TC/DS/L12135/23/01

DRAINAGE STRATEGY

AT

Teewood Farm Barn
Slaidburn Rd
Waddington
Clitheroe
BB7 3JJ

FOR

M and A Hurst

REPORT VERIFICATION

Site Address	Teewood Farm Barn, Slaidburn Rd, Waddington, Clitheroe, BB7 3JJ

Document Reference	TC/DS/L12135/23/01 Drainage Strategy
Date Originated	10 November 2023
Originator	Cameron Shearman BEng (Hons) GMICE
Checked	Matthew Johnson BSc (Hons)
Verified	Matthew Johnson BSc (Hons)

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Teewood Farm Barn, Slaidburn Rd, Waddington, Clitheroe, BB7 3JJ

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1 INTRODUCTION

1.1 Project Scope / Client Brief

Thomas Consulting has been commissioned by Mark Hurst to carry out a Drainage Strategy report in accordance with the National Planning Policy Framework (NPPF) to support a planning application that fulfils the requirements of the statutory local authorities.

1.2 Site Location & Topography

The site is located at Teewood Farm Barn, Slaidburn Rd, Waddington, Clitheroe, BB7 3JJ and this report is to support the development of a new two-storey dwelling. The approximate Ordnance Survey (OS) grid reference for the site is 372225 445472 and the location of the site is shown on Figure 1.

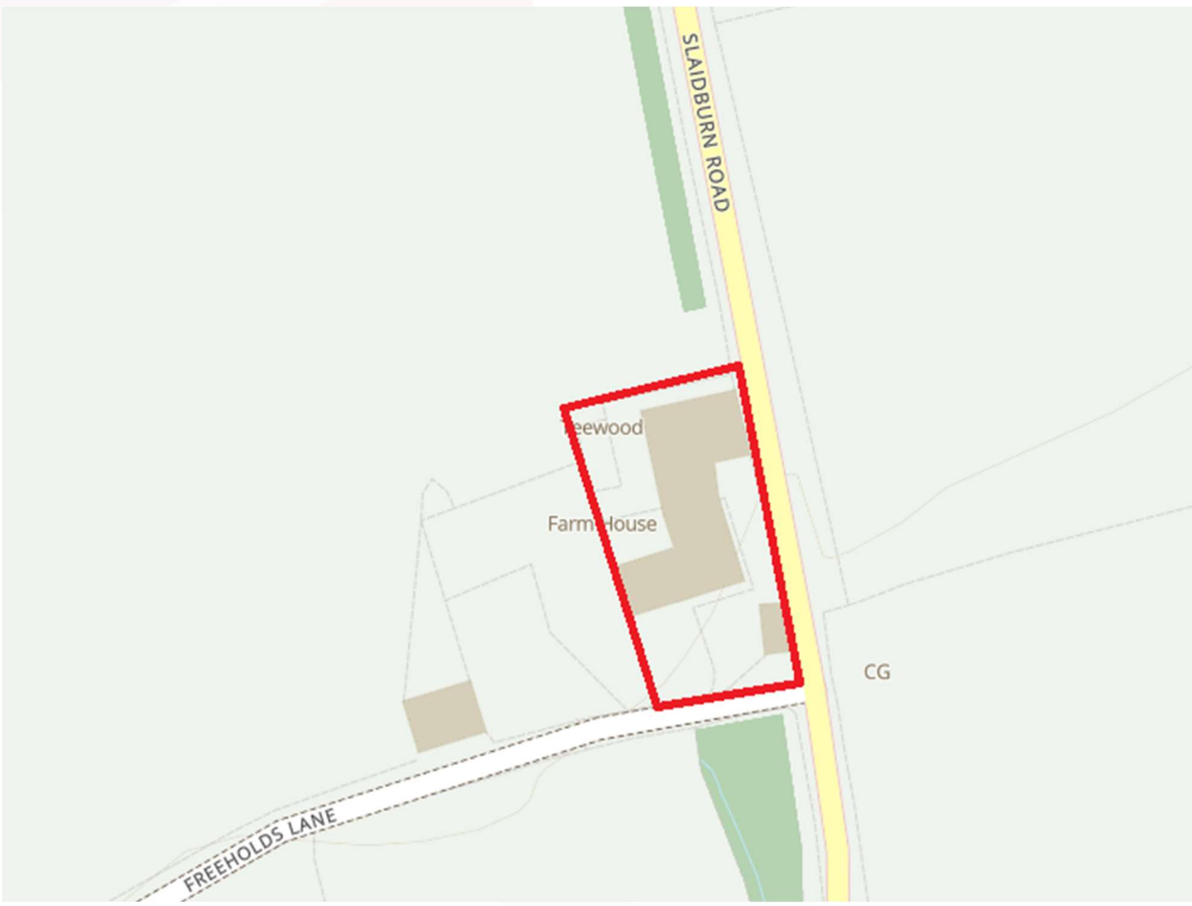


Figure 1: Site location plan (Source: OS Maps, 2023: Licence No. 100020411)

The site covers a total area of approximately 0.11 ha and comprises of existing agricultural buildings. The site is located approximately 1.8km north of the village of Waddington. A topographical survey to ordnance datum has been provided by D2R Survey Ltd and has been made available in Appendix A. The survey identifies the existing site has a shallow gradient with elevations of around 191 - 189mAOD gradually sloping from North to South. The external ground largely consists of gravel and concrete with limited amounts of grass. North of the site is a field consisting of grassland and multiple trees surrounding the border. There is also a watercourse flowing from north to south which enters a culvert running east of the development parallel to Slaidburn road. South of the site is an access gravel track and beyond this, a woodland strip and further grass fields continuing further west around the site.

1.3 National Planning Policy Framework and Planning Practice Guidelines

The NPPF and its Planning Practice Guidance (PPG) states any development other than the following outlined below is classed as a major development.

- Minor non-residential extensions: industrial/commercial/leisure etc extensions with a footprint less than 250 square meters.
- Alterations: development that does not increase the size of buildings e.g. alterations to external appearance.
- Householder development: For example, sheds, garages, games rooms etc within the curtilage of the existing dwelling, in addition to physical extensions to the existing dwelling itself. This definition excludes any proposed development that would create a separate dwelling within the curtilage of the existing dwelling e.g. subdivision of houses into flats.

The guidance also states that a site-specific flood risk assessment is required for the following site proposals.

- A site proposed in Flood Zone 2 or 3 including minor development and change of use in development type to a more vulnerable class.
- More than 1 hectare (ha) in Flood Zone 1
- Less than 1 ha in Flood Zone 1, including a change of use in development type to a more vulnerable class (for example from commercial to residential), where they could be affected by sources of flooding other than rivers and the sea (for example surface water drains, reservoirs)
- In an area within Flood Zone 1 which has critical drainage problems as notified by the Environment Agency

1.4 Environment Agency Flood Map for Planning

National Planning Policy Framework (NPPF) Flood Zones comprise Flood Zone 1, Flood Zone 2 and Flood Zone 3. The Environment Agency's Indicative Flood Map for Planning (Figure 2) shows that the site is located within the NPPF defined Flood Zone 1.

Flood Zones are based on an areas Annual Exceedance Probability (AEP) of River or Sea Flooding. For example, Flood Zone 1 has a 'Low Probability' of flooding as it has an AEP of <0.1% (Less than 1 in 1000 year) of occurring in any one year. Flood Zone 2 has a 'Medium Probability' having an AEP of 0.1-1.0% (1 in 1000 – 1 in 100 year) chance of river flooding, or 0.1-0.5% (1 in 1000 – 1 in 200 year) chance of tidal/sea flooding.

Flood Zones 3 is split between 'a' and 'b' classifications. Flood Zone 3a has a 'High Probability' of flooding as it has an AEP of >1.0% (More than 1 in 100 year) chance of river flooding, or >0.5% (More than 1 in 200 year) chance of sea/tidal flooding. Flood Zone 3b (The Functional Floodplain) comprises land where water has to flow or be stored in times of flooding. Local planning authorities should identity in the Strategic Flood Risk Assessments areas of a functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. (Not separately distinguished from Zone 3a on the Flood Map for Planning).

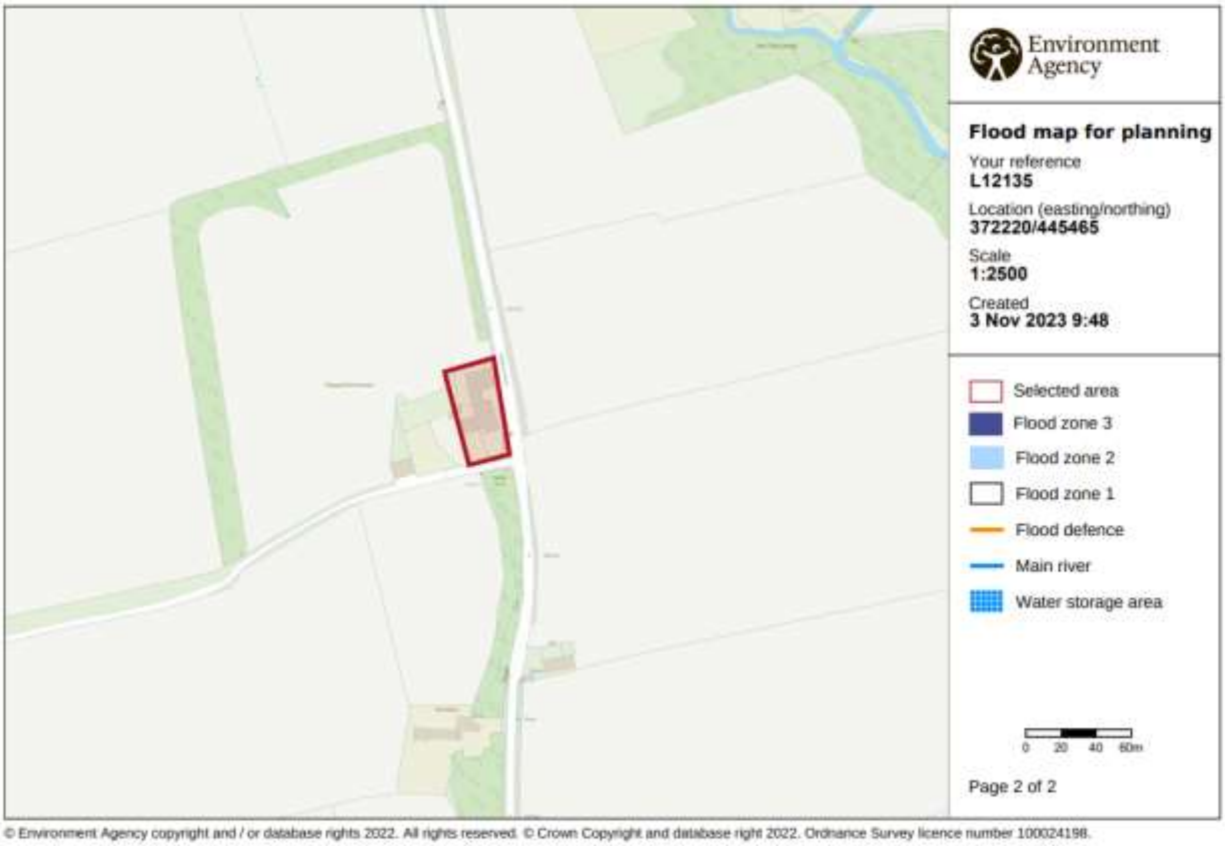


Figure 2: Environment Agency Flood Zone Map (Source: Environment Agency, 2023, GOV.UK)

1.5 Development Classification

The PPG separates each development into a vulnerability class. These classifications can be found in Figure 3, whilst in Figure 4 permittable development in relation to its classification is shown.

Vulnerability Classification	Development
Essential Infrastructure	• Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk • Essential utility infrastructure, which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood • Wind turbines
Highly Vulnerable	• Police and ambulance stations; fire stations and command centres; telecommunications installations required to be operation during flooding. • Emergency dispersal points • Basement dwellings • Caravans, mobile homes and park homes intended for permanent residential use • Installations requiring hazardous substances consent
More Vulnerable	• Hospitals • Residential institutions such as residential care homes, children's homes, prisons and hostels. • Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels. • Non-residential uses for health services, nurseries and education establishments. • Landfill and sites used for waste management facilities for hazardous waste. • Sites used for holiday or short let caravans and camping, subject to a specific warning and evacuation plan
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 distributions; non-residential institutions not included in the 'more vulnerable' class; and assemble and leisure. • Land and buildings used for agriculture and forestry • Waste treatment (except landfill & hazardous waste facilities) • Minerals working & processing (except for sand & 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.
Water-Compatible Development	• Flood control infrastructure • Water transmission infrastructure & pumping stations • Sewage transmission infrastructure & pumping stations • Sand & gravel working • Docks, marinas and wharves • Navigation facilities • Ministry of Defence installations • Ship building, repairing & dismantling, dockside fish processing & refrigeration & compatible activities requiring a waterside location • Water based recreation (excluding sleeping accommodation) • Lifeguard and coastguard stations • Amenity open space, nature conservation & biodiversity, outdoor sports and recreation and essential facilities such as changing rooms • Essential ancillary sleeping or residential accommodation for staff required by uses in this category subject to a specific warning & evacuation plan.

Figure 3: NPPF Flood Risk Vulnerability Classification (Source: National Planning Practice Guidance, 2014)

Flood Zones	Flood Risk Vulnerability Classification				
	Essential infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a †	Exception Test required †	✗	Exception Test required	✓	✓
Zone 3b *	Exception Test required *	✗	✗	✗	✓ *

Key:

✓ Development is appropriate

✗ Development should not be permitted.

Figure 4: NPPF Flood Risk Vulnerability Classification (Source: National Planning Practice Guidance, 2014)

1.6 The Proposed Development in Relation to Planning Requirement

The proposed development footprint is approximately 0.11ha and the site is located in Flood Zone 1. Being a residential dwelling, the proposed development is classified as a 'More Vulnerable' development in accordance with Figure 3 above and therefore the proposed development is deemed acceptable. A Site Specific Flood Risk Assessment is not required, and the development does not need to undertake the sequential and exception tests.

2 SITE CHARACTERISTICS

2.1 Geological Assessment

A desk-based study has been carried out to analyse the basic site geology. British Geological Survey (BGS) and Land Information Systems (LandIS) provide mapping which indicates the characteristics of the soil, superficial and bedrock layers across the site Table 1.

Principal Aquifers - These are layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifer.

Secondary A Aquifers - permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.

Secondary B Aquifers - predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons, and weathering. These are generally the water-bearing parts of the former non-aquifers.

Secondary (Undifferentiated) Aquifers - has been assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type.

Geological Assessment			
Geological Layer	**Classification**	**Description**	**Aquifer Class**
Soil	Soilscape 17	Slowly permeable seasonally wet acid loamy and clayey soils	N/A
Superficial (Drift)	Till, Devensian	Diamicton	Secondary (undifferentiated)
Bedrock (Solid)	Clitheroe Limestone Formation and Hodder Mudstone Formation	Mudstone	Secondary A

Table 1: Geological Assessment (BGS Geology Viewer, 2023)

Magic maps which are available online provide data on vulnerability zones such as source protections zones and/or groundwater vulnerability zones. The maps indicate that that the site is not located in a source protection zone and the groundwater vulnerability is identified as ‘Medium – Low’ with a Soluble Rock Risk.

2.2 Existing Surrounding Natural or Manmade Drainage Features

According to the EA Main River Maps the closest known watercourse is located approximately 5m south of the proposed development. On 28/07/23 Thomas Consulting undertook a site investigation and identified that there is a watercourse running directly adjacent to the east of the site and this watercourse becomes culverted approximately 3m north of the proposed development. It was confirmed that the roof area of the existing agricultural barn was draining into the culverted watercourse utilising the manhole shown in Figure 5. The manhole could not be lifted due to being partially buried and overgrown. After speaking with the site neighbour, they identified the manhole had an approximate depth of 2.0m. This information will require verification.

Figure 5: Existing Manhole into culverted watercourse (Google Maps Street View, 2023)

Based on the EA Main river map and topography, it has been assumed that this watercourse connects into the River Ribble. The topographical survey conducted by D2R Survey Ltd further confirms this watercourse is present and identifies that the water level is at 190.71mAOD before entering the culvert with embankments of 191.21mAOD and 191.13mAOD.

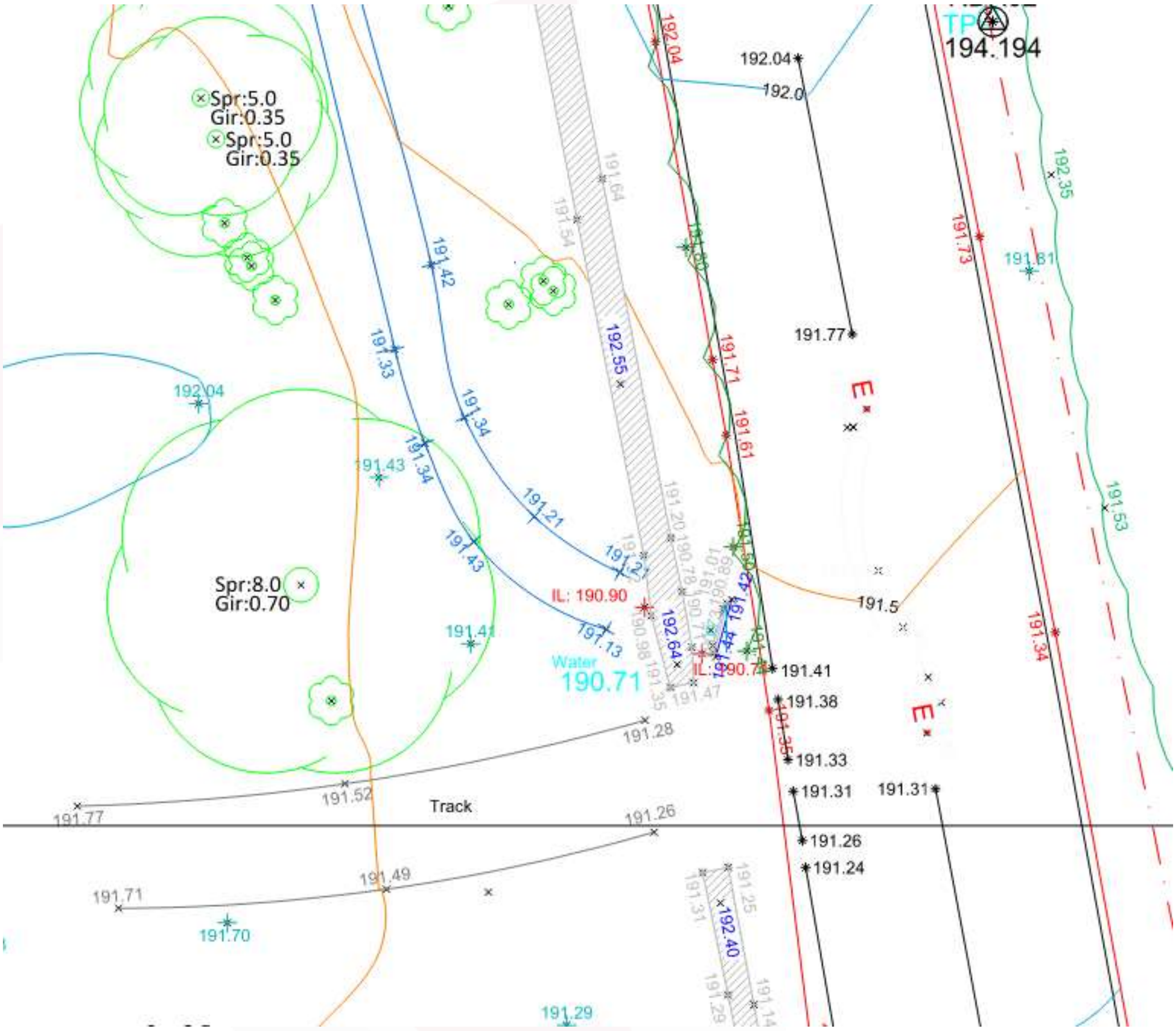


Figure 6: Topographical Extract (D2R Survey Ltd)

Furthermore, it was identified that there is an existing surface water pipe servicing the neighbours surface water drainage running underneath the existing property into the watercourse as highlighted in blue within Figure 7.

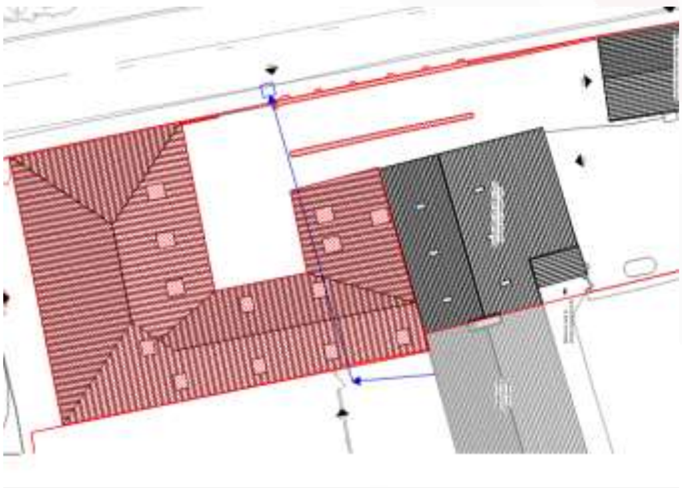


Figure 7: Existing Pipe running underneath agricultural building Sketch

The existing foul water from the site and the neighbour is routed south past Freeholds lane into a septic tank located in the existing woodland as there is no foul water sewers near the site. The approximate location of the septic tank has been highlighted in red within Figure 8 below.

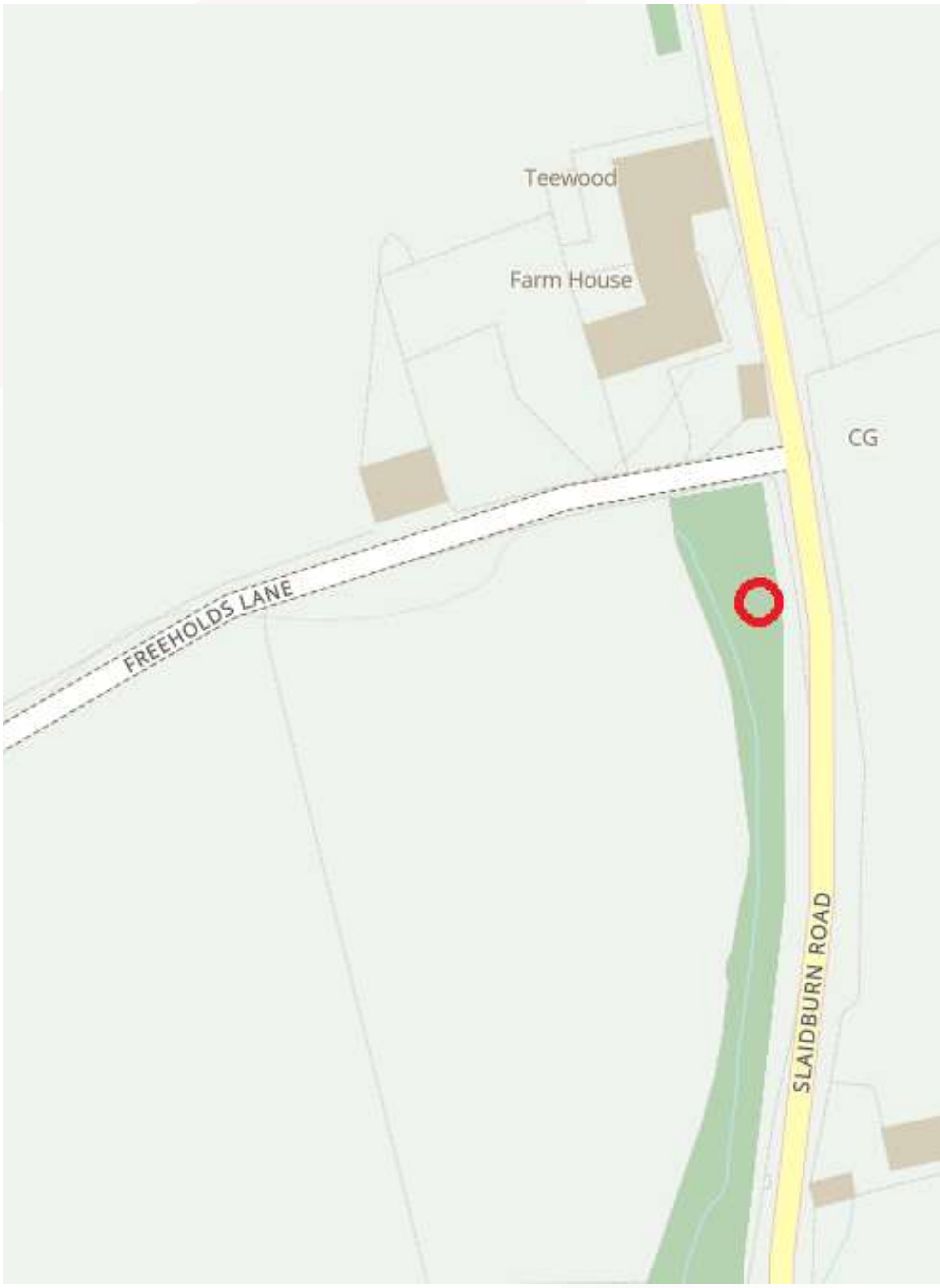


Figure 8: Approximate location of existing septic tank (OS Maps, 2023: Licence No. 100020411)

2.3 Geotechnical Assessment

Thomas Consulting instructed GEO to undertake infiltration testing on site to identify if draining via infiltration was a viable drainage method. On 19/07/2023, we received the Soil Infiltration results based on two trial pits located on site. TP1 was found unsuitable as the 'pit was filling up with the water in the ground' suggesting high groundwater was present. TP2 was monitored for 3 hours and the water level 'remained static with no drop'. The full site investigation has been made available in Appendix B.

3 SURFACE WATER DRAINAGE STRATEGY

3.1 Catchment Assessment

A catchment assessment has been completed in AutoCAD to determine the different types of proposed land cover with the results demonstrated in Table 2. A Catchment plan has been made available in Appendix C.

Catchment Assessment	
Type of Land	**Associate Area m^2 (Ha)**
Roof Areas + 10% Urban Creep	283.5
Paved Impermeable Areas	196.3
Permeable driveway	226.4
Garden & landscaped areas	400.6

Table 2: Catchment Assessment on Proposed Development

3.2 Urban Creep

Urban Creep is defined as any increase in the impervious area that is drained to an existing drainage system without planning permission being required, and therefore, without any consideration of whether the capacity of the receiving sewerage system can accommodate the increased flow. For example, the construction of patios, conservatories, small extensions, paved driveways etc (post initial construction) may all result in an increase in surface water runoff and therefore reduce the level of service of the drainage system.

To allow for future urban expansion within the development, an increase in paved surface area of 10% is often suggestion if there is no specified value stipulated by the drainage approval body or planning authority.

In this instance a 10% allowance for urban creep has been applied to the roof area of the development, which captures the potential expansion of private plots which could be developed and connected into the drainage system without planning permission or consideration to the capacity of the wider system.

3.3 Climate Change

Climate Change projections indicate that worsening rainfall events are to occur over the next few decades. These effects are becoming more prominent and speeding up in development. To account for the effects of climate change in accordance with guidance outlined by the Environment Agency on the DEFRA website which is summarised in Table 3 below:

Catchment Area	Ribble Management	
3.3% annual exceedance rainfall event		
	Central Allowance	**Upper End Allowance**
2050's	25%	35%
2070's	30%	40%
1% annual exceedance rainfall event		
	Central Allowance	**Upper End Allowance**
2050's	25%	40%
2070's	35%	50%

Table 3: Climate Change Allowances (DEFRA 2023)

As this is a residential development with an expected lifetime of circa 100 years, the upper end allowance for the 2070's should be used, which in this instance is 50%.

3.4 SuDS Hierarchy

All surface water drainage designs are to follow the SuDS Hierarchy outlined within the SuDS Manual. This hierarchy requires the designer to attempt infiltration methods, prior to proposing disposal to a watercourse. If the above two are not possible then consideration can be made to the disposal of surface water to the public sewer network. However, a connection to a dedicated sewer (i.e. surface water or foul) should always be sought in preference to the connection of a combined sewer.

Following site investigations, it has been established that infiltration methods will not be a viable solution to discharge surface water from site as stated in Section 2.3. The closest watercourse is a culverted watercourse running adjacent to the site east of the development as explained in Section 2.2. It is proposed in line with the requirements stated within the SuDS hierarchy that a connection to this watercourse is made.

3.5 Exploration of SuDS

Sustainable drainage systems (SuDS) are designed to maximise the opportunities and benefits we can secure from surface water management.

3.6 Estimated Runoff Rates

Runoff calculations have been provided in Appendix D and have been completed using guidance from CIRIA Report C753 – The SuDS Manual, V6 – 2015, Section 24.5. The calculation utilises the modified rational method to determine pre- and post-development peak rates of runoff for different return period. Below is a summary of result in.

Peak Rate of Runoff (l/s) Assessment					
Return Period	Greenfield	Pre-Development Runoff Rates	Post-Development Un-Restricted Runoff Rates	Post-Development Proposed Total Restricted Runoff Rates	Betterment (%)
Q1	0.6	6.2	4.1	2.1	66.1
Q30	1.1	15.2	9.9	3.3	78.3
Q100	1.3	19.5	12.7	3.9	80
Q100 + 50% CC	2.0	28.3	18.5	5.6	80.2

Table 4: Surface Water Rate of Runoff Results – Entire Development

As The proposed development is a brownfield site, the drainage proposed provides at least a 66% betterment for all future return periods. This has been achieved by utilising an orifice plate downstream of network restricting the runoff rate prior to discharging into the nearest watercourse.

3.7 Design Parameters

The following design parameters have been utilised within the drainage model;

- FSR data has been used for the rainfall methodology in the surface water calculations.
- CV values have been set at 0.75 for summer and 0.84 for winter, which are default industry standards.
- Storm durations have been analysed up to 1440 minutes. This is due to the critical storm duration within being contained within the 180-minute duration for the critical duration worst event. This is evident in the surface water drainage calculations provided in Appendix E.

3.8 Summary of Surface Water Drainage Proposals

Based on the above assessment the following SuDS techniques are proposed:

- Geocellular Storage Tanks & Restricted Run-Off Discharge (Flow Control Chamber)
- Swale

The SuDS have been sized to contain a future 1% AEP event of critical duration. Future climate change (50%) and urban creep (10% to housing area only) is accounted for. Although much of the paving areas surrounding the dwelling will not be positively drained, they have also been included with the drainage catchment areas for conservative design. The proposed foul and surface water drainage layout is included in Appendix F.

The proposed development consists of large amounts of constraints around the site due to the red line boundary and adjacent land. As the dwelling is a semi-detached house, the neighbouring dwelling attached prevents any underground drainage to be routed along the west of the site. Furthermore, the existing culverted watercourse runs directly east of the site adjacent to the site boundary as mentioned in Section 2.2. To limit the amount of rainwater pipes running underneath the foundations of the dwelling, the surface water drainage has been separated into two networks. These networks have been identified as north and south for clarity.

It is proposed the northern surface water network drains the roof area's facing north via rainwater pipes prior to entering a geocellular attenuation storage located within the landscaped areas north of the site. Water landing on the impermeable paved areas have been graded towards a small swale east of the site that features a perforated pipe underneath diverting the water north towards the same geocellular attenuation storage. The geocellular attenuation storage features double stacked geocellular crates (800mm deep) underneath approximately 1m of cover providing approximately 4.6m^3 of storage which is sited upstream of a flow control chamber housing a 50mmØ orifice plate. This restricts the flow providing a betterment over pre-development runoff rates as discussed in Section 3.6 prior to discharging into the existing manhole over the culverted watercourse as highlighted in Figure 5.

The Southern surface water network drains the remaining roof and paved areas via rainwater pipes and channel drains that feed into a geocellular attenuation tank situated underneath the cobbled yard. This geocellular attenuation storage consists of a singular row of geocellular crates (400mm deep) underneath approximately 1.1m of cover above. This sits upstream of a flow control chamber within the cobbled yard housing a 30mmØ orifice plate that restricts the discharge rate prior to flowing into a watercourse south of the site via a stone built headwall to ensure the longevity of the outfall.

Utilizing orifice plates smaller than 30mmØ in paved areas and 50mmØ in landscaped areas have been deemed unfeasible due to frequent blockages. The total sum of outflows for both networks are shown within Table 4 where over a 66% betterment over Pre-Development Runoff Rates has been achieved. The hydraulic calculations made available in Appendix E identify all the runoff rates for each simulated storm event.

3.9 Exceedance Routing

The drainage model has been designed as to store a 100-year return period, plus the effects of climate change and urban creep. In the rare case storm events of greater severity occur exceedance flows have been routed east onto Slaidburn Road to be picked up by highway drainage and south running onto the adjacent field.

4 CONCLUSIONS

- The site is located within Flood Zone 1.
- The proposed development is classed as a major development and according to the NPPF's PPG as a dwelling site is classed as more vulnerable to flood risk. more vulnerable developments are deemed acceptable in Flood Zone 1.
- British Geological Survey (BGS) and Land Information Systems (LandIS) have been used to identify the site geology of the site. The geology consists of Slowly permeable seasonally wet acid loamy and clayey soils above Till, Devensian and the bedrock consists of Clitheroe Limestone Formation and Hodder Mudstone Formation. According to Magic Maps online, the site is not located in a source protection zone and the groundwater vulnerability is identified as 'Medium – Low' with a Soluble Rock Risk.
- Infiltration testing was conducted on site however was deemed unviable due too little to no water being drained. Due to this, in line with the SuDS hierarchy, it has been proposed the surface water will drain to the nearest watercourse. In accordance with EA Maps, the closest watercourse is approximately 5m south of the site however upon conducting a site visit, It was identified the watercourse is culverted and runs adjacent east of the site parallel to Slaidburn Road.
- The existing site drainage was investigated on 28/07/23 and confirmed that the existing agricultural building and neighbouring dwelling discharged surface water into the culverted watercourse east of the site. Foul water from the existing site is diverted south where there is an existing septic tank within the adjacent landowner's woodland.
- The proposed northern network features a swale utilising a perforated pipe underneath diverting water into a geocellular attenuation tank prior to discharging into the culverted watercourse via a flow control chamber housing an orifice plate. This orifice plate is used to restrict the discharge rate. The proposed south network drains the south of the site utilising rainwater pipes and channel drains falling into a geocellular tank located underneath a cobbled forecourt. This water is then discharged utilising a stone built headwall into the watercourse further south.
- The site is brownfield and therefore, the proposed restricted runoff rates have been calculated in accordance with CIRIA Report C753 – The SuDS Manual, V6 – 2015, Section 24.5. The proposed restricted rates achieved by orifice plates provide at least a 66% betterment than pre-development runoff rates for all future return periods.
- The surface water drainage system has been designed to store a 100 year storm event + 50% climate change considering an extra 10% allowance for urban creep for roofed areas without affecting flood risk elsewhere. In the rare case a storm of greater severity occurs, water exceedance will flow onto the adjacent highway to be picked up within the existing highway drains within the northern network. The southern networks will flow into the adjacent field south of the site.

5 REFERENCES

[1] Ministry of Housing, Communities and Local Government, *National Planning Policy Framework*, July 2018.

[2] Ministry of Housing, Communities and Local Government, *Planning Practice Guidance to the National Planning Policy Framework*, October 2019. (Some parts of the guidance backdate)

[3] GOV.UK, DEFRA/Environment Agency Portal.

[4] British Geological Survey (BGS), Geology Viewer.

[5] Land Information System (LANDIS), Soilscapes Viewer.

[6] Natural England, Magic Map Viewer.

[7] Environment Agency, Statutory Main River Map Viewer.

[8] Marshall & Bayliss, *Flood Estimation for Small Catchments*, *Report No. 124 (IoH 124)*, Institute of Hydrology, June 1994.

[9] D.B Boorman, J.M. Hollis & A. Lilly, 1995. *Hydrology of soil types, Report No. 126. (IoH126) Institute of Hydrology*, November 1995.

[10] UK SuDS Online Tool in accordance with Environment Agency report SC030419*, Rainfall Runoff Management for Developments*, October 2013

[11] CIRIA, *The SUDS Manual Version 6, Report C753*, 2015.

[12] CIRIA, *Designing for Exceedance in Urban Drainage – Good Practice*, *Report C635*, 2006.

[13] DEFRA, *Sustainable Drainage Systems – Non-statutory technical standards for sustainable drainage systems,* March 2015.

[14] Sewer Sector Guidance, *Design and Construction Guidance for foul and surface water sewers offered for adoption under the Code for adoption agreements for water and sewerage companies operating wholly or mainly in England,* May 2021.

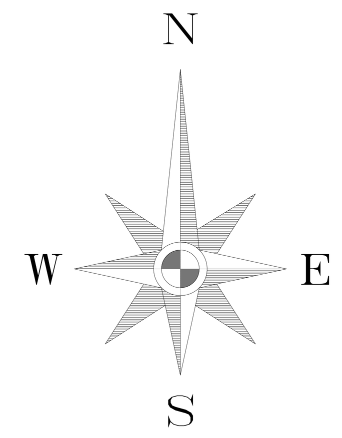
[15] CIRIA, The SUDS Manual, Report C753, 2015

APPENDIX A

TOPOGRAPHICAL SURVEY

Notes:

Survey to OS National Grid



Revision:	Description:	Date:

Drawing Title:	Topographical Survey Road
Project:	Teewood Farm, Slaidburn Road, Waddington, BB7 3JQ
Client: John Coward Architects	Drawing Status: Measured Survey

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29th Aug 2019	1:250 @ A0	WTB	WTB

Drawing Number	D2R:	CAD File:	Rev:
	D2R - TWF - 02	D2R - TWF - 01	0

APPENDIX B

INFILTRATION TESTING

Mr Tom McCann,
Thomas Consulting Engineers Ltd
21 China Street,
Lancaster,
LA1 1EX

Tom.mccann@thomasconsulting.co.uk

Date: 19.07.2023
Project No: GEO2023-5986
Project Title: Soil Infiltration Test Report – Land at Teewood Farm, Slaidburn Road, Clitheroe

Introduction:

Geo Environmental Engineering Ltd (GEO) were commissioned by Mr Tom McCann of Thomas Consulting Engineers Ltd to carry out soil infiltration tests for the proposed residential development of land and buildings at Teewood Farm, Slaiburn Road, Clitheroe, BB7 3JQ.

This report was requested specifically for the purposes of soil infiltration potential and therefore any items not specifically mentioned cannot be assumed to be covered.

Site Works:

The site works (i.e. trial pits and soil infiltration tests) were completed on the 18th July 2023. This comprised 2 No. trial pits (TP1 and TP2) excavated to a maximum depth of c.1.50m. A copy of the exploratory hole location plan and the trial pit logs are attached.

TP1:

TP1 was located to the rear (north) of the existing barn structures and was within the edge of an agricultural field. The location was overgrown and surrounded by mature trees.

The site surfacing at TP1 was unmanaged vegetation overlying made ground of loam topsoil with some anthropogenic debris and many roots/rootlets. Dark brown loam subsoil was present to c.0.70m, where natural appearing soft very sandy very gravelly clay with cobbles was present.

At TP1 a slight becoming moderate water ingress was noted at c.1.00m that resulted in the trial pit filling with water. It was therefore not possible to complete a soil infiltration test. The trial pit was increased to c.1.50m depths and the inflow became stronger as depth increase, with the pit gradually filling.

TP2:

TP2 was to be located in the front garden, to the west of a dry-stone wall. However, on viewing the area, which was landscaped with a fountain and sculpture it was decided to re-locate the trial pit to the east of the wall, closer to the barn, as per the attached Trial Pit Location Plan.

TP2 noted patchy vegetation over thin loam soil over gravel hardstand to c.0.25m. This was underlain by stiff slightly sandy slightly gravelly CLAY with occasional cobbles. TP2 remained dry and stable during excavation.

Soil Infiltration Testing:

Due to the shallow water ingress, it was not possible to test the soil infiltration at TP1 as the pit was filling up with the water in the ground. Therefore, this location is not considered suitable for a soakaway and an alternative drainage solution should be sought.

At the location of TP2 a soil infiltration test was attempted to the engineer's specification. The test location was monitored for three hours, and the water level remained static with no drop. Therefore, this location is not considered suitable for a soakaway and an alternative drainage solution should be sought.

Site Observations:

At the location of TP2 a black pipe was encountered and damaged at c.0.25m. The pipe was black plastic, c.20mm in diameter and laid in darkly coloured made ground with no bedding sand, maker tape or protective tiles. The pipe was not marked on any utility plans. A small quantity of water (c.200ml) exited the pipe when struck by the excavator bucket, so it was assumed that the pipe was redundant. It should be reported to the landowner so they can determine if they need to repair or if it is abandoned. The approximate route and location of the pipe was marked in blue paint once the trial pit was reinstated.

To the south of the site is dense woodland. Running water could be heard and was visually identified in a beck emerging from a culvert from under the access road. Whilst the beck could just be seen, it was not possible to photograph due to the vegetation. To the west of the access road into the site was an exposed paving slab beneath which was a void. Running water could also be heard from this location.

General Comments:

Consideration must be made for variations to occur in the ground conditions between the exploratory hole locations for which GEO holds no responsibility. It is therefore recommended that a "watching brief" be applied to ensure that if ground conditions appear to vary from those identified within this investigation, then advice should be sought from a suitably qualified and experienced Geo-Environmental Engineer.

The recommendations and opinions expressed in this report are based on the ground conditions observed. Consequently, GEO takes no responsibility for conditions that have not been revealed or which occur between them.

The conclusions and recommendations presented within this report are considered reasonable based on the available information. However, these cannot be guaranteed to gain regulatory approval. Therefore, the report should be passed to the appropriate regulatory authorities and/ or other key stakeholders, including warranty providers in order to seek their approval of the findings prior to undertaking any development works on site.

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If there are any queries, please do not hesitate to contact Geo-Environmental Engineering Ltd.

Yours Faithfully

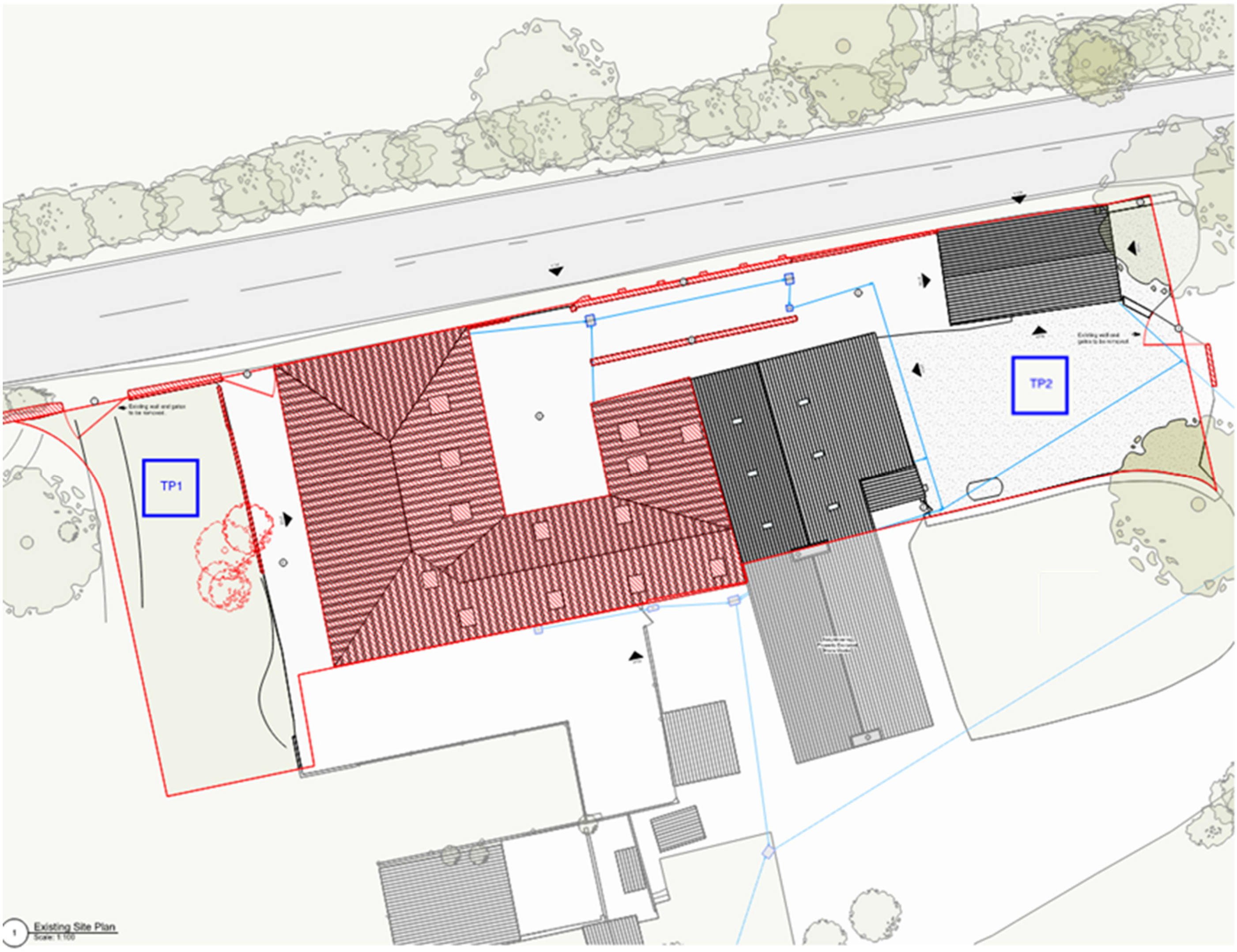
………………………………………………….
Curtis R Evans *BSc (Hons), FGS*
Director - Geo Environmental Engineering Limited
Tel: 07883 440 186

GEO Environmental Engineering Ltd
North West (Registered Office):
31 Casshow Way, Cockermouth, Cumbria CA13 9FY
North East:
Hope Street Xchange, 1-3 Hind Street, Sunderland SR1 3QD

Telephone: 07883 440 186
Email: info@geoenvironmentalengineering.com
Website: www.geoenvironmentalengineering.com
Company No.: 07180338
VAT No.: GB 986617072

GEO2023-5986: Teewood Farm Barn – Trial Pit Location Plan

(Approximate Locations – Not to Scale)



GEO2023-5986: Teewood Farm Barn – TP01

Depth From (m)	Depth To (m)	Strata Description	Legend	Testing / Samples
0.00	0.35	MADE GROUND: Grass and vegetation (unmanaged) over dark brown sandy clayey LOAM (TOPSOIL) with rare brick, tile and timber pieces. Many roots and rootlets.		
0.35	0.70	Dark brown sandy clayey LOAM (SUBSOIL).		
0.70	1.50	Soft yellow mottled brown very sandy very gravelly CLAY with cobbles.		

Log Notes:
End of trial hole at 1.50m.
Slight becoming moderate water ingress noted at c.1.00m. Rose c.0.15m in 20 minutes. Became stronger inflow as trial pit depth increased
Trial hole backfilled with arisings on completion.

Engineer: C.Evans
Site Works Date: 18/07/2023
Plant: Tracked 360 Excavator
Trial Pit Dimensions: 0.65m (W) x 1.55m (D) x 1.50m (L)

Log Key:
HSV = Hand Shear Vane (kN/m^2)
LP = Limited Penetration (HSV/CBR)
B = Bulk Bag, J = Amber Glass Jar, T = Plastic Tub

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GEO2023-5986: Teewood Farm Barn – TP02

Depth From (m)	Depth To (m)	Strata Description	Legend	Testing / Samples
0.00	0.25	MADE GROUND: Patchy vegetation (unmanaged) over thin dark brown sandy clayey LOAM (TOPSOIL) over gravel.		
0.25	1.00	Stiff dark brown slightly sandy slightly gravelly CLAY with occasional cobbles.		

Log Notes:
End of trial hole at 1.00m.
Trial pit noted as dry and stable.
Trial hole backfilled with arisings on completion.
0.25m – Black plastic pipe in edge of trial pit – damaged – c.20mm diameter, small volume of water (c.200ml), location marked at surface with blue paint upon backfilling (denoted by red ellipse).

Soil Infiltration Test:

- Water level remained static with no fall over a three-hour monitoring period. Test abandoned and treated as a fail

Engineer: C.Evans
Site Works Date: 18/07/2023
Plant: Tracked 360 Excavator
Trial Pit Dimensions: 0.65m (W) x 1.55m (D) x 1.50m (L)

Log Key:
HSV = Hand Shear Vane (kN/m^2)
LP = Limited Penetration (HSV/CBR)
B = Bulk Bag, J = Amber Glass Jar, T = Plastic Tub

Left – Start of Test
Centre – End of Test
Right – Arisings

Website: www.geoenvironmentalengineering.com
Email: info@geoenvironmentalengineering.com
Telephone: 07883 440 186

GEO2023-5986: Teewood Farm Barn – Site Works Photographs


Beck flowing south from southern site boundary near access road


Surface water from adjacent fields flowing along Freeholds Lane towards the site


Exposed paving slab with void to the west of the turning head into the adjacent property. A sound of running water could be heard


TP1 Location


TP2 Location – moved due to landscaped garden with sculpture and pond


TP2 re-location – in front of barn
Black pipe in corner of TP2. Red circles denote pipe and red line denotes route

End of Report

GEO Environmental Engineering Ltd
North West (Registered Office):
31 Casshow Way, Cockermouth, Cumbria CA13 9FY
North East:
Hope Street Xchange, 1-3 Hind Street, Sunderland SR1 3QD
Telephone: 07883 440 186
Email: info@geoenvironmentalengineering.com
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APPENDIX C

CATCHMENT PLAN

DO NOT SCALE THIS DRAWING | A1

GENERAL NOTES:

1. Before construction commences, the setting out Engineer shall ensure that all setting out information is mutually compatible with all the drawings and documents provided by the designers. Where information is apparently contradictory or ambiguous, the design Engineer and/or the Architect is to be informed immediately. Thomas Consulting will accept no liability for setting out errors where work is constructed to incorrect information.
2. All drawings and documents are to be read in conjunction with one another, are mutually compatible and shall be read as such. All documents shall be checked to ensure that they are compatible by the contractor before construction commences. In the event of apparent ambiguity or contradiction the engineer and/or architect shall be notified immediately. Thomas Consulting accept no liability in the event of not being so notified and where construction work has commenced.
3. In accordance with CDM regulations 2015 this drawing has been prepared with due attention to identifying any unusual design hazards that may exist. Unusual design hazards are hazards that a reasonably competent contractor, experienced in this type of work may not be expected to identify. In dealing with unusual design hazards we have adopted the "ERIC" principle and where possible eliminated (E) the hazard at design stage, if it has not been possible to eliminate the hazard we have endeavoured to reduce (R) it. Where it has not been possible to eliminate these hazards, the hazard is noted on the drawing with appropriate information (I) in order that the hazard can be controlled (C) during construction. It is the contractor's responsibility to fully acquaint themselves with all construction drawings before commencing construction and if in doubt about any matter to ask for clarification from the designer.
4. All drawings issued electronically for this scheme are provided for the sole purpose of assisting the design, procurement or construction of the structures for which Thomas Consulting have been appointed as Design Engineers/Consultants. They may not be used for any other purpose, nor may they be amended, copied, redistributed or issued to third parties without the written agreement of Thomas Consulting. All drawings remain under copyright to, and the intellectual property of, Thomas Consulting. Upon completion of the project, all drawings are to be deleted from your computer systems and all other electronic copies destroyed. Where electronic copies of final drawings are to be issued, these will be provided in a digital only format by Thomas Consulting (no other copies may be retained). By opening and using this drawing, it is assumed that you agree to abide by these Terms and Conditions.
5. Unless expressly agreed with a director of Thomas Consulting Ltd, for the purposes of the CDM regulations 2015 Thomas Consulting are not the Principal Designer. The client has been advised that they are required to appoint a Principal Designer. For further information see http://www.hse.gov.uk/.
6. For Typical Construction Details and Specifications please refer to Thomas Consulting Ltd drawing 300.

Key

- S100
- S101
- S200
- S300
- S401
- S400
- Permeable gravel

UC* Denotes Urban creep has been applied

REVISIONS

REV	DATE	DESCRIPTION	DRAWN BY	CHECKED BY
A	23/08/23	Updated Northern drainage network based off client feedback	CS	JP

DRAWING STATUS: FOR PLANNING

THOMAS CONSULTING
STRUCTURAL & CIVIL DESIGN ENGINEERS
Offices in Chorley, Lancaster & Shrewsbury
Tel: 01524 846022
e-mail: info@thomasconsulting.co.uk

CLIENT: MARK HURST

PROJECT: TEAWOOD FARM BARN, WADDINGTON

DRAWING TITLE: PROPOSED CATCHMENT PLAN

DATE CREATED:	DRAWING SCALE:	DRAWN BY:	CHECKED BY:	QA CATEGORY:
10/08/2023	1:100	CS	JP	

DRAWING REF: TC / L12135 / 23 / 101 | REV: A

APPENDIX D

ESTIMATED RUNOFF RATE CALCULATIONS

THOMAS CONSULTING STRUCTURAL & CIVIL DESIGN ENGINEERS

Brownfield Runoff Estimation			
Job Name:	Teewood Farm Barn		
Contract Number:	L12135	Date:	08/08/2023
Engineer:	CS	Checker:	JP

Calculation Brief

This spreadsheet has been developed to assist in estimating and documenting the brownfield runoff rates for pre-developed sites. The calculation helps demonstrate the changes a development may have on peak runoff rates and outlines any proposed restrictions for post-development runoff rates.

Information Source

This spreadhseet has been created using information obtained from CIRIA Report C753 - The SuDS Manual, V6 - 2015. Section 24.5 provides guidance on "Previously Developed Sites: Peak Runoff Rate and Runoff Volume Estimation. The calculation uses the "Modified Rational Method" to determine peak rates of runoff for different return periods.

Pre-Development Peak Runoff Rate Workings

EQ 24.5 Page 520 of the SuDS Manual: Q = 2.78 C i A

Where;

Q: Design event peak rate of runoff (l/s)

C: Non-dimensional runoff coefficient which is dependent on the catchment characteristics

i: rainfall intensity for the design return period (in mm/hr) and for a duration equal to the "time of concentration of the network

A: Total catchment area being drained (ha)

C: C is made up of the volumetric runoff coefficient Cv and routing coefficient Cr. The SuDS Manual Section 24.6.2 states the Cr should be set at 1.3, whereas the Cv can be altered between 0.8 and 1.0 depending how effectively the catchment is drained. Therefore, the Cv will be maintained as 0.9.

Cv Cr

Cv = 0.9

Cr = 1.3

i: The SuDS Manual provides an initial assessment rainfall intensity assumption, however, for conservative design the Modified Rational Method outlined in Voume 4 of the Wallingford Prodedure - HR Wallingford 1981, will be used.

M5-60 Rainfall Depth	20	mm
Ratio R	0.2	
Storm Duration	15	minutes
Duration Factor	0.53	

M1 - 15	Depth	6.5	mm	Intensity	25.9	mm/hr
M5 - 15	Depth	10.6	mm	Intensity	42.4	mm/hr
M10 - 15	Depth	13.0	mm	Intensity	51.9	mm/hr
M30 - 15	Depth	15.9	mm	Intensity	63.5	mm/hr
M100 - 15	Depth	20.4	mm	Intensity	81.7	mm/hr

A: Pre-Development Impermeable Area 0.0736 ha

Therefore;

1 Year Return Period (l/s)	6.2
30 Year Return Period (l/s)	15.2
100 Year Return Period (l/s)	19.5

THOMAS CONSULTING
STRUCTURAL & CIVIL DESIGN ENGINEERS

Brownfield Runoff Estimation			
Job Name:	Teewood Farm Barn		
Contract Number:	L12135	Date:	08/08/2023
Engineer:	CS	Checker:	JP

Post-Development Peak Runoff Rate Workings

Where;

A: Post-Development Impermeable Area 0.048 ha

Therefore;

1 Year Return Period	4.1
30 Year Return Period	9.9
100 Year Return Period	12.7

Interpolating Brownfield QBAR

Pre-Development		Reverse Ordinated RP
10 Year Return Period (l/s)	12.4	9.0
30 Year Return Period (l/s)	15.2	8.9
100 Year Return Period (l/s)	19.5	9.4
Post Development		
10 Year Return Period (l/s)	8.1	5.9
30 Year Return Period (l/s)	9.9	5.8
100 Year Return Period (l/s)	12.7	6.1

Hydrological Region 10

Estimated Brownfield QBAR Runoff Pre-Development 9.1 l/s
Estimated Brownfield QBAR Runoff Post-Development 5.9 l/s

Pre- and Post-Development Estimated Runoff Rate Summary

Pre-Development Runoff Rates			Post-Development Un-Restricted Runoff Rates			Post-Development Proposed Restricted Runoff Rate		
1 Year	6.2	l/s	1 Year	4.1	l/s	1 Year	2.1	l/s
30 Year	15.2	l/s	30 Year	9.9	l/s	30 Year	3.3	l/s
100 Year	19.5	l/s	100 Year	12.7	l/s	100 Year	3.9	l/s
100 Year + 50% CC	28.3	l/s	100 Year + 50% CC	18.5	l/s	100 Year + 50% CC	5.6	l/s

Refences

- CIRIA Report 753, The SuDS Manual, Version 6, 2015
- The Wallingford Procedure, The Modified Rational Method, Volume 4, 1981
- UK SuDS.com, HR Wallingford, Online Tools

Notes

APPENDIX E

SURFACE WATER CALCULATIONS

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	1	Maximum Rainfall (mm/hr)	50.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	England and Wales	Connection Type	Level Soffits
M5-60 (mm)	20.000	Minimum Backdrop Height (m)	0.200
Ratio-R	0.200	Preferred Cover Depth (m)	0.600
CV	0.750	Include Intermediate Ground	✓
Time of Entry (mins)	5.00	Enforce best practice design rules	✓

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
S300	0.009	5.00	189.900	450	372231.798	445476.887	0.700
S401	0.007	5.00	190.100	450	372226.408	445476.699	0.991
S400	0.003	5.00	190.200	450	372219.630	445467.191	0.700
Tank North			190.700		372223.736	445488.296	1.791
S302			190.700	450	372226.336	445489.145	1.837
Outfall North			189.950		372234.937	445473.751	1.384

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)
S3.000	S300	S401	5.393	0.600	189.200	189.109	0.091	59.3	100
S4.000	S400	S401	11.677	0.600	189.500	189.110	0.390	29.9	100
S4.001	S401	Tank North	11.901	0.600	189.109	188.909	0.200	59.5	100
S4.002	Tank North	S302	2.735	0.600	188.909	188.863	0.046	59.5	100
S4.003	S302	Outfall North	17.634	0.600	188.863	188.566	0.297	59.4	100

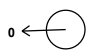
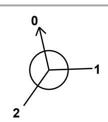
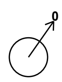
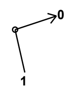
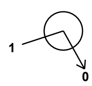
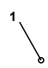
Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
S3.000	1.002	7.9	0.9	0.600	0.891	0.009	0.0	23	0.667
S4.000	1.415	11.1	0.3	0.600	0.890	0.003	0.0	11	0.602
S4.001	1.000	7.9	1.9	0.891	1.691	0.019	0.0	34	0.830
S4.002	1.001	7.9	1.9	1.691	1.737	0.019	0.0	34	0.830
S4.003	1.001	7.9	1.9	1.737	1.284	0.019	0.0	33	0.820

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
S3.000	5.393	59.3	100	Circular	189.900	189.200	0.600	190.100	189.109	0.891
S4.000	11.677	29.9	100	Circular	190.200	189.500	0.600	190.100	189.110	0.890
S4.001	11.901	59.5	100	Circular	190.100	189.109	0.891	190.700	188.909	1.691
S4.002	2.735	59.5	100	Circular	190.700	188.909	1.691	190.700	188.863	1.737
S4.003	17.634	59.4	100	Circular	190.700	188.863	1.737	189.950	188.566	1.284

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
S3.000	S300	450	Manhole	Adoptable	S401	450	Manhole	Adoptable
S4.000	S400	450	Manhole	Adoptable	S401	450	Manhole	Adoptable
S4.001	S401	450	Manhole	Adoptable	Tank North		Junction	
S4.002	Tank North		Junction		S302	450	Manhole	Adoptable
S4.003	S302	450	Manhole	Adoptable	Outfall North		Junction	

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections		Link	IL (m)	Dia (mm)
S300	372231.798	445476.887	189.900	0.700	450		0	S3.000	189.200	100
S401	372226.408	445476.699	190.100	0.991	450		1	S3.000	189.109	100
							2	S4.000	189.110	100
							0	S4.001	189.109	100
S400	372219.630	445467.191	190.200	0.700	450		0	S4.000	189.500	100
Tank North	372223.736	445488.296	190.700	1.791			1	S4.001	188.909	100
							0	S4.002	188.909	100
S302	372226.336	445489.145	190.700	1.837	450		1	S4.002	188.863	100
							0	S4.003	188.863	100
Outfall North	372234.937	445473.751	189.950	1.384			1	S4.003	188.566	100

Simulation Settings

Rainfall Methodology	FSR	Analysis Speed	Detailed
FSR Region	England and Wales	Skip Steady State	✓
M5-60 (mm)	20.000	Drain Down Time (mins)	240
Ratio-R	0.200	Additional Storage (m³/ha)	20.0
Summer CV	0.750	Check Discharge Rate(s)	x
Winter CV	0.840	Check Discharge Volume	x

Storm Durations

15	30	60	120	180	240	360	480	600	720	960	1440

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	0	0	0
30	0	0	0
100	0	0	0
100	50	0	0

Node S302 Online Orifice Control

Flap Valve	x	Design Depth (m)	0.801	Discharge Coefficient	0.600
Replaces Downstream Link	✓	Design Flow (l/s)	0.7		
Invert Level (m)	188.863	Diameter (m)	0.050		

Node Tank North Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	188.909
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	5

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	6.0	0.0	0.800	6.0	0.0	0.801	0.0	0.0

Results for 1 year Critical Storm Duration. Lowest mass balance: 95.62%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
30 minute summer	S300	18	189.224	0.024	1.0	0.0100	0.0000	OK
15 minute winter	S401	10	189.145	0.036	2.1	0.0107	0.0000	OK
15 minute summer	S400	12	189.511	0.011	0.3	0.0028	0.0000	OK
30 minute summer	Tank North	21	188.957	0.048	2.0	0.2715	0.0000	OK
30 minute winter	S302	20	188.965	0.102	2.8	0.0162	0.0000	SURCHARGED
15 minute summer	Outfall North	1	188.566	0.000	1.3	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
30 minute summer	S300	S3.000	S401	1.0	0.516	0.127	0.0105	
15 minute winter	S401	S4.001	Tank North	2.0	0.893	0.260	0.0324	
15 minute summer	S400	S4.000	S401	0.3	0.244	0.027	0.0166	
30 minute summer	Tank North	S4.002	S302	3.0	0.518	0.377	0.0151	
30 minute winter	S302	Orifice	Outfall North	1.4				1.4

Results for 30 year Critical Storm Duration. Lowest mass balance: 95.62%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	S300	10	189.240	0.040	2.5	0.0168	0.0000	OK
15 minute winter	S401	10	189.168	0.059	5.2	0.0176	0.0000	OK
15 minute winter	S400	11	189.518	0.018	0.8	0.0045	0.0000	OK
30 minute winter	Tank North	23	189.094	0.185	4.4	1.0560	0.0000	SURCHARGED
30 minute winter	S302	23	189.089	0.226	2.5	0.0359	0.0000	SURCHARGED
15 minute summer	Outfall North	1	188.566	0.000	2.1	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	S300	S3.000	S401	2.5	0.637	0.312	0.0208	
15 minute winter	S401	S4.001	Tank North	5.1	1.042	0.646	0.0746	
15 minute winter	S400	S4.000	S401	0.8	0.297	0.072	0.0329	
30 minute winter	Tank North	S4.002	S302	2.5	0.534	0.313	0.0214	
30 minute winter	S302	Orifice	Outfall North	2.3				3.5

Results for 100 year Critical Storm Duration. Lowest mass balance: 95.62%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	S300	10	189.247	0.047	3.2	0.0195	0.0000	OK
30 minute winter	S401	21	189.211	0.102	6.0	0.0306	0.0000	SURCHARGED
15 minute winter	S400	10	189.521	0.021	1.1	0.0052	0.0000	OK
30 minute winter	Tank North	24	189.169	0.260	5.7	1.4815	0.0000	SURCHARGED
30 minute winter	S302	24	189.161	0.298	2.8	0.0474	0.0000	SURCHARGED
15 minute summer	Outfall North	1	188.566	0.000	2.4	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	S300	S3.000	S401	3.2	0.665	0.403	0.0262	
30 minute winter	S401	S4.001	Tank North	5.7	0.908	0.725	0.0931	
15 minute winter	S400	S4.000	S401	1.1	0.313	0.097	0.0437	
30 minute winter	Tank North	S4.002	S302	2.8	0.568	0.363	0.0214	
30 minute winter	S302	Orifice	Outfall North	2.7				4.5

Results for 100 year +50% CC Critical Storm Duration. Lowest mass balance: 95.62%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
30 minute winter	S300	21	189.442	0.242	4.1	0.1007	0.0000	SURCHARGED
30 minute winter	S401	21	189.424	0.315	7.9	0.0945	0.0000	SURCHARGED
15 minute winter	S400	10	189.526	0.026	1.6	0.0063	0.0000	OK
60 minute winter	Tank North	43	189.338	0.429	5.5	2.4438	0.0000	SURCHARGED
60 minute winter	S302	43	189.326	0.463	3.6	0.0735	0.0000	SURCHARGED
15 minute summer	Outfall North	1	188.566	0.000	3.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
30 minute winter	S300	S3.000	S401	3.5	0.664	0.442	0.0422	
30 minute winter	S401	S4.001	Tank North	6.9	0.998	0.884	0.0931	
15 minute winter	S400	S4.000	S401	1.6	0.304	0.142	0.0549	
60 minute winter	Tank North	S4.002	S302	3.6	0.545	0.453	0.0214	
60 minute winter	S302	Orifice	Outfall North	3.5				9.7

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	1	Maximum Rainfall (mm/hr)	50.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	England and Wales	Connection Type	Level Soffits
M5-60 (mm)	20.000	Minimum Backdrop Height (m)	0.200
Ratio-R	0.200	Preferred Cover Depth (m)	1.200
CV	0.750	Include Intermediate Ground	✓
Time of Entry (mins)	5.00	Enforce best practice design rules	✓

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
S100	0.008	5.00	189.180	450	372227.703	445453.363	1.300
S101	0.017	5.00	189.050	450	372229.537	445446.265	1.300
Tank South			188.890		372230.714	445441.709	1.300
S102			188.900	600	372228.960	445438.909	1.366
S200	0.006	5.00	189.040	450	372238.455	445442.147	1.300
Outfall South			188.070		372224.633	445429.275	0.720

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)
S1.000	S100	S101	7.331	0.600	187.880	187.750	0.130	56.4	100
S1.001	S101	Tank South	4.706	0.600	187.750	187.590	0.160	29.4	100
S1.002	Tank South	S102	3.304	0.600	187.590	187.534	0.056	59.0	100
S1.003	S102	Outfall South	10.561	0.600	187.534	187.350	0.184	57.4	100
S2.000	S200	Tank South	7.753	0.600	187.740	187.590	0.150	51.7	100

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
S1.000	1.028	8.1	0.8	1.200	1.200	0.008	0.0	21	0.656
S1.001	1.428	11.2	2.6	1.200	1.200	0.025	0.0	32	1.156
S1.002	1.004	7.9	3.2	1.200	1.266	0.031	0.0	44	0.950
S1.003	1.019	8.0	3.2	1.266	0.620	0.031	0.0	44	0.964
S2.000	1.074	8.4	0.6	1.200	1.200	0.006	0.0	18	0.623

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
S1.000	7.331	56.4	100	Circular	189.180	187.880	1.200	189.050	187.750	1.200
S1.001	4.706	29.4	100	Circular	189.050	187.750	1.200	188.890	187.590	1.200
S1.002	3.304	59.0	100	Circular	188.890	187.590	1.200	188.900	187.534	1.266
S1.003	10.561	57.4	100	Circular	188.900	187.534	1.266	188.070	187.350	0.620
S2.000	7.753	51.7	100	Circular	189.040	187.740	1.200	188.890	187.590	1.200

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
S1.000	S100	450	Manhole	Adoptable	S101	450	Manhole	Adoptable
S1.001	S101	450	Manhole	Adoptable	Tank South		Junction	
S1.002	Tank South		Junction		S102	600	Manhole	Adoptable
S1.003	S102	600	Manhole	Adoptable	Outfall South		Junction	
S2.000	S200	450	Manhole	Adoptable	Tank South		Junction	

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
S100	372227.703	445453.363	189.180	1.300	450	0	S1.000	187.880	100
S101	372229.537	445446.265	189.050	1.300	450	1	S1.000	187.750	100
						0	S1.001	187.750	100
Tank South	372230.714	445441.709	188.890	1.300		1	S2.000	187.590	100
						2	S1.001	187.590	100
						0	S1.002	187.590	100
S102	372228.960	445438.909	188.900	1.366	600	1	S1.002	187.534	100
						0	S1.003	187.534	100
S200	372238.455	445442.147	189.040	1.300	450	0	S2.000	187.740	100
Outfall South	372224.633	445429.275	188.070	0.720		1	S1.003	187.350	100

Simulation Settings

Rainfall Methodology	FSR	Analysis Speed	Detailed
FSR Region	England and Wales	Skip Steady State	✓
M5-60 (mm)	20.000	Drain Down Time (mins)	240
Ratio-R	0.200	Additional Storage (m^3/ha)	20.0
Summer CV	0.750	Check Discharge Rate(s)	x
Winter CV	0.840	Check Discharge Volume	x

Storm Durations

15	30	60	120	180	240	360	480	600	720	960	1440

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	0	0	0
30	0	0	0
100	0	0	0
100	50	0	0

Node S102 Online Orifice Control

Flap Valve	x	Design Depth (m)	0.810	Discharge Coefficient	0.600
Replaces Downstream Link	✓	Design Flow (l/s)	2.0		
Invert Level (m)	187.534	Diameter (m)	0.030		

Node Tank South Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	187.590
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	184

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	22.5	0.0	0.400	22.5	0.0	0.401	0.0	0.0

Results for 1 year Critical Storm Duration. Lowest mass balance: 98.58%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	S100	10	187.902	0.022	0.9	0.0063	0.0000	OK
15 minute winter	S101	10	187.786	0.036	2.8	0.0151	0.0000	OK
120 minute winter	Tank South	84	187.680	0.090	2.5	1.9270	0.0000	OK
120 minute winter	S102	84	187.680	0.146	1.9	0.0412	0.0000	SURCHARGED
15 minute winter	S200	10	187.759	0.019	0.7	0.0048	0.0000	OK
15 minute summer	Outfall South	1	187.350	0.000	0.6	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	S100	S1.000	S101	0.9	0.462	0.108	0.0140	
15 minute winter	S101	S1.001	Tank South	2.8	1.471	0.246	0.0122	
120 minute winter	Tank South	S1.002	S102	1.9	0.330	0.239	0.0252	
120 minute winter	S102	Orifice	Outfall South	0.7				4.9
15 minute winter	S200	S2.000	Tank South	0.7	0.691	0.079	0.0176	

Results for 30 year Critical Storm Duration. Lowest mass balance: 98.58%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	S100	10	187.916	0.036	2.2	0.0100	0.0000	OK
180 minute winter	S101	132	187.857	0.107	2.4	0.0451	0.0000	SURCHARGED
180 minute winter	Tank South	132	187.856	0.266	3.0	5.6832	0.0000	SURCHARGED
180 minute winter	S102	132	187.855	0.321	1.8	0.0907	0.0000	SURCHARGED
180 minute winter	S200	132	187.856	0.116	0.6	0.0291	0.0000	SURCHARGED
15 minute summer	Outfall South	1	187.350	0.000	0.8	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	S100	S1.000	S101	2.2	0.596	0.270	0.0269	
180 minute winter	S101	S1.001	Tank South	2.4	0.998	0.214	0.0368	
180 minute winter	Tank South	S1.002	S102	1.8	0.369	0.228	0.0259	
180 minute winter	S102	Orifice	Outfall South	1.0				12.6
180 minute winter	S200	S2.000	Tank South	0.6	0.448	0.070	0.0607	

Results for 100 year Critical Storm Duration. Lowest mass balance: 98.58%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
180 minute winter	S100	132	187.959	0.079	1.0	0.0223	0.0000	OK
180 minute winter	S101	132	187.959	0.209	3.1	0.0880	0.0000	SURCHARGED
180 minute winter	Tank South	132	187.957	0.367	3.5	7.8524	0.0000	SURCHARGED
180 minute winter	S102	132	187.956	0.422	1.9	0.1193	0.0000	SURCHARGED
180 minute winter	S200	132	187.957	0.217	0.7	0.0546	0.0000	SURCHARGED
15 minute summer	Outfall South	1	187.350	0.000	0.9	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
180 minute winter	S100	S1.000	S101	1.0	0.492	0.124	0.0531	
180 minute winter	S101	S1.001	Tank South	2.9	1.021	0.258	0.0368	
180 minute winter	Tank South	S1.002	S102	1.9	0.340	0.237	0.0259	
180 minute winter	S102	Orifice	Outfall South	1.2				16.4
180 minute winter	S200	S2.000	Tank South	0.7	0.591	0.082	0.0607	

Results for 100 year +50% CC Critical Storm Duration. Lowest mass balance: 98.58%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
180 minute winter	S100	128	188.839	0.959	1.5	0.2704	0.0000	SURCHARGED
180 minute winter	S101	132	188.838	1.088	4.4	0.4581	0.0000	FLOOD RISK
180 minute winter	Tank South	132	188.834	1.244	5.2	8.5607	0.0000	FLOOD RISK
180 minute winter	S102	132	188.829	1.295	2.5	0.3664	0.0000	FLOOD RISK
180 minute winter	S200	132	188.835	1.095	1.1	0.2748	0.0000	FLOOD RISK
15 minute summer	Outfall South	1	187.350	0.000	1.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
180 minute winter	S100	S1.000	S101	1.3	0.513	0.164	0.0574	
180 minute winter	S101	S1.001	Tank South	4.2	1.067	0.379	0.0368	
180 minute winter	Tank South	S1.002	S102	2.5	0.408	0.312	0.0259	
180 minute winter	S102	Orifice	Outfall South	2.1				24.9
180 minute winter	S200	S2.000	Tank South	0.9	0.535	0.110	0.0607	

APPENDIX F

DRAINAGE LAYOUT PLAN

DO NOT SCALE THIS DRAWING — A1

GENERAL NOTES:

1. Before construction commences, the setting out Engineer shall ensure that all setting out information is mutually compatible with all the drawings and documents provided by the designers. Where information is apparently contradictory or ambiguous, the design Engineer and/or the Architect is to be informed immediately. Thomas Consulting will accept no liability for setting out errors where work is constructed to incorrect information.

2. All drawings and documents are to be read in conjunction with one another, are mutually compatible and shall be read as such. All documents shall be checked to ensure that they are compatible by the contractor before construction commences. In the event of apparent ambiguity or contradiction the engineer and/or architect shall be notified immediately. Thomas Consulting accept no liability in the event of not being so notified and where construction work has commenced.

3. In accordance with CDM regulations 2015 this drawing has been prepared with due attention to identifying any unusual design hazards that may exist. Unusual design hazards are hazards that a reasonably competent contractor, experienced in this type of work may not be expected to identify. In dealing with unusual design hazards we have adopted the "ERIC" principle and where possible eliminated (E) the hazard at design stage, if it has not been possible to eliminate the hazard we have endeavoured to reduce (R) it. Where it has not been possible to eliminate these hazards, the hazard is noted on the drawing with appropriate information (I) in order that the hazard can be controlled (C) during construction. It is the contractor's responsibility to fully acquaint themselves with all construction drawings before commencing construction and if in doubt about any matter to ask for clarification from the designer.

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Key

- Surface Water Polypropylene Inspection Chamber (PPIC)
- Surface Water Un-plasticised Poly Vinyl Chloride Pipe (PVCu)
- Perforated Filter Drain
- Foul Water Polypropylene Inspection Chamber (PPIC)
- Foul water pipe Un-plasticised Poly Vinyl Chloride Pipe (PVCu)
- Rising Main
- Existing Surface Water Culverted Watercourse
- Exceedance Route
- Geocellular Attenuation Tank
- Tricel Nova UK10 Package Treatment Plant
- Depression in ground of landscaped area
- ACO Civildrain C100 0.0 (11.00m)
- DC
- Stone Built Headwall

REVISIONS

REV	DATE	DESCRIPTION	DRAWN BY	CHECKED BY
A	23/08/23	Updated Northern drainage network based off client feedback	CS	JP
B	07/11/23	Minor updates	CS	MJ

DRAWING STATUS:
FOR PLANNING

THOMAS CONSULTING
STRUCTURAL & CIVIL DESIGN ENGINEERS
Offices in Chorley, Lancaster & Shrewsbury
Tel: 01524 846022
e-mail: info@thomasconsulting.co.uk

CLIENT:
MARK HURST

PROJECT:
TEAWOOD FARM BARN, WADDINGTON

DRAWING TITLE:
DRAINAGE LAYOUT

DATE CREATED:	DRAWING SCALE:	DRAWN BY:	CHECKED BY:	QA CATEGORY:
10/08/2023	1:100	CS	JP	

DRAWING REF:	REV:
TC / L12135 / 23 / 102	B