DRAINAGE IMPACT ASSESSMENT

FOR

PROPOSED RESEDENTIAL LIVING DEVELOPMENT

AT

LAND TO REAR OF 132 SCARBOROUGH ROAD, BRIDLINGTON, EAST YORKSHIRE.

ON BEHALF OF

H. LINFORD
J.HARRIS

Project ref:	**30047/DIA/WOB**
Date First Issued:	**17th February 2024**
Issue:	**01**
Revision Date:	**N/A**
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APPENDICES

Document Revision Box			
Revision	Date	Description	Author
01	17th February '24	First issued	WOB

1.0 Introduction

GGP Consult has been instructed by H. Linford to prepare a drainage impact assessment for the proposed residential living development on land to the rear of 132 Scarborough Road, Bridlington, East Yorkshire.

The following assessment will detail how the proposed development will drain surface and foul water from the site with consideration to the National Planning Policy Framework (NPPF).

2.0 Description of Existing Site

The site is located within Bridlington. The site is on the boundary of a residential developments & local fields.

The site has an area of 2,995m² and is partially impermeable with 2 existing building located within the boundary as well as a concrete road leading off from Scarborough Road. The site is understood that the site is currently occupied due to the existing buildings being 'garages' for neighbouring residents. The site is bound to the north & east by Local Fields, to the west & south by residential dwellings.

Approximately, the grid reference for the site is TA 17142 68490.

Refer to Appendix I for the Existing Site Location Plan.

Refer to Appendix II for the Existing Impermeable Area.

The site has an average existing level of 34.000m.

2.1 Description of Existing Site Drainage

The existing site is understood to be partially positively drained; however, the true extent of the existing drainage system is currently unknown.

It is understood that the concrete road serving the two separate garages and their associated roofs are positively drained down the concrete road into the existing systems within Scarborough Road.

Note – This is to be confirmed prior to construction allowing a full understanding of the existing system to be clarified.

Additionally, a Yorkshire Water Combined & Surface water systems are located to the southwest of the site within Scarborough Road.

3.0 Proposed Site

It is proposed to develop a Residential Living Development concluding of 4 houses. This is to be accompanied by a car park on the scheme, 2 bays per development.

The living complex will have a FFL of 33.700m AOD.

As the site doesn't comprises more than 10 dwellings, is greater than 0.5ha of developable area and has over 0.1ha in floor area, it is classified as a major development and the Lead Local Flood Authority are not required to be consulted as part of the planning process unless otherwise stated.

4.0 Design Philosophy

Part H of the Building Regulations details a preferred hierarchy for surface water disposal. Consideration should firstly be given to discharge to infiltration system, watercourse, surface water sewer & combined sewer in that priority order.

Ground investigation is to be carried out on the development, so a full understanding of the ground conditions is understood prior to construction. It is noted that the client is to undertake BRE 365 testing allowing the use of infiltration on the scheme to be investigated. Allowing this preferred option to be used or signed off as unacceptable.

The closest watercourse is located 1km to the south of the site; this has been identified as a Dyke/Ditch which runs through the town of Bridlington, which has been deemed as an unfeasible connection.

As the connection into the Dyke/Ditch located to the south of the site is unfeasible, it is proposed that the drainage system be discharged into the combined / surface water system within Scarborough Road, this is to be done through a proposed a split Foul and Surface water system. Surface water will leading into the existing 225mm Existing Yorkshire water system located within Scarborough Road. Therefore the Foul water will flow into the 200mm Combined Drain within Scarborough Road.

Therefore, it is proposed to discharge into the existing Yorkshire Water Surface/Combined water systems

5.0 Proposed Site Drainage

As mentioned within section 4.0, it is proposed to discharge into the existing Yorkshire Water surface water system within Scarborough Road (pending approval from Yorkshire Water).

It is proposed to discharge through a HydroBrake from the development at a rate of 3.5l/s.

In accordance with local drainage standards, a 40% climate change allowance will be applied to the calculations.

The existing site has an impermeable area of 2,995m² and is discharged at an unrestricted rate, note that the following discharge route is not yet finalised and fully understood, further surveys will be undertaken to understand the flow direction.

Surface water from the development is to be collected by a series of chambers, gullies and pipes where it will be brought into the landscaped area and discharged into a cellular storage system.

Surface water runoff from the hardstanding road will be collected by several gullies located in the road and discharged into a Klargester NSBP003 Bypass Separator before discharging into the proposed attenuation tank.

A Wavin AquaCell Core-R cellular storage system is to be used. This will be designed to contain 77.4m³ of runoff at 95% voids. This has been designed to contain the 1:100 year + 40% CC below ground. Refer to section 6.0 for calculation details.

The tank will discharge into a Hydro-Brake flow control chamber located to the south of the tank where the site runoff will be restricted to 3.5l/s. This is to have a design head of 0.800m AOD and to be fitted with a catchpit.

This is to discharge into a proposed surface water manhole within the site. A manhole connection will be formed into the existing 225Ø Yorkshire Water Surface Sewer located within Scarborough Road.

Refer to Appendix III for the Proposed Surface Water Drainage Layout.

Foul water from the development is to be collected through a series of soil vent pipes, sewers and manhole chambers. This will be brought to the southwest of the site where it will discharge into the proposed combined manhole located within the site. Discharging into the existing 200mm existing sewer located to the west of the development. A manhole connection will be required for this.

Refer to Appendix VI for the Proposed Foul Water Drainage Layout.

6.0 Point of Discharge

6.1 Interception Storage

a) Preliminary calculations have been undertaken in accordance with "SUDS Manual 2015, Section 24.8, simple approaches to interception delivery and compliance assessment".

The proposed site does not incorporate rainwater harvesting, infiltration, permeable paving, or other suitable SUDS components.

6.2 Water Quality

Define pollution hazard indices – see below tables

TABLE 4.3 Minimum water quality management requirements for discharges to receiving surface waters and groundwater

Land use	Pollution hazard level	Requirements for discharge to surface waters, including coasts and estuaries[2]	Requirements for discharge to groundwater
Residential roofs	Very low	Removal of gross solids and sediments only	
Individual property driveways, roofs (excluding residential), residential car parks, low traffic roads (eg cul de sacs, home zones, general access roads), non-residential car parking with infrequent change (eg schools, offices)	Low	Simple index approach[3] *Note: extra measures may be required for discharges to protected resources[1]*	
Commercial yard and delivery areas, non-residential car parking with frequent change (eg hospitals, retail), all roads except low traffic roads and trunk roads/motorways	Medium	Simple index approach[3] *Note: extra measures may be required for discharges to protected resources[1]*	Simple index approach[3] *Note: extra measures may be required for discharges to protected resources[1]* In England and Wales, Risk Screening[4] must be undertaken first to determine whether consultation with the environmental regulator is required. In Northern Ireland, the need for risk screening should be agreed with the environmental regulator.
Trunk roads and motorways	High	Follow the guidance and risk assessment process set out in HA (2009)	
Sites with heavy pollution (eg haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured, industrial sites	High	Discharges may require an environmental licence or permit[5]. Obtain pre-permitting advice from the environmental regulator. Risk assessment is likely to be required[6].	

Pollution Hazard Level is 'Low'.

TABLE 26.2 Pollution hazard indices for different land use classifications

Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydro-carbons
Residential roofs	Very low	0.2	0.2	0.05
Other roofs (typically commercial/ industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05
Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day	Low	0.5	0.4	0.4
Commercial yard and delivery areas, non-residential car parking with frequent change (eg hospitals, retail), all roads except low traffic roads and trunk roads/motorways[1]	Medium	0.7	0.6	0.7
Sites with heavy pollution (eg haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured; industrial sites; trunk roads and motorways[1]	High	0.8[2]	0.8[2]	0.9[2]

Pollution Hazard Level is 'Low'.

TABLE 26.3 Indicative SuDS mitigation indices for discharges to surface waters

	Mitigation indices[1]		
Type of SuDS component	**TSS**	**Metals**	**Hydrocarbons**
Filter strip	0.4	0.4	0.5
Filter drain	0.4[2]	0.4	0.4
Swale	0.5	0.6	0.6
Bioretention system	0.8	0.8	0.8
Permeable pavement	0.7	0.6	0.7
Detention basin	0.5	0.5	0.6
Pond[4]	0.7[3]	0.7	0.5
Wetland	0.8[3]	0.8	0.8
Proprietary treatment systems[5,6]	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the 1 in 1 year return period event, for inflow concentrations relevant to the contributing drainage area.		

As the site hardstanding is over 800m², mitigation measures are required. Therefore, the site will use a 'Proprietary treatment system'.

6.3 Peak Flow Rate & Volume Control

6.3.1 Brownfield Site

a) As existing the site is entirely brownfield.

Catchment areas can be defined as follows,

Catchment Areas

Existing

Total Existing Impermeable Area	= 375m^2
Total Existing Permeable Area	= 2,620m^2
Total Site Area	= **2,995m^2**

Proposed

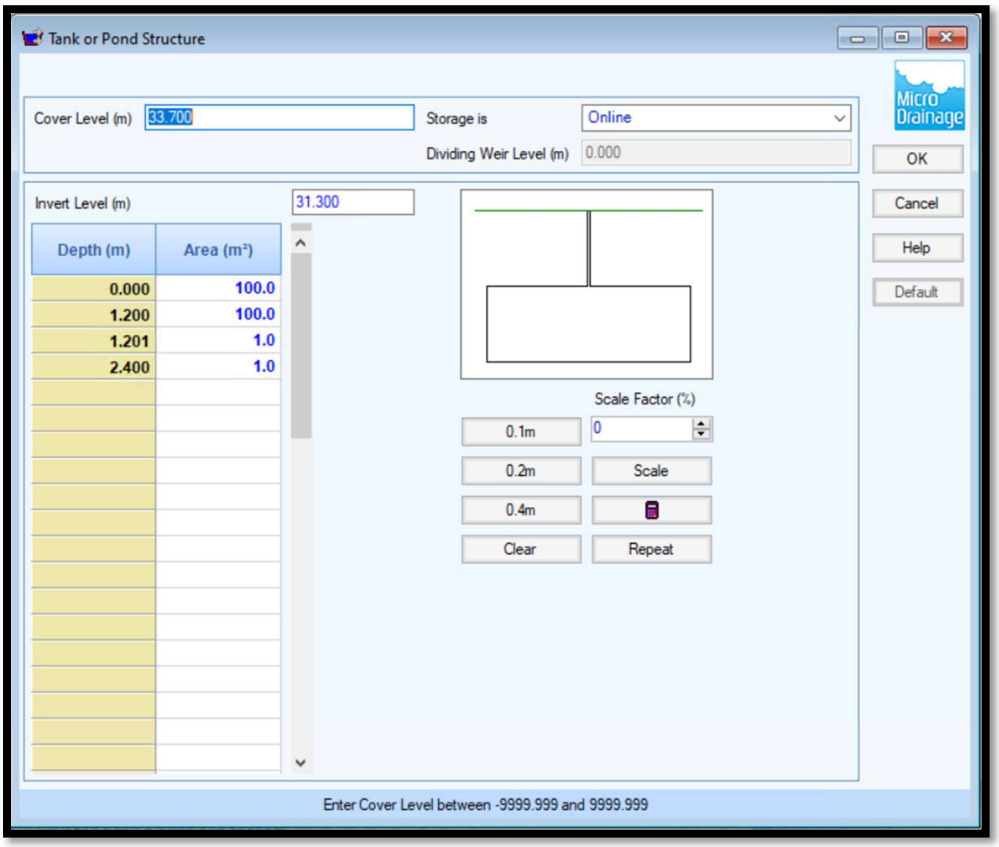
Proposed Impermeable Road Area	= 767m^2
Proposed Impermeable Building Area	= 590m^2
Proposed Impermeable Carpark Area	= 92m^2
Proposed Impermeable Patio Area	= 231m^2
Total Impermeable Area	= **1,680m^2**
Proposed Permeable Ground Area	= 1,315m^2
Total Permeable Area	= **1,315m^2**

Refer to Appendix V for the Proposed Impermeable Area Layout

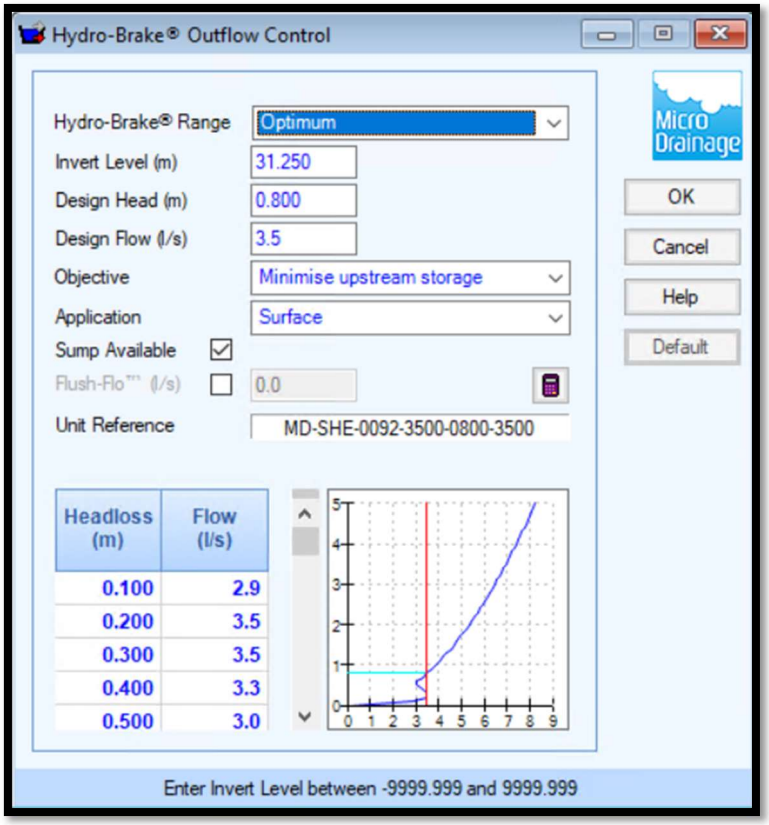
b) The following MicroDrainage output are based on a Hydrobrake set to 3.5l/s at 0.800m Head and an attenuation volume of 77.4m^3

Additional parameter within the model are;

Ground Level	= 33.700m AOD
Tank Invert Level	= 31.300m AOD
Area	= 100m^2
Length	= 8.5m
Width	= 8m
Depth	= 1.2m
Void Ratio	= 0.95%
Total Impermeable Area	= 0.168ha



Extract from Source Control – Showing Model Tank Parameters



Extract from Source Control – Showing Model Flow Control Parameters

c) The below table identifies the storage structure along with drain downtime for the 1:100 yr. 6hr event + 40% CC.

The below results are a summary taken from the MicroDrainage Model.

Structure Name	Cover Level	Max Water Level	Peak Discharge Rate (l/s)	Above Ground Flooding	Flooding Depth
SW Tank	33.700m AOD	32.016m AOD (360 Winter)	2.5l/s	0.0m³	0mm

See Appendix VI for full MicroDrainage calculations for the above.

d) The below table identifies the storage structure along with drain downtime for the 1:1 yr. event + 40% CC.

The below results are a summary taken from the MicroDrainage Model.

Structure Name	Cover Level	Max Water Level	Peak Discharge Rate (l/s)	Above Ground Flooding	Flooding Depth
SW Tank	33.700m AOD	31.460m AOD (120 Winter)	3.5l/s	0.0m³	0mm

As shown above, all flows up to and including the 1:1-year storm event can be contained below ground. See Appendix VI for full MicroDrainage calculations for the above.

e) The below table identifies the storage structure along with drain downtime for the 1:30 yr. event + 40% CC.

The below results are a summary taken from the MicroDrainage Model.

Structure Name	Cover Level	Max Water Level	Peak Discharge Rate (l/s)	Above Ground Flooding	Flooding Depth
SW Tank	33.700m AOD	31.849m AOD (180 Winter)	3.5l/s	0.0m³	0mm

As shown above, all flows up to and including the 1:30-year storm event can be contained below ground. See Appendix VII for full MicroDrainage calculations for the above.

f) The below table identifies the storage structure along with drain downtime for the 1:100 yr. event + 40% CC.

The below results are a summary taken from the MicroDrainage Model.

Structure Name	Cover Level	Max Water Level	Peak Discharge Rate (l/s)	Above Ground Flooding	Flooding Depth
SW Tank	33.700m AOD	32.074m AOD (180 Winter)	3.5l/s	0.0m³	0mm

As shown above, no above-ground flooding occurs during the 1:100 year storm event +40 CC.

Refer to Appendix VI for full MicroDrainage calculations for the above.

As shown above, all flows up to and including the 1:100 year storm event +30% CC can be contained below ground.

7.0 Construction Design Elements

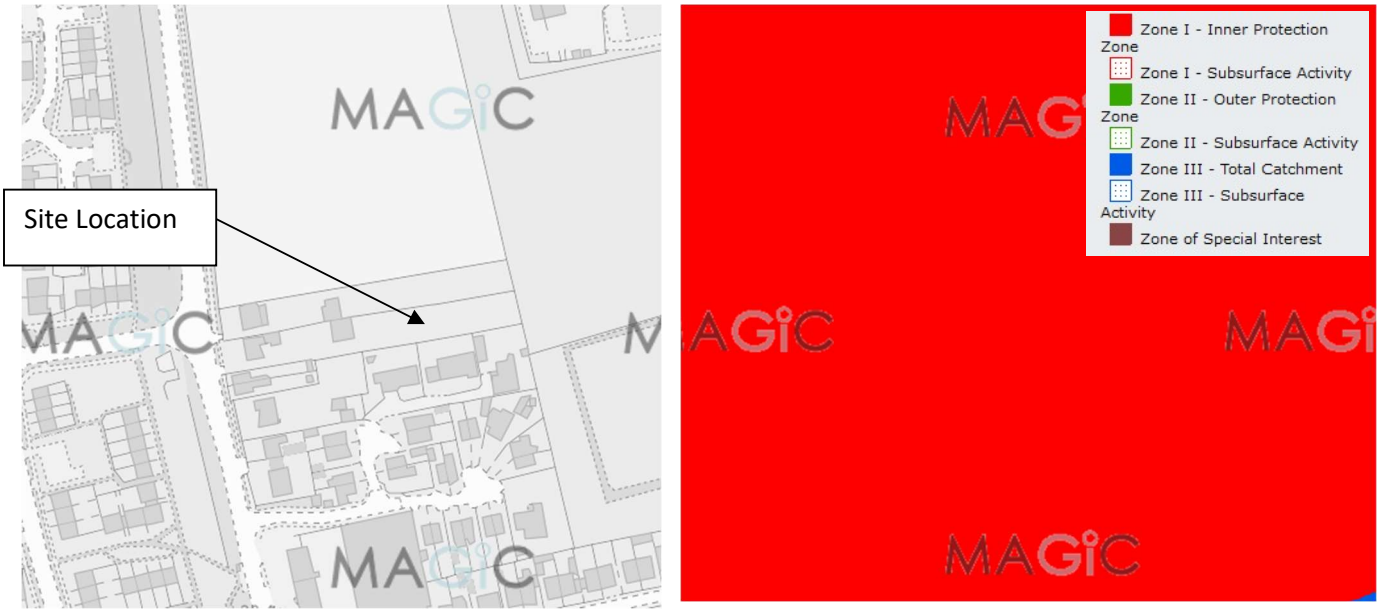
a) All chambers discharging directly to attenuation structures should be preceded by a catchpit manhole to help remove sediment prior to discharge.

b) Channel drains are to have sump units to help remove sediment prior to discharge.

c) All SUDs structures are to be lined with an impermeable geomembrane due to local ground conditions

7.1 Water Quality Treatment

As shown on the Environment Agency map below, the site is located within 'Zone 1 – Inner Protection Zone'.



7.2 Functionality of the Design

a) The client has full ownership on the land within the redline boundary. Along with the obligation to construct new access for the site.

b) Pipework is to be maintained as per manufacturer's instructions.

8.0 Maintenance

Recommendations for inspection and maintenance can be seen in the table overleaf. It is worth noting that both the drainage and highway elements of the design will remain under the ownership of the landowner who will be solely responsible for the maintenance and upkeep of these elements of the proposal.

The landowner will perform a thorough site inspection biannually and as a minimum the following maintenance item should be actioned without fail.

- Lifting of manhole lids to check flows.
- Catchpits to be emptied.
- Rodding of external pipework.

Where defects exist, maintenance will be carried out in accordance with the below maintenance schedule. In addition to this a CCTV survey of the full drainage system will be undertaken every 5 years to check the condition of the pipework

ITEM	DEFECT CHECK	DETAILED INSPECTION VISUAL INSPECTION	ACTION REQUIRED	REPLACEMENT	ADDITIONAL COMMENTS
FLOW CHECK	Surface water ponding	6months. Lifting of manhole lids to check flows.	Check downstream for blockages. Clean system and undertake CCTV survey if issues are identified	N/A	Under the maintenance responsibility of the landowner.
MANHOLE COVERS	Broken lids.	6 months.	Replace.	When broken.	Under the maintenance responsibility of the landowner.
MANHOLE	Blockages, surcharging.	6months. Lifting of manhole lids to check flows.	Check downstream for blockages. Clean system and undertake CCTV survey if issues are identified	N/A	Under the maintenance responsibility of the landowner.
INSPECTION CHAMBER	Blockages, surcharging.	6months. Lifting of manhole lids to check flows.	Check downstream for blockages. Clean system and undertake CCTV survey if issues are identified	N/A	Under the maintenance responsibility of the landowner.
SILT TRAPS/ CATCHPITS	Blockages, slit build up	6months. Lifting of manhole to check for silt.	Empty and clean sump	N/A	Under the maintenance responsibility of the landowner.
PIPEWORK	Blockages, Cracking	6 months.	Rodding required	When damaged.	Under the maintenance responsibility of the landowner.
GUTTERING	Blockages	6 months.	Cleaning and removal of debris	N/A	Under the maintenance responsibility of the landowner.
ACCESS ROAD	Surface damage	6 months.	Pressure washing of surface Surface Patching when required	When damaged. (Surfacing to be patched to original specification.)	Under the maintenance responsibility of the landowner.
GULLIES	Blockages, silt removal	Yearly	Gullies to be inspected and emptied to reduce sediment entry to the tank.	N/A	Under the maintenance responsibility of the landowner.

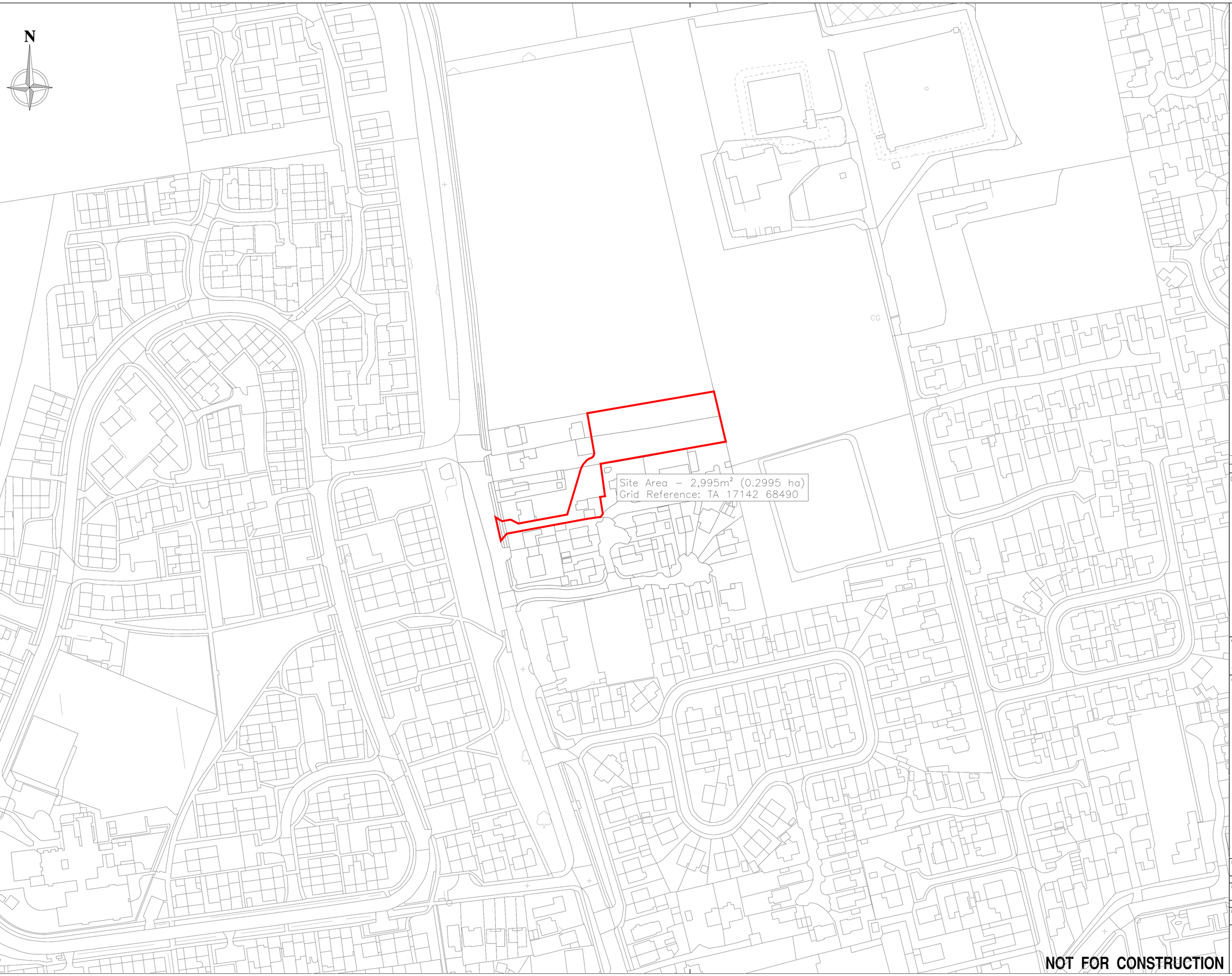
9.0 Attenuation Summary

Within section 6.3.1, various storm periods have been modelled based on outline parameters. This has resulted in a required attenuation volume to satisfy the storm events up to and including the 1:100yr storm.

From the calculations undertaken, it has been established that 77.4m³ of attenuation is required to be contained up to the 1:100yr event while maintaining a peak discharge rate no greater than 3.5l/s

APPENDIX I

Existing Site Location Plan



NOTES:-

1. All dimensions must be checked on site and not scaled from this drawing.
2. The Contractor shall make a survey of the site and shall be responsible for obtaining all dimensions and levels necessary for the proper fabrication of the structure as indicated.
3. All levels shown on this drawing are relative to Agreed Datum
4. This drawing is to be read in conjunction with 30047/100 Series Drawings.
5. All existing invert levels are to be confirmed by contractor prior to construction. Connection subject to approval.

Denotes Site Boundary Area – 2,995m²

Rev	Date	Description	DR	CH
A	15/02/24	ISSUED FOR APPROVAL	WP	JMC

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J. Harris

Job Title
Land to rear of 132,
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East Yorkshire

Drawing Title
Site Location Plan

Status
APPROVAL

Scale	Date
1:1000 @ A1	Feb' 2024

Drawn By	Checked	Approved
W. Brown	J.H.C	J.H.C

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APPENDIX II

Existing Impermeable Area

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Denotes Site Boundary Area – 2,995m²

Denotes Existing Impermeable Road Area – 309m²

Denotes Existing Impermeable Building Area – 66m²

Denotes Existing Permeable Grassed Area – 2,620m²

Proposed Total Impermeable Area – 375m²

Proposed Total Permeable Area – 2,620m²

Rev	Date	Description	DR	CH
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Land to rear of 132,
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Drawing Title
Existing Impermeable Area Plan

Status
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Scale	Date
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Drawn By	Checked	Approved
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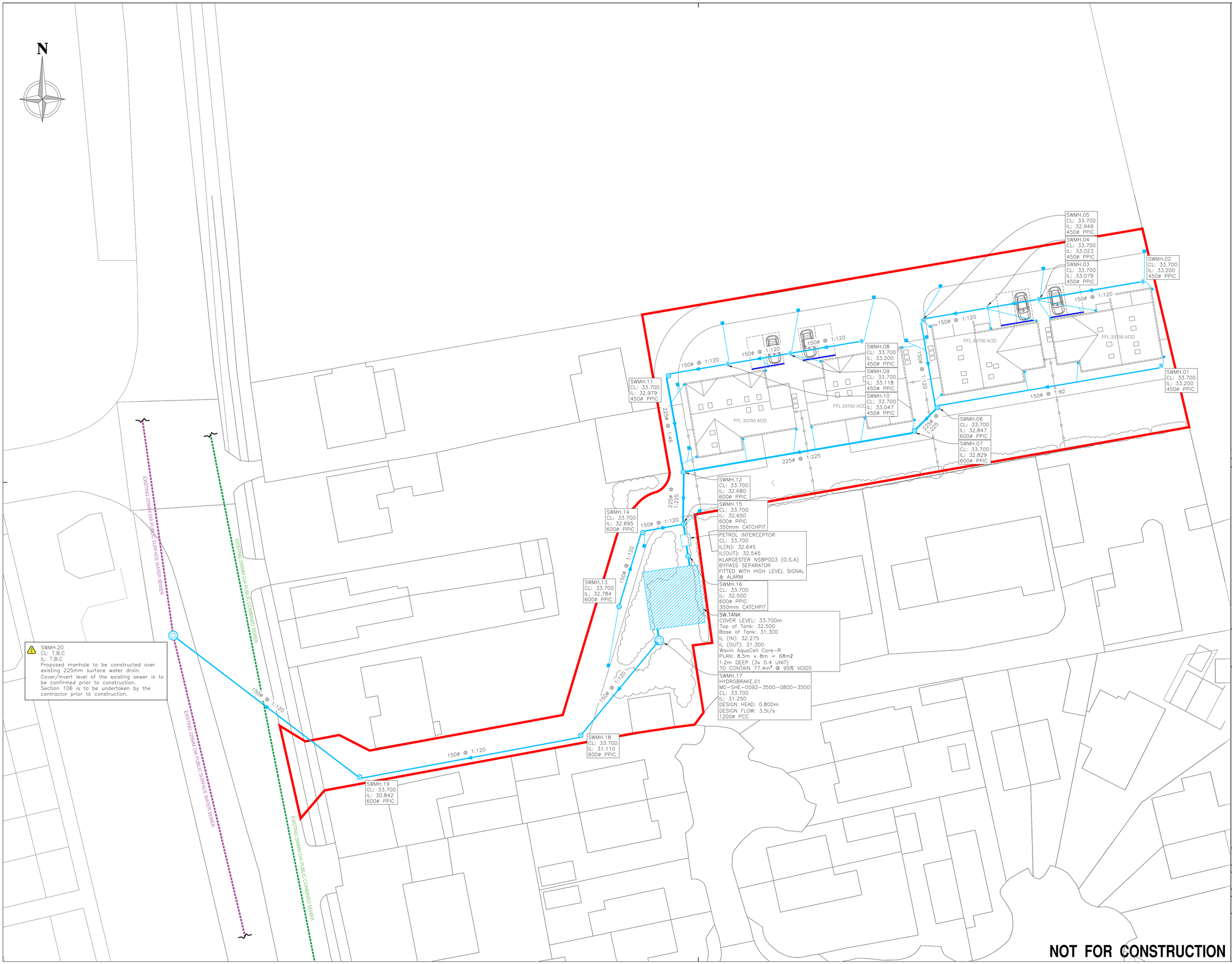
APPENDIX III

Proposed Surface Water Drainage Layout



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- Proposed Site Boundary
- Proposed Surface Water Sewer
- Proposed Surface Water Concrete Chamber
- Proposed Surface Water PPIC Chamber
- Proposed HydroBrake Chamber
- Proposed Rainwater Pipe
- Proposed Channel Drain
- Proposed Gully Drain
- Existing Surface Water Sewer

⚠ Cover Level of +33.700 has been used across the full scheme. Confirmation of proposed levels to be undertaken prior to construction

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A	15/02/24	ISSUED FOR APPROVAL	WP	JHC

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Land to rear of 132,
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Drawing Title
Proposed Surface Water Drainage Layout

Status
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Scale	Date
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Drawn By	Checked	Approved
W. Brown	J.H.C	J.H.C

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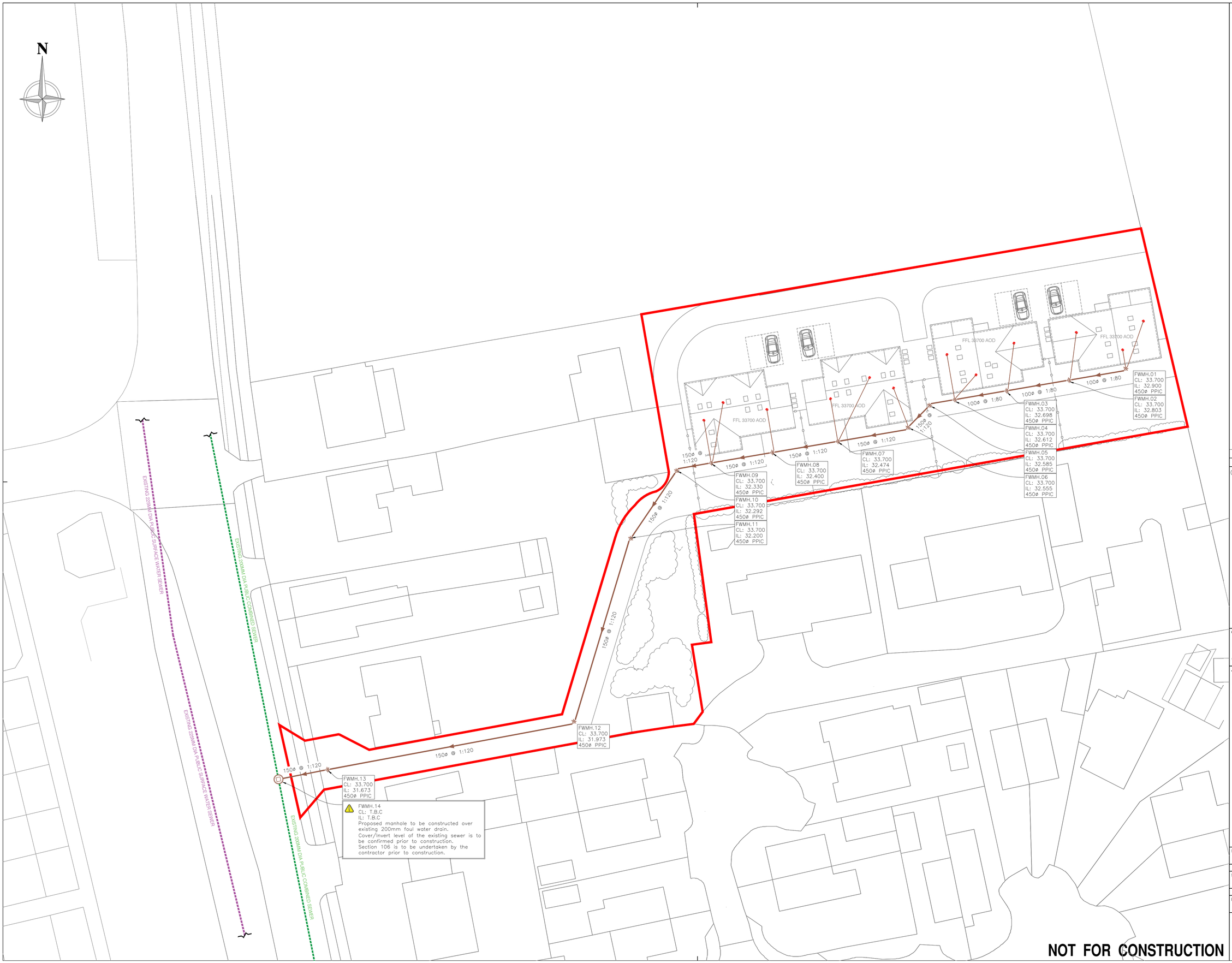
APPENDIX VI

Proposed Foul Water Drainage Layout



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- Proposed Site Boundary
- Proposed Foul Water Sewer
- Proposed Foul Water Concrete Chamber
- Proposed Foul Water PPIC Chamber
- Proposed Soil Vent Pipe
- Existing Combined Water Sewer

⚠ Cover Level of +33.700 has been used across the full scheme. Confirmation of proposed levels to be undertaken prior to construction

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Drawn By	Checked	Approved
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30047 / 104	A

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APPENDIX V

Proposed Impermeable Area Layout

FFL 33700 AOD

FFL 33700 AOD

FFL 33700 AOD

FFL 33700 AOD

NOTES:-

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Denotes Site Boundary Area – 2,995m²

Denotes Proposed Impermeable Road Area – 767m²

Denotes Proposed Impermeable Building Area – 590m²

Denotes Proposed Impermeable Carpark Area – 92m²

Denotes Proposed Impermeable Patio Area – 231m²

Denotes Proposed Permeable Grassed Area – 1,315m²

Proposed Total Impermeable Area – 1,680m²

Proposed Total Permeable Area – 1,315m²

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W. Brown	J.H.C	J.H.C

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APPENDIX VI

1:100 Year Storm Event +40% CC (3.5l/s)

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	31.681	0.381	3.5	38.1	O K
30 min Summer	31.800	0.500	3.5	50.0	O K
60 min Summer	31.904	0.604	3.5	60.4	O K
120 min Summer	31.964	0.664	3.5	66.4	O K
180 min Summer	31.963	0.663	3.5	66.3	O K
240 min Summer	31.948	0.648	3.5	64.8	O K
360 min Summer	31.919	0.619	3.5	61.9	O K
480 min Summer	31.888	0.588	3.5	58.8	O K
600 min Summer	31.857	0.557	3.5	55.7	O K
720 min Summer	31.824	0.524	3.5	52.4	O K
960 min Summer	31.752	0.452	3.5	45.2	O K
1440 min Summer	31.620	0.320	3.5	32.0	O K
2160 min Summer	31.483	0.183	3.5	18.3	O K
2880 min Summer	31.406	0.106	3.4	10.6	O K
4320 min Summer	31.351	0.051	2.9	5.1	O K
5760 min Summer	31.332	0.032	2.4	3.2	O K
7200 min Summer	31.322	0.022	2.0	2.2	O K
8640 min Summer	31.315	0.015	1.7	1.5	O K
10080 min Summer	31.310	0.010	1.5	1.0	O K
15 min Winter	31.731	0.431	3.5	43.1	O K
30 min Winter	31.867	0.567	3.5	56.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	132.507	0.0	41.6	21
30 min Summer	88.791	0.0	55.9	36
60 min Summer	56.713	0.0	71.4	64
120 min Summer	34.923	0.0	87.9	122
180 min Summer	25.885	0.0	97.8	168
240 min Summer	20.787	0.0	104.7	196
360 min Summer	15.281	0.0	115.4	262
480 min Summer	12.263	0.0	123.6	332
600 min Summer	10.330	0.0	130.1	402
720 min Summer	8.975	0.0	135.6	472
960 min Summer	7.181	0.0	144.7	606
1440 min Summer	5.235	0.0	158.3	850
2160 min Summer	3.809	0.0	172.7	1192
2880 min Summer	3.035	0.0	183.5	1528
4320 min Summer	2.200	0.0	199.5	2208
5760 min Summer	1.749	0.0	211.5	2936
7200 min Summer	1.464	0.0	221.3	3672
8640 min Summer	1.267	0.0	229.8	4400
10080 min Summer	1.121	0.0	237.2	5136
15 min Winter	132.507	0.0	46.7	21
30 min Winter	88.791	0.0	62.6	35

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	31.988	0.688	3.5	68.8	O K
120 min Winter	32.068	0.768	3.5	76.8	O K
180 min Winter	32.074	0.774	3.5	77.4	O K
240 min Winter	32.055	0.755	3.5	75.5	O K
360 min Winter	32.016	0.716	3.5	71.6	O K
480 min Winter	31.972	0.672	3.5	67.2	O K
600 min Winter	31.925	0.625	3.5	62.5	O K
720 min Winter	31.877	0.577	3.5	57.7	O K
960 min Winter	31.771	0.471	3.5	47.1	O K
1440 min Winter	31.565	0.265	3.5	26.5	O K
2160 min Winter	31.401	0.101	3.4	10.1	O K
2880 min Winter	31.352	0.052	3.0	5.2	O K
4320 min Winter	31.327	0.027	2.2	2.7	O K
5760 min Winter	31.315	0.015	1.7	1.5	O K
7200 min Winter	31.308	0.008	1.5	0.8	O K
8640 min Winter	31.303	0.003	1.3	0.3	O K
10080 min Winter	31.300	0.000	1.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	56.713	0.0	80.0	64
120 min Winter	34.923	0.0	98.5	120
180 min Winter	25.885	0.0	109.6	174
240 min Winter	20.787	0.0	117.2	222
360 min Winter	15.281	0.0	129.3	278
480 min Winter	12.263	0.0	138.4	358
600 min Winter	10.330	0.0	145.8	434
720 min Winter	8.975	0.0	152.0	510
960 min Winter	7.181	0.0	162.1	662
1440 min Winter	5.235	0.0	177.3	888
2160 min Winter	3.809	0.0	193.4	1196
2880 min Winter	3.035	0.0	205.5	1500
4320 min Winter	2.200	0.0	223.5	2204
5760 min Winter	1.749	0.0	236.9	2936
7200 min Winter	1.464	0.0	247.8	3672
8640 min Winter	1.267	0.0	257.4	4408
10080 min Winter	1.121	0.0	265.7	0

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.355	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.168

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.084	4	8	0.084

Model Details

Storage is Online Cover Level (m) 33.700

Tank or Pond Structure

Invert Level (m) 31.300

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	100.0	1.200	100.0	1.201	1.0	2.400	1.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0092-3500-0800-3500
Design Head (m)	0.800
Design Flow (l/s)	3.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	92
Invert Level (m)	31.250
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.800	3.5
Flush-Flo™	0.238	3.5
Kick-Flo®	0.521	2.9
Mean Flow over Head Range	-	3.0

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	2.9	1.200	4.2	3.000	6.5	7.000	9.7
0.200	3.5	1.400	4.5	3.500	7.0	7.500	10.0
0.300	3.5	1.600	4.8	4.000	7.4	8.000	10.3
0.400	3.3	1.800	5.1	4.500	7.8	8.500	10.6
0.500	3.0	2.000	5.3	5.000	8.2	9.000	10.9
0.600	3.1	2.200	5.6	5.500	8.6	9.500	11.2
0.800	3.5	2.400	5.8	6.000	9.0		
1.000	3.9	2.600	6.0	6.500	9.3		

APPENDIX VII

1:30 Year Storm Event +40% CC (3.5l/s)

Summary of Results for 30 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	31.586	0.286	3.5	28.6	O K
30 min Summer	31.668	0.368	3.5	36.8	O K
60 min Summer	31.736	0.436	3.5	43.6	O K
120 min Summer	31.770	0.470	3.5	47.0	O K
180 min Summer	31.763	0.463	3.5	46.3	O K
240 min Summer	31.748	0.448	3.5	44.8	O K
360 min Summer	31.717	0.417	3.5	41.7	O K
480 min Summer	31.685	0.385	3.5	38.5	O K
600 min Summer	31.654	0.354	3.5	35.4	O K
720 min Summer	31.623	0.323	3.5	32.3	O K
960 min Summer	31.566	0.266	3.5	26.6	O K
1440 min Summer	31.475	0.175	3.5	17.5	O K
2160 min Summer	31.394	0.094	3.4	9.4	O K
2880 min Summer	31.358	0.058	3.1	5.8	O K
4320 min Summer	31.333	0.033	2.4	3.3	O K
5760 min Summer	31.321	0.021	2.0	2.1	O K
7200 min Summer	31.313	0.013	1.7	1.3	O K
8640 min Summer	31.308	0.008	1.5	0.8	O K
10080 min Summer	31.304	0.004	1.3	0.4	O K
15 min Winter	31.625	0.325	3.5	32.5	O K
30 min Winter	31.720	0.420	3.5	42.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	102.243	0.0	32.1	21
30 min Summer	67.875	0.0	42.7	35
60 min Summer	43.136	0.0	54.3	64
120 min Summer	26.588	0.0	67.0	120
180 min Summer	19.796	0.0	74.7	154
240 min Summer	15.981	0.0	80.4	182
360 min Summer	11.821	0.0	89.2	248
480 min Summer	9.531	0.0	96.0	314
600 min Summer	8.060	0.0	101.5	380
720 min Summer	7.026	0.0	106.1	446
960 min Summer	5.653	0.0	113.9	572
1440 min Summer	4.155	0.0	125.6	810
2160 min Summer	3.050	0.0	138.3	1148
2880 min Summer	2.447	0.0	147.9	1476
4320 min Summer	1.792	0.0	162.5	2204
5760 min Summer	1.436	0.0	173.6	2936
7200 min Summer	1.209	0.0	182.7	3672
8640 min Summer	1.051	0.0	190.6	4400
10080 min Summer	0.933	0.0	197.5	5120
15 min Winter	102.243	0.0	36.0	21
30 min Winter	67.875	0.0	47.9	35

Summary of Results for 30 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	31.804	0.504	3.5	50.4	O K
120 min Winter	31.849	0.549	3.5	54.9	O K
180 min Winter	31.845	0.545	3.5	54.5	O K
240 min Winter	31.826	0.526	3.5	52.6	O K
360 min Winter	31.785	0.485	3.5	48.5	O K
480 min Winter	31.732	0.432	3.5	43.2	O K
600 min Winter	31.679	0.379	3.5	37.9	O K
720 min Winter	31.629	0.329	3.5	32.9	O K
960 min Winter	31.540	0.240	3.5	24.0	O K
1440 min Winter	31.418	0.118	3.4	11.8	O K
2160 min Winter	31.352	0.052	2.9	5.2	O K
2880 min Winter	31.333	0.033	2.4	3.3	O K
4320 min Winter	31.316	0.016	1.8	1.6	O K
5760 min Winter	31.308	0.008	1.4	0.8	O K
7200 min Winter	31.302	0.002	1.2	0.2	O K
8640 min Winter	31.300	0.000	1.0	0.0	O K
10080 min Winter	31.300	0.000	0.9	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	43.136	0.0	60.8	62
120 min Winter	26.588	0.0	74.9	118
180 min Winter	19.796	0.0	83.7	172
240 min Winter	15.981	0.0	90.1	196
360 min Winter	11.821	0.0	100.0	274
480 min Winter	9.531	0.0	107.6	346
600 min Winter	8.060	0.0	113.7	414
720 min Winter	7.026	0.0	118.9	480
960 min Winter	5.653	0.0	127.6	606
1440 min Winter	4.155	0.0	140.7	826
2160 min Winter	3.050	0.0	154.9	1128
2880 min Winter	2.447	0.0	165.7	1476
4320 min Winter	1.792	0.0	182.0	2204
5760 min Winter	1.436	0.0	194.4	2928
7200 min Winter	1.209	0.0	204.7	3672
8640 min Winter	1.051	0.0	213.5	0
10080 min Winter	0.933	0.0	221.3	0

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.355	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.168

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.084	4	8	0.084

Model Details

Storage is Online Cover Level (m) 33.700

Tank or Pond Structure

Invert Level (m) 31.300

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	100.0	1.200	100.0	1.201	1.0	2.400	1.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0092-3500-0800-3500
Design Head (m)	0.800
Design Flow (l/s)	3.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	92
Invert Level (m)	31.250
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.800	3.5
Flush-Flo™	0.238	3.5
Kick-Flo®	0.521	2.9
Mean Flow over Head Range	-	3.0

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	2.9	1.200	4.2	3.000	6.5	7.000	9.7
0.200	3.5	1.400	4.5	3.500	7.0	7.500	10.0
0.300	3.5	1.600	4.8	4.000	7.4	8.000	10.3
0.400	3.3	1.800	5.1	4.500	7.8	8.500	10.6
0.500	3.0	2.000	5.3	5.000	8.2	9.000	10.9
0.600	3.1	2.200	5.6	5.500	8.6	9.500	11.2
0.800	3.5	2.400	5.8	6.000	9.0		
1.000	3.9	2.600	6.0	6.500	9.3		

APPENDIX VIII

1:1 Year Storm Event +40% CC (3.5l/s)

Summary of Results for 1 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	31.403	0.103	3.4	10.3	O K
30 min Summer	31.425	0.125	3.4	12.5	O K
60 min Summer	31.439	0.139	3.5	13.9	O K
120 min Summer	31.441	0.141	3.5	14.1	O K
180 min Summer	31.435	0.135	3.5	13.5	O K
240 min Summer	31.427	0.127	3.4	12.7	O K
360 min Summer	31.409	0.109	3.4	10.9	O K
480 min Summer	31.392	0.092	3.3	9.2	O K
600 min Summer	31.379	0.079	3.3	7.9	O K
720 min Summer	31.368	0.068	3.2	6.8	O K
960 min Summer	31.353	0.053	3.0	5.3	O K
1440 min Summer	31.336	0.036	2.5	3.6	O K
2160 min Summer	31.322	0.022	2.0	2.2	O K
2880 min Summer	31.314	0.014	1.7	1.4	O K
4320 min Summer	31.305	0.005	1.3	0.5	O K
5760 min Summer	31.300	0.000	1.1	0.0	O K
7200 min Summer	31.300	0.000	0.9	0.0	O K
8640 min Summer	31.300	0.000	0.8	0.0	O K
10080 min Summer	31.300	0.000	0.7	0.0	O K
15 min Winter	31.417	0.117	3.4	11.7	O K
30 min Winter	31.445	0.145	3.5	14.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	41.703	0.0	13.1	19
30 min Summer	27.689	0.0	17.4	31
60 min Summer	17.920	0.0	22.5	48
120 min Summer	11.387	0.0	28.6	84
180 min Summer	8.699	0.0	32.8	118
240 min Summer	7.177	0.0	36.2	152
360 min Summer	5.419	0.0	40.9	216
480 min Summer	4.438	0.0	44.7	278
600 min Summer	3.801	0.0	47.8	338
720 min Summer	3.350	0.0	50.6	396
960 min Summer	2.744	0.0	55.3	514
1440 min Summer	2.074	0.0	62.7	754
2160 min Summer	1.564	0.0	70.9	1108
2880 min Summer	1.281	0.0	77.4	1472
4320 min Summer	0.968	0.0	87.8	2204
5760 min Summer	0.794	0.0	96.0	0
7200 min Summer	0.680	0.0	102.8	0
8640 min Summer	0.598	0.0	108.5	0
10080 min Summer	0.536	0.0	113.5	0
15 min Winter	41.703	0.0	14.7	19
30 min Winter	27.689	0.0	19.5	31

Summary of Results for 1 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	31.460	0.160	3.5	16.0	O K
120 min Winter	31.460	0.160	3.5	16.0	O K
180 min Winter	31.448	0.148	3.5	14.8	O K
240 min Winter	31.433	0.133	3.5	13.3	O K
360 min Winter	31.404	0.104	3.4	10.4	O K
480 min Winter	31.380	0.080	3.3	8.0	O K
600 min Winter	31.362	0.062	3.2	6.2	O K
720 min Winter	31.352	0.052	2.9	5.2	O K
960 min Winter	31.338	0.038	2.5	3.7	O K
1440 min Winter	31.322	0.022	2.0	2.2	O K
2160 min Winter	31.310	0.010	1.5	1.0	O K
2880 min Winter	31.303	0.003	1.3	0.3	O K
4320 min Winter	31.300	0.000	1.0	0.0	O K
5760 min Winter	31.300	0.000	0.8	0.0	O K
7200 min Winter	31.300	0.000	0.7	0.0	O K
8640 min Winter	31.300	0.000	0.6	0.0	O K
10080 min Winter	31.300	0.000	0.5	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	17.920	0.0	25.3	52
120 min Winter	11.387	0.0	32.1	90
180 min Winter	8.699	0.0	36.8	128
240 min Winter	7.177	0.0	40.4	162
360 min Winter	5.419	0.0	45.9	228
480 min Winter	4.438	0.0	50.0	290
600 min Winter	3.801	0.0	53.6	344
720 min Winter	3.350	0.0	56.7	404
960 min Winter	2.744	0.0	61.9	522
1440 min Winter	2.074	0.0	70.2	756
2160 min Winter	1.564	0.0	79.4	1112
2880 min Winter	1.281	0.0	86.8	1496
4320 min Winter	0.968	0.0	98.3	0
5760 min Winter	0.794	0.0	107.6	0
7200 min Winter	0.680	0.0	115.2	0
8640 min Winter	0.598	0.0	121.5	0
10080 min Winter	0.536	0.0	127.1	0

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.355	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.168

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.084	4	8	0.084

Model Details

Storage is Online Cover Level (m) 33.700

Tank or Pond Structure

Invert Level (m) 31.300

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	100.0	1.200	100.0	1.201	1.0	2.400	1.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0092-3500-0800-3500
Design Head (m)	0.800
Design Flow (l/s)	3.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	92
Invert Level (m)	31.250
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.800	3.5
Flush-Flo™	0.238	3.5
Kick-Flo®	0.521	2.9
Mean Flow over Head Range	-	3.0

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	2.9	1.200	4.2	3.000	6.5	7.000	9.7
0.200	3.5	1.400	4.5	3.500	7.0	7.500	10.0
0.300	3.5	1.600	4.8	4.000	7.4	8.000	10.3
0.400	3.3	1.800	5.1	4.500	7.8	8.500	10.6
0.500	3.0	2.000	5.3	5.000	8.2	9.000	10.9
0.600	3.1	2.200	5.6	5.500	8.6	9.500	11.2
0.800	3.5	2.400	5.8	6.000	9.0		
1.000	3.9	2.600	6.0	6.500	9.3		