Thorpe Leazes Farm,

Stockton-on-Tees

Flood Risk Assessment & Drainage Strategy

Issue Date:

18th September 2023

Report Number:

23006-FRA-01

Client:

Tom Walker & Sons

Revision:

A

Coast Consulting Engineers Ltd
7 Silverton Court, Northumberland Business Park, NE23 7RY
Tel. 0191 597 7879

Contents

Revision	Date	Comments	Prepared by	Checked by
-	05.04.23	Initial issue	PL	PL
A	18.09.23	Updated to suit revised architect's layout	PL	PL

Executive Summary

Site Location	The proposed development is located at Thorpe Leazes Farm which is located approximately 7km northwest of Stockton-on-Tees, accessed from a Category C Road Thorpe Leazes Lane.
Site Proposals	The proposed development is a new building to expand the existing cheese packaging business with a proposed car park compromising of 66 car parking spaces.
Ground Conditions	A review of the British Geological Survey of publicly available historical borehole logs shows the soil to be of stiff clays.
Nearest Watercourse	Maudlin Gutter, a tributary of Thorpe Beck, 400m south of the site.
Nearest Surface Water Sewer.	None.
Nearest Combined Sewer	None.
Nearest Foul Water Sewer	None.
Flood Zone	Entirely within Flood Zone 1.
Surface Water Flooding	None.
Ground Water	None. Stiff clays.
Surface Water Discharge Rates	Car park = 2.5 l/s. Building 3.0 l/s.
SUDS	Permeable block paving for the car park and swale for the building.

1. Introduction

Coast Consulting Engineers (CCE) have been commissioned by Tom Walker & Sons to assess the flood risk associated with a proposed development north west of Thorpe Thewles, in Stockton-on-Tees. This Flood Risk Assessment (FRA) is reviewed in accordance with the National Planning Policy Framework (NPPF) for Development and Flood Risk. In conjunction with assessing the site for flood risk a proposed drainage strategy has been prepared.

This site-specific FRA has been undertaken to determine the risk of flooding to the proposed development from all sources in accordance with the NPPF and to assess the flood risk to others as a result of the development. The assessment will recommend how the risk can be managed in line with planning policy requirements.

One of the key aims of the NPPF is to ensure that flood risk is considered at all stages of the planning process to avoid inappropriate development in areas at risk of flooding and to direct development away from areas at highest risk. Where new development is necessary in such areas, the policy aims to make it safe without increasing flood risk elsewhere and where possible, reducing flood risk overall.

1.1 National Planning Policy Framework (NPPF)

The NPPF (February 2019) requires that:

- A site-specific flood risk assessment must demonstrate that the development will be safe for its lifetime taking account the vulnerability of its users, without increasing flood risk elsewhere, and where possible, will reduce flood risk overall.

- A site-specific flood risk assessment is required for proposals greater than 1 ha in size in a Flood Zone 1; all proposals for new development in Flood Zones 2 and 3, or in an area within Flood Zone 1 which has critical drainage problems (as identified in the Strategic Flood Risk Assessment).

The following definitions for flood zones are derived from NPPF:

FLOOD ZONE 1:

This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).

FLOOD ZONE 2:

This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% – 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% – 0.1%) in any year.

FLOOD ZONE 3:

This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.

In addition to the risk of flooding from rivers or sea, consideration must also be given to surface water flooding, flooding due to ground water and flooding from artificial sources such as sewer failure or overtopping of reservoirs.

2. Site location, Topographical Features and Proposals

2.1 Site Location

The proposed development is located at Thorpe Leazes Farm which is located approximately 7km northwest of Stockton-on-Tees.

The National Grid Reference for the site is NZ 387 247 and the nearest postcode is TS21 3HZ.

Please refer to the site location plan below.

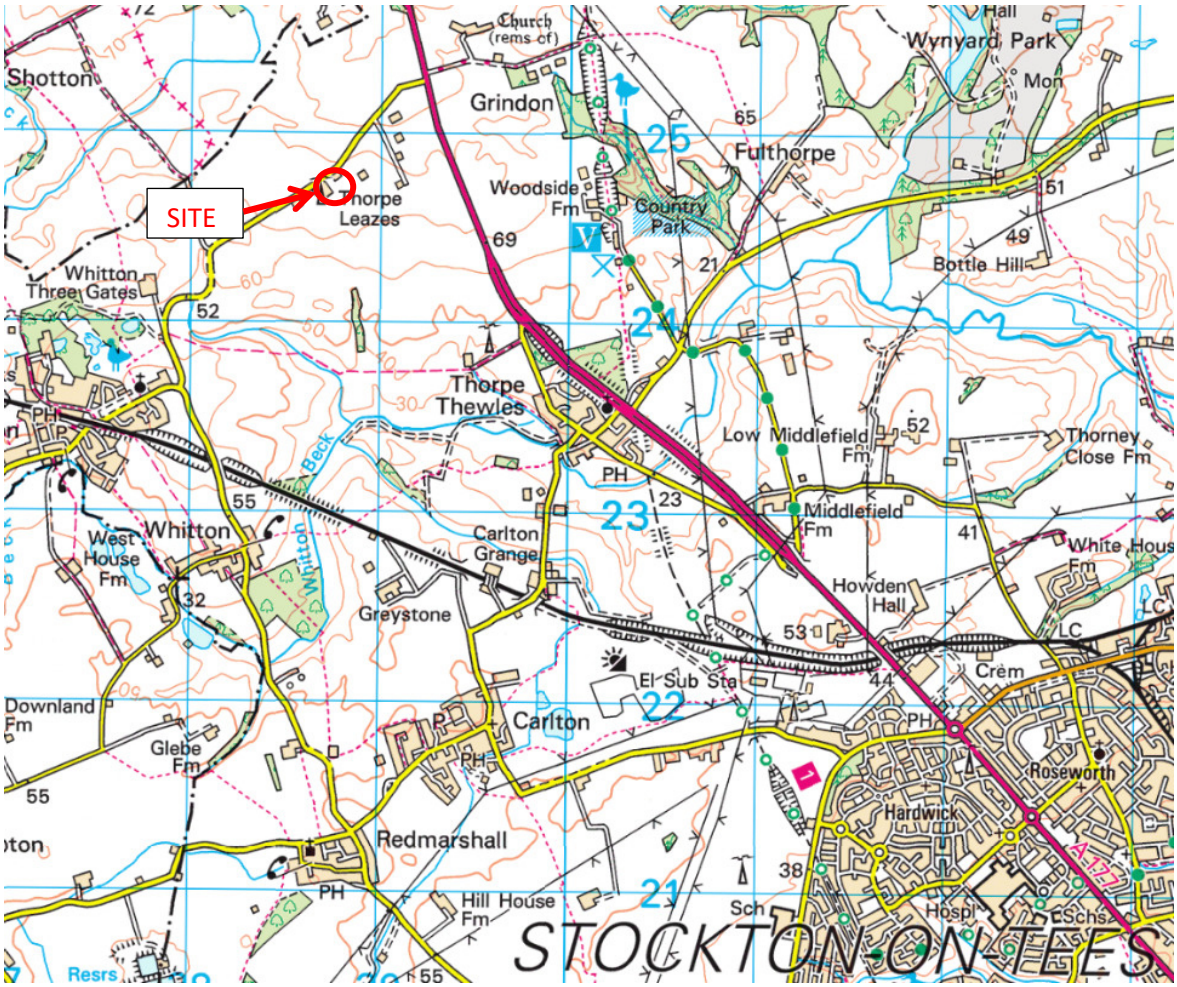


Figure 2.1 - Site Location

2.2 Existing Site Description

The site has an area of 0.6 Ha which comprises of grassland with a site access road to the north from Thorpe Leazes Lane which is 0.7km due west off the A177.

The site is bound by:

- Eastern Boundary – Existing housing with back gardens.

- Northern Boundary – Thorpe Leazes Lane Class C Road.
- Western Boundary – Existing Tom Walker & Sons business premises.
- Southern Boundary – Open farmland.

The site has a high point on the middle western boundary with a reasonable fall from the middle of the site towards Thorpe Leazes Lane in a north easterly direction of approximately 1 in 35, and from the high point towards the south eastern boundary of 1:42. A topographical survey by Site Scan (P22135-A) dated 26th August 2022 is shown in Appendix A.

2.3 Existing NWL Sewers and Highway Drainage

Existing sewer records have been obtained from Northumbrian Water Ltd (NWL). The sewer records show there are no existing sewers within or near to the site area. A copy of the sewer records can be found in Appendix B.

Following a site walkover there appears to be an existing Stockton Borough Council highway drain located within the site boundary. The position of one of the manholes for this can be seen on the Proposed Drainage Layout in Appendix E.

2.4 Existing Ground Conditions

At the time of writing a Phase I Desk Top Study or Phase II Ground investigation report had not been prepared.

A review of the British Geological Survey of publicly available historical borehole logs shows the soil to be of stiff clays. The borehole location and extract of the log can be found in Appendix C.

2.5 Development Proposals

The proposed development is a new building to expand the existing cheese packaging business with a proposed car park compromising of 66 car parking spaces. The access for the new building and car park will be from an existing access off Thorpe Leazes Lane. For the latest Architectural Layout please refer to Appendix D.

3. Potential Sources of Flooding and Proposed Mitigation

As required by the National Planning Policy Framework (NPPF) and Technical Guidance to the NPPF, each potential source of flooding needs to be considered; rivers and sea, land, groundwater, sewers and artificial sources (such as reservoirs and canals). Consideration also needs to be given to the flood risk vulnerability classification for this type of development.

3.1 Flood Zone Classification

Environment Agency flood maps have been acquired to assist with this assessment. The flood maps indicate that the development boundary is located entirely within an area classified as a Flood Zone 1. Land located within a flood zone 1 is defined as having less than a 1 in 1,000 annual probability of flooding from rivers or the sea (low risk). Refer to the extract below which identifies the Flood Zones within and in proximity to the development site. The site is not considered to be at risk of flooding from rivers or sea.

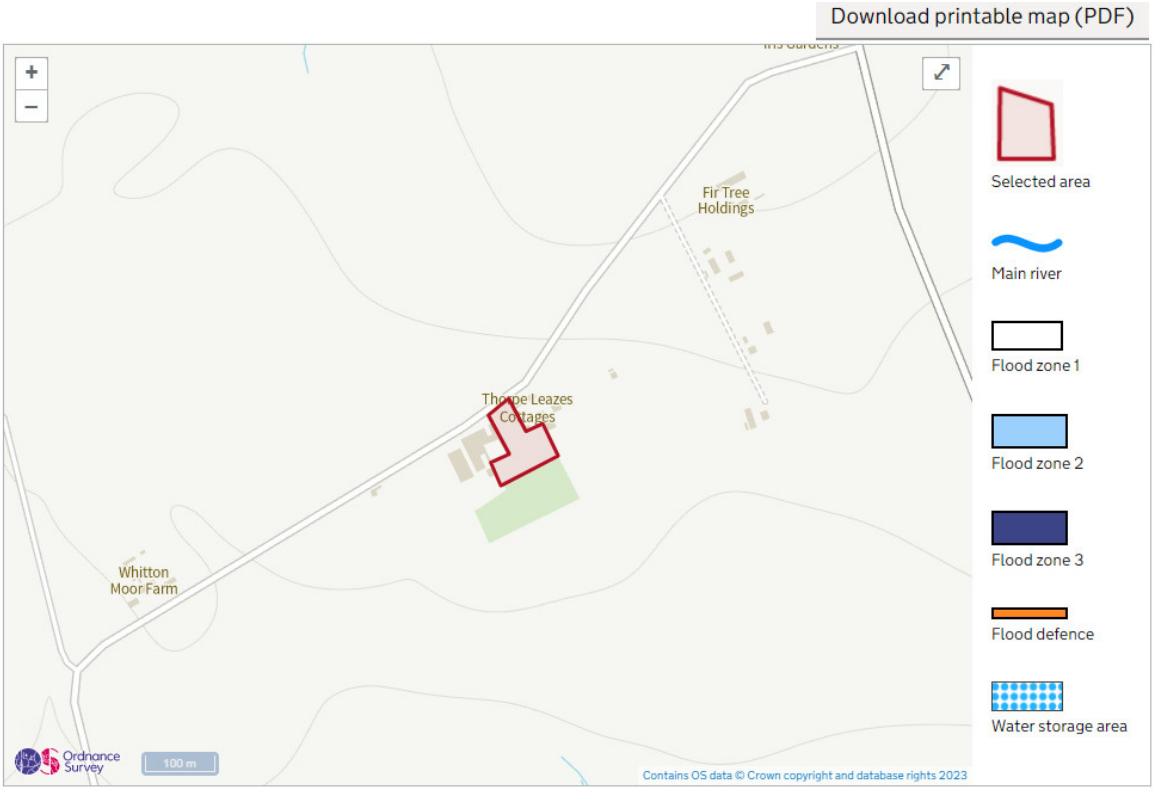


Figure 3.1 – Flood Zone Classification

3.2 Flood Risk Vulnerability Classification

Table 2 of the Planning Practice Guide (2022) states the following with respect to flood risk vulnerability classification. The text highlighted in bold below is the classification for this site, with the less vulnerable descriptions extracted also shown below.

Less vulnerable

- Police, ambulance and fire stations which are not required to be operational during flooding.
- **Buildings used for shops; financial, professional and other services; restaurants, cafes and hot food takeaways; offices; general industry, storage and distribution; non-residential institutions not included in the 'more vulnerable' class; and assembly and leisure.**
- Land and buildings used for agriculture and forestry.
- Waste treatment (except landfill* and hazardous waste facilities).
- Minerals working and processing (except for sand and gravel working).
- Water treatment works which do not need to remain operational during times of flood.
- Sewage treatment works, if adequate measures to control pollution and manage sewage during flooding events are in place.
- Car parks.

Table 3 of the Technical Guidance to the National Planning Policy Framework states the following with respect to appropriate land uses:

Table 3: flood risk vulnerability and flood zone 'compaibility'

Flood Risk Vulnerability Classification (See Table 2)	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a	Exception Test required	x	Exception Test required	✓	✓
Zone 3b functional floodplain	Exception Test required	x	x	x	✓

Key: ✓ Development is appropriate.
X Development should not be permitted.

An exception test will not be required in this instance as development is located outside of a flood zone 2 or flood zone 3.

3.3 Surface Water Flood Risk

EA flood maps shown below in Figure 3.2 show there is no existing surface water flooding existing on the site. Flood risk from surface water flooding can therefore be deemed as **low**.

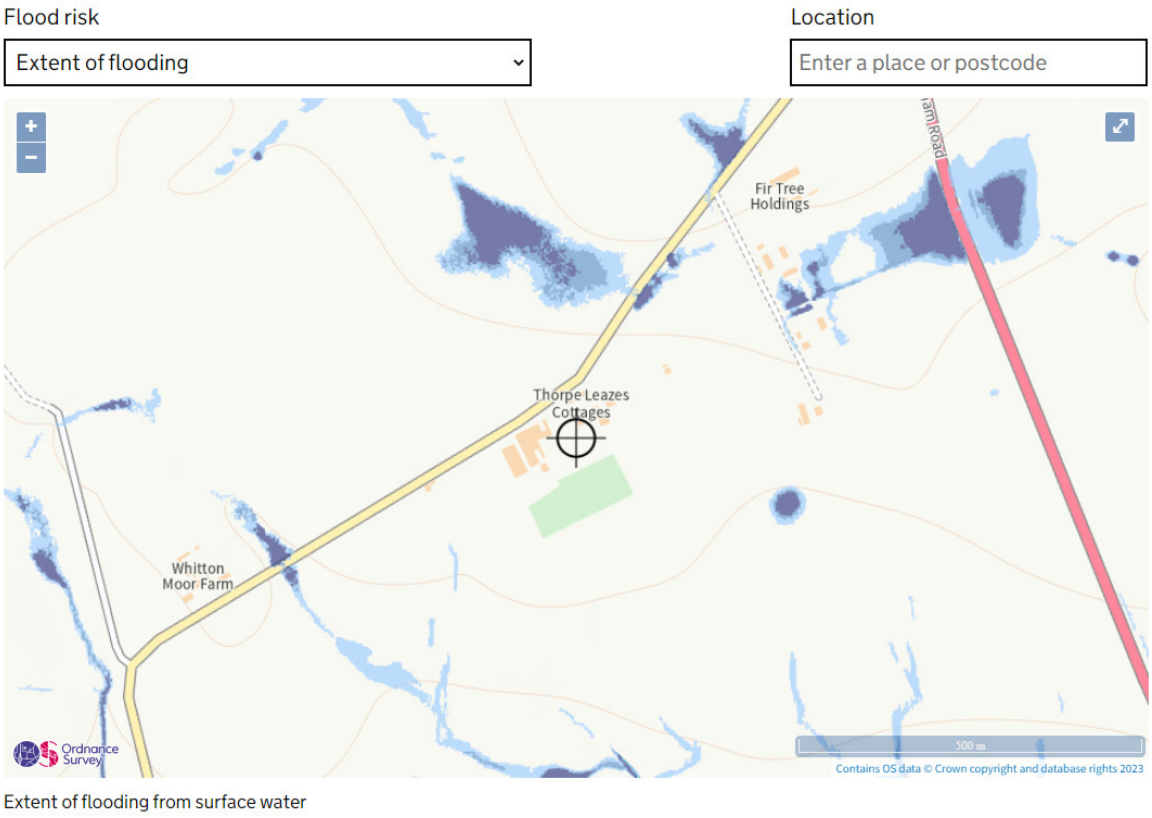


Figure 3.2 – Extent of surface water flooding

3.4 Groundwater Flood Risk

Flooding due to groundwater occurs when the levels of water below the ground rise and emanate above finished ground level. This occurs more frequently when the site is underlain by a permeable strata. As noted earlier in Section 2.4 Existing Ground Conditions the historical borehole logs in the vicinity suggest the site is underlain by stiff clays which is an impermeable strata preventing a risk associated with groundwater rise. The risk of flooding due to groundwater therefore can be deemed as **low**.

3.5 Sewer Flood Risk

Existing sewer flood records have been obtained from Northumbrian Water Ltd (Appendix B). The records show that there are no existing on-site foul or surface water sewers in the vicinity of the site. The risk of sewer flooding can therefore be deemed as **low**.

3.6 Reservoir Flood Risk

Artificial sources of flood risk such as man-made ponds or reservoirs can cause a potential risk of flooding. The flood map below shows that there is no potential flooding of the site from ponds or reservoirs, therefore the risk of flooding due to this source can be deemed as **low.**

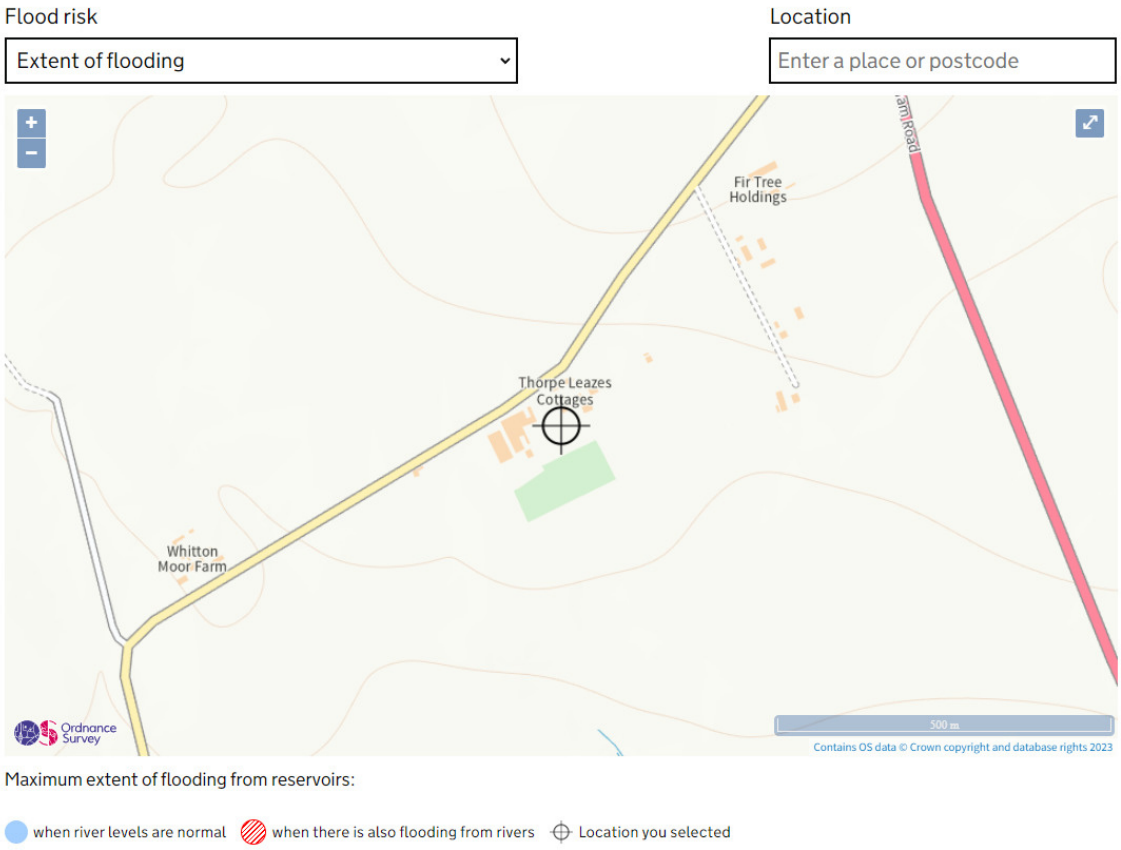


Figure 3.4 – Extent of reservoir flooding

3.7 Conclusion of Flood Risk

The proposed development is entirely within a Flood Zone 1 in line with the guidance contained within the NPPF for flooding. The site has been assessed for flood risk with respect to surface water, groundwater, existing sewers and reservoirs and all of these risks have been categorised as being low risk. As such the proposed development is deemed appropriate with respect to flood risk in accordance with the guidance contained within the NPPF for flooding.

4. Surface and Foul Water Disposal

The proposed development is a new building to expand the existing cheese packaging business with a proposed car park compromising of 66 car parking spaces. The access for the new building and car park will be from an existing access off Thorpe Leazes Lane. For the latest Architectural Layout please refer to Appendix D.

4.1 Surface Water Outfall

Part H of the Building Regulations 2010 provides a recommended hierarchy for surface water disposal:

1. By infiltration
2. To watercourse
3. To sewer

4.1.1 Infiltration

As noted in Sections 2.4 (Existing ground conditions) and 3.4 (Groundwater flood risk) above the presence of existing clays would mean the use of infiltration drainage techniques would not be successful.

4.1.2 Watercourse

There is an existing watercourse, the Maudlin Gutter, 100m to the southwest of the southwest corner of the site. On site drainage investigations deduced there exists an outflow pipe from the existing foul water treatment tanks. The indicative route can be seen on the Proposed Drainage Layout in Appendix E. It is proposed to connect to this pipe at the shallowest point possible for southern half of the proposed development.

4.1.3 Sewer (Surface Water)

Existing surface water sewer records have been obtained from Northumbrian Water Limited, as shown in Appendix B. There are no existing sewers in the vicinity of the site with the only outfall in the vicinity being an existing highway drain as can be seen on the Proposed Drainage Layout in Appendix E. As the car park can outfall to the piped connection to the watercourse it is proposed to connect to this drainage system subject to the approval of Stockton Borough Council. The connection being heavily restricted using a Hydro-Brake flow control device with the outflow rate limited to the lowest possible using the smallest diameter orifice within the control.

4.2 SUDS Techniques

In line with National Planning Policy, SUDS techniques are to be utilised as part of the design of the surface water network. The applicable techniques and the benefits that they bring to the development are outlined below and are shown on the Proposed Drainage Layout in Appendix E.

- Source Control: **Permeable car parking** will reduce the effects of pollution in run-off to the environment and will eliminate surface ponding. The construction will be used as a method of source control to clean/treat any potential pollutants within the stone sub-base. The voids within stone sub-base/aggregate will provide the surface water storage volume required when surcharged flows result from the restricted flow. The storage volume required to limit the outflow to 2.5 l/s is 143m^3 for all storms including the 1:100-year event plus 45% allowance for climate change (using the upper end allowance assuming development lifetime beyond 2060).

- Site Control: **Swale –** The vegetated surface with flat bottom open channel is designed to convey, treat and attenuate the surface water runoff from the new building. It is designed to enhance the natural landscape and provides aesthetic and biodiversity benefits whilst being a functional drainage system. The storage volume required to limit the outflow to 3 l/s is 300m^3 for all storms including the 1:100-year event plus 45%.

4.3 Existing and Proposed Surface Water Flows

The proposed drainage layout can be found in Appendix E which shows the proposed flows are restricted at manholes S1 and S5 by a vortex flow control called a Hydro-brake. The flows are limited to a minimum flow rate stipulated by the minimum size orifice diameter within the flow control unit of 75mm. It is industry standard to not reduce this diameter any less at the risk of the unit becoming frequently blocked and becoming a maintenance liability. Table 4.1 below shows pre and post development flows.

	Pre or Post Development	Flow Rate (l/s)		
		1 in 1 Year	1 in 30 Year	1 in 100 (+ 45% Climate Change for post development)
Car Park	**Pre-development**	1.2	2.1	2.5
	Post-development	1.9	2.5	2.5
Building	**Pre-development**	1.7	3.0	3.5
	Post-development	2.5	2.5	3.0

Table 4.1 – Pre and Post Development Surface Water Flow Rates (l/s)

A copy of the proposed drainage calculations for the 2 surface water drainage systems can be found in Appendix F.

4.4 Maintenance

The Proposed Drainage Layout provides the maintenance schedule for the SUDs features, the swale and permeable paved car park. It will be the responsibility of the owner of the site to maintain the SUDs features in line with the maintenance schedules shown.

4.5 Foul Water

It is proposed to connect the foul flows into the existing foul water treatment tank. The capacity of the existing tank is being investigated however it is expected the additional flows are low and the tank being capable of accepting the additional flow.

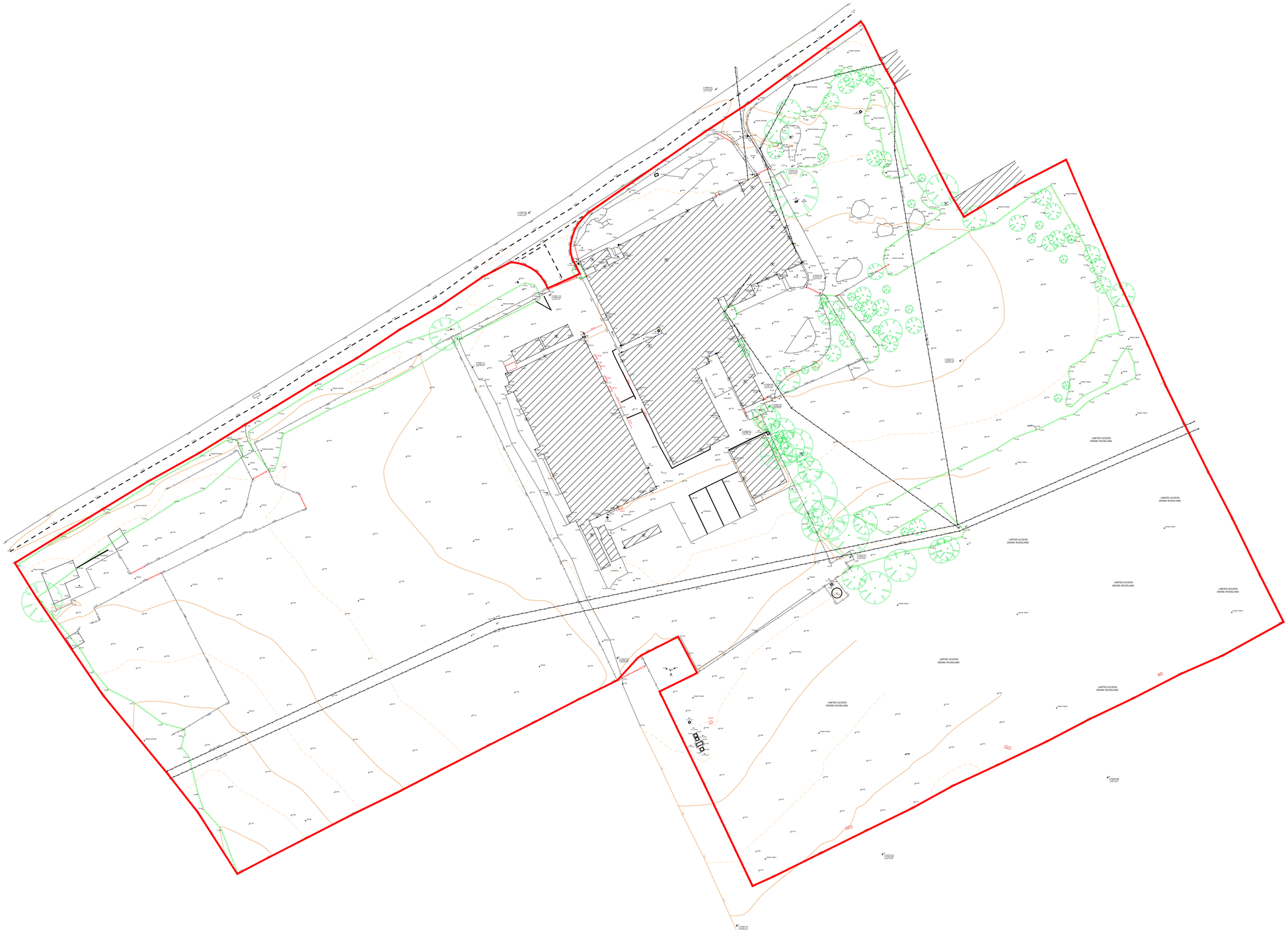
5. References

The following reference documents have been used in the preparation of this report.

- National Planning Policy Framework 2019.
- Planning Practice Guidance 2014.
- Environment Agency online flood maps.
- Design and Construction Guidance for foul and surface water sewers offered for adoption under the Code.
- Building Regulations Document H 2010.
- Improving the Flood Performance of New Buildings – Defra.
- Rainfall runoff management for developments SC030219 – Defra.
- Susdrain.org
- The SuDS Manual CIRIA C753.
- North-East Lead Local Flood Authorities Sustainable Drainage Local Standards – July 2020
- Non-statutory technical standards for sustainable drainage – LASOO
- British Geological Survey online maps.

Appendix A –
Topographical Survey

REV	BY	DATE	NOTE
X	XX	XX/XX/XX	NOTE



0 20 40 60 80 100

Metres

N

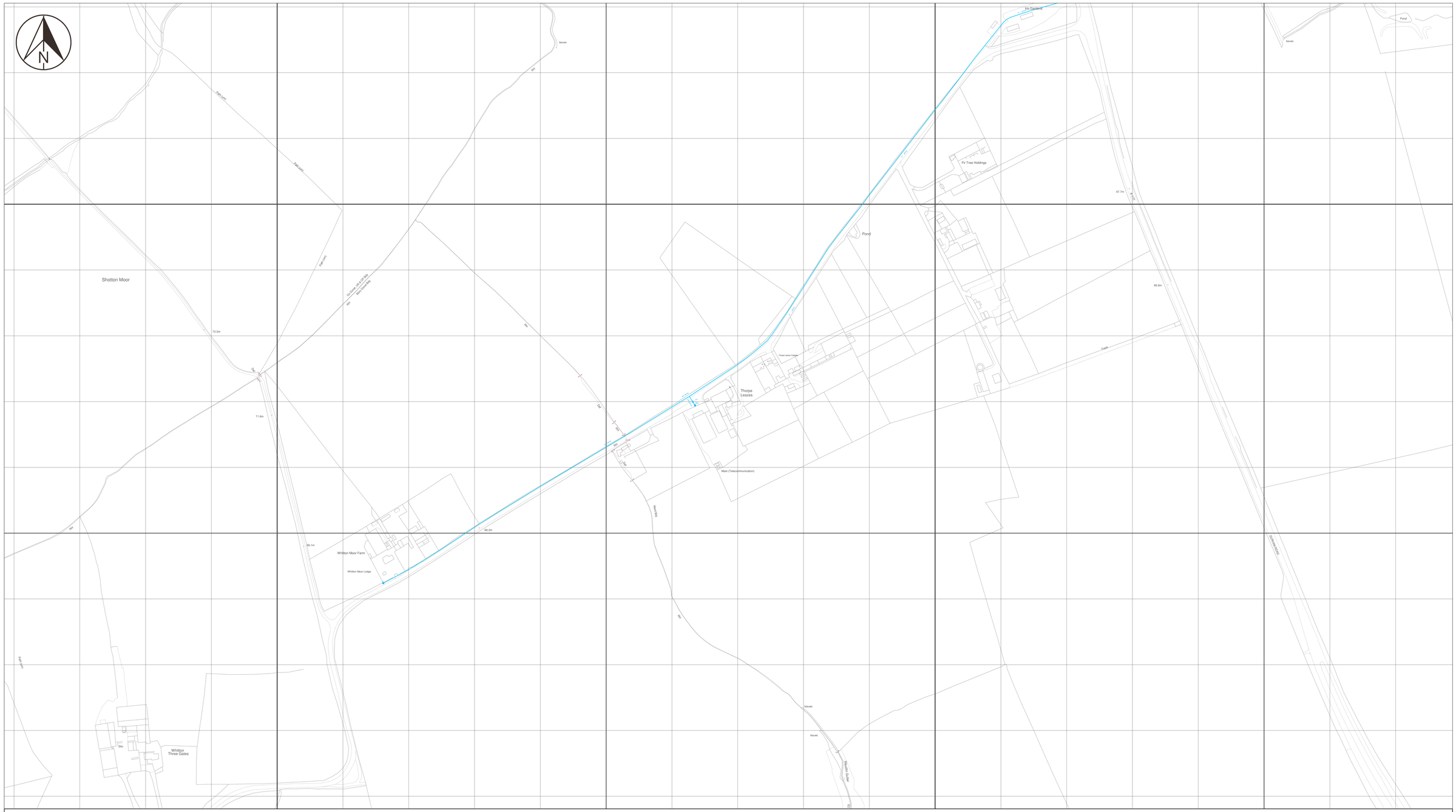
TOFFEE FACTORY | NEWCASTLE-UPON-TYNE | NE1 2DF | 0191 495 7700 | INFO@PODNEWCASTLE.CO.UK

PROJECT:
Thorpe Leazes Farm

DRAWING TITLE:
Existing Site Plan

CLIENT:			STATUS:	
Tom Walker & Sons			Planning	
SCALE:	SHEET SIZE:	DATE:	DWN BY:	CHECKED BY:
1:500	A1	12.22	NG	CVB
PROJECT NO:	DRAWING NO:			REVISION:
1450-WAL	PD-00.02			

Appendix B –
NWL Sewer Records



Waste Water - NWL Responsibility

Combined	
Foul	
Surface	
Treated Eff	
Untreated Eff	
Overflow	

Private/Non NWL

Combined	
Foul	
Surface	
Treated Eff	
Trade Eff	
Watercourse	

Proposed

Combined	
Foul	
Surface	

Water Network - Network Types

Distribution	
Treated	
Raw	
Fire	
Supply	
Private	

AB Asbestos	
Abandoned	
Out of Comm	
Proposed	

NORTHUMBRIAN WATER living water

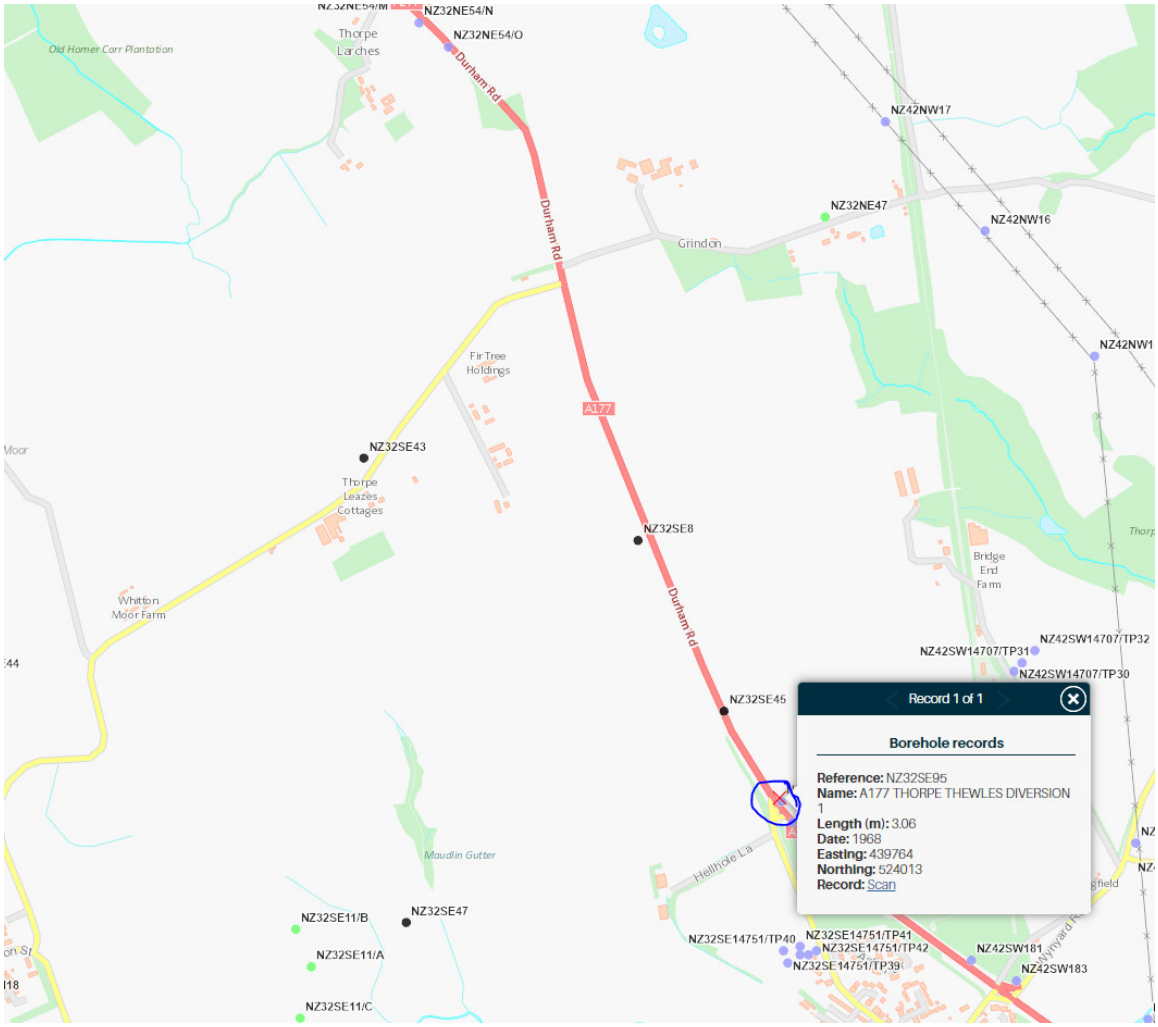
User : BOWMS
Title :

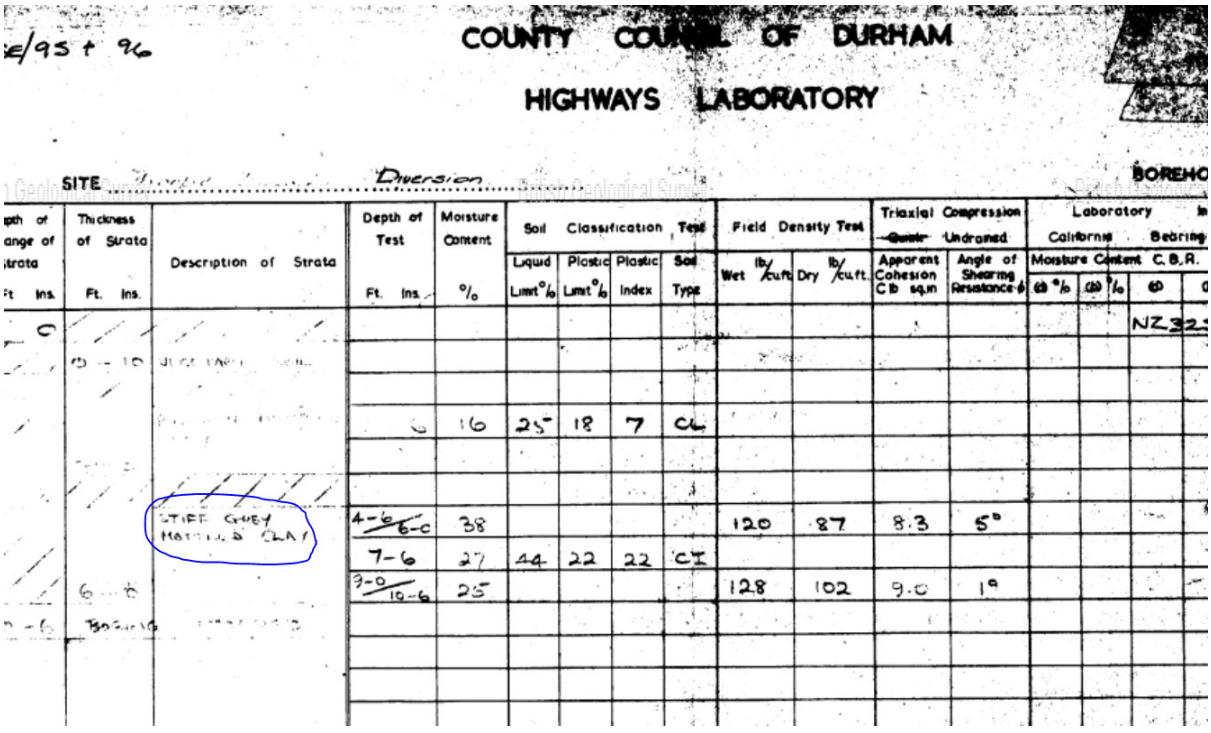
Date : 02/02/2023 10:05:37
Centre Point : 438686,524693

Map Sheet : NZ3824NE
Paper / Scale : A0@1:2000

20 m

Appendix C –
BGS Location and Log





COUNTY COUNCIL OF DURHAM

HIGHWAYS LABORATORY

SITE ... Diversion ... BOREHO

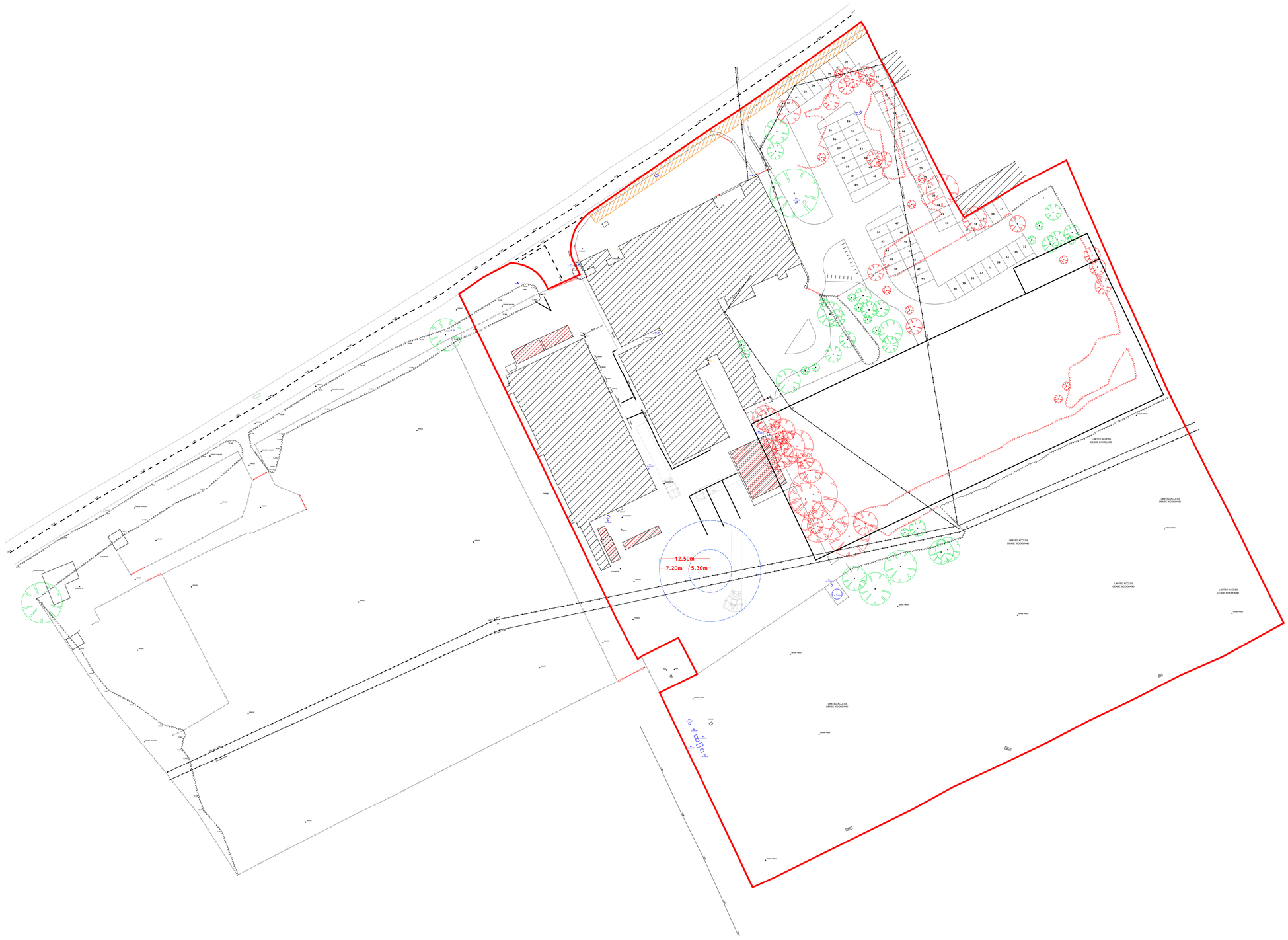
Thickness of Strata Ft. Ins.	Description of Strata	Depth of Test Ft. Ins.	Moisture Content %	Soil Classification Test: Liquid Limit %	Plastic Limit %	Plastic Index	Soil Type	Field Density Test: Wet lb/cu.ft.	Dry lb/cu.ft.	Triaxial Compression Undrained: Apparent Cohesion C lb sq.in	Angle of Shearing Resistance ϕ	Laboratory California Bearing: Moisture Content %	%	C.B.R.
														NZ32
		5	16	25	18	7	CL							
	STIFF GREY MOTTLED CLAY	4-6 6-0	38					120	87	8.3	5°			
		7-6	27	44	22	22	CI							
		9-0 10-6	25					128	102	9.0	1°			

Appendix D –
Architectural Proposed Site Plan

REV	BY	DATE	NOTE
X	XX	XX/XX/XX	NOTE

KEY:

- EV Parking
- Vegetation to be removed
- HGV Turning Circle
- Temporary Structures to be removed
- Thorpe Leazes Lane 3m Offset



0 20 40 60 80 100

Metres

N

TOFTEE FACTORY | NEWCASTLE-UPON-TYNE | NE1 2DF | 0191 495 7700 | INFO@PODNEWCASTLE.CO.UK

PROJECT:
Thorpe Leazes Farm

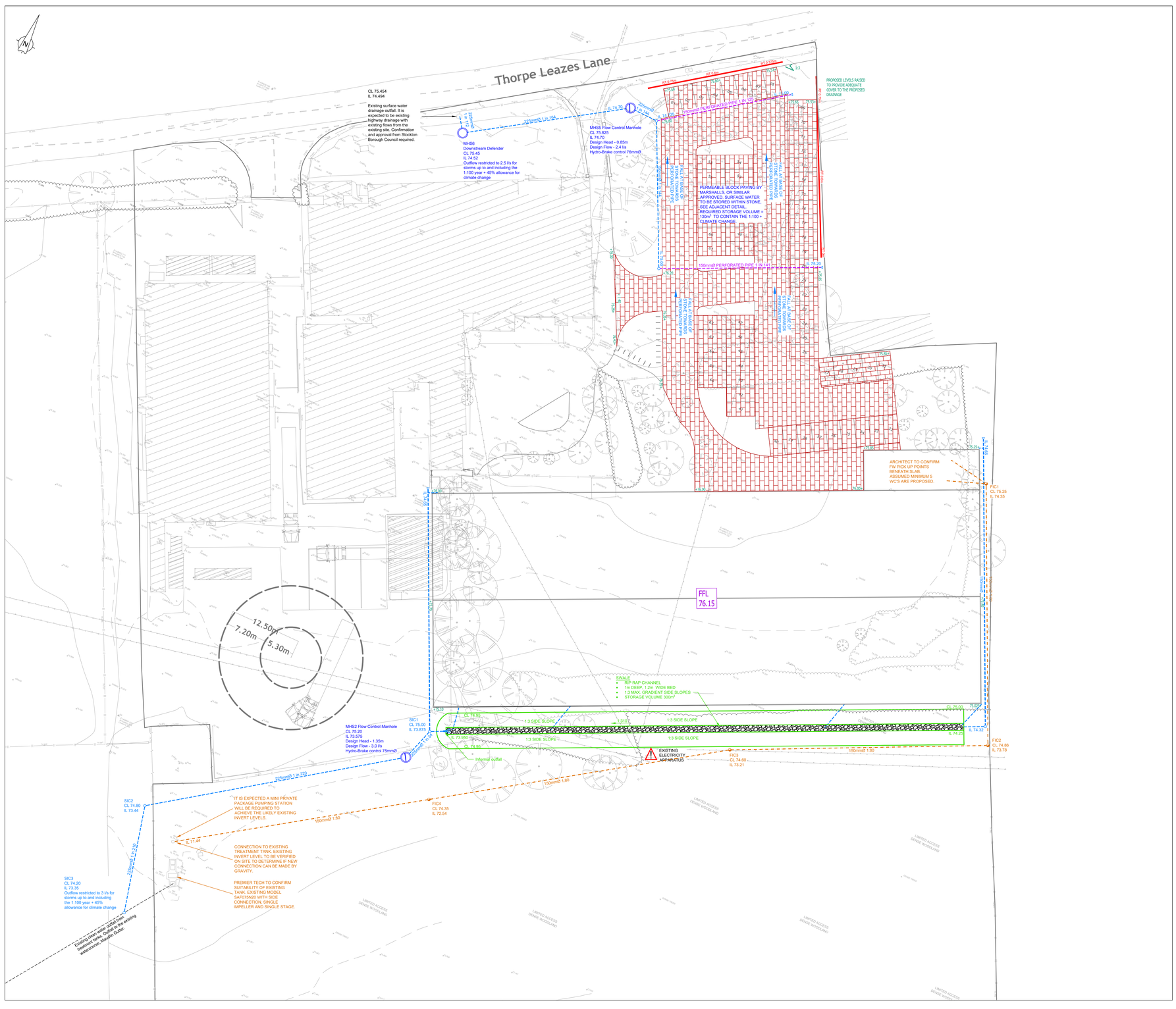
DRAWING TITLE:
Proposed Site Plan

CLIENT:	STATUS:
Tom Walker & Sons	Planning

SCALE:	SHEET SIZE:	DATE:	DWN BY:	CHECKED BY:
1:500	A1	08.23	MG	CVB

PROJECT NO:	DRAWING NO:	REVISION:
1450-WAL	PD-10.01	

Appendix E –
Proposed Drainage Layout



SUDS MAINTENANCE SCHEDULES

Operation and Maintenance Schedule for the Swales

Maintenance Schedule	Action Required	Frequency
Regular Maintenance	Remove litter and debris	Monthly, or as required
	Cut grass – Bed to be maintained at minimum 100mm height	Monthly (during growing season), or as required.
	Manage other vegetation and remove nuisance plants	Monthly at start, then as required
	Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly
	Inspect vegetation coverage	Monthly for 6 months, quarterly for 2 years, then half-yearly
	Inspect inlets and facility surface for silt accumulation, establish appropriate silt removal frequencies	Half yearly
Occasional Maintenance	Reseed areas of poor vegetation growth, alter plant types to better suit conditions, if required	As required or if bare soil is exposed over 10% or more of the swale treatment area
Remedial Actions	Repair erosion or other damage by re-turfing or reseeding	As required
	Relevel uneven surfaces and reinstate design levels	As required
	Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface	As required
	Remove and dispose of oils and petrol residues using safe standard practices	As required

Permeable Paving Maintenance Schedule

Maintenance Schedule	Action Required	Frequency
Monitoring	Checking joints are clear from dust and sediment.	Quarterly
Regular Maintenance	Brushing and suction sweeping of the surface, replacement of top 20mm of jointing material, herbicide application and weed removal.	Annually
Remedial Actions	As with conventional concrete block pavements, depressions, rutting and cracked or broken blocks, considered to be detrimental to the structural and hydraulic performance of the pavement or a hazard to users, will require appropriate corrective action. When applicable, replacement of part or the whole pavement may be required.	As required

HIGHWAYS
1. ALL EXCAVATIONS BELOW TRAFFICKED AREAS TO BE BACKFILLED WITH TYPE 1 AND COMPACTED IN LAYERS NOT EXCEEDING 150MM.
2. LOCAL AUTHORITY BUILDING CONTROL TO BE CONTACTED AS SOON AS CONTRACTOR IS ON SITE TO ENABLE EARLY DISCUSSIONS WITH THE CLERK OF WORKS.
GENERAL DRAINAGE
3. MANHOLE/INSPESPECTIONCHAMBER COVERS IN TRAFFICKED AREAS TO BE LOADING TYPE D400 AND B125 IN NON-TRAFFICKED AREAS.
4. ALL GULLIES TO BE TRAPPED AS SHOWN ON THE DETAILS DRAWINGS.
5. POSITION AND LEVELS OF EXISTING MANHOLES AND SEWERS/DRAINAGE ARE TO BE CHECKED ON SITE AS SOON AS POSSIBLE AND PREFERABLY BEFORE SITE ACTIVITIES COMMENCE.
6. THE SEWER CONNECTION IS TO BE CARRIED OUT BY A UU APPROVED CONTRACTOR.
7. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH THE DRAINAGE DETAILS DRAWINGS.
8. ADOPTED DRAINAGE IS TO COMPLY WITH 'DESIGN AND CONSTRUCTION GUIDANCE'.
9. PIPE SURROUND TO BE GRANULAR TYPE 'S' UNLESS NOTED OTHERWISE
10.DRAINAGE IS TO COMPLY WITH ALL STATUTORY REQUIREMENTS AND ACCORD WITH BS EN 752 AND BUILDING REGULATIONS APPROVED DOCUMENT H.
11.PIPE BEDDING SHOULD GRANULAR UNLESS NOTED OTHERWISE AND THE GRANULAR MATERIAL TO BE TO BS882 PT 2 AND TO BUILDING REGULATIONS PART H.
12.FOR DRAINAGE PIPES TO BE CAST IN CONCRETE TO HAVE ROCKER PIPES EITHER SIDE OF CONCRETE.

Surface Water Drainage

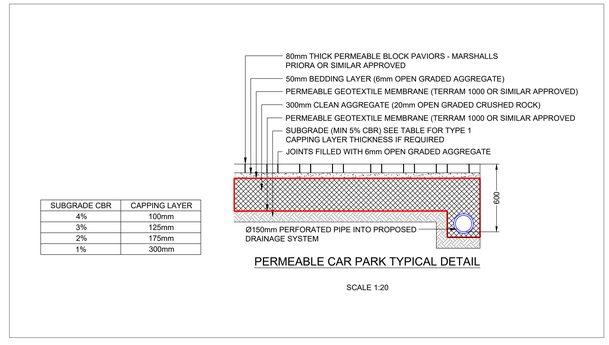
- 80.00 - Rodding eye
- 80.00 - Inspection chamber, 475mmØ. Non man entry (>1.2m)
- Manhole - Concrete Ring (see manhole schedule for further detail).
- Private PVC-U 100mm (unless noted otherwise) drainage pipe.
- Permeable Paving collection pipe
- Mini informal swale outfall with integrated rip rap by Aco or similar .

Foul Drainage

- 80.00 - Shallow inspection chamber. 600mm to invert level, 300mmØ.
- 80.00 - Inspection chamber, 475mmØ. Non man entry (>1.2m)
- Manhole - Concrete Ring (see manhole schedule for further detail).
- Private PVC-U 150mm (unless noted otherwise) drainage pipe.

Layout Key

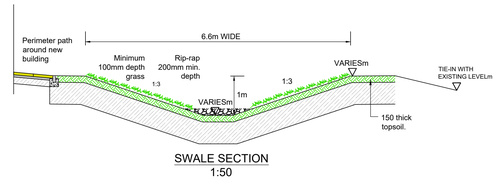
- FFL 60.075 - Proposed Finished Floor Level
- +116.025 - Proposed finished level.
- RT 0.15m - Proposed retaining wall with retained height



SUBGRADE CBR	CAPPING LAYER
4%	100mm
3%	125mm
2%	175mm
1%	300mm

PERMEABLE CAR PARK TYPICAL DETAIL

SCALE 1:20



SWALE SECTION
1:50

Do not scale

Issue	Date	Description	By	Chkd	Appd
P2	18.09.23	Updated to suit revised layout.	PL	PL	PL
P1	05.04.23	Preliminary Issue	PL	PL	PL

COAST CONSULTING ENGINEERS
7 Silverton Court, Northumberland Business Park, NE23 7RY
0191 5977979

Client: TOM WALKER & SONS

Job Title: THORPE LEAZES FARM

Drawing Title: PROPOSED DRAINAGE LAYOUT

Scale at A0: 1:250

Drawing Status: PLANNING

Job No: 23006

Drawing No: 01

Issue: P2

Appendix F –
Drainage Calculations

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Surface Network 1

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	17.400	Add Flow / Climate Change (%)	0
Ratio R	0.350	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Surface Network 1

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	28.124	0.200	140.6	0.000	5.00	0.0	0.600	o	150	Pipe/Conduit	
1.001	25.682	0.190	135.2	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
2.000	23.735	0.190	124.9	0.100	5.00	0.0	0.600	o	150	Pipe/Conduit	
1.002	5.036	0.035	143.9	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.003	29.466	0.180	163.7	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.004	3.266	0.026	125.6	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.55	75.200	0.000	0.0	0.0	0.0	0.85	14.9	0.0
1.001	50.00	6.05	75.000	0.000	0.0	0.0	0.0	0.86	15.2	0.0
2.000	50.00	5.44	75.000	0.100	0.0	0.0	0.0	0.90	15.9	13.5
1.002	50.00	6.13	74.735	0.100	0.0	0.0	0.0	1.09	43.3	13.5
1.003	50.00	6.61	74.700	0.100	0.0	0.0	0.0	1.02	40.5	13.5
1.004	50.00	6.66	74.520	0.100	0.0	0.0	0.0	1.17	46.3	13.5

Free Flowing Outfall Details for Surface Network 1

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.004	S7	75.454	74.494	0.000	1350	0

Simulation Criteria for Surface Network 1

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	2
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	2	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	17.400	Storm Duration (mins)	30
Ratio R	0.350		

Online Controls for Surface Network 1

Hydro-Brake® Optimum Manhole: S5-HB, DS/PN: 1.003, Volume (m³): 2.1

Unit Reference	MD-SHE-0076-2400-0850-2400
Design Head (m)	0.850
Design Flow (l/s)	2.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	76
Invert Level (m)	74.700
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.850	2.4
Flush-Flo™	0.256	2.4
Kick-Flo®	0.540	2.0
Mean Flow over Head Range	-	2.1

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	2.1	1.200	2.8	3.000	4.3	7.000	6.4
0.200	2.4	1.400	3.0	3.500	4.6	7.500	6.6
0.300	2.4	1.600	3.2	4.000	4.9	8.000	6.8
0.400	2.3	1.800	3.4	4.500	5.2	8.500	7.0
0.500	2.1	2.000	3.6	5.000	5.5	9.000	7.2
0.600	2.0	2.200	3.7	5.500	5.7	9.500	7.4
0.800	2.3	2.400	3.9	6.000	5.9		
1.000	2.6	2.600	4.0	6.500	6.2		

Storage Structures for Surface Network 1

Cellular Storage Manhole: S1, DS/PN: 1.000

Invert Level (m) 75.200 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.35
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	1000.0	1000.0	0.201	0.0	1000.0
0.200	1000.0	1000.0			

Cellular Storage Manhole: S3, DS/PN: 2.000

Invert Level (m) 75.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.35
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	1045.0	1045.0	0.201	0.0	1045.0
0.200	1045.0	1045.0			

Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 1

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	2
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR	Ratio R 0.366
Region	England and Wales	Cv (Summer)	1.000
M5-60 (mm)	18.000	Cv (Winter)	1.000

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360
Return Period(s) (years)	100
Climate Change (%)	45

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	S1	15 Summer	100	+45%					75.200
1.001	S2	240 Summer	100	+45%					75.137
2.000	S3	240 Summer	100	+45%					75.148
1.002	S4	240 Summer	100	+45%	100/15 Summer				75.137
1.003	S5-HB	240 Summer	100	+45%	100/15 Summer				75.136
1.004	S6-DD	360 Summer	100	+45%					74.562

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S1	-0.150	0.000	0.00			0.0	OK	
1.001	S2	-0.013	0.000	0.01			0.1	OK	
2.000	S3	-0.002	0.000	0.33		243	5.0	OK	
1.002	S4	0.177	0.000	0.11			3.1	SURCHARGED	
1.003	S5-HB	0.211	0.000	0.06			2.4	SURCHARGED	
1.004	S6-DD	-0.183	0.000	0.08			2.4	OK	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Surface Network 2

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	19.200	Add Flow / Climate Change (%)	0
Ratio R	0.304	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Surface Network 2

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	91.944	0.300	306.5	0.368	5.00	0.0		0.045	3 \=/	1200	1:3 Swale	
1.001	7.670	0.225	34.1	0.000	0.00	0.0	0.600		o	225	Pipe/Conduit	
1.002	46.106	0.210	219.6	0.000	0.00	0.0	0.600		o	300	Pipe/Conduit	
1.003	18.940	0.090	210.4	0.000	0.00	0.0	0.600		o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	42.99	10.10	74.250	0.368	0.0	0.0	0.0	0.30	74.4	42.8
1.001	42.87	10.16	73.875	0.368	0.0	0.0	0.0	2.25	89.4	42.8
1.002	41.41	10.88	73.575	0.368	0.0	0.0	0.0	1.06	74.7	42.8
1.003	40.86	11.18	73.365	0.368	0.0	0.0	0.0	1.08	76.3	42.8

Free Flowing Outfall Details for Surface Network 2

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.003	SIC3	74.200	73.275	0.000	450	0

Simulation Criteria for Surface Network 2

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	2	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.200	Storm Duration (mins)	30
Ratio R	0.304		

Online Controls for Surface Network 2

Hydro-Brake® Optimum Manhole: MHS2, DS/PN: 1.002, Volume (m³): 3.1

Unit Reference	MD-SHE-0075-3000-1525-3000
Design Head (m)	1.525
Design Flow (l/s)	3.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	75
Invert Level (m)	73.575
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.525	3.0
Flush-Flo™	0.328	2.6
Kick-Flo®	0.670	2.1
Mean Flow over Head Range	-	2.4

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	2.1	1.200	2.7	3.000	4.1	7.000	6.1
0.200	2.5	1.400	2.9	3.500	4.4	7.500	6.3
0.300	2.6	1.600	3.1	4.000	4.7	8.000	6.5
0.400	2.5	1.800	3.2	4.500	5.0	8.500	6.7
0.500	2.5	2.000	3.4	5.000	5.2	9.000	6.9
0.600	2.3	2.200	3.5	5.500	5.4	9.500	7.0
0.800	2.2	2.400	3.7	6.000	5.7		
1.000	2.5	2.600	3.8	6.500	5.9		

Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 2

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR	Ratio R 0.353
Region	England and Wales	Cv (Summer)	1.000
M5-60 (mm)	18.000	Cv (Winter)	1.000

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360
Return Period(s) (years)	100
Climate Change (%)	45

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	Swale 1	360 Winter	100	+45%					74.930
1.001	SIC1	360 Winter	100	+45%	100/15 Summer				74.929
1.002	MHS2	360 Winter	100	+45%	100/15 Summer				74.927
1.003	SIC2	360 Winter	100	+45%					73.405

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	Swale 1	-0.170	0.000	0.01			36.3	FLOOD RISK	
1.001	SIC1	0.829	0.000	0.07			4.5	FLOOD RISK	
1.002	MHS2	1.052	0.000	0.04			2.8	FLOOD RISK	
1.003	SIC2	-0.260	0.000	0.04			2.8	OK	

Coast Consulting Engineers Ltd

7 Silverton Court

Northumberland Business Park

NE23 7RY

Tel. 0191 597 7879