

3.10 The poultry unit is required to have a 150mm fall internally throughout its length to facilitate periodic cleaning operations.

3.11 The external concrete hardstanding will be drained to a buried sealed storage tank when cleaning operations are taking place. The contents will be tankered off site.

3.12 During normal operations the clean run-off from the concrete hardstanding will discharge to the surface water drainage system. The control of the discharge will be via a locked valve documented in the site operational procedures

Site Restrictions

3.13 The concrete hardstanding will be an extension off the existing hardstanding which will dictate the proposed concrete hardstandings and floor level of the new poultry unit.

3.14 As built levels of the existing hardstanding and poultry unit have not been provided and it is recommended that they are checked prior to commencing construction of the new unit.

3.15 There ground levels in the location of the proposed poultry unit fall towards the concrete hardstanding and access track but at a steeper gradient than the proposed poultry unit. This means that the southern end of the new unit will cutting in to the existing ground by a small amount.

3.16 The new poultry unit could potentially disrupt surface water flows and potentially cause some minor ponding in heavy rainfall events. To mitigate for this it is proposed that ground levels are lowered slightly over the proposed pipe trenches to provide a flow path for any surface flows.

3.17 The proposed new poultry unit and drainage pipework may also interfere with the existing land drainage system. Therefore it is also proposed that a land drain is installed around the perimeter of the construction area which picks up any severed land drains and re-connects them to the undisturbed land drainage system.

3.18 Considering the site contours and the existing ditches and dykes the most practical solution is to work with the fall in the building floor and contours and discharge the surface water to the ditch on the north side of the access track.

3.19 To meet the operational requirement of providing any open attenuation as far away from the poultry unit as practical it is proposed to provide any attenuation near to Hagnaby Lane.

3.20 The ditch is approximately 1.0m deep at the eastern end near the proposed poultry unit and falls around 1.0m in the 500m to the Hagnaby Lane, which should provide adequate fall fro the proposed flows in the ditch.

Pipework

3.21 The majority of the surface water generated will be from the poultry shed roofs. Normal practice is to provide 4No down pipes per side at quarter points along the each half of the building. One eight of the roof area is added at each connection point.

3.22 At the Building Regulations Design Figure of 0.014 l/s/m2 this adds 4.9 l/s per connection point. A 150mm pipe laid at 1 in 150 has a capacity of 15.0 l/s and is adequate for the first three lengths of pipe. From this point the pipe size needs to be increased to 225mm laid at 1 in 225mm which as a capacity of 35.0 l/s. This pipe is adequate for the remaining roof drainage pipework but needs to be increased to 300mm diameter laid at 1 in 300 for the last run into the ditch after the hardstanding is connected.

3.23 There should be sufficient fall available for the pipe lengths at the minimum gradient quoted above to provide some cover to the pipes at the upstream ends of the pipework runs.

3.24 Calculations are presented in Appendix 1.

Attenuation

3.25 A rainfall run-off analysis has been undertaken for a range of storms up to the 1 in 100 year plus climate change event. With a peak discharge of 5.0 l/s and an average discharge of 4.25l/s an attenuation volume of 235m3 is required to attenuate all storms. The critical duration storm was 6.0 hours. A copy of the calculation spreadsheet is provided in Appendix 1.

3.26 With the aim of not increasing the potential open water that may attract migrating birds and increase avian flu risk the option of providing attenuation in the existing ditch, along with an existing widened and deepened section near Hagnaby Lane was considered.

3.27 The existing ditch can be widened out to a 1.0m base with 1 in 1.5 side slopes and a constant 1 in 500 longitudinal fall, as shown on Drawing 805-002 contained in Appendix 1.

3.28 The existing widening and deepening of the ditch increases the width to 7.0m over a 13.0m length. Although deeper for silt collection purposes the deepened section toes not provided any further attenuation volume.

3.29 It is proposed to increased the length of the widened section by 7.0m to 20.0m but only t the depth of the incoming ditch

3.30 With a maximum water depth at the Hagnaby Lane end of 600mm an attenuation volume of 255m3 is provided, slightly in excess of the initial estimate of 235m3. The storage depth would reduce to zero at a distance of 300m from the discharge control device near to Hagnaby Lane. Approximately 200m from the poultry unit.

3.31 A more accurate simulation was then undertaken for the 75% winter and 50% summer 1 in 100 plus 40% climate change 6.0 hour storm rain profiles, using the head discharge curve for the proposed discharge control device.

3.32 The simulation showed that for the 1 in 100 year plus climate change 50% summer storm, the widened ditch, shown on the drawings. filled to a maximum depth of 594mm at the outlet which is 98% of design capacity (excluding freeboard). The peak discharge was 4.99 l/s.

3.33 The simulation showed that for the 1 in 100 year plus climate change 75% winter storm, the widened ditch, shown on the drawings, filled to a maximum depth of 591mm which is 97% of design capacity (excluding freeboard). The peak discharge was 4.98 l/s.

3.34 With both storms the depth of water stored in the ditch will reduce to zero at around 300m from the outfall, 200m from the Poultry Unit.

The Water Quality and Suds Treatment

3.35 The run-off entering the surface water drainage system will come from either the building roofs or the concrete aprons around the building.

3.36 Commercial roofs have a low pollution hazard level and treatment of the discharge via a silt trap, cellular crates should provide an adequate level of treatment.

3.37 Initially, the concrete apron to the north of the building could be considered to have a medium pollution hazard level but on closer examination, the majority of the vehicular traffic is during the seven weekly cleaning out exercise when the surface will discharge to a sealed tank.

3.38 For normally operations when the surface discharges to the surface water system there will be minimal vehicular traffic and the pollution hazard level will be low. Flow will pass through a grass filter strip and equivalent of a filter drain, which should provide an adequate level of treatment.

Exceedance flows

3.39 Considering storm events greater than 1 in 100 year plus climate change. For flows in exceedance of pipe capacity the flows will emerge from chambers etc, external to the building and flow overland, following the natural contours to the existing ditch.

3.40 The cleaned out ditch, to bank full, has more than adequate capacity for flows in excess of 1 in 100 year return period.

3.41 If the attenuation storage is filled from storms in exceedance of the design criteria, the discharge control system will have an overflow allowing excess floodwater to flow downstream

Outline Design

3.42 An illustration of the outline design of the proposed surface water drainage system is shown on Drawing 803/003 and 004 provided in Appendix 1.

3.43 The detailed design, (for construction) of the surface water system will need to follow the principles of drainage contained in this report.

4.0 FUTURE MANAGEMENT & MAINTENANCE

4.1 The surface water drainage system will remain in private ownership who shall be responsible for ongoing maintenance.

4.2 The system will require little maintenance.

4.3 Any gullies or channel drain in the hardstanding should be emptied and cleaned out on an annual basis.

4.4 The ditch between the site and Hagnaby Lane will need cleaning out at nomial 5-10 year intervals

4.5 The discharge control device requires little maintenance but should be inspected annually.

5.0 CONSTRUCTION PHASE

5.1 The Construction Phase has the potential to discharge silt laden water. This can be mitigated by the construction of trenches and sumps around the construction area which will intercept any overland flows prior to discharge to the ditches.

5.2 As a back up a temporary dam could be constructed part way along the ditch alongside the access track. The dam should be a maximum of 50% of bank height such that high flows will remain within the ditch.

5.3 The proposed works to widen and clean out the ditch should be undertaken towards the end of the project when construction of the poultry unit and hardstanding is complete and the risk of contaminated discharges has passed.

6.0 APPENDIX 1 SUPPORTING INFORMATION

a) HR Wallingford Greenfield Run-off Calculation

b) Plans of Existing Land Drainage

c) Impermeable Area Calculations

d) Simplified Run-off Analysis to determine Critical Storm

e) Details of Proposed Vortex Control Device

f) Simulation for 75% Winter and 50% Summer Critical Storms

g) Drawing 805-001- Existing Contours and Drainage Features

h) Drawing 805-002 – Proposed Poultry Unit & Outline of Proposed SW Drainage Design

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	George Shuttleworth
Site name:	Keal Cotes
Site location:	Poplar Farm

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site Details

Latitude:	53.13156° N
Longitude:	0.02335° E
Reference:	3205137984
Date:	Aug 28 2024 09:39

Runoff estimation approach IH124

Site characteristics

Total site area (ha): 1.0

Methodology

Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	2	2
HOST class:	N/A	N/A
SPR/SPRHOST:	0.3	0.3

Hydrological characteristics

	Default	Edited
SAAR (mm):	611	611
Hydrological region:	5	5
Growth curve factor 1 year:	0.87	0.87
Growth curve factor 30 years:	2.45	2.45
Growth curve factor 100 years:	3.56	3.56
Growth curve factor 200 years:	4.21	4.21

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

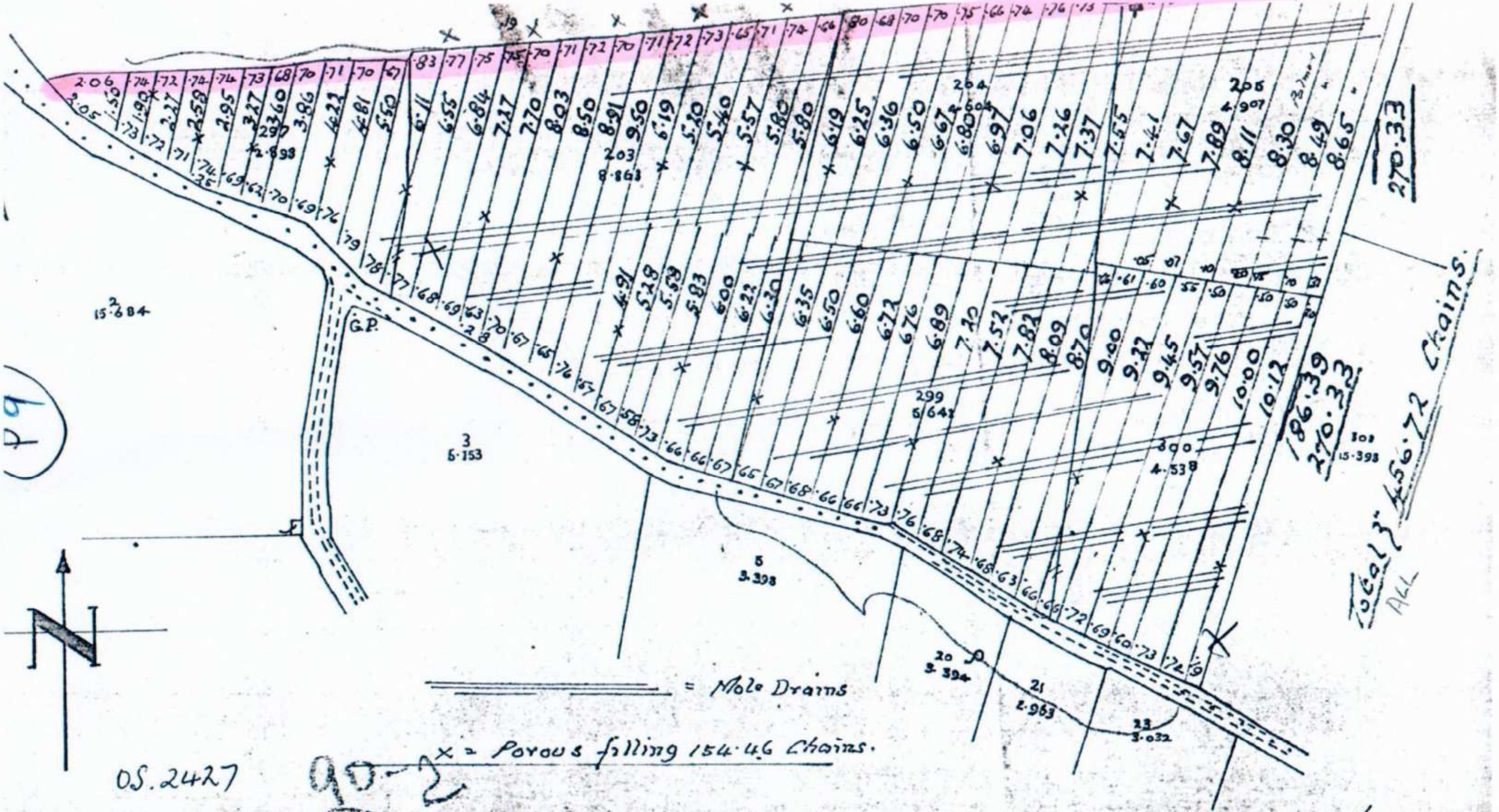
(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited

Q_{BAR} (l/s):	1.55	1.55
1 in 1 year (l/s):	1.35	1.35
1 in 30 years (l/s):	3.81	3.81
1 in 100 year (l/s):	5.53	5.53
1 in 200 years (l/s):	6.54	6.54



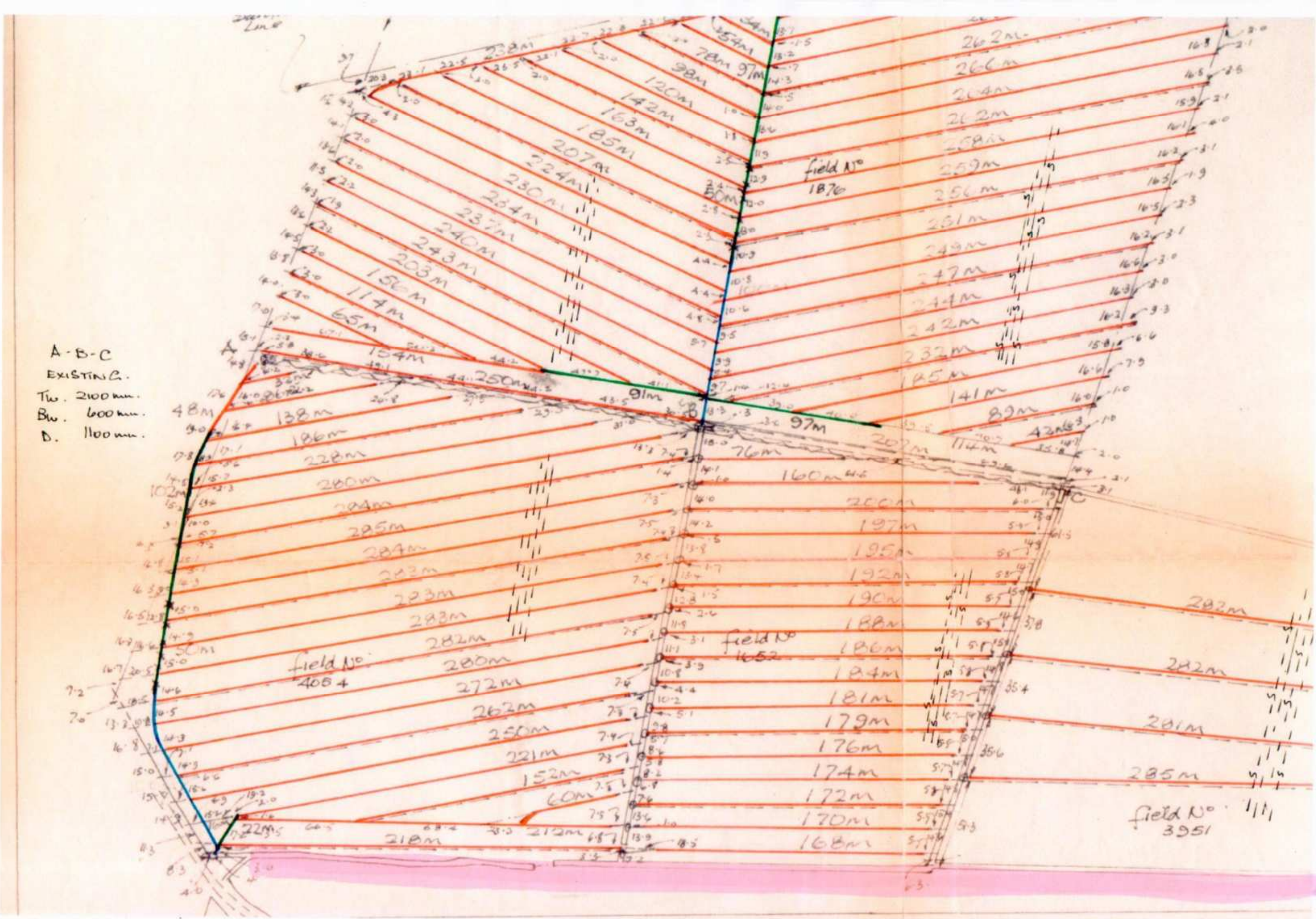
Scale 1/2500

O.S. Sheet Nos. 92-4 • 82-14' 1905 Edition

New 3" Land Drainage Scheme Surveyed and

Certified Correct By:- W. W. Stubbs
West Heal

07905 2508



A-B-C
EXISTING.
Tw. 2100mm.
Bw. 600mm.
D. 1100mm.
field N° 1876
field N° 4054
field N° 1652
field N° 3951
C

ARTIFICIAL SURFACES

Location				Area (m²)
Poultry Units	1	110	25	2772
End Roof	1	1.5	13	19
Concrete Hardstanding	1	1	906	906
Total				3697

CONSIDER DISCHARGE FROM POULTRY UNIT ROOF

Assume Rainwater pipes at Quarter Points		
Roof Area Draining to rainwater Pipe	346.5	m2
Concrete Hardstanding	906	m2

Check Pipe Capacity

Pipe	Area	Cum Area	Run-off at 0.14 l/s/m2	Pipe	Capacity at Min Grad
1	346.5	346.5	4.9	150	15
2	346.5	693	9.7	150	15
3	346.5	1039.5	14.6	150	15
4	346.5	1386	19.4	225	36.5
5	2292	3696.9	51.8	300	63

Check Levels on Longest Pipe Run

Levels	Length	Gradient	
Ditch IL			6.5
Pipe 5	10	300	6.53
Pipe 4	50	225	6.76
Pipe 3	27.5	150	6.64
Pipe 2	27.5	150	6.90
Pipe 1	27.5	150	7.16
Min GL			7.5
Min Cover			0.19

Consider Attenuation in Existing Ditch

Ditch Depth	1	m
Side Slope 1 in	1.5	
Base Width	1	m
Max Water Depth	0.6	m
Ditch Length Available for Storage	300	m
Ditch Slope 1 in	500	m
CSA Deep End	1.14	m2
CSA Shallow end	0	m2
Average CSA	0.57	m2
Storage	171	m3

Ditch Widening Near Road		
Length	20	m2
Width	7	m2
Area	140	m2
Depth	0.6	m
Storage Provided	84.0	m3
Total Storage Provided	255	m3

ATTENUATION & DISCHARGE TO WATERCOURSE

Calculation of Rain Profiles

M5-60	20
r	0.4

D (mins)	15	30	60	120	240	360	720	1440
Z1	0.64	0.81	1	1.21	1.4	1.62	1.8	2.2
M5-D	12.8	16.2	20.0	24.2	28.0	32.4	36.0	44.0
Z2(100)	1.94	1.99	2.03	2.02	2.01	1.95	1.92	1.86
Z2(30)	1.50	1.52	1.53	1.54	1.53	1.51	1.49	1.45
Z2(2)	0.80	0.80	0.81	0.82	0.83	0.83	0.84	0.85
Z2(1)	0.62	0.62	0.64	0.65	0.67	0.68	0.69	0.71
MT-D(100)	24.83	32.24	40.60	48.88	56.28	63.18	69.12	81.84
MT-D(30)	19.20	24.62	30.60	37.15	42.84	48.92	53.64	63.80
MT-D(2)	10.24	12.96	16.20	19.84	23.24	26.89	30.24	37.40
MT-D(1)	7.87	10.04	12.70	15.73	18.76	22.03	24.84	31.24
I(100)	99.33	64.48	40.60	24.44	14.07	10.53	5.76	3.41
I(30)	76.80	49.25	30.60	18.57	10.71	8.15	4.47	2.66
I(2)	40.96	25.92	16.20	9.92	5.81	4.48	2.52	1.56
I(1)	31.49	20.09	12.70	7.87	4.69	3.67	2.07	1.30

Calculation of Flows and Volumes

Contributing Impermeable Area = 3697 m2
Climate Change of 40%
Flows (l/s) = 2.78 x I x A(ha) x Global warming

Storm	15	30	60	120	240	360	720	1440
1 in 100 yr	142.92	92.77	58.42	35.17	20.24	15.15	8.29	4.91
1 in 30 yr	110.50	70.86	44.03	26.72	15.41	11.73	6.43	3.82
2 in 30 yr	58.93	37.29	23.31	14.28	8.36	6.45	3.63	2.24
1 in 1 yr	45.31	28.90	18.27	11.32	6.75	5.28	2.98	1.87

Volume (m3) = Cv x A(ha) x I x D/60 Cv= 1.00

Storm	15	30	60	120	240	360	720	1440
1 in 100 yr	128.52	166.85	210.13	253.01	291.29	327.00	357.74	423.58
1 in 30 yr	99.37	127.45	158.38	192.26	221.73	253.21	277.62	330.21
1 in 2 yr	53.00	67.08	83.85	102.71	120.28	139.18	156.51	193.57
1 in 1 yr	40.74	51.98	65.73	81.41	97.10	114.03	128.56	161.69

Initial Estimate of Balancing Volume Required

For Peak Discharge of 5.00 l/s Av Discharge Factor= 0.85 Av Qout = **4.25** l/s

Storm	15	30	60	120	240	360	720	1440
1 in 100 yr	124.70	159.20	194.83	222.41	230.09	235.20	174.14	56.38
1 in 30 yr	95.55	119.80	143.08	161.66	160.53	161.41	94.02	0.00
1 in 2 yr	49.17	59.43	68.55	72.11	59.08	47.38	0.00	0.00
1 in 1 yr	36.92	44.33	50.43	50.81	35.90	22.23	0.00	0.00

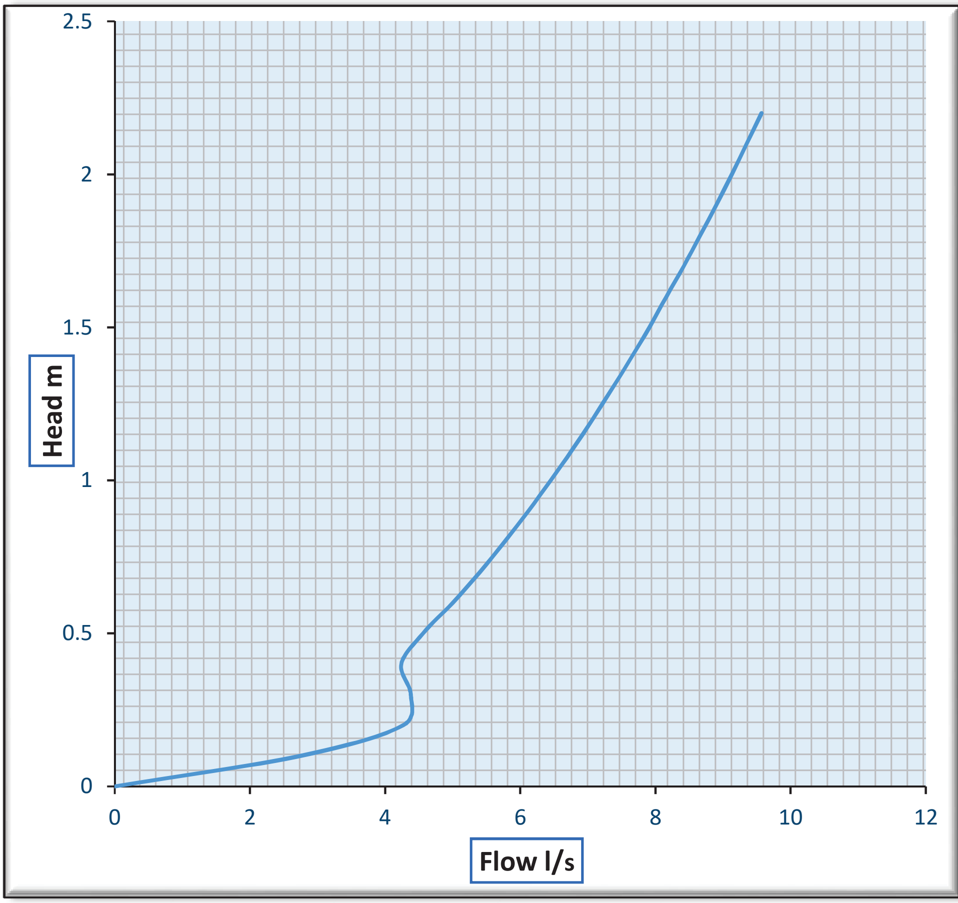
Storage required for 1 in 30 yr storm **162** m3
Storage required for 1 in 100 yr storm **235** m3

CROWN WATER Data Sheet

107 mm QR3 Type Vortex Flow Control

Job Ref : 14150118

Client Name	George Shuttleworth	Date	15-01-2018
Project Name	Hasthorpe Road	For the attention of	George Shuttleworth



Head m	Flow l/s
0	0.000
0.1	2.750
0.2	4.270
0.3	4.380
0.4	4.240
0.5	4.560
0.6	5.000
0.7	5.400
0.8	5.770
0.9	6.120
1	6.450
1.1	6.770
1.2	7.070
1.3	7.360
1.4	7.640
1.5	7.910
1.6	8.160
1.7	8.420
1.8	8.660
1.9	8.900
2	9.130
2.1	9.350
2.2	9.570

Design Flow	5 l/s	Flush Flow	4.43 l/s
Design Head	0.6 m	At Head	0.257 m
Minimum PipePipe	150 mm	Kickback Flow	4.24 l/s
Sump Depth	320 mm	At Head	0.399 m

Note: Surface Water Only

Crown Water Ltd
Index House
Ascot SL5 7ET
Tel 01344 886996 Fax 01344 886646
sales@crownwater.com
Company Registration Number *9514593*

QMS ISO 9001 REGISTERED FIRM

Storage in Existing Ditch (Cleaned Out)

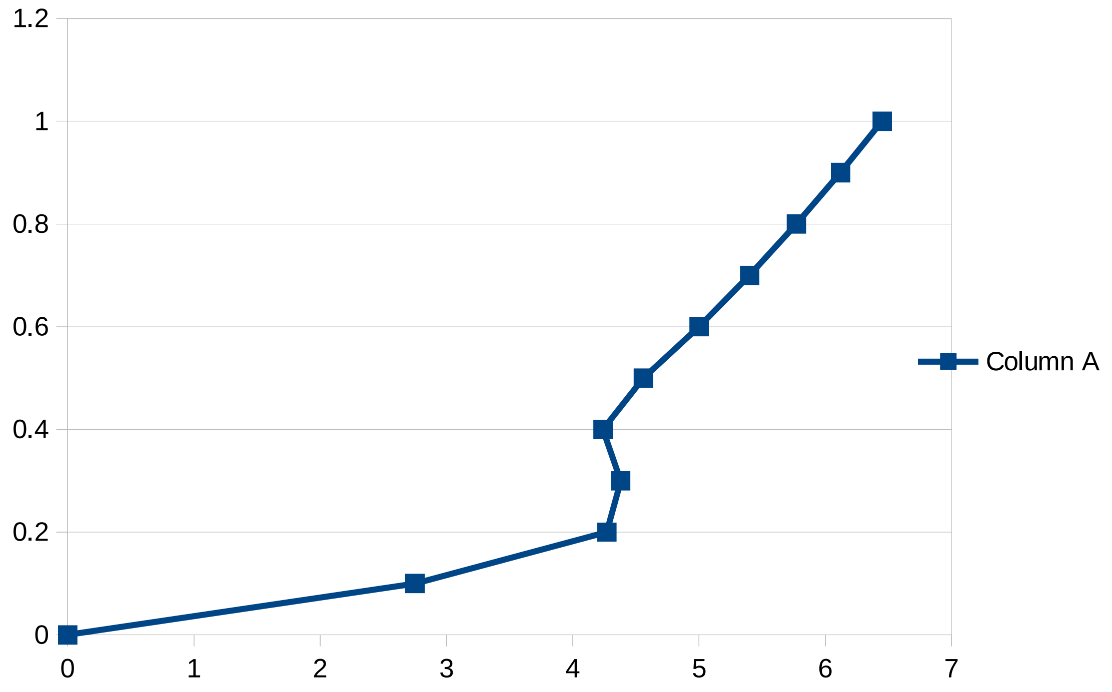
Assumed IL of Discharge Control Device	5.5
Side Slopes 1 in	1.5
Longitudinal Slope 1 in	500
Base Width	1
CSA formula =(b+1.5d) x d	
Length to 0 CSA = slope x depth	
Volume = av CSA x Length	
Length of Widened Section	20
Width of Widened Section	7

Volume in Widened Section L x W x Depth
Total Volume = $140d+250d^2+375d^3$

Head Above IL	Area	Length	Volume	Storage in Widened Section	Total Storage Volume	Check Using Formula
0	0	0	0	0	0	
0.025	0.03	12.5	0.16	3.50	4	4
0.050	0.05	25.0	0.67	7.00	8	8
0.075	0.08	37.5	1.56	10.50	12	12
0.100	0.11	50.0	2.88	14.00	17	17
0.125	0.15	62.5	4.64	17.50	22	22
0.150	0.18	75.0	6.89	21.00	28	28
0.175	0.22	87.5	9.67	24.50	34	34
0.200	0.26	100.0	13.00	28.00	41	41
0.225	0.30	112.5	16.93	31.50	48	48
0.250	0.34	125.0	21.48	35.00	56	56
0.275	0.39	137.5	26.71	38.50	65	65
0.300	0.44	150.0	32.63	42.00	75	75
0.325	0.48	162.5	39.28	45.50	85	85
0.350	0.53	175.0	46.70	49.00	96	96
0.375	0.59	187.5	54.93	52.50	107	107
0.400	0.64	200.0	64.00	56.00	120	120
0.425	0.70	212.5	73.94	59.50	133	133
0.450	0.75	225.0	84.80	63.00	148	148
0.475	0.81	237.5	96.60	66.50	163	163
0.500	0.88	250.0	109.38	70.00	179	179
0.525	0.94	262.5	123.17	73.50	197	197
0.550	1.00	275.0	138.02	77.00	215	215
0.575	1.07	287.5	153.95	80.50	234	234
0.600	1.14	300.0	171.00	84.00	255	255
0.625	1.21	312.5	189.21	87.50	277	277
0.650	1.28	325.0	208.61	91.00	300	300

Discharge Control Device

Head (m)	Flow (l/s)
0	0
0.1	2.75
0.2	4.27
0.3	4.38
0.4	4.24
0.5	4.56
0.6	5
0.7	5.4
0.8	5.77
0.9	6.12
1	6.45



Simplified Formula

H up to 0.2	Q=H x 21.35
0.2<H<0.4	Q=4.29
Above 0.4	Q= 4.29 +3.6(H-0.4)

RAIN PROFILE 6.0 HOUR 1 IN 100 YR 75% WINTER

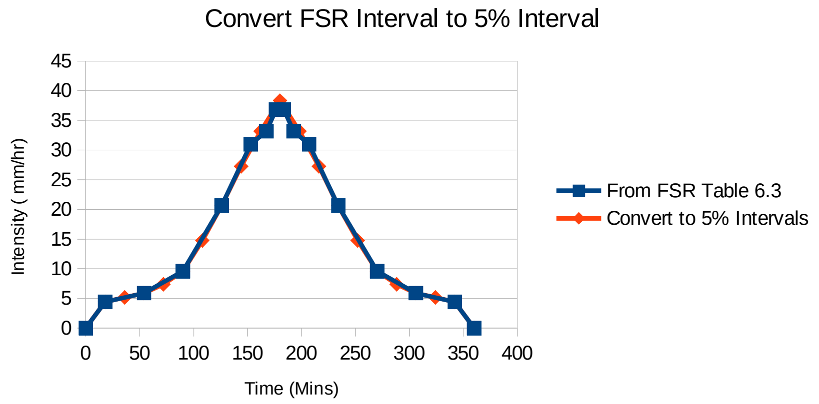
Critical Storm Duration	360	min
1 in 100 average Intensity	10.53	mm/hr
Cv	1.00	
Climate Change	1.40	

From FSR Table 6.3

% Duration of Storm	Proportion of I	Mins from Centre	Time from Start Mins	Intensity mm/hr
0		180	0	0
5	0.3	162	18	4.42
15	0.4	126	54	5.90
25	0.65	90	90	9.58
35	1.4	54	126	20.64
42.5	2.1	27	153	30.96
46.5	2.25	12.6	167.4	33.17
49	2.5	3.6	176.4	36.86
51	2.5	-3.6	183.6	36.86
53.5	2.25	-12.6	192.6	33.17
57.5	2.1	-27	207	30.96
65	1.4	-54	234	20.64
75	0.65	-90	270	9.58
85	0.4	-126	306	5.90
95	0.3	-162	342	4.42
100		-180	360	0.00

Convert to 5% Intervals

%	Time Mins	Proportion of I	Intensity (mm/hr)
0	0.0	0	0
5	18.0	0.3	4.42
10	36.0	0.35	5.16
15	54.0	0.4	5.90
20	72.0	0.5	7.37
25	90.0	0.65	9.58
30	108.0	1	14.74
35	126.0	1.4	20.64
40	144.0	1.85	27.27
45	162.0	2.25	33.17
50	180.0	2.6	38.33
55	198.0	2.25	33.17
60	216.0	1.85	27.27
65	234.0	1.4	20.64
70	252.0	1	14.74
75	270.0	0.65	9.58
80	288.0	0.5	7.37
85	306.0	0.4	5.90
90	324.0	0.35	5.16
95	342.0	0.3	4.42
100	360.0	0	0.00



RAIN PROFILE6 .0 HOUR 1 IN 100 YR 50% SUMMER

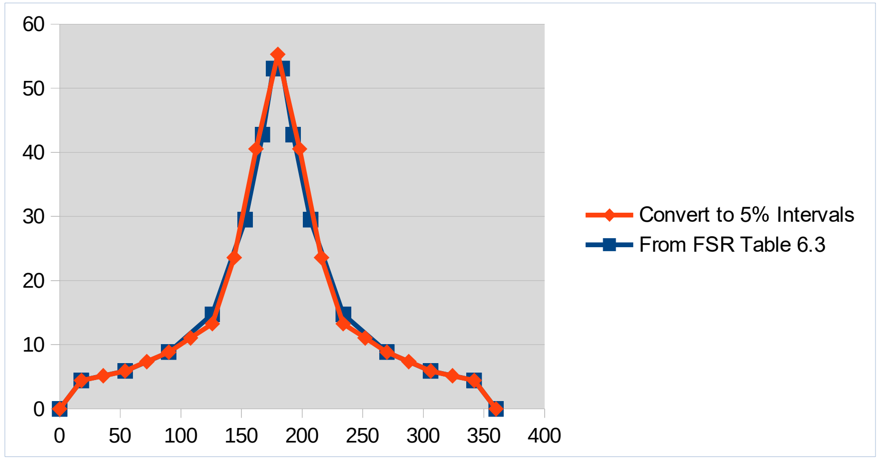
Critical Storm Duration	360	min
I in 100 Rainfall Intensity	10.53	mm/hr
Cv	1.00	
Climate Change	1.40	

From FSR Table 6.3

% Duration of Storm	Proportion of I	Mins from Centre	Time from Start Mins	Intensity mm/hr
0		180	0	0
5	0.30	162	18	4.42
15	0.40	126	54	5.90
25	0.60	90	90	8.85
35	1.00	54	126	14.74
42.5	2.00	27	153	29.48
46.5	2.90	12.6	167.4	42.75
49	3.60	3.6	176.4	53.07
51	3.60	-3.6	183.6	53.07
53.5	2.90	-12.6	192.6	42.75
57.5	2.00	-27	207	29.48
65	1.00	-54	234	14.74
75	0.60	-90	270	8.85
85	0.40	-126	306	5.90
95	0.30	-162	342	4.42
100		-180	360	0.00
				Totals

Convert to 5% Intervals

% Duration of Storm	Time from Start Mins	Proportion of I	Intensity (mm/hr)
0	0	0	0
5	18.0	0.3	4.42
10	36.0	0.35	5.16
15	54.0	0.4	5.90
20	72.0	0.5	7.37
25	90.0	0.6	8.85
30	108.0	0.75	11.06
35	126.0	0.9	13.27
40	144.0	1.6	23.59
45	162.0	2.75	40.54
50	180.0	3.75	55.28
55	198.0	2.75	40.54
60	216.0	1.6	23.59
65	234.0	0.9	13.27
70	252.0	0.75	11.06
75	270.0	0.6	8.85
80	288.0	0.5	7.37
85	306.0	0.4	5.90
90	324.0	0.35	5.16
95	342.0	0.3	4.42
100	360.0	0	0.00



ATTENUATION FOR CRITICAL STORM DURATION OF 6.0 hrs
75% Winter Storm
Connected Area 3697 m2 Max Storage 255

Cellular Storage
From Storage Sheet
Volume = $140h+250d^2+375d^3$

Discharge Control
From Discharge Control Sheet

H up to 0.2	Q=H x 21.35
0.2<H<0.4	Q=4.29
Above 0.4	Q= 4.29 +3.6(H-0.4)

Instructions Adjust head at DCV at each interval to give checksum=0 or close to 0

Time	Rainfall				DCV	Storage		Discharge Control				Check Sum	
	Rainfall	Av Rainfall mm/hr	Vol In m3	Cum In m3	Head h	Depth in Ditch	Vol m3	Out-flow l/s	Av Flow Out l/s	Vol Out m3	Cum Out m3	Inflow - Storage - Out = 0	% Design Capacity
0.0	0	0	0.00	0.00	0.000	0.000	0.0	0.00	0.00	0.00	0.00	0.00	0
18.0	4.42	2.21	2.45	2.45	0.016	0.016	2.3	0.34	0.17	0.18	0.18	-0.04	1
36.0	5.16	4.79	5.31	7.77	0.045	0.045	6.8	0.96	0.65	0.70	0.89	0.04	3
54.0	5.90	5.53	6.13	13.90	0.073	0.073	11.7	1.56	1.26	1.36	2.25	-0.05	5
72.0	7.37	6.63	7.36	21.26	0.101	0.101	17.1	2.16	1.86	2.01	4.25	-0.08	7
90.0	9.58	8.48	9.40	30.66	0.132	0.132	23.7	2.82	2.49	2.69	6.94	0.02	9
108.0	14.74	12.16	13.49	44.15	0.173	0.173	33.6	3.69	3.26	3.52	10.46	0.05	13
126.0	20.64	17.69	19.62	63.77	0.227	0.227	49.0	4.29	3.99	4.31	14.77	-0.05	19
144.0	27.27	23.96	26.57	90.34	0.291	0.291	71.2	4.29	4.29	4.63	19.40	-0.22	28
162.0	33.17	30.22	33.52	123.85	0.359	0.359	99.8	4.29	4.29	4.63	24.03	-0.01	39
180.0	36.86	35.01	38.83	162.69	0.426	0.426	134.0	4.38	4.34	4.68	28.72	-0.03	53
198.0	33.17	35.01	38.83	201.52	0.483	0.483	168.2	4.59	4.49	4.85	33.56	-0.24	66
216.0	27.27	30.22	33.52	235.04	0.525	0.525	196.7	4.74	4.66	5.04	38.60	-0.23	77
234.0	20.64	23.96	26.57	261.61	0.554	0.554	218.1	4.84	4.79	5.18	43.78	-0.22	86
252.0	14.74	17.69	19.62	281.23	0.572	0.572	232.1	4.91	4.88	5.27	49.04	0.13	91
270.0	9.58	12.16	13.49	294.72	0.582	0.582	240.1	4.95	4.93	5.32	54.36	0.26	94
288.0	7.37	8.48	9.40	304.12	0.588	0.588	245.0	4.97	4.96	5.35	59.72	-0.59	96
306.0	5.90	6.63	7.36	311.47	0.590	0.590	246.6	4.97	4.97	5.37	65.09	-0.25	97
324.0	5.16	5.53	6.13	317.61	0.591	0.591	247.5	4.98	4.98	5.37	70.46	-0.32	97
342.0	4.42	4.79	5.31	322.92	0.591	0.591	247.5	4.98	4.98	5.38	75.83	-0.38	97
360.0	0.00	2.21	2.45	325.37	0.587	0.587	244.2	4.96	4.97	5.37	81.20	0.00	96

ATTENUATION FOR CRITICAL STORM DURATION OF 6.0 hrs
50% Summer Storm
Connected Area 3697 m2 Max Storage 255

Cellular Storage
From Storage Sheet
Volume = $140h+250d^2+375d^3$

Discharge Control
From Discharge Control Sheet

H up to 0.2	Q=H x 21.35
0.2<H<0.4	Q=4.29
Above 0.4	Q= 4.29 +3.6(H-0.4)

Instructions Adjust head at DCV at each interval to give checksum=0 or close to 0

Time	Rainfall				DCV	Storage		Discharge Control				Check Sum	
	Rainfall	Av Rainfall mm/hr	Vol In m3	Cum In m3	Head h	Depth in Ditch	Vol m3	Out-flow l/s	Av Flow Out l/s	Vol Out m3	Cum Out m3	Inflow - Storage - Out = 0	% Design Capacity
0.0	0	0.00	0.00	0.00	0.000	0.000	0.0	0.00	0.00	0.00	0.00	0.00	0
18.0	4.42	2.21	2.45	2.45	0.016	0.016	2.3	0.34	0.17	0.18	0.18	-0.04	1
36.0	5.16	4.79	5.31	7.77	0.045	0.045	6.8	0.96	0.65	0.70	0.89	0.04	3
54.0	5.90	5.53	6.13	13.90	0.073	0.073	11.7	1.56	1.26	1.36	2.25	-0.05	5
72.0	7.37	6.63	7.36	21.26	0.101	0.101	17.1	2.16	1.86	2.01	4.25	-0.08	7
90.0	8.85	8.11	8.99	30.25	0.131	0.131	23.5	2.80	2.48	2.67	6.93	-0.15	9
108.0	11.06	9.95	11.04	41.28	0.163	0.163	31.1	3.48	3.14	3.39	10.32	-0.12	12
126.0	13.27	12.16	13.49	54.77	0.198	0.198	40.4	4.23	3.85	4.16	14.48	-0.14	16
144.0	23.59	18.43	20.44	75.21	0.249	0.249	56.1	4.29	4.26	4.60	19.08	-0.02	22
162.0	40.54	32.06	35.56	110.77	0.330	0.330	86.9	4.29	4.29	4.63	23.71	0.16	34
180.0	55.28	47.91	53.14	163.91	0.429	0.429	135.7	4.39	4.34	4.69	28.40	-0.17	53
198.0	40.54	47.91	53.14	217.05	0.507	0.507	184.1	4.68	4.53	4.90	33.30	-0.36	72
216.0	23.59	32.06	35.56	252.61	0.549	0.549	214.3	4.83	4.75	5.13	38.43	-0.08	84
234.0	13.27	18.43	20.44	273.05	0.569	0.569	229.7	4.90	4.86	5.25	43.68	-0.31	90
252.0	11.06	12.16	13.49	286.54	0.579	0.579	237.7	4.93	4.92	5.31	48.99	-0.11	93
270.0	8.85	9.95	11.04	297.58	0.586	0.586	243.4	4.96	4.95	5.34	54.33	-0.11	95
288.0	7.37	8.11	8.99	306.57	0.591	0.591	247.5	4.98	4.97	5.37	59.70	-0.60	97
306.0	5.90	6.63	7.36	313.93	0.593	0.593	249.1	4.98	4.98	5.38	65.08	-0.28	98
324.0	5.16	5.53	6.13	320.06	0.594	0.594	250.0	4.99	4.99	5.39	70.47	-0.37	98
342.0	4.42	4.79	5.31	325.37	0.594	0.594	250.0	4.99	4.99	5.39	75.85	-0.44	98
360.0	0.00	2.21	2.45	327.82	0.590	0.590	246.6	4.97	4.98	5.38	81.23	-0.05	97

PLAN 1:1250

CONTOURS AND SPOT LEVELS COPIED FROM A GRID OF
LIDAR LEVELS DOWNLOADED FROM THE DEFRA WEB-SITE

NOTES
1. DO NOT SCALE FROM THIS DRAWING

REV	DESCRIPTION	AP	DATE

George Shuttleworth Ltd
Consulting Engineers
gsl_engineers@outlook.com
1 Fulmar Court, Fulmar Rd, Lincoln, LN6 3NE
Tel 07940 927285

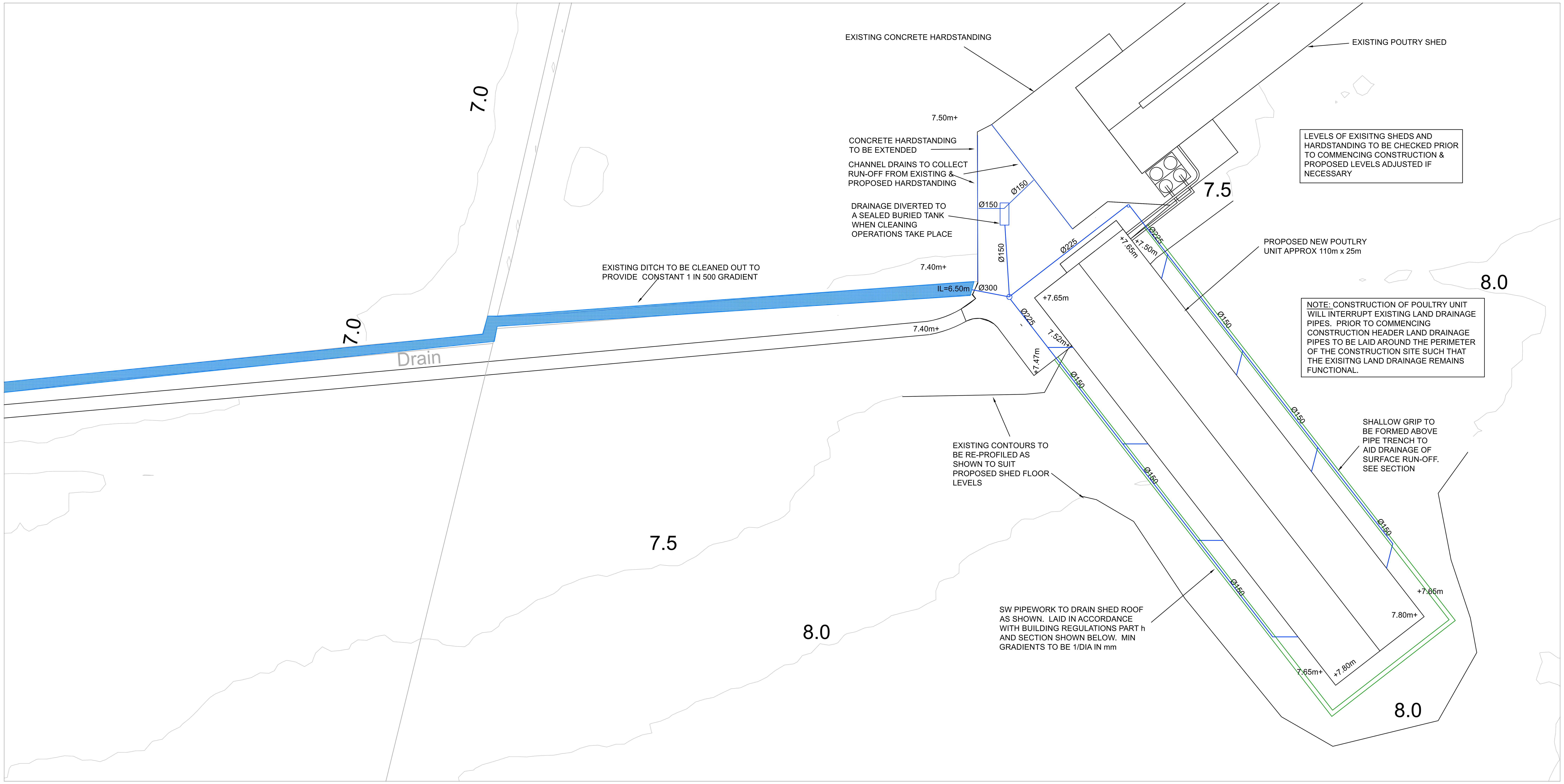
CLIENT: WRIGHT EGGS LTD

PROJECT: NEW POULTRY UNIT AT POPLAR FARM, KEAL COTES, LINCOLNSHIRE

DRAWING TITLE: EXISTING SITE, CONTOURS AND DRAINAGE FEATURES

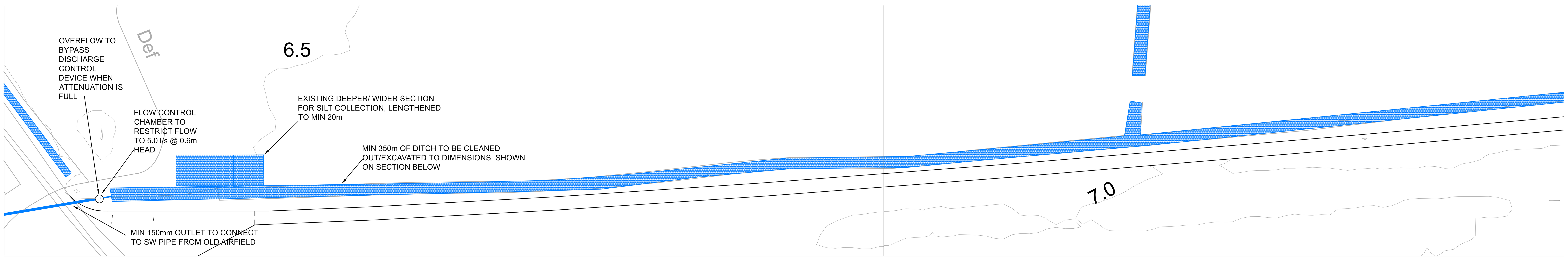
SCALE	APPROVED BY	DATE
1:1250	GS	SEPT 24

DRG SIZE	DRAWING NO.	REV.
A1	805-001	-

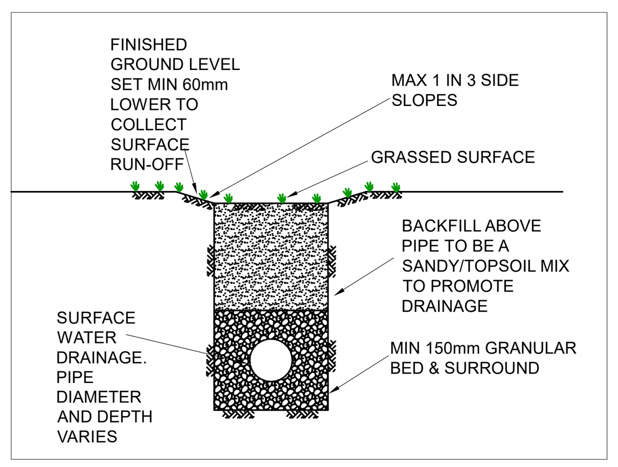


PLAN 1:500

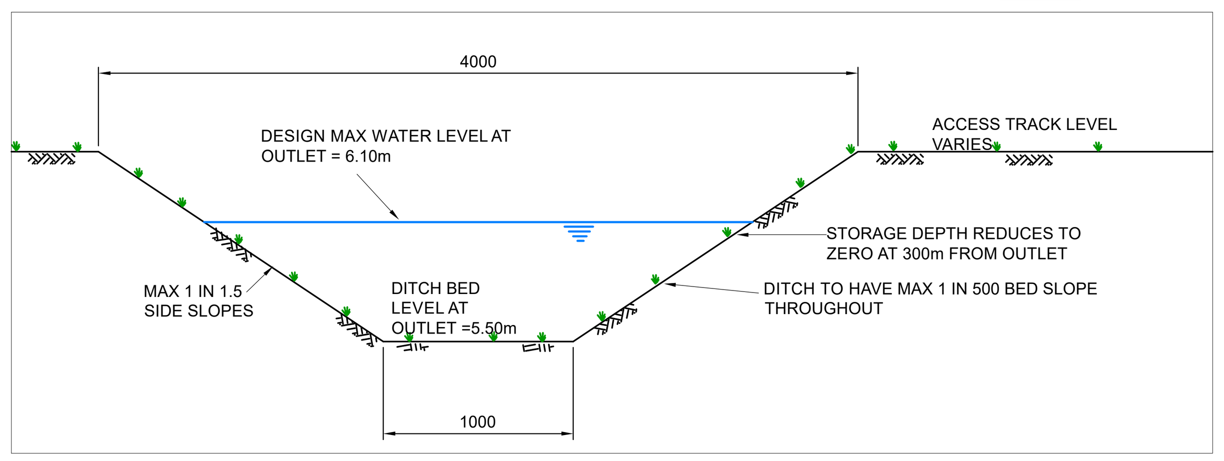
CONTOURS AND SPOT LEVELS COPIED FROM A GRID OF LIDAR LEVELS DOWNLOADED FROM THE DEFRA WEB-SITE



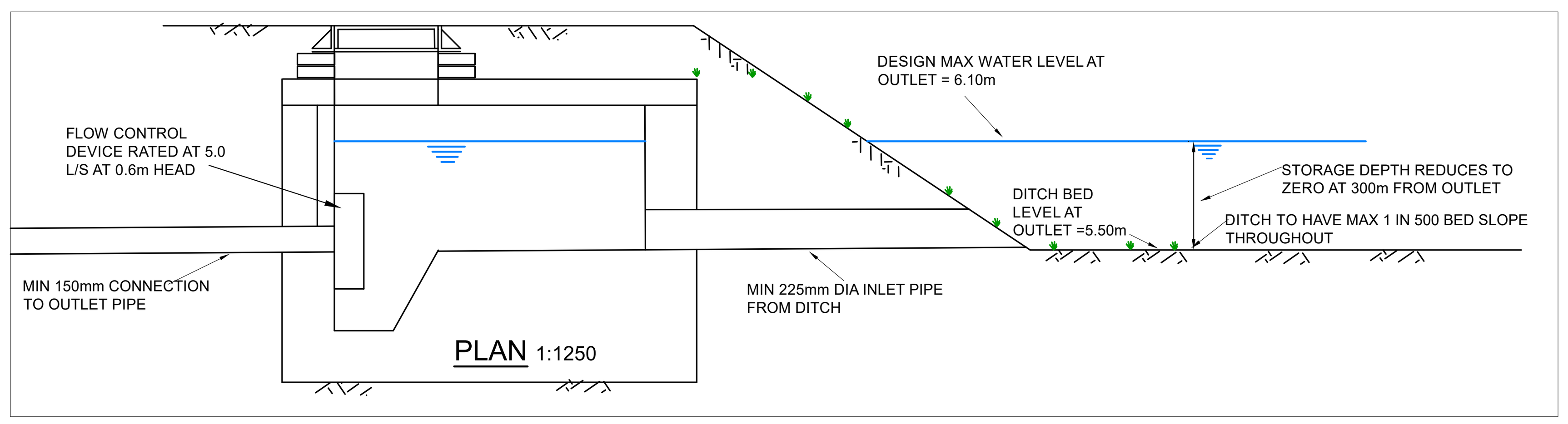
PLAN 1:500



SECTION THRO' SHED PIPEWORK TRENCH 1:33.3



SECTION THRO' PROPOSED LOWER 350m OF DITCH 1:33.3



SECTION THRO' END OF DITCH & FLOW CONTROL CHAMBER 1:33.3

DRAWING TITLE: OUTLINE OF PROPOSED SW DRAINAGE SYSTEM

DATE	REV.
SEPT 24	A

SCALE	APPROVED BY	DRG SIZE	DRAWING NO.
AS SHOWN	GS	A1	805-002

CLIENT: WRIGHT EGGS LTD

PROJECT: NEW POULTRY UNIT AT POPLAR FARM, KEAL COTES, LINCOLNSHIRE

George Shuttleworth Ltd
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Tel 07940 927285

REV	DESCRIPTION	AP	DATE
A	GEN UPDATE	GS	24-09-24

NOTES
1. DO NOT SCALE FROM THIS DRAWING