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Your ref:

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**Drainage Calculations for:
ECS Capital Ltd**

**For
Proposed Development
At
Greenwood Rd/ Gladeside Rd
Wythenshawe
Manchester
M22 9RA**

Company Reg No. 07280496

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Construction (Design & Management) Regulations 2015.

Under the C(D&M) Regs the designer's responsibility is limited to the reasonably foreseeable risks to persons involved in the construction, maintenance and repair of a structure from hazards that arise from the design. Therefore, this DRA only assesses the possible hazards that may arise from the specific structural design at this stage of the project. Should any alterations to the structure be carried out without the knowledge of the designer then no responsibility can be attributed.

It is the Contractors responsibility to use this document for the construction and future maintenance of the building as designed at this stage. This is not a Method Statement.

Under the C(D&M) Regulations 2015 it is the client's responsibility to ensure that every person designing the structure and every contractor who has been or may be appointed to work on the project is promptly provided with sufficient pre-construction information to ensure so far as is reasonably practicable the health and safety of all persons engaged in the construction work, liable to be affected by the way in which it is carried out, and who will use the structure in future.

Designers Risk Analysis.

Considerations to be given are:

During initial construction.

Noise and vibrations. Not only consider the effects these may have on workers but also neighbours.

Contamination. Where ground may be contaminated may need to consider substructure works that do not allow leaching through surface etc.

Falls from height, generally over 2m. These include around edges of deep excavations, upper floor and roof edges.

Collapse of the structure under both temporary and permanent imposed loads.

Handling of structural elements. Consideration must be given to the weight of elements specified and whether mechanical handling is feasible. Otherwise consider splicing beams and columns etc or the use of lightweight masonry if acceptable.

Fire. Although on site welding may be necessary, using this near combustible materials is not wise.

Long term.

Falls from height, generally over 2m. Consideration should be given for the future maintenance of the building such as ladder restraint to upper walls.

Collapse of the structure under the permanent imposed loads. The structural elements should be clearly marked on the drawings.

Standard documents.

Documents used:

Building Regulation Approved Documents	Part A	Structure
	Part B	Fire
	Part C	Site Preparation
	Part H	Drainage
British Codes of Practice	BS8110 Part 1	Concrete
	BS5950 Part 1	Steel
	BS5628 Part	Unreinforced masonry
	BS5977	Lintel design
	BS5268 Part	Timber
	BS6399 Parts	Dead & Imposed loads
Euro Codes	EC1	Actions on structures
	EC2	Concrete design
	EC3	Steel Design
	EC5	Timber design
	EC6	Masonry design
NHBC Standards 2011	Chapter 4.3	Building near Trees

BELOW GROUND DRAINAGE DESIGN.

Surface Water Drainage Design.

Construction of a new apartment building on the site of a former public house.

The apartment building comprises ground floor carparking and 40 number one and two bedroom apartments over three floors. The property is to be constructed with a steel frame and transfer slab at first floor level with timber framed brick clad structure above.

The management of surface water has been considered in respect of the SuDS Hierarchy (below, as detailed in Building Regulations Part H and CIRIA 753- The SuDSManual , section 3.2.3)

The SuDS Hierarchy

	SuDS technique	Flood Reduction	Pollution Reduction	Landscape & Wildlife Benefit
 Most Sustainable	Living roofs	✓	✓	✓
	Basins and ponds - Constructed wetlands - Balancing ponds - Detention basins - Retention ponds	✓	✓	✓
	Filter strips and swales	✓	✓	✓
	Infiltration devices - soakaways - infiltration trenches and basins	✓	✓	✓
	Permeable surfaces and filter drains - gravelled areas - solid paving blocks - porous paviers	✓	✓	
	Tanked systems - over-sized pipes/tanks - storm cells	✓		
	Least Sustainable			

SuDS Drainage Hierarchy				
			Suitability	Comment
	1	Infiltration		Due to the Impermeable nature of the subsoil (Impermeable Clay/ cohesive Subsoil proved by site investigations on site)
	2	Discharge to surface water		There are no surface water features within close proximity of the site.
	3	Discharge to surface water Sewer, Highways Drain or other surface water drainage system	X	Allow for attenuation system and discharge surface water into the 375 dia surface water sewer in Greatfield Rd at a rate of 5l/sec (as agreed with United Utilities plc- E mail 28-3-19)
	4	Discharge to combined Sewer		N/A
	5	Discharge to a foul sewer (should not be considered as a possible option		N/A

Drainage Design

The approximate area of the original public house was **312m²**

The new residential development has a total roof and terrace area of **1550m²**

External paths and hardstanding is to be of permeable paving.

Design the surface water drainage to allow for 1 year/ 30 year and 100year storm return periods with a storm duration of 15 min/ 30 min/ 60 min and allow for **40% climate change increase**.

Due to the impermeable nature of the subsoil allow for attenuations tanks with a restricted discharge to the adopted sewers at a rate equivalent to that from the original building with a maximum discharge of 5l/sec (as advised by United Utilities PLC).

Consider the building roof and terrace area as a whole served by attenuation tanks along each side of the building and below the garden terrace.

Consider total impermeable surface area for the building = **1550m²**

Checking the overall run off from the new building and the original building .

Consider	1 year storm over duration of	15min
		30min
		60min
	30 year storm over duration of	15min
		30min
		60min
	100year storm over duration of	15min
		30min
		60min

Allow for a climate change increase of 40%

Analysing these cases, the flow rates for the new building (1550m²- Total area) are:

1 year storm	15.1l/s,	9.9l/s	&	6.5l/s
30 year storm	37.0l/s,	23.8l/s	&	15.0l/s
100 year storm	48.3l/s,	31.3l/s	&	16.9l/s respectively.

100 year storm/ 15 min duration Design Rainfall calculations

DESIGN RAINFALL

In accordance with the Wallingford Procedure

Tedds calculation version 2.0.00

Design rainfall intensity

Location of catchment area;	Manchester
Storm duration;	D = 15 min
Return period;	Period = 100 yr
Ratio 60 min to 2 day rainfall of 5 yr return period;	r = 0.360
5-year return period rainfall of 60 minutes duration;	M5_60min = 18.0 mm
Increase of rainfall intensity due to global warming;	p _{climate} = 40 %
Factor Z1 (Wallingford procedure);	Z1 = 0.62
Rainfall for 15min storm with 5 year return period;	M5_15min _i = Z1 × M5_60min × (1 + p _{climate}) = 15.6 mm
Factor Z2 (Wallingford procedure);	Z2 = 1.99
Rainfall for 15min storm with 100 year return period;	M100_15min = Z2 × M5_15min _i = 31.2 mm
Design rainfall intensity;	I _{max} = M100_15min / D = 124.7 mm/hr

Maximum surface water runoff

Catchment area;	A _{catch} = 1550 m ²
Percentage of area that is impermeable;	p = 90 %
Maximum surface water runoff;	Q _{max} = A _{catch} × p × I _{max} = 48.3 l/s

**100 year storm/ 15 min duration Design Rainfall calculations
for original building (312m²) without climate change increase**

DESIGN RAINFALL

In accordance with the Wallingford Procedure

Tedds calculation version 2.0.00

Design rainfall intensity

Location of catchment area	Manchester
Storm duration	D = 15 min
Return period	Period = 100 yr
Ratio 60 min to 2 day rainfall of 5 yr return period	r = 0.360
5-year return period rainfall of 60 minutes duration	M5_60min = 18.0 mm
Increase of rainfall intensity due to global warming	p _{climate} = 0 %
Factor Z1 (Wallingford procedure)	Z1 = 0.62
Rainfall for 15min storm with 5 year return period	M5_15min _i = Z1 × M5_60min = 11.2 mm
Factor Z2 (Wallingford procedure)	Z2 = 1.93
Rainfall for 15min storm with 100 year return period	M100_15min = Z2 × M5_15min _i = 21.5 mm
Design rainfall intensity	I _{max} = M100_15min / D = 86.1 mm/hr

Maximum surface water runoff

Catchment area	A _{catch} = 312 m ²
Percentage of area that is impermeable	p = 90 %
Maximum surface water runoff	Q _{max} = A _{catch} × p × I _{max} = 6.7 l/s

Maximum discharge from the original public house (without an increase for climate change) is 6.7 l/sec. therefore the existing branch drain should be suitable for the proposed discharge from the site and into the adopted combined sewer.

Based on the United Utilities Pre-Development Advice provide a Hydro-brake flow restrictor with a maximum flow of 5L/sec to control/ restrict the discharge rate into the existing 375mm diameter surface water sewer in Greatfield Road

ATTENUATION DESIGN

In accordance with CIRIA publication C753 - The SUDS Manual

Tedds calculation version 1.0.03

EA Defra method

Site characteristics

Location;	Manchester
Hydrological region;	10
Soil type (Wallingford Procedure W.R.A.P map);	3
Standard percentage runoff;	SPR = 0.37
Average annual rainfall;	SAAR = 880 mm
5 year return period rainfall of 60 minute duration;	M5_60min = 18.0 mm
Ratio 60-minute to 2 day rainfalls of 5 year return;	r = 0.36
Rainfall intensity increase due to global warming;	p _{climate} = 40%
Impervious area req. attenuation storage;	α = 90.0 %

Catchment details

Subcatchment	Name	Area (ha)	PIMP (%);	Impermeable. area (ha)
1;	Roofs;	0.16;	90.0;	0.14;
Total		0.16;	90.0;	0.14;

Greenfield runoff rates

Catchment area;	AREA = 50.00 hectare
Greenfield runoff rate (50 hectare site);	$\bar{Q}_{\text{rural}} = 0.00108 \text{ m}^3/\text{s} \times (\text{AREA}/1\text{km}^2)^{0.89} \times (\text{SAAR}/1\text{mm})^{1.17} \times \text{SPR}^{2.17} =$ 187.7 l / s
Greenfield runoff rate;	$\bar{Q} = \bar{Q}_{\text{rural}} / \text{AREA} \times A =$ 0.6 l / s
Greenfield runoff rate per unit area;	$\bar{Q}_A = \bar{Q} / A =$ 3.8 l / s / hectare

Estimated site discharges

FSR growth rate (1 year);	FSR _{1yr} = 0.87
Discharge (1 year);	Q _{1yr} = $\bar{Q} \times \text{FSR}_{1\text{yr}} =$ 0.5 l/s
FSR growth rate (30 year);	FSR _{30yr} = 1.70
Discharge (30 year);	Q _{30yr} = $\bar{Q} \times \text{FSR}_{30\text{yr}} =$ 1.0 l/s
FSR growth rate (100 year);	FSR _{100yr} = 2.08
Discharge (100 year);	Q _{100yr} = $\bar{Q} \times \text{FSR}_{100\text{yr}} =$ 1.2 l/s

Estimated attenuation volume - 1 year

Attenuation storage vol (fig A7.1 - A7.8);

Basic storage volume ;

FEH rainfall factor (figs A11.1, A6.1.1 - A6.3.4);

Storage volume ratio (fig A8.1 - A8.8);

Adjusted storage volume;

Hydrological regional volume ratio (fig A9.1);

Final estimated attenuation storage;

$$Uvol_{1yr} = 134.2 \text{ m}^3 / \text{hectare}$$

$$BSV_{1yr} = Uvol_{1yr} \times \alpha \times A = 18.72 \text{ m}^3$$

$$FF_{1yr} = 0.95$$

$$SVR_{1yr} = 1.69$$

$$ASV_{1yr} = SVR_{1yr} \times BSV_{1yr} = 31.62 \text{ m}^3$$

$$HR_{1yr} = 1.00$$

$$Vol_{1yr} = HR_{1yr} \times ASV_{1yr} = 31.71 \text{ m}^3$$

Library item: Estimated attenuation output

Estimated attenuation volume - 30 year

Attenuation storage vol (fig A7.1 - A7.8);

Basic storage volume ;

FEH rainfall factor (figs A11.1, A6.1.1 - A6.3.4);

Storage volume ratio (fig A8.1 - A8.8);

Adjusted storage volume;

Hydrological regional volume ratio (fig A9.1);

Final estimated attenuation storage;

$$Uvol_{30yr} = 294.6 \text{ m}^3 / \text{hectare}$$

$$BSV_{30yr} = Uvol_{30yr} \times \alpha \times A = 41.09 \text{ m}^3$$

$$FF_{30yr} = 0.90$$

$$SVR_{30yr} = 1.73$$

$$ASV_{30yr} = SVR_{30yr} \times BSV_{30yr} = 71.12 \text{ m}^3$$

$$HR_{30yr} = 1.09$$

$$Vol_{30yr} = HR_{30yr} \times ASV_{30yr} = 77.69 \text{ m}^3$$

Library item: Estimated attenuation output

Estimated attenuation volume - 100 year

Attenuation storage vol (fig A7.1 - A7.8);

Basic storage volume ;

FEH rainfall factor (figs A11.1, A6.1.1 - A6.3.4);

Storage volume ratio (fig A8.1 - A8.8);

Adjusted storage volume;

Hydrological regional volume ratio (fig A9.1);

Final estimated attenuation storage;

$$Uvol_{100yr} = 374.6 \text{ m}^3 / \text{hectare}$$

$$BSV_{100yr} = Uvol_{100yr} \times \alpha \times A = 52.25 \text{ m}^3$$

$$FF_{100yr} = 0.90$$

$$SVR_{100yr} = 1.73$$

$$ASV_{100yr} = SVR_{100yr} \times BSV_{100yr} = 90.43 \text{ m}^3$$

$$HR_{100yr} = 1.13$$

$$Vol_{100yr} = HR_{100yr} \times ASV_{100yr} = 102.24 \text{ m}^3$$

Library item: Estimated attenuation output

Attenuation storage required

Vol. increase due to head-discharge relationship;

$$p_{hydro} = 1.25$$

Maximum attenuation storage required;

$$V_{req_max} = Vol_{30yr} \times p_{hydro} = 97.1 \text{ m}^3$$

Interception storage

Interception rainfall depth;

$$d_{int} = 5 \text{ mm}$$

Volume of interception storage required;

$$V_{int_req} = 0.8 \times A_{imp} \times d_{int} = 5.58 \text{ m}^3$$

Long term storage

Proportion of paved area draining in to network;

$$\alpha = 0.9$$

Proportion of pervious area draining in to network;

$$\beta = 0.5$$

Rainfall depth for 100years, 6 hour event;

$$RD = M100_360 = 78.8 \text{ mm}$$

Extra runoff vol of dev.runoff over greenfield runoff; $Vol_{xs} = \max(RD \times A \times (PIMP \times \alpha \times 0.8 + ((1 - PIMP) \times \beta \times SPR) - SPR), 0m^3) = 36.23 m^3$

Treatment volume

Treatment volume (assume 80% runoff); $T_{vol} = 0.8 \times A \times 15mm \times PIMP = 16.74 m^3$

Provide min 97.1m3 of attenuation storage for the whole building

**Apportion attenuation tanks based on area of rainwater
from each side of the building and the garden terrace**

Provide min 2.1m wide x 1.35m deep x 14m long

**ESS EcoCell Attenuation tanks either side of the building with
min 0.15 dp x 13m x 13m ESS AquaDrain 50 Modular Geo-Viod
below the terraced garden area or equivalent attenuation tanks.
ESS EcoCell Attenuation tanks and AquaDrain Modular Geo- Void
to be installed in accordance with manufacturers specification.**

**Provide Hydro-brake flow restrictor with a maximum flow of 5L/sec to
control the discharge into the existing 375mm sewer in Greatfield Road**



