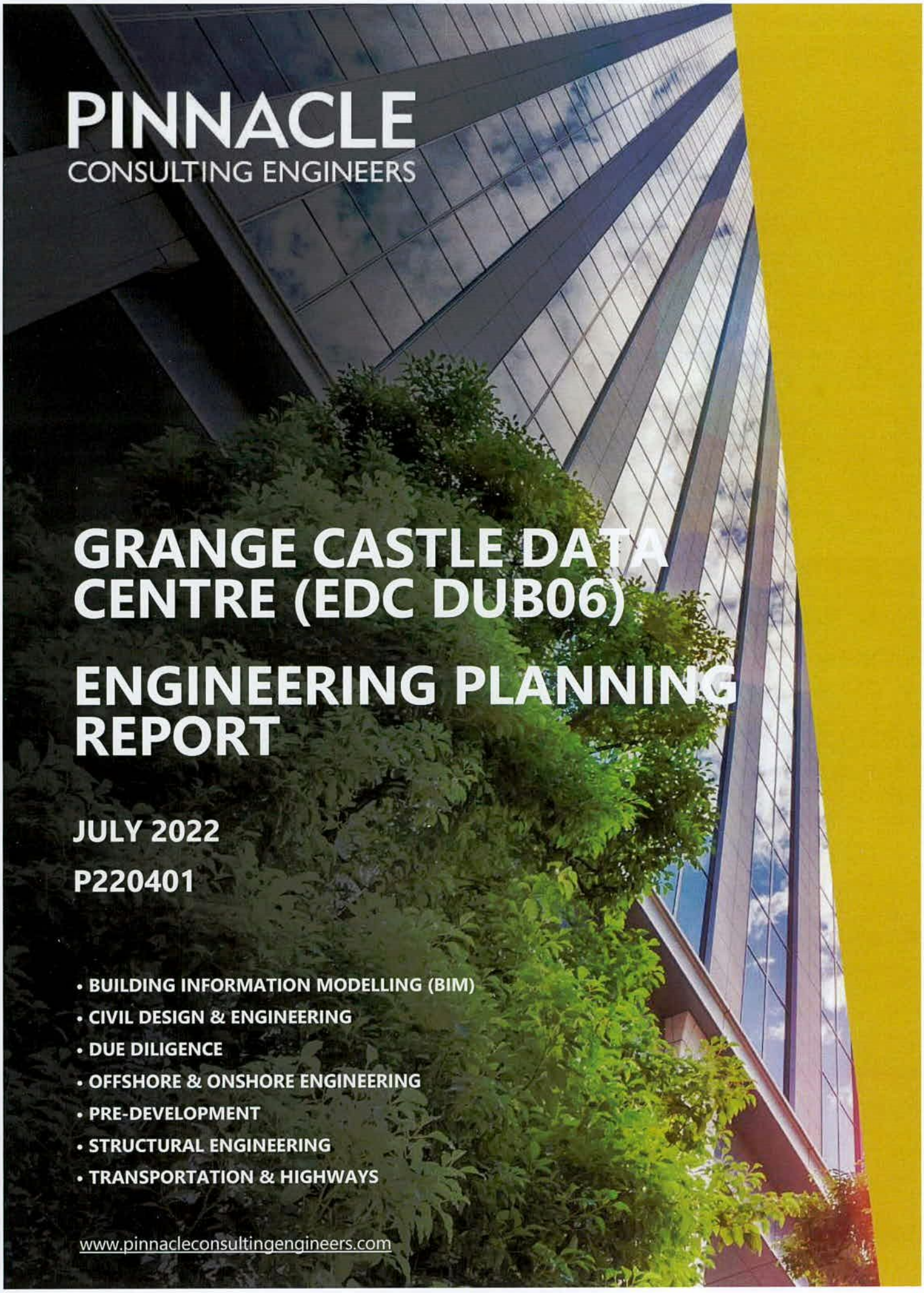

PINNACLE
CONSULTING ENGINEERS

GRANGE CASTLE DATA CENTRE (EDC DUB06)

ENGINEERING PLANNING REPORT

JULY 2022

P220401

- BUILDING INFORMATION MODELLING (BIM)
- CIVIL DESIGN & ENGINEERING
- DUE DILIGENCE
- OFFSHORE & ONSHORE ENGINEERING
- PRE-DEVELOPMENT
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Project Name	Grange Castle Data Centre (EDC DUB06)					
Document Title	Engineering Planning Report					
Document Number	P220401					
This Document Comprises	DCS	TOC	Text	List of Tables	List of Figures	No of Annexures
	-	-	-	-	**2**	**5**

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	Name	Position	Date
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Approved by	James Mayer	Director	22/07/2022

REVISIONS

Revision By	Date	Context
V1	July 2022	First Draft
V2	July 2022	Internal Comments Revised
V3	August 2022	Internal Comments Revised

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1 EXECUTIVE SUMMARY

We, EdgeConneX Ireland Limited are applying for permission for development at this site of 5.14 hectares (red line boundary in Figure 1) that is located within the townland of Ballymakaily to the west of the Newcastle Road (R120), Lucan, Co. Dublin, please see Figure 1 below for site location and subject planning application.

This report was prepared for South Dublin County Council in connection with the planning application and addresses the existing and proposed civil infrastructure.

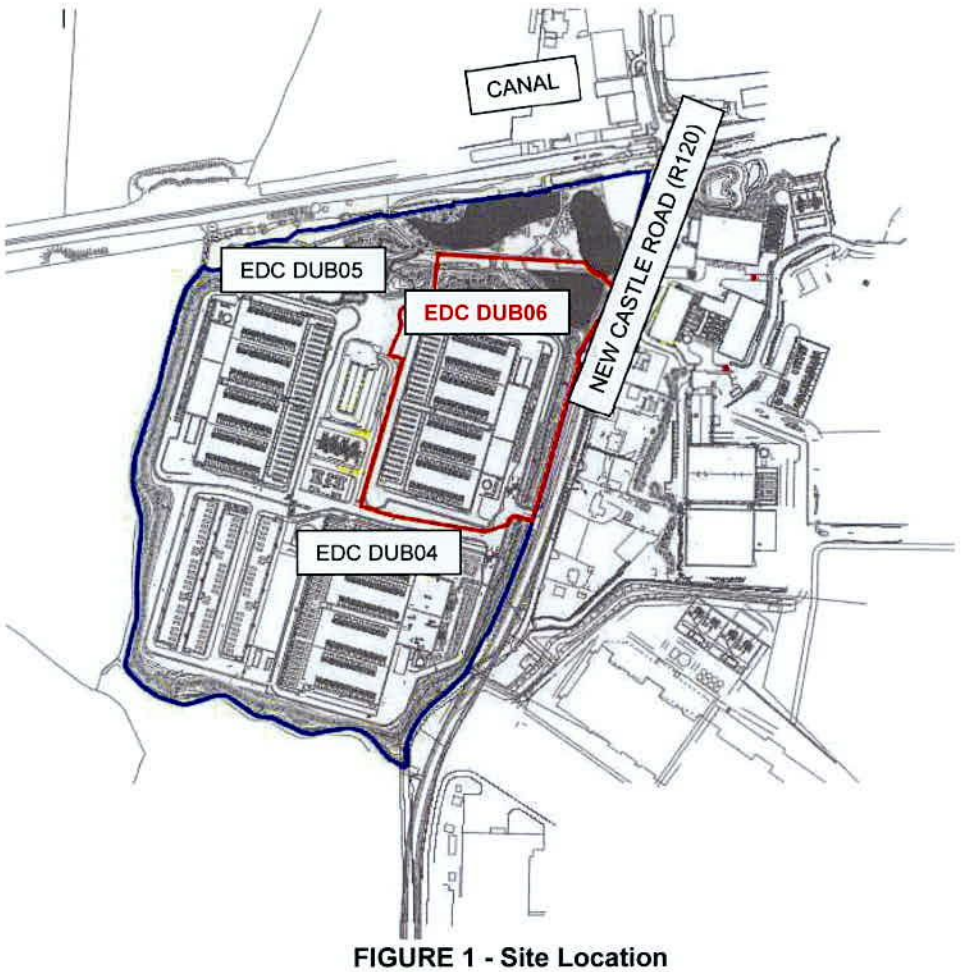


FIGURE 1 - Site Location

The development will consist of the construction of two no. adjoined single storey data centres with associated office and service areas with an overall gross floor area of 15,274sqm that will comprise of the following:

- Construction of 2 no. adjoined single storey data centres with a gross floor area of 12,859sqm that will include a single storey goods receiving area / store and single storey office area (2,415sqm) with PV panels above, located to the east of the data centres as well as associated water tower, sprinkler tank, pump house and other services;
- The data centres will also include plant at roof level; with 24 no. standby diesel generators with associated flues (each 25m high) that will be located within a generator yard to the west of the data centres;
- New internal access road and security gates to serve the proposed development that will provide access to 36 no. new car parking spaces (including 4 no. electric and 2 no. disabled spaces) and sheltered bicycle parking to serve the new data centres;
- New attenuation ponds to the north of the proposed data centres; and
- Green walls are proposed to the south and east that will enclose the water tower and pump house compound.

The development will also include ancillary site works, connections to existing infrastructural services as well as fencing and signage. The development will include minor modifications to the permitted landscaping to the west of the site as granted under SDCC Planning Ref. SD19A/0042 / ABP Ref. PL06S.305948 and Ref. SD21A/0042. The site will remain enclosed by landscaping to all boundaries. The development will be accessed off the R120 via the permitted access granted under SDCC Planning Ref. SD19A/0042 / ABP Ref. PL06S.305948 and SD21A/0042.

An Environmental Impact Assessment Report (EIAR) has been submitted with this application.

The following engineering drawings have been prepared for the proposed development, refer to Annexure B:

- EDCDUB-PIN-06-ZZ-DR-C-200-Rev C01 Proposed Watermain Layout
- EDCDUB-PIN-06-ZZ-DR-C-201-Rev C02 Proposed Drainage Layout
- EDCDUB-PIN-06-ZZ-DR-C-205-Rev C01 Standard Wastewater Infrastructure Details
- EDCDUB-PIN-06-ZZ-DR-C-206-Rev C01 Standard Water Infrastructure Details
- EDCDUB-PIN-06-ZZ-DR-C-210-Rev C01 External Works Drawing
- EDCDUB-PIN-06-ZZ-DR-C-265-Rev C01 Proposed Ponds

2 INTRODUCTION

The purpose of this report is to address the civil infrastructural aspects of the proposed data centre development, located within the townland of Ballymakaily to the west of the Newcastle Road (R120), Lucan, Co. Dublin

The new proposed data halls will result in a portion of the eastern area of the site being developed, comprising an area of 5.14 ha, with associated landscaping elements.

The redline if Figure 2 below shows the redline boundary. Refer to the architects site plan for the exact redline boundary position.

There are no known public sewer drainage pipes or watermains, presently located on the subject site. Foul, surface water and watermain connection points are available in Newcastle Road (R120) to the east of the development.

This report has been prepared to outline the existing and proposed drainage, pollution control measures and water main infrastructure, in order to support the proposed development application.

FIGURE 2 - Site Location (Source Google Maps)

3 EXISTING DRAINAGE AND WATERMAIN SERVICES

3.1 Existing Foul Water Drainage Networks

South Dublin County Council record drawings have identified 2 No. 450mm Ø spur connections, located along the eastern boundary of the property, within the newly constructed R120 (Newcastle Road) upgrade, adjacent to the subject site. These spur connections were left out to facilitate development of these lands and for the lands further west, known as Grange Castle West. This 450mm Ø sewer then connects into the existing Grange Castle Business Park pumping station, as laid under Reg. Ref. SD16A/0214. The effluent from this pumping station is then pumped via 3 No. rising mains, i.e. 100mm Ø, 200mm Ø & 450mm Ø, into the local infrastructural network.

The existing foul sewer reticulation network has adequate capacity to cater for the proposed effluent discharge from the subject site and there are no known issues noted with the sewer reticulation network

3.2 Existing Surface Water Drainage Services

South Dublin County Council record drawings have identified a 900mm Ø road crossing, which was installed as part of the newly constructed R120 (Newcastle Road) upgrade, adjacent to the subject site. This pipe is then connected into a 900mm Ø pipe located along a section of road on the opposite side to the subject site. This gravity surface sewer then runs in a northerly direction, prior to connecting into a ditch/stream network, which discharges through 3 No. aquaducts / culverts of varying sizes and which are located beneath the Grand Canal to the east. This outfall is then drained via a tributary into the Griffeen River.

The aforementioned sewer / culvert, has been identified as having capacity to accommodate the proposed discharge from the subject site.

3.3 Existing Water Main Network

South Dublin County Council record drawings have identified an existing 16" (400mm) Ø main located along the eastern boundary of the property, within the newly constructed R120 (Newcastle Road) upgrade, adjacent to the subject site. 2No. 300mm Ø capped connections with sluice valves, have been left off the aforementioned trunk water main, in order to facilitate development of these lands and for the lands further west, known as Grange Castle West.

The aforementioned existing watermain is ultimately fed off the existing infrastructure to the north of the 12th Lock Bridge.

From discussions with the South Dublin County Council, it is understood that there is adequate capacity within the existing watermain network to supply the proposed development.

4 PROPOSED SITE DRAINAGE AND WATER SUPPLY

4.1 Proposed Foul Water Drainage

An Irish Water Pre-Connection Enquiry is not required for wastewater as confirmed by Irish Water in the Confirmation of Feasibilities, stating that confirmation / consent is required from SDCC when applying for a connection, as the network & Grange Castle pumping station is under the auspices of SDCC.

It is proposed to discharge foul water from the proposed development, via a 225mm Ø gravity foul sewer outfall and discharge into the existing 450mm Ø connection, as granted under Planning Reg. Ref. SD19A/0042.

The proposed network connects into the EX FOUL MH, with an invert level of 63.15m, prior to the ultimate outfall discharging into the Grange Castle Pumping Station, which has already been approved under the aforementioned planning grant - refer Drawing No. EDCDUB-PIN-06-ZZ-DR-C-201-Rev C02.

It is proposed that all foul condensate effluent from the proposed new data halls, will be connected into head manholes adjacent to the data halls. The office building contains 6 No. WC's, with a predicted maximum number of daily staff being in the region of circa 40 people, over a 24hr period. Based on Irish Water's Code of Practice of 200ltr/hd/day, the peak wastewater flow will not be in excess of circa 0.54l/s.

All on-site gravity foul sewers have been designed to be a minimum 150mm / 225mm diameter uPVC Class SN8 pipes, with gradients designed to achieve self-cleansing velocities.

4.2 Proposed Surface Water Drainage

Storm water from the proposed development has been designed in accordance with the GDSDS and ensures that Best Management Practice has been incorporated into the design.

It should be noted that the subject site currently comprises a greenfield site and the proposed surface water measures are aimed at improving the general surface water management of the site, by introducing interceptors, attenuation measures and by restricting the ultimate discharge, etc.

Storm water from the roof areas of the proposed building units, will be directed via rain water pipes into an on-site reticulation system. The outflow from this system will be connected into the

surface water drainage network collecting run-off from the road areas and will be ultimately discharged into 2 stormwater storage ponds / wetland area, located in a landscaped area to the northern end of the site adjacent to the canal - refer Drawing No.'s EDCDUB-PIN-06-ZZ-DR-C-201-Rev C02.

Based on the hardstand and roof area for this current application, i.e. circa 33 400m2 (3.34 Ha), the attenuation volume required has been calculated as being circa 2,727m3, which will be provided for as mentioned above, in 2 storage ponds and a swale. The remaining land area of 17 276m^2 will be landscaped. Refer Appendix A for Surface Water Calculations.

Storm water from all car park areas and access roads / delivery areas will be drained as follows:-

- A series of on-site gullies and channels draining into a separate system of below ground gravity storm water sewers for road areas
- Parking bays will be constructed with Permeable paving.

Prior to discharging into the proposed ponds / wetland area, the storm water from the car park and access roads, which is drained via the methods as described above, will be directed through an appropriately sized Conder Separator (or similar approved) petrol interceptor - refer Appendix C for Interceptor Details. Generic details pertaining to the permeable paving system can be found contained within Annexure E of this report.

Site investigations have been carried out and the results have shown that the existing sub-soil would provide inadequate soil infiltration rates and thus it is not practical to install a soakaway system.

By way of complying with sustainability elements i.e. SuDS, the surface water run-off from the entire development, has been attenuated within the methods as described above, catering for a 1:100yr storm event + 20% climate change. Refer to Appendix A for surface water calculations.

The site QBar for this development is 6.6l/s and is based on the 3.34ha roof, road and carpark area.

The surface water discharge for this application will incorporate the road areas, parking, service yard area and the roof water from the proposed data halls, which then ultimately feeds into the existing network as previously mentioned. Refer Appendix B, Dwg. No. EDCDUB-PIN-06-ZZ-DR-C-210-Rev C01, for a drawing indicating the various surface areas of this application; all areas are hardstanding of various types, with the respective coefficients detailed below: -

The following volumes have been provided for storage within the site:

- SW Attenuation Pond 1 provides a storage volume of 900m³
- SW Attenuation Pond 2 provides a storage volume of 1700m³
- SW Swale (with rain garden) provides a storage volume of 70m³
- Permeable Paving sub-base provides a combined storage volume of 54m³

The total combine storage volume provided for the site is 2 724m³ and the outflow will be restricted to 6.6 l/s with a hydrobrake system installed in the final connection manhole before discharging into the existing stormwater channel. Refer Annexure A for hydraulic calculations.

The co-efficients used for the various surface types are as follows:

- Roof 0.90
- Concrete (Service Yard) 0.85
- Asphalt (Road) 0.85
- Landscaping 0.25
- Permeable Paving 0.60

4.3 Proposed Water Mains

It is intended to serve the proposed development via connection off the previously granted 150mm Ø network, as granted under Planning Reg. Ref. SD19A/0042, which has fed off the existing 400mm Ø trunk main located along the R120 (Newcastle Road). Refer Drawing No. EDCDUB-PIN-06-ZZ-DR-C-200-Rev C01.

Hydrants will be installed in accordance with the Requirements of the Building Regulations and in accordance with the recommendations contained in the Technical Guidance Documents, Section B – Fire Safety, dated 2006, and these are detailed on our engineering drawings.

Water demand for the development has been based on Irish Water's criteria, i.e. 150 litres/hd/day = 6,000 litres/hd/day (based on 40 PE) = 0.069 litres/second.

Avg. Demand = 0.069 l/s x 1.25 = 0.086 litres/second

Peak Demand = 0.086 l/s x 5 = 0.43 litres/second

Water meters, sluice valves and hydrants, in line with Irish Water requirements and specifications, will be installed at the connections onto the aforementioned existing water mains, as required. A Pre-Connection Enquiry application has been submitted to Irish Water (CDS21000754) in respect of the water supply and we are still awaiting a response to same.

Water meters, sluice valves and hydrants, in line with Irish Water requirements and specifications, will be installed at the connections onto the existing water mains as required. All internal water pipes will be HDPE PE100 SDR 17 pipes.

4.4 Standard Drainage Details

All standard drainage details including manhole details, pipe bedding, channels, hydrants etc. are shown on Drawing No.'s EDCDUB-PIN-06-ZZ-DR-C-205-Rev C01 and EDCDUB-PIN-06-ZZ-DR-C-206-Rev C01. Details of the types and construction methods will be agreed with Irish Water and the Local Authority, prior to construction. Drains generally will consist of PVC (to IS 123) or concrete spigot and socket pipes to (IS 6).

Drains shall be laid to comply with the Requirements of the Building Regulations and in accordance with the recommendations contained in the Technical Guidance Documents, Section H – Drainage & Wastewater Disposal, dated 2016.

Strict separation of surface water and foul sewerage will be imposed on the development. Drains will be laid out to minimise the risk of inadvertent connections of sinks, dishwashers etc. to the surface water system.

In order to minimise the risk of floating contamination of the surface water system, road gullies will be precast trapped gullies to BS5911:Part2:1982.

Concrete bed and surround to the pipe runs will be used where the cover to the pipes is less than 900mm, where the pipes are sufficiently close to the building, or where the pipe runs are below the ground floor slab.

All works are to be carried out in accordance with Irish Water's Code of Practice for Wastewater Infrastructure, dated July 2020 : Document IW-CDS-5030-03 & with Irish Water's Code of Practice for Water Infrastructure, dated July 2020 : Document IW-CDS-5020-03 and any subsequent revisions thereof.

5 SURFACE AND GROUNDWATER IMPACTS

5.1 Construction Phase

Water pollution will be minimised by the implementation of good construction practices. Such practices will include adequate bunding for oil containers, wheel washers and dust suppression on site roads, and regular plant maintenance. The Construction Industry Research and Information Association provides guidance on the control and management of water pollution from construction sites in their publication Control of Water Pollution from Construction Sites, Guidance for Consultants and Contractors – C532 CIRIA Report (Masters-Williams et al, 2001), which provides information on these issues.

Pollutants can commonly include suspended solids, oil, chemicals, cement, cleaning materials and paints. These can enter controlled waters in various ways:

- directly into a watercourse
- via drains or public sewers
- via otherwise dry ditches
- in old field drains
- by seepage into groundwater systems
- through excavations into underlying aquifers
- by disturbance of an already contaminated site

The proximity of the site to streams, aquifers and water abstractions; potential sources, pathways and impacts of pollution; and the historical uses of the site and nearby areas should be examined early in project planning and design, to ensure that suitable redesign and mitigation measures are undertaken as necessary.

During construction, careful management and planning will help minimise water pollution. This may include adequate bunding of all oil tanks, wheel washers and dust suppression on haul roads, particular care to be taken near watercourses, and regular plant maintenance.

A contingency plan for pollution emergencies should also be developed and regularly updated, which would identify the actions to be taken in the event of a pollution incident.

The CIRIA document (2001), recommends that a contingency plan for pollution emergencies should address the following:

- containment measures

- emergency discharge routes
- list of appropriate equipment and clean-up materials
- maintenance schedule for equipment
- details of trained staff, location, and provision for 24-hour cover
- details of staff responsibilities
- notification procedures to inform the relevant environmental protection authority
- audit and review schedule
- telephone numbers of statutory water undertakers and local water company
- list of specialist pollution clean-up companies and their telephone numbers

5.2 Operational Phase

The sources of pollution that could potentially have an effect on surface or groundwater during the operational phase of the development will be oil and fuel leaks from parked cars, service vehicles, HGV delivery's etc.

Storm water attenuation measures will be incorporated into the scheme as mentioned previously.

It is not anticipated that flooding of the site will occur.

5.3 Mitigation Measures

The construction management of the building project will incorporate protection measures to minimise as far as possible the risk of spillage that could lead to surface and groundwater contamination.

All appropriate methods will be utilised to ensure that surface water arising during the course of construction activities will contain minimum sediment, prior to the ultimate discharge to the existing watercourse.

Storm water attenuation measures will be incorporated into the scheme as mentioned previously.

Best practice in design and construction will be employed for the installation of surface water and sanitary drainage.

6 SUSTAINABILITY

6.1 Site development

In order to minimize material export and import to the site and the impact of this on the surrounding road network, we are proposing to maintain existing on-site levels as far as is practical. Where this is not feasible, a terrain model will be produced, which will indicate the volumes of cut/fill material, based on the proposed levels and a levels balance will be struck across the site, thereby mitigating any significant import/export of material for site development.

6.2 Site Drainage

Storm water drainage proposals for the site have been designed in accordance with the GDSDS and incorporate on-site storm water attenuation, in the form of permeable paving and rain water harvesting thereby limiting the discharge to ground of storm water from the developed site to the equivalent Q-bar run-off rates.

The attenuation system proposed is in keeping with other developments within Grange Castle Business Park. The pond / wetland area not only provides flood storage, but also provides ecological benefits as well.

7 CONCLUSIONS

In conclusion, the proposed development of the site by the applicant, for use as a Data Centre development, is considered a suitable use of the site. Local infrastructure has the capacity to serve the proposed development.

The site will be developed in a sustainable manner, in order to minimise the impact of the development during construction and throughout the lifespan of the proposed development.

Accordingly, there are no reasons in relation to the drainage elements as to why this scheme should not be granted planning permission, and with this in mind, the Planning Authority is respectfully requested to recommend a grant of planning permission.

ANNEXURE A – SURFACE WATER CALCULATIONS

Qbar Calculation
Using IOH Report 124 for Sites < 25 km²

Catchment Name
DUB 06

[1] $Q_{bar} = 0.00108 * (AREA)^{0.89}(SAAR)^{1.17}(SOIL)^{2.17}$ — **Estimation of QBAR from IOH Report 124 for catchments less than 25 km² using the 3 variable equation**

SITE AREA =	5.07	Ha	Overall Redline Area
CATCHMENT AREA =	3.34	Ha (excl. Public Open Space)	Overall Catchment Area (Hectares) For catchments < 50 hectares in area, flow rates are linearly interpolated for smaller areas.
AREA =	0.033	km²	Area of the Catchment (km²)
SAAR =	754	mm	Standard Annual Average Rainfall (mm)
SOIL =	0.30		
$M5_{60}$	16.8	mm	
$M5_{2DAY}$	61.9	mm	
$R=(M5_{60}/M5_{2d})$	0.27		

Soil Type Expressed as a Percentage	Soil 1	Soil 2	Soil 3	Soil 4	Soil 5
	0	100	0	0	0
SOIL Value	0.15	0.30	0.40	0.45	0.50

Soil index value (SPR) calculated from Flood Studies Report Vol V Fig I 4.18(1) - The Classification of Soils from Winter Rainfall Acceptance Rate .

Flood Return Event	[5]Growth Factor	Permitted Flow (l/s)
1	0.85	5.6
QBAR	1	6.6
10	1.67	11.1
30	2.1	13.9
50	2.33	15.5
100	2.6	17.3
200	2.85	18.9
1000	3.5	23.2

[4]QBar from Site with Factorial Error Allowance

r^2 =	0.847
n =	71
fse =	1.651

Q'_{bar} = 10.96 l/s

(With Allowance for the standard factorial error)

Pro-rata based on 50 Ha Site area to calculate Qbar

Q_{bar} =	0.00004	cumecs/Ha
Q_{bar} =	2.0	l/s/Ha

$Q_{bar[rural]}$ = 6.6 l/s

Catchment Characteristics

DUB 06	Area (m²)	Runoff Coeff.	Effective Area (m²)
Roofs & Balconies - Type 1 (Draining to gullies)	-	1.00	0.0
Roofs - Type 2 (Draining to SUDS Soakaway features)	-	0.90	0.0
Green Roofs	-	0.85	0.0
Roads and Footpaths - Type 1 (Draining to gullies)	-	0.80	0.0
Roads and Footpaths - Type 2 (Draining to Suds features)	-	0.70	0.0
Paved Areas	-	0.80	0.0
Permeable Paving	-	0.70	0.0
Grass over Basement	-	0.70	0.0
Parks (contributing)	-	0.30	0.0
Public Open Space (non-contributing)	-	0.00	0.0

Include Public Open Space in Effective Catchment Area? no — Assumed open space area does not drain to surface water network

Effective Catchment Area 0.0 m²

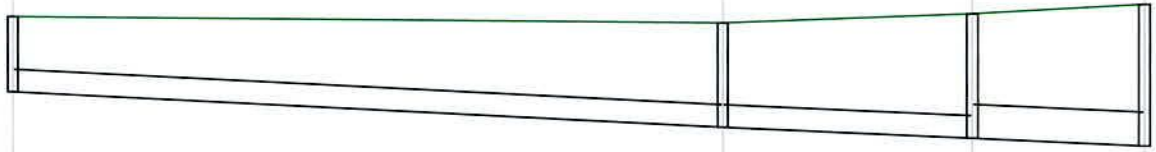
Effective Catchment Runoff Coefficient 0.00

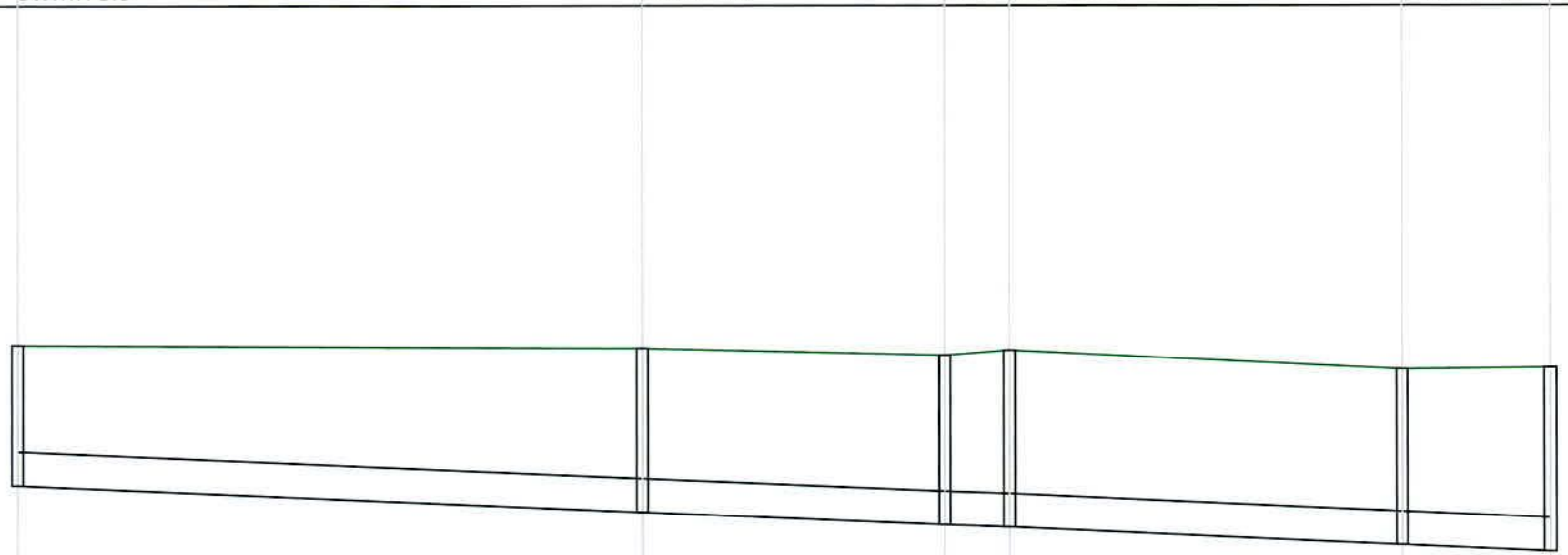
Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 304087, Northing: 230773,

	Interval		Years												
DURATION	6months,	1year,	2,	3,	4,	5,	10,	20,	30,	50,	75,	100,	150,	200,	250,	500,
5 mins	2.3,	3.4,	4.1,	5.0,	5.7,	6.2,	8.0,	10.0,	11.4,	13.4,	15.2,	16.6,	18.8,	20.6,	22.1,	N/A ,
10 mins	3.2,	4.8,	5.7,	7.0,	7.9,	8.7,	11.1,	14.0,	15.9,	18.7,	21.2,	23.2,	26.3,	28.7,	30.7,	N/A ,
15 mins	3.8,	5.7,	6.7,	8.3,	9.3,	10.2,	13.1,	16.4,	18.7,	22.0,	24.9,	27.3,	30.9,	33.8,	36.2,	N/A ,
30 mins	5.0,	7.4,	8.7,	10.7,	12.0,	13.1,	16.7,	20.9,	23.7,	27.7,	31.4,	34.2,	38.7,	42.2,	45.1,	N/A ,
1 hours	6.6,	9.6,	11.2,	13.7,	15.5,	16.8,	21.3,	26.5,	30.0,	35.0,	39.4,	42.9,	48.4,	52.6,	56.2,	N/A ,
2 hours	8.6,	12.5,	14.6,	17.7,	19.9,	21.6,	27.2,	33.7,	38.0,	44.1,	49.6,	53.9,	60.5,	65.7,	70.0,	N/A ,
3 hours	10.1,	14.6,	17.0,	20.6,	23.1,	25.0,	31.4,	38.7,	43.6,	50.5,	56.7,	61.5,	69.0,	74.8,	79.7,	N/A ,
4 hours	11.4,	16.2,	18.9,	22.9,	25.6,	27.7,	34.7,	42.7,	48.1,	55.6,	62.3,	67.6,	75.7,	82.0,	87.3,	N/A ,
6 hours	13.3,	18.9,	22.0,	26.6,	29.7,	32.1,	40.1,	49.2,	55.2,	63.7,	71.3,	77.2,	86.3,	93.4,	99.3,	N/A ,
9 hours	15.6,	22.1,	25.6,	30.8,	34.4,	37.2,	46.2,	56.5,	63.3,	72.9,	81.5,	88.1,	98.4,	106.4,	113.0,	N/A ,
12 hours	17.5,	24.7,	28.5,	34.3,	38.2,	41.2,	51.2,	62.4,	69.8,	80.3,	89.6,	96.8,	108.0,	116.6,	123.8,	N/A ,
18 hours	20.5,	28.8,	33.2,	39.8,	44.3,	47.7,	59.0,	71.8,	80.2,	92.0,	102.5,	110.6,	123.1,	132.8,	140.8,	N/A ,
24 hours	23.0,	32.1,	37.0,	44.2,	49.1,	52.9,	65.3,	79.3,	88.4,	101.3,	112.7,	121.5,	135.1,	145.6,	154.3,	184.7,
2 days	28.9,	39.2,	44.6,	52.5,	57.8,	61.9,	75.1,	89.6,	99.1,	112.2,	123.7,	132.5,	146.0,	156.4,	164.9,	194.5,
3 days	33.6,	44.9,	50.7,	59.2,	64.9,	69.2,	83.0,	98.2,	108.0,	121.4,	133.2,	142.2,	155.9,	166.3,	174.9,	204.4,
4 days	37.8,	49.9,	56.1,	65.1,	71.0,	75.6,	90.0,	105.7,	115.8,	129.6,	141.6,	150.8,	164.7,	175.3,	183.9,	213.6,
6 days	45.1,	58.5,	65.4,	75.2,	81.7,	86.6,	102.0,	118.7,	129.3,	143.8,	156.3,	165.8,	180.1,	191.0,	199.9,	230.1,
8 days	51.6,	66.2,	73.5,	84.1,	91.0,	96.2,	112.5,	130.0,	141.1,	156.2,	169.1,	178.9,	193.7,	204.8,	213.9,	244.7,
10 days	57.5,	73.2,	81.0,	92.1,	99.4,	104.9,	122.0,	140.2,	151.7,	167.3,	180.7,	190.8,	205.9,	217.3,	226.6,	257.9,
12 days	63.1,	79.6,	87.9,	99.6,	107.2,	112.9,	130.7,	149.6,	161.5,	177.6,	191.3,	201.7,	217.1,	228.8,	238.3,	270.2,
16 days	73.5,	91.6,	100.6,	113.3,	121.5,	127.7,	146.7,	166.8,	179.4,	196.3,	210.7,	221.5,	237.6,	249.7,	259.5,	292.4,
20 days	83.0,	102.7,	112.3,	125.9,	134.6,	141.1,	161.3,	182.4,	195.5,	213.2,	228.1,	239.3,	256.0,	268.5,	278.6,	312.4,
25 days	94.3,	115.5,	125.9,	140.4,	149.7,	156.6,	178.0,	200.3,	214.1,	232.5,	248.1,	259.8,	277.1,	290.0,	300.4,	335.2,

NOTES:
N/A Data not available
These values are derived from a Depth Duration Frequency (DDF) Model
For details refer to:
'Fitzgerald D. L. (2007), Estimates of Point Rainfall Frequencies, Technical Note No. 61, Met Eireann, Dublin',
Available for download at www.met.ie/climate/dataproducts/Estimation-of-Point-Rainfall-Frequencies_TN61.pdf

PINNACLE CONSULTING ENGINEERS	Pinnacle Engineering Grosvenor Court 67a Patrick Street Dun Laoghaire, County Dublin	File: DUB06 Hydraulic Model - 1.100 24hr Rev2.f Network: Storm Network Francois Jansen van Rensburg 2022/07/21	Page 1 Ballycoolin Hydraulic Model Rev 1 1:100 year 24 hour storm

Node Name	SWMH 3.9		SWMH 3.8		SWMH 3.7	SWMH 3.6
A4 drawing Hor Scale 900 Ver Scale 100 Datum (m) 58.000						
Link Name	1.000		1.001		1.002	
Section Type	300mm		300mm		450mm	
Slope (1:X)	180.3		212.2		204.9	
Cover Level (m)	64.796		64.714		64.840	64.968
Invert Level (m)	63.800	63.330	63.330	63.190	63.190	63.090
Length (m)	84.720		29.710		20.494	



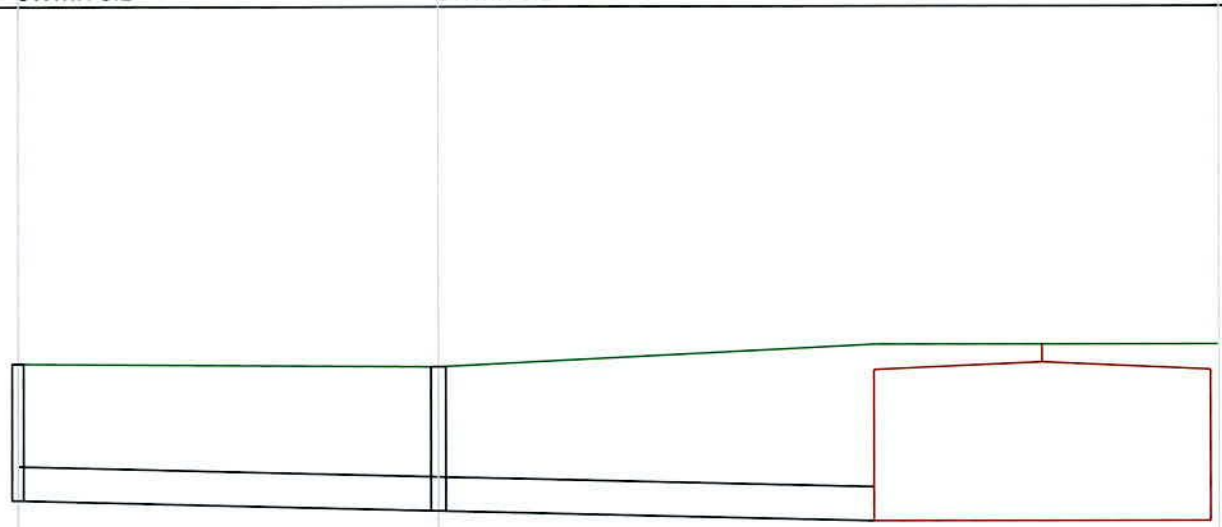
A4 drawing

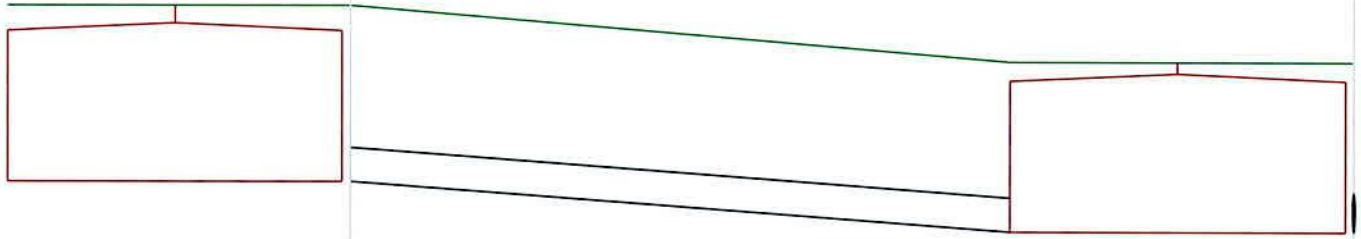
Hor Scale 900
Ver Scale 100

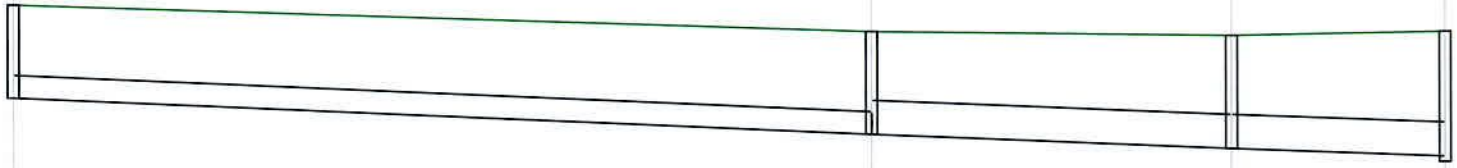
Datum (m) 58.000

Node Name	SWMH 3.6		SWMH 3.5		SWMH 3.4	SWMH 3.3		SWMH 3.2		SWMH 3.1
Link Name	1.003		1.004		1.005	1.006		1.007		
Section Type	450mm		450mm		450m	450mm		450mm		
Slope (1:X)	209.1		215.2		259.8	197.0		198.1		
Cover Level (m)	64.968		64.926		64.833	64.899		64.641		64.661
Invert Level (m)	63.090	62.730	62.730	62.560	62.560	62.530	62.530	62.290	62.290	62.200
Length (m)	75.276		36.582		7.793	47.279		17.833		

Node Name	SWMH 3.1		Pond 2	SWMH CON
A4 drawing Hor Scale 900 Ver Scale 100 Datum (m) 58.000				
Link Name	1.008		P2	
Section Type	525mm		300mm	
Slope (1:X)	303.3		486.7	
Cover Level (m)	64.661		64.300	64.300
Invert Level (m)	62.200	62.050	62.050	61.980
Length (m)	45.492		34.072	

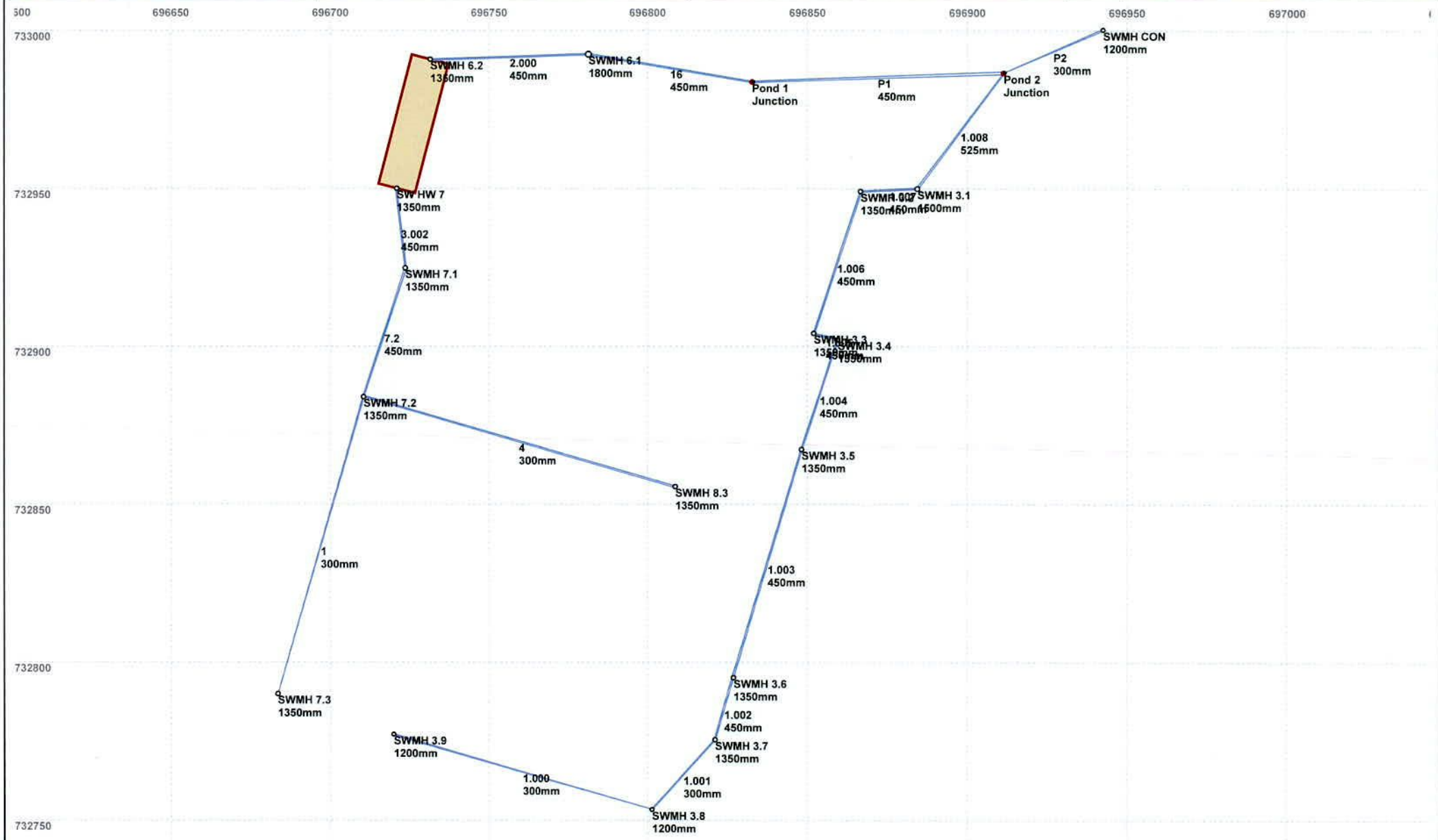
Node Name	SWMH 6.2	SWMH 6.1	Pond 1
A4 drawing Hor Scale 900 Ver Scale 100 Datum (m) 58.000			
Link Name	2.000	16	
Section Type	450mm	450mm	
Slope (1:X)	357.4	370.9	
Cover Level (m)	64.786	64.747	65.035
Invert Level (m)	62.980	62.840 62.840	62.700
Length (m)	50.029	51.921	

Node Name	Pond 1	Pond 2
A4 drawing Hor Scale 900 Ver Scale 100 Datum (m) 58.000		
Link Name	P1	
Section Type	450mm	
Slope (1:X)	121.1	
Cover Level (m)	65.035	64.300
Invert Level (m)	62.700	62.050
Length (m)	78.719	

Node Name	SWMH 8.3		SWMH 7.2		SWMH 7.1	SW HW 7
A4 drawing Hor Scale 900 Ver Scale 100 Datum (m) 58.000						
Link Name	4		7.2		3.002	
Section Type	300mm		450mm		450mm	
Slope (1:X)	204.3		220.0		241.6	
Cover Level (m)	65.180	64.809		64.750		64.800
Invert Level (m)	63.950	63.450	63.450	63.255	63.255	63.150
Length (m)	102.156		42.903		25.365	

Node Name		SW HW 7	SWMH 6.2
A4 drawing Hor Scale 900 Ver Scale 100 Datum (m) 58.000			
Link Name		Pond	
Section Type			
Slope (1:X)			
Cover Level (m)		64.800	64.786
Invert Level (m)		63.080	62.980
Length (m)			

Node Name	SWMH 7.3	SWMH 7.2
A4 drawing Hor Scale 900 Ver Scale 100 Datum (m) 58.000		
Link Name	1	
Section Type	300mm	
Slope (1:X)	217.3	
Cover Level (m)	64.791	64.809
Invert Level (m)	63.900	63.450
Length (m)	97.770	



Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	100	Maximum Rainfall (mm/hr)	40.0
Additional Flow (%)	20	Minimum Velocity (m/s)	0.70
FSR Region	Scotland and Ireland	Connection Type	Level Inverts
M5-60 (mm)	16.800	Minimum Backdrop Height (m)	1.200
Ratio-R	0.270	Preferred Cover Depth (m)	0.800
CV	0.750	Include Intermediate Ground	✓
Time of Entry (mins)	15.00	Enforce best practice design rules	x

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
SWMH 3.9	0.696	15.00	64.796	1200	696720.010	732777.151	0.996
SWMH 3.8			64.714	1200	696801.320	732753.357	1.384
SWMH 3.7			64.840	1350	696821.119	732775.509	1.650
SWMH 3.6			64.968	1350	696826.881	732795.176	1.878
SWMH 3.5	0.748	15.00	64.926	1350	696848.219	732867.364	2.196
SWMH 3.4			64.833	1350	696859.521	732902.156	2.273
SWMH 3.3			64.899	1350	696851.987	732904.150	2.369
SWMH 3.2			64.641	1350	696866.585	732949.119	2.351
SWMH 3.1			64.661	1500	696884.400	732949.929	2.461
SW HW 7			64.800	1350	696720.940	732950.013	1.720
Pond 1			65.035		696832.642	732983.777	2.335
SWMH 6.1	0.424	15.00	64.747	1800	696781.455	732992.481	1.907
SWMH 6.2	0.695	15.00	64.786	1350	696731.451	732990.886	1.806
SWMH 7.2			64.809	1350	696710.472	732883.959	1.359
SWMH 8.3		15.00	65.180	1350	696808.598	732855.549	1.230
SWMH 7.3	0.777	15.00	64.791	1350	696683.467	732789.993	0.891
SWMH 7.1			64.750	1350	696723.637	732924.792	1.495
Pond 2			64.300		696911.310	732986.608	2.250
SWMH CON			64.300	1200	696942.496	733000.332	2.320

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
8	SWMH 8	SWMH 9	84.720	0.600	63.800	63.330	0.470	180.3	300	19.60	40.0
9	SWMH 9	SWMH 11	29.710	0.600	63.330	63.190	0.140	212.2	300	20.49	40.0
11	SWMH 11	SWMH 18	20.494	0.600	63.190	63.090	0.100	204.9	450	21.03	40.0
18	SWMH 18	SWMH 12	75.276	0.600	63.090	62.730	0.360	209.1	450	23.31	40.0
12	SWMH 12	SWMH 13	36.582	0.600	62.730	62.560	0.170	215.2	450	24.19	40.0
13	SWMH 13	SWMH 14	7.793	0.600	62.560	62.530	0.030	259.8	450	24.30	40.0

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)
8									
9									
11									
18									
12									
13									

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
14	SWMH 14	SWMH 15	47.279	0.600	62.530	62.290	0.240	197.0	500	24.97	40.0
15	SWMH 15	SWMH 15.1	17.833	0.600	62.290	62.200	0.090	198.1	500	25.34	40.0
P1	Pond 1	Pond 2	78.719	0.600	62.700	62.050	0.650	121.1	450	28.22	40.0
2	SWMH 7.2	SWMH 3	98.976	0.600	63.450	62.980	0.470	210.6	450	23.54	40.0
3	SWMH 3	SWMH 16	50.029	0.600	62.980	62.840	0.140	357.4	450	26.12	40.0
16	SWMH 6.1	Pond 1	51.921	0.600	62.840	62.700	0.140	370.9	450	27.26	40.0
1	SWMH 7.3	SWMH 7.2	97.770	0.600	63.900	63.450	0.450	217.3	300	19.62	40.0
15.1	SWMH 15.1	Pond 2	45.492	0.600	62.200	62.050	0.150	303.3	500	26.75	40.0
P2	Pond 2	SWMH CON	34.072	0.600	62.050	61.980	0.070	486.7	300	28.77	40.0
4	SWMH 8.3	SWMH 7.2	102.156	0.600	63.950	63.450	0.500	204.3	300	16.31	40.0
7.2	SWMH 7.2	SWMH 7.1	42.903	0.600	63.450	63.255	0.195	220.0	450	20.14	40.0
2.000	SWMH 6.2	SWMH 6.1	50.029	0.600	62.980	62.840	0.140	357.4	450	15.78	40.0
1.000	SWMH 3.9	SWMH 3.8	84.720	0.600	63.800	63.330	0.470	180.3	300	16.21	40.0
1.001	SWMH 3.8	SWMH 3.7	29.710	0.600	63.330	63.190	0.140	212.2	300	16.67	40.0
1.002	SWMH 3.7	SWMH 3.6	20.494	0.600	63.190	63.090	0.100	204.9	450	16.91	40.0
1.003	SWMH 3.6	SWMH 3.5	75.276	0.600	63.090	62.730	0.360	209.1	450	17.81	40.0
1.004	SWMH 3.5	SWMH 3.4	36.582	0.600	62.730	62.560	0.170	215.2	450	18.25	40.0
1.005	SWMH 3.4	SWMH 3.3	7.793	0.600	62.560	62.530	0.030	259.8	450	18.35	40.0
1.006	SWMH 3.3	SWMH 3.2	47.279	0.600	62.530	62.290	0.240	197.0	450	18.90	40.0
1.007	SWMH 3.2	SWMH 3.1	17.833	0.600	62.290	62.200	0.090	198.1	450	19.10	40.0
1.008	SWMH 3.1	Pond 2	45.492	0.600	62.200	62.050	0.150	303.3	525	19.69	40.0
3.002	SWMH 7.1	SW HW 7	25.365	0.600	63.255	63.150	0.105	241.6	450	20.47	40.0

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)
14									
15									
P1	1.846	293.6	145.6	1.885	1.800	1.119	0.0	224	1.842
2				0.909					
3									
16	1.050	166.9	145.6	1.457	1.885	1.119	0.0	327	1.176
1	1.062	75.1	101.1	0.591	1.059	0.777	0.0	300	1.076
15.1					1.750				
P2	0.706	49.9	333.5	1.950	2.020	2.563	0.0	300	0.715
4	1.096	77.5	0.0	0.930	1.059	0.000	0.0	0	0.000
7.2	1.366	217.3	101.1	0.909	1.045	0.777	0.0	216	1.343
2.000	1.069	170.1	90.4	1.356	1.457	0.695	0.0	233	1.085
1.000	1.168	82.5	90.6	0.696	1.084	0.696	0.0	300	1.183
1.001	1.075	76.0	90.6	1.084	1.350	0.696	0.0	300	1.089
1.002	1.416	225.2	90.6	1.200	1.428	0.696	0.0	198	1.342
1.003	1.402	223.0	90.6	1.428	1.746	0.696	0.0	199	1.331
1.004	1.382	219.7	187.9	1.746	1.823	1.444	0.0	322	1.544
1.005	1.256	199.8	187.9	1.823	1.919	1.444	0.0	349	1.419
1.006	1.445	229.8	187.9	1.919	1.901	1.444	0.0	311	1.603
1.007	1.440	229.1	187.9	1.901	2.011	1.444	0.0	312	1.599
1.008	1.281	277.2	187.9	1.936	1.725	1.444	0.0	318	1.371
3.002	1.303	207.3	101.1	1.045	1.200	0.777	0.0	222	1.296

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)
8	84.720	180.3	300			63.800			63.330	
9	29.710	212.2	300			63.330			63.190	
11	20.494	204.9	450			63.190			63.090	
18	75.276	209.1	450			63.090			62.730	
12	36.582	215.2	450			62.730			62.560	
13	7.793	259.8	450			62.560			62.530	
14	47.279	197.0	500			62.530			62.290	
15	17.833	198.1	500			62.290			62.200	
P1	78.719	121.1	450	Circular	65.035	62.700	1.885	64.300	62.050	1.800
2	98.976	210.6	450		64.809	63.450	0.909		62.980	
3	50.029	357.4	450			62.980			62.840	
16	51.921	370.9	450	Circular	64.747	62.840	1.457	65.035	62.700	1.885
1	97.770	217.3	300	Circular	64.791	63.900	0.591	64.809	63.450	1.059
15.1	45.492	303.3	500			62.200		64.300	62.050	1.750
P2	34.072	486.7	300	Circular	64.300	62.050	1.950	64.300	61.980	2.020
4	102.156	204.3	300	Circular	65.180	63.950	0.930	64.809	63.450	1.059
7.2	42.903	220.0	450	Circular	64.809	63.450	0.909	64.750	63.255	1.045
2.000	50.029	357.4	450	Circular	64.786	62.980	1.356	64.747	62.840	1.457
1.000	84.720	180.3	300	Circular	64.796	63.800	0.696	64.714	63.330	1.084
1.001	29.710	212.2	300	Circular	64.714	63.330	1.084	64.840	63.190	1.350
1.002	20.494	204.9	450	Circular	64.840	63.190	1.200	64.968	63.090	1.428
1.003	75.276	209.1	450	Circular	64.968	63.090	1.428	64.926	62.730	1.746
1.004	36.582	215.2	450	Circular	64.926	62.730	1.746	64.833	62.560	1.823
1.005	7.793	259.8	450	Circular	64.833	62.560	1.823	64.899	62.530	1.919
1.006	47.279	197.0	450	Circular	64.899	62.530	1.919	64.641	62.290	1.901

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
8								
9								
11								
18								
12								
13								
14								
15								
P1	Pond 1		Junction		Pond 2		Junction	
2	SWMH 7.2	1350	Manhole	Adoptable				
3								
16	SWMH 6.1	1800	Manhole	Adoptable	Pond 1		Junction	
1	SWMH 7.3	1350	Manhole	Adoptable	SWMH 7.2	1350	Manhole	Adoptable
15.1					Pond 2		Junction	
P2	Pond 2		Junction		SWMH CON	1200	Manhole	Adoptable
4	SWMH 8.3	1350	Manhole	Adoptable	SWMH 7.2	1350	Manhole	Adoptable
7.2	SWMH 7.2	1350	Manhole	Adoptable	SWMH 7.1	1350	Manhole	Adoptable
2.000	SWMH 6.2	1350	Manhole	Adoptable	SWMH 6.1	1800	Manhole	Adoptable
1.000	SWMH 3.9	1200	Manhole	Adoptable	SWMH 3.8	1200	Manhole	Adoptable
1.001	SWMH 3.8	1200	Manhole	Adoptable	SWMH 3.7	1350	Manhole	Adoptable
1.002	SWMH 3.7	1350	Manhole	Adoptable	SWMH 3.6	1350	Manhole	Adoptable
1.003	SWMH 3.6	1350	Manhole	Adoptable	SWMH 3.5	1350	Manhole	Adoptable
1.004	SWMH 3.5	1350	Manhole	Adoptable	SWMH 3.4	1350	Manhole	Adoptable
1.005	SWMH 3.4	1350	Manhole	Adoptable	SWMH 3.3	1350	Manhole	Adoptable
1.006	SWMH 3.3	1350	Manhole	Adoptable	SWMH 3.2	1350	Manhole	Adoptable

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)
1.007	17.833	198.1	450	Circular	64.641	62.290	1.901	64.661	62.200	2.011
1.008	45.492	303.3	525	Circular	64.661	62.200	1.936	64.300	62.050	1.725
3.002	25.365	241.6	450	Circular	64.750	63.255	1.045	64.800	63.150	1.200

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.007	SWMH 3.2	1350	Manhole	Adoptable	SWMH 3.1	1500	Manhole	Adoptable
1.008	SWMH 3.1	1500	Manhole	Adoptable	Pond 2		Junction	
3.002	SWMH 7.1	1350	Manhole	Adoptable	SW HW 7	1350	Manhole	Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
SWMH 3.9	696720.010	732777.151	64.796	0.996	1200				
						0	1.000	63.800	300
SWMH 3.8	696801.320	732753.357	64.714	1.384	1200		1	1.000	63.330	300
							0	1.001	63.330	300
SWMH 3.7	696821.119	732775.509	64.840	1.650	1350		1	1.001	63.190	300
							0	1.002	63.190	450
SWMH 3.6	696826.881	732795.176	64.968	1.878	1350		1	1.002	63.090	450
							0	1.003	63.090	450
SWMH 3.5	696848.219	732867.364	64.926	2.196	1350		1	1.003	62.730	450
							0	1.004	62.730	450
SWMH 3.4	696859.521	732902.156	64.833	2.273	1350		1	1.004	62.560	450
							0	1.005	62.560	450
SWMH 3.3	696851.987	732904.150	64.899	2.369	1350		1	1.005	62.530	450
							0	1.006	62.530	450
SWMH 3.2	696866.585	732949.119	64.641	2.351	1350		1	1.006	62.290	450
							0	1.007	62.290	450
SWMH 3.1	696884.400	732949.929	64.661	2.461	1500		1	1.007	62.200	450
							0	1.008	62.200	525

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
SW HW 7	696720.940	732950.013	64.800	1.720	1350	 1	3.002	63.150	450
Pond 1	696832.642	732983.777	65.035	2.335		 1 0	16 P1	62.700 62.700	450 450
SWMH 6.1	696781.455	732992.481	64.747	1.907	1800	 1 0	2.000 16	62.840 62.840	450 450
SWMH 6.2	696731.451	732990.886	64.786	1.806	1350	 0	2.000	62.980	450
SWMH 7.2	696710.472	732883.959	64.809	1.359	1350	 1 2 0	1 4 7.2	63.450 63.450 63.450	300 300 450
SWMH 8.3	696808.598	732855.549	65.180	1.230	1350	 0	4	63.950	300
SWMH 7.3	696683.467	732789.993	64.791	0.891	1350	 0	1	63.900	300
SWMH 7.1	696723.637	732924.792	64.750	1.495	1350	 1 0	7.2 3.002	63.255 63.255	450 450
Pond 2	696911.310	732986.608	64.300	2.250		 1 2 0	P1 1.008 P2	62.050 62.050 62.050	450 525 300
SWMH CON	696942.496	733000.332	64.300	2.320	1200	 1	P2	61.980	300

Simulation Settings

Rainfall Methodology	FSR	Drain Down Time (mins)	1440
FSR Region	Scotland and Ireland	Additional Storage (m³/ha)	0.0
M5-60 (mm)	16.300	Check Discharge Rate(s)	✓
Ratio-R	0.270	1 year (l/s)	5.6
Summer CV	0.750	30 year (l/s)	13.0
Winter CV	0.840	100 year (l/s)	16.5
Analysis Speed	Normal	Check Discharge Volume	✓
Skip Steady State	x	100 year 1440 minute (m³)	997

Storm Durations

1440

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
100	20	0	0

Pre-development Discharge Rate

Site Makeup	Greenfield	Growth Factor 30 year	1.95
Greenfield Method	IH124	Growth Factor 100 year	2.48
Positively Drained Area (ha)	3.340	Betterment (%)	0
SAAR (mm)	754	QBar	6.6
Soil Index	2	Q 1 year (l/s)	5.6
SPR	0.30	Q 30 year (l/s)	13.0
Region	11	Q 100 year (l/s)	16.5
Growth Factor 1 year	0.85		

Pre-development Discharge Volume

Site Makeup	Greenfield	Return Period (years)	100
Greenfield Method	FSR/FEH	Climate Change (%)	0
Positively Drained Area (ha)	3.340	Storm Duration (mins)	1440
Soil Index	2	Betterment (%)	0
SPR	0.30	PR	0.344
CWI	116.148	Runoff Volume (m^3)	997

Node Pond 1 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	x	Sump Available	✓
Invert Level (m)	62.700	Product Number	CTL-SHE-0131-1000-2000-1000
Design Depth (m)	2.000	Min Outlet Diameter (m)	0.150
Design Flow (l/s)	10.0	Min Node Diameter (mm)	1500

Node Pond 2 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	x	Sump Available	✓
Invert Level (m)	62.050	Product Number	CTL-SHE-0120-6600-1050-6600
Design Depth (m)	1.050	Min Outlet Diameter (m)	0.150
Design Flow (l/s)	6.6	Min Node Diameter (mm)	1200

Node Pond 1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	1.0	Invert Level (m)	62.700
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	570

Depth (m)	Area (m^2)	Inf Area (m^2)	Depth (m)	Area (m^2)	Inf Area (m^2)	Depth (m)	Area (m^2)	Inf Area (m^2)
0.000	733.0	0.0	2.000	733.0	0.0	2.100	0.0	0.0

Node Pond 2 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	1.0	Invert Level (m)	62.050
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	1620.0	0.0	2.000	1620.0	0.0	2.100	0.0	0.0

Node SWMH 6.2 Flow through Pond Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Main Channel Length (m)	50.000
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	62.980	Main Channel Slope (1:X)	500.0
Safety Factor	1.0	Time to half empty (mins)	0	Main Channel n	0.350

Inlets

SW HW 7

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	50.0	0.0	1.800	500.0	0.0

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
100 year +20% CC 1440 minute summer	16.181	4.337	100 year +20% CC 1440 minute winter	10.874	4.337

Results for 100 year +20% CC 1440 minute summer. 2880 minute analysis at 30 minute timestep. Mass balance: 99.83%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
1440 minute summer	SWMH 3.9	750	63.909	0.109	23.5	0.1231	0.0000	OK
1440 minute summer	SWMH 3.8	750	63.448	0.118	23.5	0.1333	0.0000	OK
1440 minute summer	SWMH 3.7	750	63.292	0.102	23.5	0.1454	0.0000	OK
1440 minute summer	SWMH 3.6	750	63.187	0.097	23.5	0.1389	0.0000	OK
1440 minute summer	SWMH 3.5	2460	62.990	0.260	48.7	0.3716	0.0000	OK
1440 minute summer	SWMH 3.4	2460	62.990	0.430	48.7	0.6149	0.0000	OK
1440 minute summer	SWMH 3.3	2460	62.990	0.460	48.7	0.6576	0.0000	SURCHARGED
1440 minute summer	SWMH 3.2	2460	62.990	0.700	48.7	1.0013	0.0000	SURCHARGED
1440 minute summer	SWMH 3.1	2460	62.990	0.790	48.2	1.3953	0.0000	SURCHARGED
1440 minute summer	SW HW 7	1110	63.768	0.688	25.5	0.9842	0.0000	OK
1440 minute summer	Pond 1	1110	63.767	1.067	55.7	782.1359	0.0000	SURCHARGED
1440 minute summer	SWMH 6.1	1110	63.767	0.927	56.1	2.3604	0.0000	SURCHARGED
1440 minute summer	SWMH 6.2	1110	63.768	0.788	46.9	1.1272	0.0000	SURCHARGED
1440 minute summer	SWMH 7.2	1110	63.768	0.318	26.2	0.4549	0.0000	OK
1440 minute summer	SWMH 8.3	30	63.950	0.000	0.0	0.0000	0.0000	OK
1440 minute summer	SWMH 7.3	750	64.025	0.125	26.2	0.1790	0.0000	OK
1440 minute summer	SWMH 7.1	1110	63.768	0.513	26.2	0.7339	0.0000	SURCHARGED
1440 minute summer	Pond 2	2460	62.990	0.940	57.5	1522.3170	0.0000	SURCHARGED
1440 minute summer	SWMH CON	720	62.041	0.061	6.6	0.0000	0.0000	OK

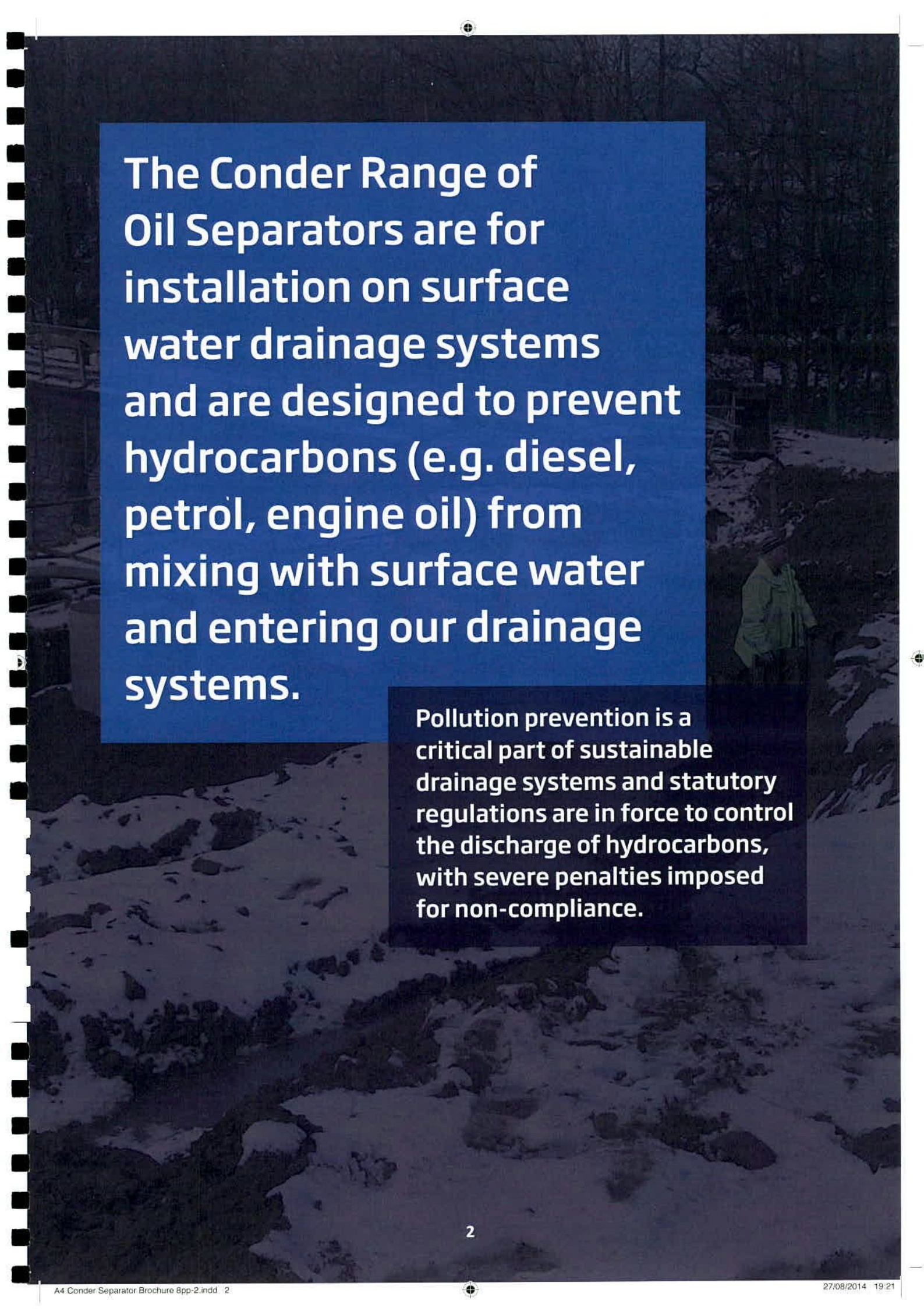
Link Event	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
1440 minute summer	SWMH 3.9	1.000	SWMH 3.8	23.5	0.965	0.285	2.0641	
1440 minute summer	SWMH 3.8	1.001	SWMH 3.7	23.5	1.008	0.309	0.6930	
1440 minute summer	SWMH 3.7	1.002	SWMH 3.6	23.5	0.908	0.104	0.5310	
1440 minute summer	SWMH 3.6	1.003	SWMH 3.5	23.5	0.671	0.105	3.5659	
1440 minute summer	SWMH 3.5	1.004	SWMH 3.4	48.7	1.014	0.222	4.5854	
1440 minute summer	SWMH 3.4	1.005	SWMH 3.3	48.7	1.064	0.244	1.2250	
1440 minute summer	SWMH 3.3	1.006	SWMH 3.2	48.7	1.045	0.212	7.4910	
1440 minute summer	SWMH 3.2	1.007	SWMH 3.1	48.2	0.924	0.210	2.8255	
1440 minute summer	SWMH 3.1	1.008	Pond 2	47.7	0.991	0.172	9.8278	
1440 minute summer	SW HW 7	Flow through pond	SWMH 6.2	23.5	0.054	0.029	105.3222	
1440 minute summer	Pond 1	P1	Pond 2	9.8	0.386	0.033	10.4841	
1440 minute summer	SWMH 6.1	16	Pond 1	55.7	0.904	0.334	8.2265	
1440 minute summer	SWMH 6.2	2.000	SWMH 6.1	41.8	0.619	0.246	7.9268	
1440 minute summer	SWMH 7.2	7.2	SWMH 7.1	26.2	0.784	0.121	5.9668	
1440 minute summer	SWMH 8.3	4	SWMH 7.2	0.0	0.000	0.000	3.5969	
1440 minute summer	SWMH 7.3	1	SWMH 7.2	26.2	1.062	0.349	3.9103	
1440 minute summer	SWMH 7.1	3.002	SW HW 7	25.5	0.463	0.123	4.0189	
1440 minute summer	Pond 2	P2	SWMH CON	6.6	0.551	0.132	0.4089	859.1

Results for 100 year +20% CC 1440 minute winter. 2880 minute analysis at 30 minute timestep. Mass balance: 99.84%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
1440 minute winter	SWMH 3.9	750	63.894	0.094	17.7	0.1058	0.0000	OK
1440 minute winter	SWMH 3.8	750	63.431	0.101	17.7	0.1144	0.0000	OK
1440 minute winter	SWMH 3.7	750	63.278	0.088	17.7	0.1256	0.0000	OK
1440 minute winter	SWMH 3.6	750	63.174	0.084	17.7	0.1208	0.0000	OK
1440 minute winter	SWMH 3.5	2610	63.079	0.349	36.7	0.5001	0.0000	OK
1440 minute winter	SWMH 3.4	2610	63.079	0.519	36.7	0.7432	0.0000	SURCHARGED
1440 minute winter	SWMH 3.3	2610	63.080	0.550	36.7	0.7865	0.0000	SURCHARGED
1440 minute winter	SWMH 3.2	2610	63.079	0.789	36.7	1.1297	0.0000	SURCHARGED
1440 minute winter	SWMH 3.1	2610	63.079	0.879	36.3	1.5541	0.0000	SURCHARGED
1440 minute winter	SW HW 7	1200	63.912	0.832	19.1	1.1902	0.0000	OK
1440 minute winter	Pond 1	1200	63.911	1.211	41.2	887.6472	0.0000	SURCHARGED
1440 minute winter	SWMH 6.1	1200	63.911	1.071	41.3	2.7267	0.0000	SURCHARGED
1440 minute winter	SWMH 6.2	1200	63.912	0.932	34.0	1.3332	0.0000	SURCHARGED
1440 minute winter	SWMH 7.2	1200	63.912	0.462	19.7	0.6608	0.0000	SURCHARGED
1440 minute winter	SWMH 8.3	30	63.950	0.000	0.0	0.0000	0.0000	OK
1440 minute winter	SWMH 7.3	750	64.007	0.107	19.7	0.1532	0.0000	OK
1440 minute winter	SWMH 7.1	1200	63.912	0.657	19.7	0.9398	0.0000	SURCHARGED
1440 minute winter	Pond 2	2610	63.080	1.030	45.7	1667.7950	0.0000	SURCHARGED
1440 minute winter	SWMH CON	690	62.041	0.061	6.6	0.0000	0.0000	OK

Link Event	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
1440 minute winter	SWMH 3.9	1.000	SWMH 3.8	17.7	0.895	0.214	1.6767	
1440 minute winter	SWMH 3.8	1.001	SWMH 3.7	17.7	0.933	0.233	0.5644	
1440 minute winter	SWMH 3.7	1.002	SWMH 3.6	17.7	0.838	0.079	0.4328	
1440 minute winter	SWMH 3.6	1.003	SWMH 3.5	17.7	0.624	0.079	4.9722	
1440 minute winter	SWMH 3.5	1.004	SWMH 3.4	36.7	0.944	0.167	5.3144	
1440 minute winter	SWMH 3.4	1.005	SWMH 3.3	36.7	0.985	0.184	1.2347	
1440 minute winter	SWMH 3.3	1.006	SWMH 3.2	36.7	0.982	0.160	7.4910	
1440 minute winter	SWMH 3.2	1.007	SWMH 3.1	36.3	0.887	0.159	2.8255	
1440 minute winter	SWMH 3.1	1.008	Pond 2	35.9	0.980	0.130	9.8278	
1440 minute winter	SW HW 7	Flow through pond	SWMH 6.2	17.1	0.051	0.021	141.6607	
1440 minute winter	Pond 1	P1	Pond 2	9.8	0.405	0.034	11.8529	
1440 minute winter	SWMH 6.1	16	Pond 1	41.2	0.891	0.247	8.2265	
1440 minute winter	SWMH 6.2	2.000	SWMH 6.1	30.7	0.620	0.180	7.9268	
1440 minute winter	SWMH 7.2	7.2	SWMH 7.1	19.7	0.818	0.091	6.7977	
1440 minute winter	SWMH 8.3	4	SWMH 7.2	0.0	0.000	0.000	3.5969	
1440 minute winter	SWMH 7.3	1	SWMH 7.2	19.7	0.979	0.262	4.2348	
1440 minute winter	SWMH 7.1	3.002	SW HW 7	19.1	0.473	0.092	4.0189	
1440 minute winter	Pond 2	P2	SWMH CON	6.6	0.551	0.132	0.4092	899.6

ANNEXURE B – LAYOUT DRAWINGS



The Conder Range of Oil Separators are for installation on surface water drainage systems and are designed to prevent hydrocarbons (e.g. diesel, petrol, engine oil) from mixing with surface water and entering our drainage systems.

Pollution prevention is a critical part of sustainable drainage systems and statutory regulations are in force to control the discharge of hydrocarbons, with severe penalties imposed for non-compliance.

Compliance

The Conder Range of Oil Separators fully conform to both the Environment Agency's latest PPG guidelines and European standard BSEN-858-1-2 and are proven to effectively separate oil and water. Under test, the Conder Bypass performed to less than 1 mg/l and in doing so guarantees minimal environmental impact and ensures public safety.

Classes of Separator

There are two classes of separator which are defined by performance.

Class 1

Class 1 Separators are designed to achieve a concentration of less than 5mg/l of oil under standard test conditions. These conditions are required for discharges to surface water drains and the water environment.

Class 2*

Class 2 Separators are designed to achieve a concentration of less than 100mg/l oil under standard test conditions and are suitable for dealing with discharges where a lower quality requirement applies such as discharges to the foul sewer.

*Class 2 available in forecourt separators only.

Selecting the Right Separator

Conder offers a full range of Separators for varying use and application:

- Bypass Separator
- Full Retention Separator
- Forecourt Separator
- Wash Down and Silt Separators

If you're unsure of what type of Conder Oil Separator you require please use the below chart to help you identify the most suitable product for your project.

The guidance given is for the use of separators in surface water drainage systems that discharge to rivers and soakways.

Is there a risk of oil contaminating the drainage from the site?

YES	YES	YES	YES	NO
Risk of infrequent light contamination and potential for small spills only e.g. car park.	Risk of regular contamination of surface water run off with oil and/ or risk of larger spills e.g. vehicle maintenance area, goods vehicle parking or vehicle manoeuvring.	Risk of regular Drainage will also contain dissolved oils, detergents or degreasers such as vehicle wash water and trade effluents e.g. industrial sites.	Fuel oils are delivered to and dispensed on site e.g. retail fuel forecourts.	Very low risk of oil contamination e.g. roofwater.
YES				YES
Source control SUDS must be considered and incorporated where suitable.				Separator not required.
IF NOT SUITABLE	YES	YES	YES	
By-pass separator with alarm required. Class 1 if discharge to surface water. Class 2 if discharge to foul sewer.	Full retention separator with alarm required. Class 1 if discharge to surface water. Class 2 if discharge to foul sewer.	Trade effluents must be directed to the foul sewer. It may need to pass through a separator before discharge to sewer to remove.	Full retention 'forecourt' separator with alarm required. Class 1 if discharge to surface water. Class 2 if discharge to foul sewer.	Clean water should not be passed through the separator unless the size of the unit increased accordingly.

The use of SUDS should be considered at all sites and they should be incorporated where suitable. SUDS can be used to polish the effluent from these separators before it enters the environment.

Source control SUDS should be considered where possible.

Separator Alarms

All oil separators are required by legislation to be fitted with an oil level alarm system with recommendations that the alarm is installed, tested, commissioned and regularly serviced by a qualified technician.

The alarm indicates when the separator is in need of immediate maintenance in order for it to continue to work effectively. Conder Aqua Solutions can offer a full technical and service package for a variety of alarm options.

The Conder Range of Bypass Separators

The Conder Range of Bypass Separators are used to fully treat all flows generated by rainfall rates of up to 6.5mm/hr. Bypass Separators are used when it is considered an acceptable risk not to provide full treatment for high flows, for example where only small spillages occur and the risk of spillage is small.

Typical Application

- Car parks
- Roadways and major trunk roads
- Light industrial and goods yards

Features and Benefits

- Innovative design
- Compact and easy to handle/install
- Fully compliant to the Environment Agency's PPG3 guidelines
- Low product and install costs
- Full BSI certification
- Exceeds industry standards
- Easy to service
- Fully tested and verified with a range from CNSB 3 to CNSB 1000 (Class 1)

Performance

Conder Bypass Separators have been designed to treat all flow up to the designed nominal size. Any flow in excess of the nominal size is allowed to bypass the separation chamber thereby keeping the separated and trapped oil safe.

How it Works

Step 1

During the early part of a rain storm, which is a time of high oil contamination, all of the contaminated water flow passes through the sediment collection chamber and enters the separation chamber through a patented oil skimming and filter device.

Step 2

All of the oil then proceeds to the separation chamber where it is separated to the Class 1 standard of 5 mg/l and safely trapped.

Step 3

As the rainstorm builds up to its maximum and the level of oil contamination reduces significantly, the nominal size flow continues to pass through the separation chamber and any excess flow of virtually clean water is allowed to bypass directly to the outlet.

Specification

Larger models up to CNSB 1000 are available.

Area Drained (m^2)	Tank Code including Silt	Length including Silt (mm)	Silt Capacity (L)	Oil Storage Capacity (L)	Diameter (mm)	Height (mm)	Base to inlet Invert (mm)	Base to outlet Invert (mm)	Access (mm)
1667	CNSB3s/21	1400	300	45	1026	2200	1730	1680	750
2500	CNSB4.5s/21	1785	450	67.5	1026	1875	1270	1220	600
3333	CNSB6s/21	1975	600	90	1026	1875	1270	1220	600
4444	CNSB8s/21	2165	800	120	1026	1875	1270	1220	600
5555	CNSB10s/21	2485	1000	150	1026	1875	1270	1220	600
8333	CNSB15s/21	2670	1500	225	1210	2150	1450	1400	600
11111	CNSB20s/21	3115	2000	300	1210	2150	1450	1400	600
13889	CNSB25s/21	3555	2500	375	1210	2150	1450	1400	600
16667	CNSB30s/21	3470	3000	450	1510	2690	1770	1720	750
22222	CNSB40s/21	4040	4000	600	1510	2690	1770	1720	750
27778	CNSB50s/21	4655	5000	750	1510	2690	1770	1720	750
33333	CNSB60s/21	4415	6000	900	1880	3300	2025	1975	2 x 600
44444	CNSB80s/21	5225	8000	1200	1880	3300	2025	1975	2 x 600
55556	CNSB100s/21	6010	10,000	1500	1880	3300	2025	1975	2 x 600

Note: It is a requirement of PPG3 that you have a silt capacity either in your tank or in an upstream catch pit.

The Conder Range of Full Retention Separators

The Conder Range of Full Retention Separators are designed to treat the full flow that can be delivered by a drainage system, which is normally equivalent to the flow generated by a rainfall intensity of 65mm/hr. Full Retention Separators are used where there is a risk of regular contamination with oil and a foreseeable risk of significant spillages.

Typical Application

- Sites with hi-risk of oil contamination
- Fuel storage depots
- Refuelling facilities
- Petrol forecourts
- Vehicle maintenance areas/workshops
- Where discharge is to a sensitive environment

Features and Benefits

- All surface water is treated
- Automatic closure device (ACD) fitted as standard

Performance

All Conder Full Retention Separators have an automatic closure device (ACD) fitted as standard. This is compulsory for all PPG3 compliant Full Retention Separators and prevents accumulated pollutants flowing through the unit when maximum storage level is reached.

How it Works

Step 1

Contaminated water enters the separator where the liquid is retained for a sufficient period to ensure that the lighter than water pollutants (such as oil, petrol) separate and rise to the surface of the water.

Step 2

The decontaminated water then passes through the coalescing filter before it is safely discharged from the separator, with the remaining pollutants being retained in the separator.

Step 3

Retained pollutants must be emptied from the separator once the level of oil is reached, or the oil level alarm is activated. This waste should be removed from the separator under the terms of The Waste Management Code of Practice.

Specification Larger models available upon request.

Area Drained (m^2)	Tank code Incl. Silt	Length including Silt (mm)	Slit Capacity (L)	Oil Storage Capacity	Diameter (mm)	Height (mm)	Base to inlet Invert (mm)	Base to outlet Invert (mm)
222	CNS4s/11	2319	400	40	1026	1655	1295	1245
333	CNS6s/11	3414	600	60	1026	1655	1295	1245
444	CNS8s/11	3197	800	80	1210	1855	1480	1430
556	CNS10s/11	3957	1000	100	1210	1855	1480	1430
833	CNS15s/11	3870	1500	150	1510	2180	1780	1730
1111	CNS20s/11	5060	2000	200	1510	2180	1780	1730
1667	CNS30s/11	5369	3000	300	1880	2560	2030	1980
2222	CNS40s/11	7059	4000	400	1880	2560	2030	1980
2778	CNS50s/11	4080	5000	500	2600	3315	2730	2680
3333	CNS60s/11	4805	6000	600	2600	3315	2730	2680
3889	CNS70s/11	5529	7000	700	2600	3315	2730	2680
4444	CNS80s/11	6254	8000	800	2600	3315	2730	2680
5556	CNS100s/11	6751	10,000	1,000	2600	3315	2730	2680

Note: It is a requirement of PPG3 that you have a silt capacity either in your tank or in an upstream catch pit.

Conder Range of Forecourt Separators

Conder Forecourt Separators have been designed for specific use in petrol filling stations and other similar applications. The size of this separator has been specifically increased in order to retain the possible loss of the contents from one compartment of a road tanker, which could be up to 7,600 litres.

Forecourt separators are an essential infrastructure requirement for all forecourts so as to ensure compliance with both health and safety and environmental legislation.

Application Areas

- Petrol forecourts
- Refuelling facilities
- Fuel storage depot

Features and Benefits

- All surface water is treated
- Available in Class 1 and Class 2
- Automatic Closure Device (ACD) fitted as standard
- Includes 2000L silt capacity

Performance

All Conder Forecourt Separators have an automatic closure device (ACD) fitted as standard. This is compulsory for all PPG3 compliant Full Retention Separators and prevents accumulated pollutants flowing through the unit when maximum storage level is reached.

How it Works

Step 1

Contaminated water enters the separator where the liquid is retained for a sufficient period to ensure that the lighter than water pollutants (such as oil, petrol) separate and rise to the surface of the water.

Step 2

The decontaminated water then passes through the coalescing filter before it is safely discharged from the separator, with the remaining pollutants being retained in the separator.

Step 3

Retained pollutants must be emptied from the separator once the level of oil is reached, or the oil level alarm is activated. This waste should be removed from the separator under the terms of The Waste Management Code of Practice.

Specification

Tank Code	Volume (L)	Length (mm)	Diameter (mm)	Height (mm)	Base to inlet (mm)	Base to outlet (mm)	Access (mm)
ANO/11*	10000	4250	1800	2100	1600	1550	750
ANT/12**	10000	4250	1800	2100	1600	1550	750
LNO/11***	10000	4250	1800	2100	1600	1550	750

*Class 1 Forecourt Separator suitable for discharging to surface water drains

**Class 2 Forecourt Separator suitable for discharging to foul drains only

*** Class 1 Forecourt Separator suitable for installation in granular materials

Conder Range of Washdown and Silt Separators

Conder Washdown and Silt Separators are for use in areas such as car washes, pressure wash facilities or other cleaning facilities and must be discharged to the foul water drainage system in accordance with PPG13.

Application Areas

- Car wash facilities
- Tool hire depots
- Pressure washer facilities

Features and Benefits

- Available in 1,2 and 3 stage options
- Efficient silt and hydrocarbon removal

Performance

The Environment Agency's PPG13 requires that discharge from pressure washers must discharge to a foul drainage system. Where there is no foul drainage available, the effluent must be contained within a sealed drainage system or catchpit for disposal by a licenced waste contractor.

Silt build-up is the primary concern with washdown facilities and so the Conder range of washdown and silt separators are used to remove the silt and will allow some separation of hydrocarbons.

Detergents that are used in wash down areas will break down and disperse hydrocarbons (hindering the separation process). Therefore it is important to remember the main function of wash down separators is to remove silt.

How it Works

Step 1

Contaminated wash down water enters the unit where the heavier solids, silts, settle to the bottom of the tank.

Step 2

The lighter liquids, hydrocarbons, will rise to the surface and be retained within the tank.

Step 3

Treated water will exit the separator via the dipped outlet.

Specification

Although it is recognised that single stage separators give the most efficient separation, 2 and 3 chamber Conder Washdown and Silt Separators are available on request.

Tank Code	Capacity (L)	Silt Storage	Diameter (mm)	Length (mm)	Access Diameter (mm)	Base to Inlet Invert (mm)	Base to Outlet Invert (mm)
CWS2/12	2000	1000	1000	2713	600	1290	1240
CWS3/12	3000	1500	1200	2853	600	1475	1425
CWS4/12	4000	2000	1200	3737	600	1475	1425
CWS6/12	6000	3000	1500	3636	600	1775	1725
CWS8/12	8000	4000	1800	3443	600	2030	1980
CWS10/12	10000	5000	1800	4250	600	2030	1980

FST Silt Trap

Large quantities of silt can be associated with washdown areas. The Conder FST silt trap is ideal for easy removal of silt either manually or by a waste disposal contractor.

The FST range of silt traps are available with varying grades of covers from B125 up to E600 to allow installation in all types of vehicle or plant washdown facilities.

Conder Range of Alarm Systems

All separators must be fitted with an alarm in order to provide visual and audible warning when the level of oil reaches 90% of its storage volume, as required by The Environment Agency's PPG3.

The alarm system will then be triggered to indicate that the separator is in need of immediate emptying, in order to continue effective operation.

Features and Benefits

- Option for installation at a remote supervisory point
- Audible and visual
- Eliminates unnecessary waste management visits
- Easy installation
- Audible, visual and text message alert alarm systems available

Mains Powered System

Mains powered alarm systems are best suited to new build situations or sites where installation of the necessary cabling and ducting is straight forward and economical. The probe located in the separator will, when surrounded by floating hydrocarbons, activate an alarm condition on the remote panel to advise that the unit requires emptying.

Solar Powered System (Flashing Beacon)

This option requires no mains power supply or any significant cabling and ducting, making it extremely economical for large sites and retro fitting alarms to existing oil separators. A High Intensity Beacon will flash when a problem is detected.

Solar GSM Alarm

The Solar GSM alarm sends a status report on your separator to a mobile phone number of your choice. The status of the GSM alarm can also be tested at any time by simply sending a pre-recorded text message, via your directed mobile phone, for added peace of mind.

Peripherals

Coalescing Filters

The Conder Coalescing Filter is designed to separate residual oil in already separated oil/water and ensures a discharge quality of less than 5mg/litre of oil in water.

Features and Benefits

- Handle for easy removal and cleaning
- Flashing beacons (with option of siren kit)
- Kiosks
- Probe brackets
- Bas 1000 intrinsically safe junction box
- High level probe
- Silt level probe
- Oil level probe

Servicing

The Environmental Agency's PPG3 guidelines stipulate that every 6 months, and in accordance with manufacturer's instructions, experienced personnel should carry out maintenance to both the separator and alarm.

Conder and our service partners can offer a full technical and service package including separator and alarm installation, commissioning, oil and silt removal and route service contracts.

CONDER AQUA SOLUTIONS
A PREMIER TECH AND EPS JOINT COMPANY

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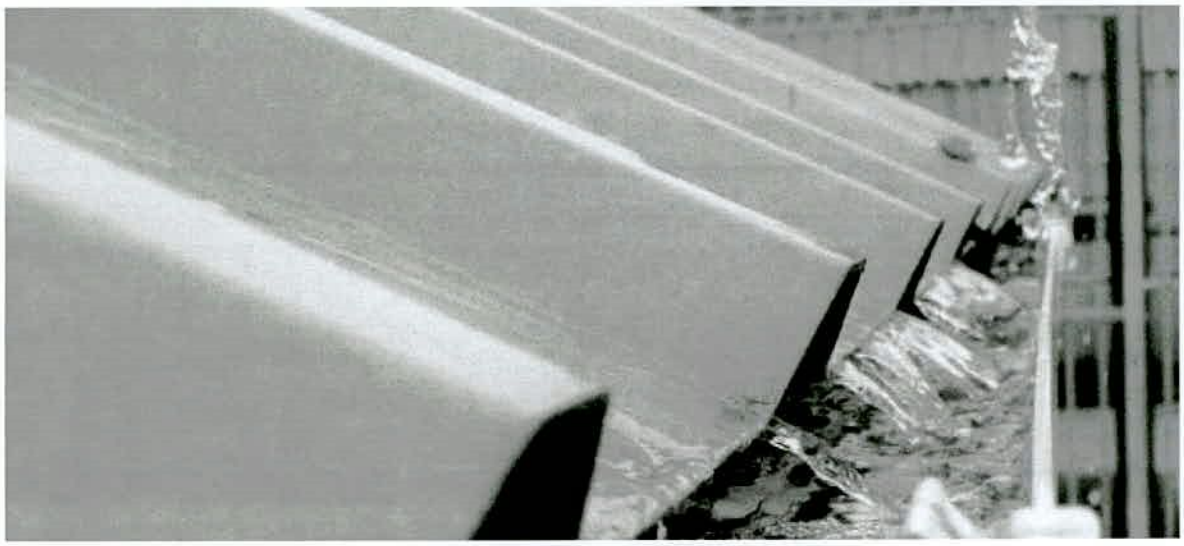
ANNEXURE D – RAINWATER HARVESTING DETAILS

Tri-Cel Package Rainwater Harvesting System.
A simple package solution, complete with a tri-cel rain control centre & tank.
- Overground & underground systems available –
- Pump direct to the services or to a header tank –



The tri-cel rain harvesting system is a simple solution for taking "free" rainwater off the roof on commercial or domestic buildings and reusing this water to flush toilets or as process water in factories etc. As water metering becomes more prevalent in Europe, using free Rainwater is an easy cost saving solution available to all.

Our simple system uses a tank (underground or overground) and a control centre. Almost any capacity in a single tank, either as an underground or overground system is available. A pressure controlled pump feeds the rainwater through a special pipework system to the building. If there is insufficient rainwater, only the required amount of water is drawn from the mains water supply, however the system always favours the rain harvesting tank. Once more rainwater becomes available, the system comes back online and the mains water is automatically shut off.

"Clean Water"
The rainwater is filtered from the roof using a volume filter (roof sizes up to 350m2 (larger filters available up to 3,000m2). Multiple filters may be required for different down pipes.

Overground systems are suitable for ground level or in a basement, reducing the costs of underground excavations & installation and are suitable for existing buildings. Our experienced site crews will assemble the tank and commission the system on site, all you have to do is plumb to the building. Underground systems, only a manhole and small control cabinet are visible after installation. Again we commission the system on site.

Introduction.

Today, we are using more water than ever before according to a Cambridge water study. Luxurious showers, large jacuzi baths, and manicaured gardens have all added to this rise in water usage. Although we sometimes feel, that its always raining, the water still has to be pumped, cleaned, treated and piped to meet our demands. All water goes through the same process, even the water for toilets.

The toilet.

A third of all domestic water used goes down the toilet. The average person uses about 150 litres of water per day. A bath uses 90 litres, 45 litres for a 5 minute shower, 110 litres for a washing machine and 45 litres for a dishwasher

Commercial applications.

Commercial water varies depending on the application, but large hotels, airporst and football grounds can waste a lot of water, literally flushing money down the toilet.

Commercial water charges

Ireland. Water charges are payable if water is being supplied for use by business, trade or manufacture. This includes hospitals, sanatoriums, homes for people with mental or physical disabilities, maternity homes, convalescent homes, laboratories, clinics, health centres, schools or clubs. Water rates vary and information can be found at local County Council level.

Drinking Rainwater.

We DO NOT recommend drinking harvested rainwater. Rainwater should only be used for flushing toilets and urinals. If to be used as process water, testing may be required to ensure compliance with local legislation. Harvested rainwater comes from roofs, and filtering typically only remove leaves moss etc. Filters will not remove, Legionella, Cryptosporidiosis, bacteria or excrement from birds, bats etc. Even with UV treatment, water would require regular testing etc, and we DO NOT recommend even for use in hand washing.

Potable Water Tanks

Underground tanks are not acceptable as "Potable Water Tanks" by the Irish Local Authorities, due to the possibilities of leeching from damage caused by underground growths, earth movements etc.

Scope.

1. Rainfall

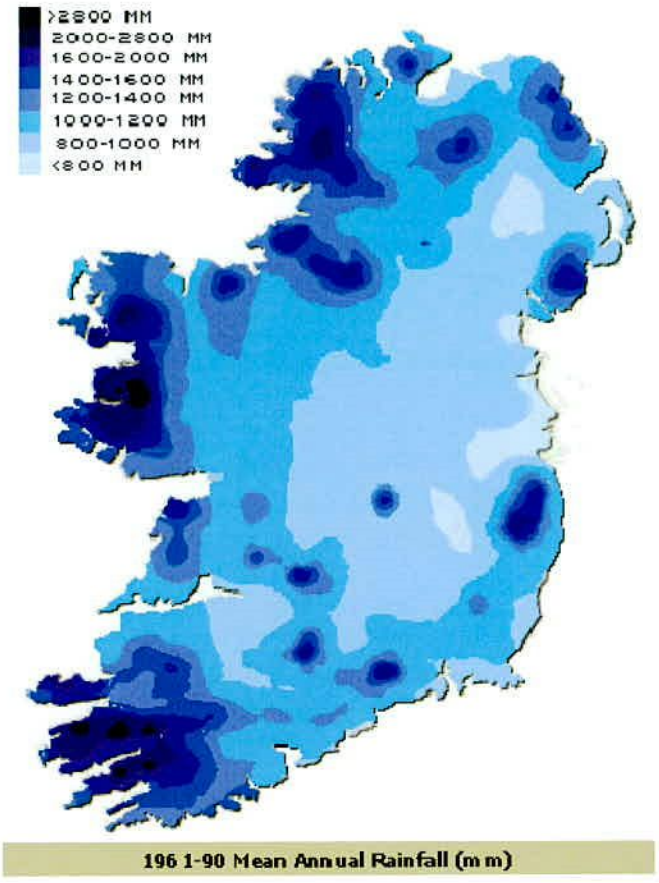
Rainfall in Ireland.

Most of the eastern half of the country has between 750 and 1000 millimetres (mm) of rainfall in the year. Rainfall in the west generally averages between 1000 and 1250 mm. In many mountainous districts rainfall exceeds 2000mm per year. The wettest months, almost everywhere are December and January. April is the driest month generally but in many southern parts, June is the driest. Hail and snow contribute relatively little to the precipitation measured.

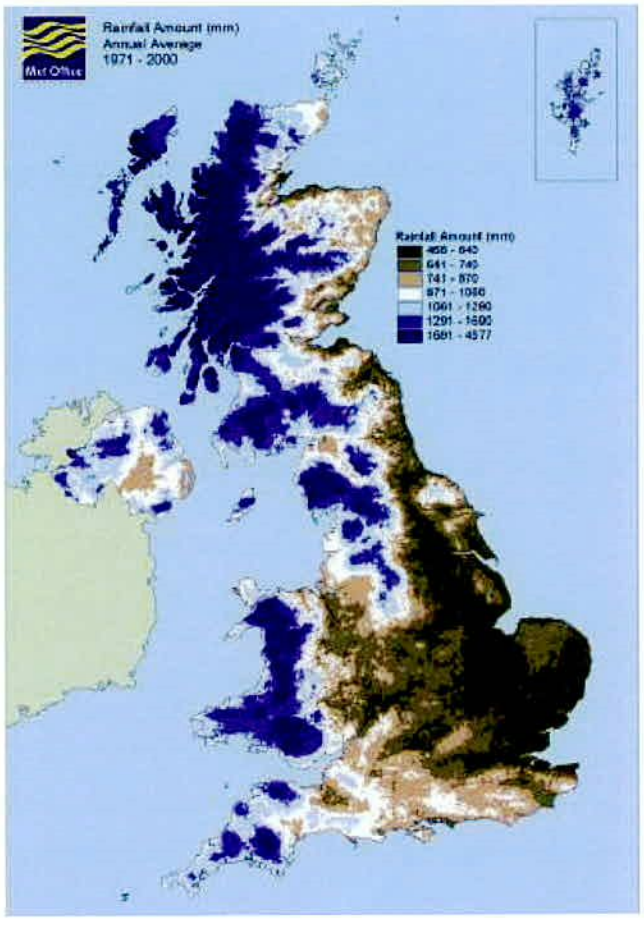
.

Rainfall in England, Scotland & Wales.

Rainfall in England varies widely. The Lake District is the wettest part, with average annual totals exceeding 2,000 mm, comparable with the western Highlands of Scotland). The Pennines and the moors of south-west England are almost as wet. However, all of East Anglia, much of the Midlands, eastern and north-eastern England, and parts of the south-east receive less than 700 mm a year. Typically, it rains on about one day in three in England, more often in winter, though long, dry spells occur in most years. Near the south coast there is a maximum of rainfall, with totals in July barely half those in January; western, northern and eastern coasts are more likely to see the driest month in spring and the wettest in late autumn. Inland for example, at London and Birmingham, thunder occurs on an average of 15 days a year, but in the west and north-west the frequency declines to around eight days per year. Facts and figures. Maximum in a day (09-09 UTC): 279 mm at Martinstown (Dorset) on 18 July 1955.



196 1-90 Mean Annual Rainfall (mm)

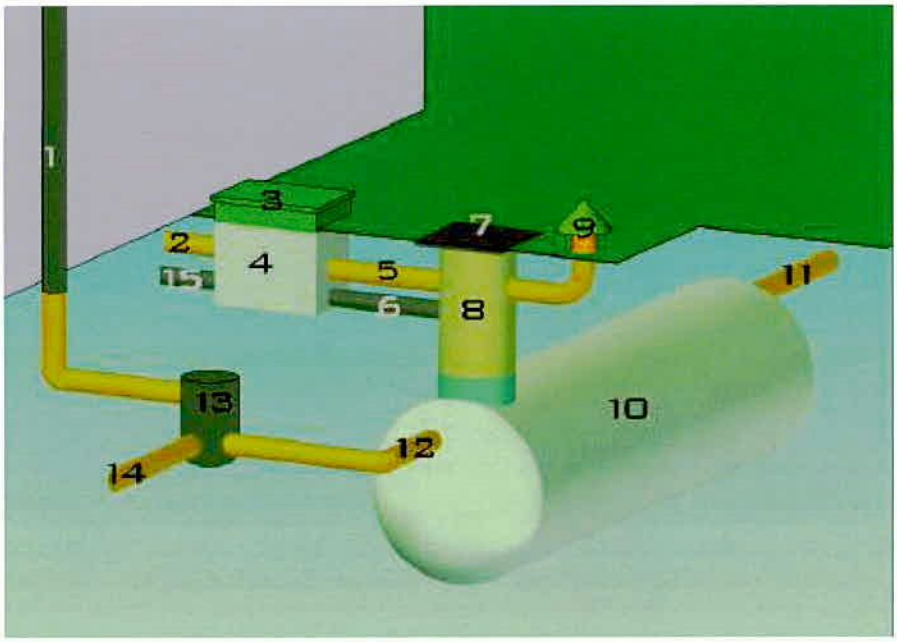


System sizing. (Source Environment Agency, UK)

Rainfall can be sporadic, but the tank size is usually less than imagined. As a guideline, size the tank of the system to hold 18 days worth of demand. Or 5% of annual yield, whichever is lower. To calculate the optimum tank size, first calculate the potential yield. Once you know the potential yield, simply find 5% of this.

Roof area in m2 x drainage factor x filter efficiency x annual rainfall in mm x 0.05.

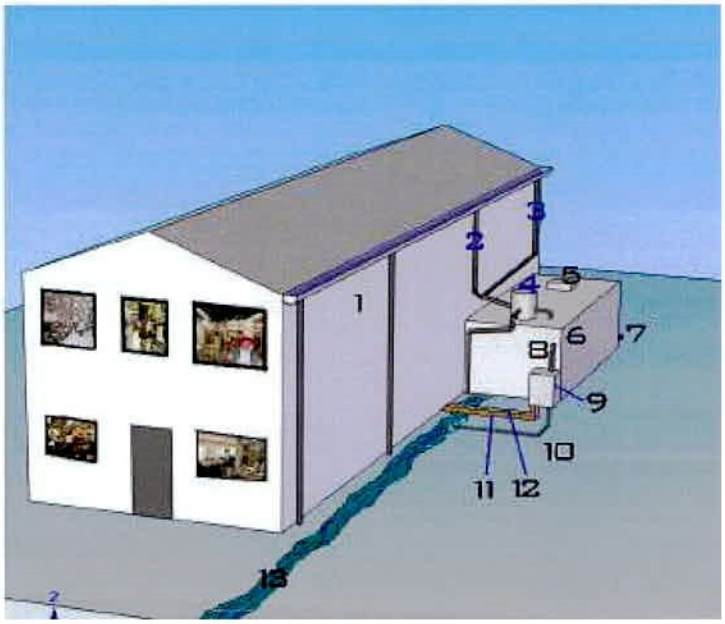
2. The Tri-Cel Package Rainwater Harvesting System.



1. Building down-pipe to filter
2. 4" duct, for Rainwater to services
3. TCRC Tank cover
4. TCRC Tank
5. 4" duct, for rainwater suction from the tank
6. 4" duct, for overflow to the rainwater tank
7. Manhole cover
8. Tank shaft
9. Vent
10. Tank
11. Overflow to storm drain
12. Harvested water inlet from filter
13. Filter
14. Overflow to storm drain
15. 4" duct for back-up mains water connection

Underground and over ground solutions. Typically overground tanks are placed into basements or existing buildings whereby an underground installation is undesirable. Overground systems can offer a more cost effective solution, not requiring excavations, groundworks etc. Package system consisting of an underground or overground tank, a TCRC Tank with tri-cel rain centre, filter with extension, calmed inlet with dip pipe, floating suction filter with hose and overflow siphon. Header tank system is also available.

1. Building
2. Down pipe
3. Down pipe
4. Filter with overflow to storm drain and pipe to fill the rainwater harvesting tank
5. Tank cover
6. Rainwater harvesting tank
7. Rainwater tank overflow to storm drain
8. Pump suction pipe for removing rainwater from tank
9. Kiosk for Tri-Cel rain centre
10. Overflow to storm drain
11. Duct for mains back up water pipe
12. Duct for rainwater delivery to WC's
13. Storm drain



Drawing not to scale. Drawing is for indicative purposes only.

3. Components:

Tri-cel rain centre. The tri-cel rain centre is a ready to connect compact central unit for rainwater harvesting and can be used with any tank, over or underground. The modular design ensures ease of installation and consists of a-mains back-up tank with an integrated mechanical float valve for reliable water supply. The rainwater centre microprocessor controls the entire sequence of functions and ensures reliable performance. The display provides information on the actual state of operation. If the censors detect that there is no rainwater available in the tank, the 3-way valve switches over to mains water. Once rainwater is again available, the centre automatically switches back, ensuring that recycled water is primarily used.

Filtering the rainwater

Tri-Cel VF filter (WISY filters available to 3,000m2)

The Tri-Cel VF filter, filters leaves, moss and other debris from the water, ensuring cleanliness of water supplied. For roof areas of up to 350m2, the filter requires very little maintenance. Dirt is directly flushed away from the rainwater harvesting system. 80% to 95% of the rainwater is cleaned and fed into the tank for reusing. The filter inside of VF1 is s/s and can easily be cleaned, as opposed to being replaced. Telescopic extensions are available (right hand photo). As an extra precaution in areas with lots of leaves, a Down pipe filters "Rainus" also aid filtration.

Optional "Rainus" – downpipe filter.

WISY Filters: WISY WFF 100, 150, 300 suitable for roofs up to 200m2, 500m2 & 3,000 m2 respectively.

Calmed inlet.

The dip pipe & calmed inlet ensures a non-turbulent supply of rainwater into the tank. This slow flow of water helps in preventing sediments from being stirred up.

Floating suction filter.

The Floating suction filter is used for taking rainwater from the tank. The floating ball ensures that the water is always taken from the cleanest layer (the top of the tank). Included are a non-return valve, dirt collector and hose connection

Siphon.

Siphon for tank overflow with stench trap, rodent stop and connection for backwash.

4. Tri-Cel rain centre Technical information.

Tri-Cel rain centre

The "tri-cel rain centre".

- Pump.
- Armoured cable.
- Tank contents gauge.
- Pressure switch
- Dry run protection.
- Rainwater outlet.
- System control panel.
- Pressure gauge.
- Capillary tube for pressure indication.
- Float valve inlet for mains back up.
- 3-way valve. Mains back up water tank.
- Connection for maximelder.
- The rain centre is housed in the TRRC Tank, which is partially buried.

The Tri-Cel rain centre can be used as a rain water system control unit for all standard rainwater tanks. It can be retrofitted above or below ground. The pump, the processor units and all other elements are modularly arranged around the mains water reserve tank, a highly compact, plug and play solution. This compact system design incorporates the reserve tank with a mechanical float valve, which ensures reliable and safe water supply. The microprocessor-controlled Tri-Cel rain centre controls the entire system and ensures superior reliability.
Tri-Cel rain centre uses rainwater from the collection tank. If the tank is empty, the Tri-Cel rain centre uses a sensor to switch to mains water supply from the reserve tank via a 3-way valve. A short rain shower is sufficient for the Tri-Cel rain centre to switch back to rain water supply. An integrated level indicator shows the level in the rainwater tank. The system will work with either above or belowground.

TCRC Tank dimensions	**1060 x 760 x 680mm**
Dimensions tri-cel rain centre H x W x D	**600 x 650 x 300mm**
Weight tri-cel rain centre empty	**27.5 kg**
Weight tri-cel rain centre with water	**45 kg**
Capacity of reserve tank	**18 litres**
Operating temperature	
Water	**+ 4°C to + 35°C**
Ambient	**+ 4°C to + 40°C**
Supply voltage	**230V ac, 50Hz**
Maximum consumption	**1500 VA**
Maximum motor power	**550 W**
Maximum pumping height	**40 m**
Maximum pressure	**4.0 bar**
Maximum capacity	**4,500 litres / hour**
Maximum suction height	**8 m**
Maximum distance – tank to control unit	**15 m**
Emergency overflow	**DN50**
Protection class	**1 (EN 60335-1)**
Protection rating	**IP42 (EN 60529)**
Electrical safety	**According to EN 60335-1**
Mains in pipe	**¾ " BSP**
Pipework carrying rainwater to services	**1" BSP**
Suction pipework from RWHS	**1" BSP**

5. Pumping to a Header tank

Our header tank system differs from the standard system, whereby the harvested rainwater is pumped to a "Header" tank in an attic and the services are then drawn from there, for use in WC's. The Tri-Cel Rainwater Harvesting Tank will collect rainwater as with the standard system. This water will then be pumped via the Tri-Cel Rain Centre or a submersible pump up into an attic header tank, (available in standard sizes with a cover up to 9000 litres (2,000 gallons) in a one-piece tank or as a sectional tank of any capacity). The pump, pumps the rainwater via a LOWARA GENYO 16A R15-25. This is an electronic pressure / flow switch for control and protection of electric pumps. It has an Adjustable start Pressure of 1.5 ÷ 2.5 bar. The header tank will have 2 ball valves, one standard mains ball valve, which will be set at a lower position than the rainwater ball valve. In the first instance, rainwater will always fill the header tank. If rainwater is unavailable, the level in the header tank will drops to a pre set level, and then the mains water will automatically maintain the header tank levels. When more rainwater enters the RHH Tank, it will automatically enter the header tank.

6. Tanks used with the rainwater harvesting system "RHS"

Underground tanks: 3,000 litres to 150, 000 litres in one single tank. Recent tri-cel rain harvesting systems include from left, domestic system 3.5m3 system, 16m3, 30m3 & 75m3 systems.

Typical arrangement, underground tanks.

Tank with access manway, TCRC Tank containing the tri-cel rain centre, inlet from down pipe and overflow to storm drain.

Overground tank: One-Piece to 9,000 litres and any other capacity (any length x any width x 3m high)

Overground installations.

Overground installations offer a suitable cost effective solution especially in existing builds, whereby costly excavations can be avoided. The systems are suitable for either indoor (typically in a basement) or outdoor. Our package system can offer a relatively maintenance free system, whereby the tanks and the tri-cel rainwater centre require minimal maintenance. Overground tanks are built on site by KMG Killarney Plastics Ltd dedicated site crews and commissioned at that time. We can offer a bespoke package to suit all of your rainwater harvesting requirements.

Filter placed on the tank roof for ease of installation.

7. *The operations manual*

The operations manual details the following: Commissioning, Operation, Inspection and Maintenance, Troubleshooting

Systems component		Inspection		Maintenance	
		Interval		Interval	
		Annually	Monthly	Annually	Monthly
1	Tank	YES			
2	Float valve		YES	YES	
3	Reinforced/pressure Suction hose		YES		
4	Controller		YES		
5	Pump with switch		YES	Every 1000 h or 5 years	
6	Sensor and suction Sieve/filter	YSE		When the collector is checked	

Inspection and Maintenance

The tri-Cel rain centre system comprises components, which require inspection and maintenance. Inspections may be performed by the owner/operator of the system, however KMG Killarney Plastics Ltd are pleased to offer a "Servicing Contract to maintain your system"

Potable "Drinking" water.

Rainwater is NOT always suitable to be considered Potable water. Rainwater also contains pollutants, soil, plant parts, insect parts, bacteria, algae, and sometimes, radioactive materials that the rain/snow has washed out of the air. If filtered and or boiled, you could probably drink the water safely. However, it is safer yet to get your water from municipal water supplies or from wells that are frequently tested. The classification of a water as potable (i.e. fit for drinking) or otherwise is not just based on the opinion of an individual analyst, but on the requirements of the 1988 "Drinking Water Regulations" made by the then Minister for the Environment. The drinking water regulations cover a total of 53 bacteriological, chemical and physical parameters for each of which an upper concentration limit or MAC is specified, source "EPA the quality of drinking water in Ireland 2002".

Underground "POTABLE" tanks are unacceptable to the Irish Local Authorities due to the possibility of leeching and the lack of inspection possibilities and are therefore unavailable.

Above ground tanks are available as Rainwater Harvesting Systems and we recommend that not consume or wash, shower etc in rainwater.

Format 30 Potable Water Tanks are available from KMG Killarney Plastics Ltd, to suit all of your POTABLE water requirements and these are fully compliant with Irish, UK and EU legislation.

8. *Glossary of terms*

Access Shaft Extensions

Loose shafts should be sealed using s/s bolts, silicon sealant, sikaflex or similar prior to installation to prevent ingress of groundwater under high water table conditions. It is the contractor's responsibility to ensure a watertight seal.

Connections.

Only RH Kit connections are supplied with the system. Standard connections are supplied, however plumbing to the building is the responsibility of others.

Installation guidelines for GRP cylindrical underground tanks and overground tanks available on request (separate document).

Construction.
Underground tanks are to be manufactured from GRP and supplied by KMG Killarney Plastics Ltd. The GRP construction will contain glassfibre and polyester resins. The walls are rigid, self-supporting and cylindrical in shape, suitable for "man weight". Overground systems are constructed from Hot press moulded Sheet Moulding Compound panels. KMG Killarney Plastics Ltd are Europe's largest manufacturer of Hot Press SMC panels.

Control of Groundwater
Tanks must not be subjected to buoyant forces during installation, taking account of ground water levels and surface water run-off, and their accumulation in the tank pit, even if tanks are anchored. The excavation area should be adequately drained, in order to permanently remove ground water from the proximity of the tank (or tanks). This is critical in order to avoid flotation of the tanks. Incorrectly installed tanks that move, rotate or float may be damaged, and KMG Killarney Plastics Ltd, will not be liable for this damage. The excavation should be maintained dry by pumping or whatever suitable means until the cover depth reaches 300mm minimum above the tank. Refer to the technical manual.

Dimensions and tank capacities.
Underground tanks: Standard Diameter sizes: 1.5m, 1.7m, 1.8, 2.5m and 3m. Standard Lengths are 2.2m to 15m. Standard capacities from 3.5m3 to 150m3 in a single tank and multiple tanks can be connected. Dia 1.7m: 3m3 to 3.5m3, Dia 1.8m: 5m3 to 40m3, Dia 2.5m: 16m3 to 80m3, Dia 3.0m: 60m3 to 150m3, Dia 4.0m: on request
Sectional tanks: sectional tanks are in general 0.5m to 3m in height, any length and any width. Capacity 1m3 to 1,200 m3 and larger

Electrical Installation of the unit.
All electrical work to be carried out by competent person using suitable materials for the application. Electrical work must be carried out strictly to the manufacturer's instructions and to 'The National Rules For Electrical Installations' (ETCI) published by the 'Electro-Technical Council Of Ireland' or equivalent UK / EU regulations. Supply voltage: 230V 50hz. We recommend armoured cable be brought to the TCRC Tank and that a waterproof plug and socket are used.

Loadings
The tanks are designed to take a man-weight loading. Tanks are not suitable for vehicular or animal loadings.

Manways & turrets.
Standard underground tank, include manways of dia. 750mm. GRP shaft standard height is 0.7m. Covers are not supplied but must be fitted. Sectional tanks have a lockable manway fitted to the system.

Manway covers and Fencing.
Once the system has been completely installed, we recommend that a suitable lockable manhole, be put in place in order to prevent access by unauthorised people that could fall into the tank and be harmed. We also recommend that a fenced area may be required to ensure that access is restricted to the system and control cabinet. Access must be restricted to suitable trained maintenance personnel only. It is imperative that entry is not possible whereby (especially) children can be caused harm, by falling into the system. Local authority / government regulations, must be adhered to in relation to fence specifications and design.

Plumbing the system.
Competent ground-works site personnel should connect the plumbing from the building to the system. The system is only for rainwater from roof areas, not car parks etc. Do not plumb water or storm-water from drains, footpaths, car parks etc, into the rainwater harvesting system. The TRRC Tank will have a 4" (100mm ID) pipe, which must be plumbed to the rainwater storage tank. The mains back-up must be plumbed to the mains. The 1" BSP to the services (WC's) must be plumbed.

- **A mains-shut off must be fitted to the system by the mechanical contractors. This is required for maintenance and/or replacement of parts.**
- **A bypass valve must be fitted, in order to be able to manually bypass the system during power outages.**
- **The onsite mechanical contractors are to ensure that all plumbing connections are leak free.**

System orientation.
Your system may be constructed from 1 or more tanks depending on your requirements. The orientation of the tanks in general will be in series. We recommend that when the system arrives on site that it is inspected for damage, from miss-handling etc. If any damage is seen or suspected, please notify us immediately. Refer to installation instructions, available on request.

TCRC Tank for Tri-Cel Rain Centre:
The tri-cel rain centre will be placed into a separate underground tank, the TCRC Tank. This lockable tank is to be partially buried, leaving the grass green part overground. The tank will house all of the components belonging to the tri-cel rain centre and must be connected to the system via a 4" (100mm ID) pipe(s). The tank must remain waterproof, and any other drilled holes must be sealed against ingress of water. This pipe will need a rope laid placed in it, in order to pull through the hoses, plumbing works etc. Run the pipework from the 110mm connection on the cabinet to the manway shaft. The tank is normally laid in wet cement. Ensuring that you are a maximum of 2 meters from the system, prepare a suitable location. Ensure that the tank is placed dead level in the cement.

- An optional overground Kiosk is available, in place of the TCRC Tank. The Kiosk is green and 980mm width x 700mm depth x 1200mm height. There is an additional cost. Please consult sales.

Ventilation
Ventilation is crucial to the system.

9. Safety Precautions.
Safety is paramount, and "best practices" should be followed at all times in relation to the system. Health & Safety legislation must be followed at all times.

10. Terms & Conditions:
Subject to Killarney Plastics Ltd standard terms and conditions, available on request. Killarney Plastics Ltd. believe that the information contained is accurate, and is printed for information only. No warrants, express or implied, are contained therein, nor does any legal liability attach to Killarney Plastics Ltd. for any reason whatsoever. Property rights of the subject belong to Killarney Plastics Ltd., and transfer of these rights is not granted by possession of this document. KMG Killarney Plastics Limited shall not be liable for any damage or loss, including consequential loss, caused by the failure of any equipment.

In accordance with Killarney Plastics Ltd normal policy of product development, this specification is subject to change without notice. Aug 2008.

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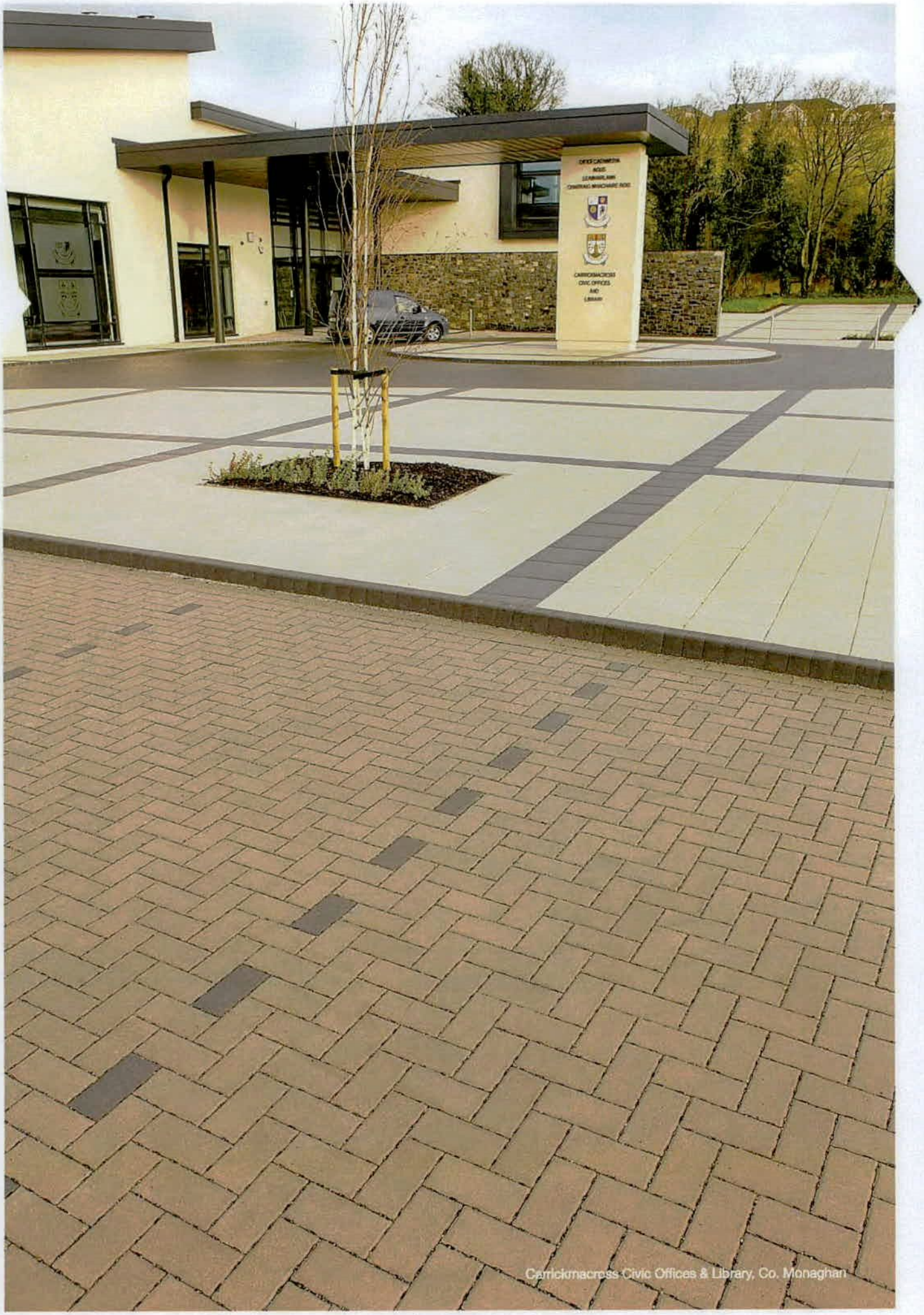
ANNEXURE E – PERMEABLE PAVING DETAILS

Clima-Pave™

Permeable Paving Solutions

Kilsaran

ideas taking shape



Carrickmacross Civic Offices & Library, Co. Monaghan

Clima-Pave™

The rapid development of previously green-field sites and the associated creation of impermeable areas such as roofs, car parks and footpaths will mean that at project conception stage there will be potentially large volumes of surface water to be dealt with. Traditionally this has been done by piping the surface water into storage tanks or discharging it into nearby streams or surface water drainage. This method of drainage is not currently favoured by planners and designers, as it simply moves the surface water downstream where it still has to be dealt with. This is especially important where large volumes of water need to be dealt with during heavy rainfall events. Piping large volumes of water into streams and rivers increases the risk of flooding and also allows for the potential pollution of local water courses and drinking water supplies.

Sustainable Urban Drainage Systems (SUDS) and Water Source Control

Planners are encouraging the use of Sustainable Urban Drainage Systems (SUDS) in all new developments, in particular the use of appropriate source control techniques is important as this allows for the containment of the surface water collected on the site and for this surface water to be dealt with on-site as opposed to traditionally draining it off-site. SUDS, as a sustainable development approach to Surface Water Design Techniques, has the aim of balancing the following:

1. **To manage water run-off from developed areas to similar quantities prior to development (Source Control)**
2. **Reduce and avoid incidences of downstream flooding**
3. **To protect or enhance water quality of the run-off**
4. **To improve or enhance the amenity where possible**

Advantages of Permeable Paving

- Permeable Paving is a 'source control' method. Water is managed and dealt with on-site without piping off to storage tanks or surface water treatment systems
- The Water Framework Directive (Directive 2000/60/EC) requires that surface water discharges are managed to ensure that risk of contamination or pollution are mitigated. Permeable paving systems filter contaminants by microbial action. There is no requirement for additional filtering/polishing with Permeable Paving in normal use
- Separate attenuation tank systems are not required
- No need for gullies or channels or conventional drainage
- Recharges ground water
- Roofs, roads and other non-permeable areas can be discharged into permeable paving (No gullies required)
- No ponding or surface water
- Collected water can potentially be re-used for non-potable purposes
- Improves water quality

Clima-Pave™, the permeable paving solution from Kilsaran, offers an advantage over traditional SUDS techniques, such as storm water attenuation tanks. This is because the stone based sub-base, which needs to be installed for any type of surfacing material, is adapted to an open graded material in permeable paving systems. This allows the water collected from the site to be stored in the pavement and either infiltrated back into the ground or discharged at a controlled rate into the surface water drainage system.

The Clima-Pave™ system is constructed using our specially engineered permeable paving block, which has enlarged joints on all sides, typically 4-8mm in width. When the blocks have been laid, a corresponding slot is formed between the paving blocks which are then filled with a clean 3mm aggregate. This allows water to rapidly drain from the surface down into the pavement.

Traditional block paving is laid on a sand bedding layer and a Type 1/CL. 804 sub-base. To allow for storage and infiltration of the surface water percolating through the block, permeable block paving is laid on a grit laying course instead of sand and an open-graded stone sub-base instead of Type 1/CL. 804.

Clima-Pave™
Permeable Paving Solutions

Advantages of Clima-Pave™ for your project

Clima-Pave™ from Kilsaran offers the widest range of permeable paving products for use in commercial, retail and civic projects.

Kilsaran can also offer a full site-specific permeable paving design for your project, taking into account the site ground conditions, drainage requirements and structural and traffic loading requirements for the site. This is a chargeable service and Kilsaran will provide an indemnified design provided by our nominated Consulting Engineer who will visit the site if required to appraise the installation.

Clima-Pave™
Technical Information

- Design Guidance
- Permeable Paving Aggregates
- Materials for HGV Trafficked Pavements
- Typical Design Diagrams
- Construction & Maintenance Guidelines

Design Guidance

Clima-Pave™ permeable paving provides a structural pavement suitable for both pedestrian and vehicular traffic depending on design. The water management and permeable functionality of the pavement is largely dependent on the correct specification and design of the pavement to meet the unique requirements of the individual site. The correct specification, testing and installation of aggregates is of paramount importance with any permeable paving system to ensure the finished pavement meets both initial and long term design requirements.

We advise that all permeable pavements require a site-specific design which should be carried out in accordance with BS 7533-13:2009 'Pavements constructed with clay, natural stone of concrete pavers. Part 13 Guide for the design of permeable pavements constructed with concrete paving blocks and flags, natural stone slabs and setts and clay pavers'.

We can provide a design service to customers who require a site specific design to be carried out for their project. In order to carry out this, we require a completed Clima-Pave™ Permeable Paving Design form available to download from our website, from our Sales team or can be requested by emailing technical@kilsaran.ie. This form should be returned via email with the supporting information about the site to enable a design to be carried out.

The information required includes:

- **Drawings of proposed site layout in AutoCad**
- **Full existing and proposed site levels for the pavement**
- **Full site investigation report to establish ground conditions and soaked CBR values of the sub-grade at formation level**
- **Infiltration values from soak-pit testing to BRE 365**
- **Overall drainage design strategy for the site**
- **Planning requirements or conditions for the site relating to paving and drainage (e.g. discharge limits)**
- **Any other pertinent site specific information or client / contractor requirements**

Design Guidance Basics

The below information is provided for guidance purposes only at project conception stage to allow appraisal of a permeable pavement system. Full independent advice should be sought from both the Consulting Engineer and the Contractor prior to the commencement of works. A full site-specific design will always be required in accordance with the above guidelines and BS 7533-13:2009.

The design information below is based on BS 7533-13:2009 which should also be consulted at project appraisal stage.

Types of Permeable Pavement

There are three main types of permeable pavement commonly used on sites:

System A – Full Infiltration: All water from the pavement is infiltrated to the ground

Suitable for sites with good ground conditions, higher CBR values and soils which will readily allow water to dissipate through the ground. These favourable conditions are rarely encountered on larger sites.

System B – Partial Infiltration: Most water infiltrated to ground with excess water piped off

Suitable for sites with medium ground conditions. The soil will infiltrate some of the water in the system. When storm events occur and water builds up in the system due to the soil being at capacity for drainage, perforated pipes are laid in the bottom of the sub-base to deal with the excess, taking it to the surface water drainage system. This is the most commonly used type of permeable pavement.

System C – Fully Tanked System: No water is allowed to infiltrate to ground

This type of system is used where poor sub-grade drainage conditions exist (heavy clays), where the stability of the sub-grade would diminish if extra surface water was introduced, or where ground water levels are within 1 metre of the formation level (system could gain water). In this system the sub-base acts essentially as an attenuation tank, wrapped in an impermeable polythene membrane and all water is piped out.

Selection of Pavement Type

The type of permeable pavement system to be adapted is based primarily on site ground conditions, site suitability and the permeability values of the sub-grade encountered on site from infiltration soak-pit testing. Table 1 gives guidance on the suitability of the three types of permeable pavement system.

Table 1: Guidance on selection of a pavement system

		System A - total infiltration	System B - partial infiltration	System C - no infiltration
Permeability of subgrade defined by coefficient of permeability, *k* (m/s)	10^{-4} to 10^{-3}	✓	✓	✓
	10^{-6} to 10^{-5}	✗	✓	✓
	10^{-10} to 10^{-8}	✗	✗	✓
Highest recorded water table within 1000mm of formation level		✗	✗	✓
Pollutants present in subgrade		✗	✗	✓

Selection of Pavement Sub-Base Thickness

The design of the sub-base for the permeable pavement should take into account the traffic loadings likely to use the pavement. It is essential to take into account any future increase in traffic volume and any HGV traffic which may use the pavement irrespective of how frequent. The correct loading category should be then selected from Table 2 taking into account the above considerations. It should be noted that no layers of the permeable pavement are designed for site traffic to use them and when finished the permeable pavement surface should not be trafficked by site traffic vehicles which are heavier than that for which the pavement was designed. It is advisable to complete paving works after all other work in the vicinity has been completed.

Typical build up details for each traffic category are illustrated on page 20 and 21 for guidance purposes.

Table 2: Loading Categories

1 DOMESTIC PARKING	2 CAR	3 PEDESTRIAN	4 SHOPPING	5 COMMERCIAL	6 HEAVY TRAFFIC
No Large Goods Vehicles	Emergency Large Goods Vehicles only	One Large Goods Vehicles per week	Ten Large Goods Vehicles per week	100 Large Goods Vehicles per week	1000 Large Goods Vehicles per week
Zero standard axles	**100 standard axles**	**0.016msa**	**0.15msa**	**1.5msa**	**15msa**
Patio	Car Parking Bays and Aisles	Town/city Pedestrian Street	Retail development delivery access route	Industrial Premises	Main road
Private Drive	Railway Station platform	Nursery Access	School/college access road	Lightly Trafficked Public Road	Distribution Centre
Decorative feature	External Car Showroom	Parking area to residential development	Office block delivery route	Light Industrial development	Bus Station (bus every 5 minutes)
Enclosed Playground	Sports Stadium Pedestrian route	Garden centre external display area	Deliveries to small residential development	Mixed retail/ industrial development	Motorway Truck Stop
Footway with zero vehicle overrun	Footway with occasional overrun	Cemetery Crematorium	Garden centre delivery route	Town Square	Bus Stop
	Private drive/ footway crossover	Hotel Parking	Fire Station Yard	Footway with regular overrun	Roundabout
		Airport Car Park with no bus pickup	Airport Car Park with bus to terminal	Airport landside roads	Bus Lane
		Sports Centre	Sports Stadium access route/ forecourt		

msa = millions of standard 8,000 kg axles

Sub-Base Thickness For Water Storage

The sub base depth must also take into consideration the water storage requirements for the site. The depth of sub-base may have to be adjusted to allow for increased site specific water storage. Further guidance on hydraulic factors can be found in BS 7533-13:2009 section 5.4.

Adjustment To Pavement Design For Low CBR Sub-Grade

In the case of CBR values below 5%, either ground improvement work will be required for the site, or the thickness of the coarse graded aggregate sub-base will have to be adjusted in accordance with 5.6.3 and table 9 of BS 7533-13:2009

Permeable Paving Aggregates

All materials used as permeable paving aggregate must comply to the grading and physical requirements below, as well at the general requirements of BS EN 12620 and BS EN 13242. Sub-base laying course materials should be clean, sound, non-friable and sound crushed rock material. Rounded gravel materials are not recommended for sub-base layers. The jointing material may be either clean crushed material or clean gravel material. The materials should be tested to confirm that it meets the requirements below.

The contractor shall also ensure that on-going deliveries to site are checked frequently for grading, shape and inspected to ensure cleanliness.

During installation on site, great care and attention must be paid to ensure that the aggregates are kept free of contamination and deleterious matter. Construction traffic cannot be allowed to traverse the layers of permeable paving aggregates during installation.

4/40mm Coarse Graded Permeable Paving Aggregate

Sieve Size (mm)	Percentage Passing
80	100
63	98-100
40	90-99
31,5	-
20	25-70
10	-
4	0-15
2	0-5

4/20mm Coarse Graded Permeable Paving Aggregate

Sieve Size (mm)	Percentage Passing
40	100
31,5	98-100
20	90-99
10	25-70
4	0-15
2	0-5

2/6.3mm Laying Course Paving Aggregate

Sieve Size (mm)	Percentage Passing
14	100
10	98-100
6.3	80-99
2	0-20
1	0-5

3mm Jointing Grit

Sieve Size (mm)	Percentage Passing
40	100
8	100
6.3	95-100
4	85-99
2	15-35
1	0-10
0.063	0.0-1.5

Property	Category to BS EN 13242 or BS EN 12620
Grading	4/20 (preferred) or 4/40 as per table above
Fines Content	F4
Shape	FI20
Resistance to Fragmentation	LA30
Water Absorption to BS EN 1097-6:2000	WA2
For water absorption > 2% Magnesium Sulfate Soundness	MS18
Resistance to Wear	MDE20
Acid Soluble Sulfate Content	AS0.2
Total Sulfur	≤1% by mass
Recycled Aggregates	Seek guidance from Kilsaran Technical Department

Materials for HGV Trafficked Areas

For loading category 3 and above as detailed in Table 2 page 17, these pavement types are designed to accommodate HGV traffic either on an occasional or more frequent basis. The pavement structure therefore requires a 'stiffening layer' to accommodate the HGV traffic which exerts significantly increased loading on the pavement. This stiffening layer can be either a hydraulically-bound coarse graded aggregate (porous no fines concrete) as detailed below and shown on the section details on pages 20 and 21 or alternatively a 80mm thick layer of DBM macadam as detailed below.

DBM Macadam Material

The DBM material should be an AC 32 Dense Base complying with the requirements of BS EN 13108-1 and should be supplied and installed to meet the requirements of BS 594987:2010. The DBM should be punctured after installation at 750mm centres with 100mm diameter holes. The holes should be fully filled and compacted with the appropriate coarse graded permeable paving aggregate as used in the layer underneath.

Hydraulically-Bound Coarse Graded Aggregate (Porous No Fines Concrete)

Porous concrete provides a stiffening transfer layer in concrete block permeable pavements which are to receive heavier traffic loads. The lack of sand (fines) in the mixture allows the material to act as a transfer drainage layer, whereby the open-graded matrix of the material allows for 20%-30% voids within the compacted volume of the material. Special measures are to be taken in the production, installation and curing of this material. Kilsaran can provide information and guidance on this upon request.

Product Standard	BS EN 14227-1
Material Compositon	Hydraulically Bound Coarse Graded Aggregate is a mixture of a coarse aggregate (usually 20mm nominal size), cement and water.
Typical Compressive Strength	Class C5/6 in accordance with IS EN 14227-1,Table 2 Line 4. Other strength classes available upon request from supplier.

Typical Design Diagrams

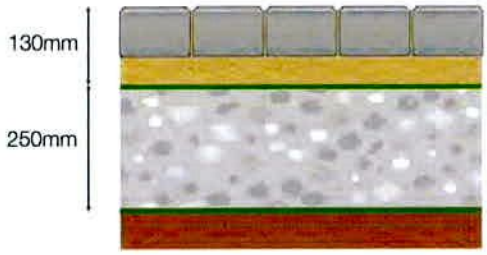
Below are typical build-up details for permeable pavement systems based on BS 7533-13:2009. These diagrams are based on ideal site conditions for drainage and CBR values of 5% or greater. The diagrams are for project appraisal purposes only and in all cases a site specific design in accordance with BS 7533-13:2009 will be required.

Key:

- 2 / 6.3mm Laying Course
- Hydraulically-Bound Coarse Graded Aggregate or 80mm of DBM Macadam
- 4 / 20mm Coarse Graded Aggregate and /or 4/40mm Coarse Graded Aggregate
- Capping Material
- Approved Geotextile
- Approved Impermeable Membrane

System A & B (Infiltrating & Partial Infiltration Systems)

LOAD CATEGORY 1



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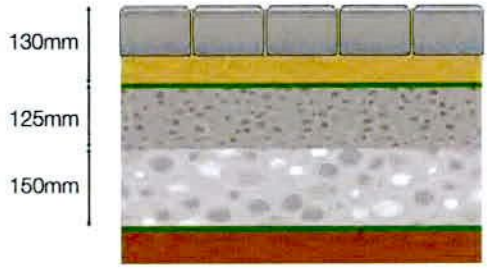

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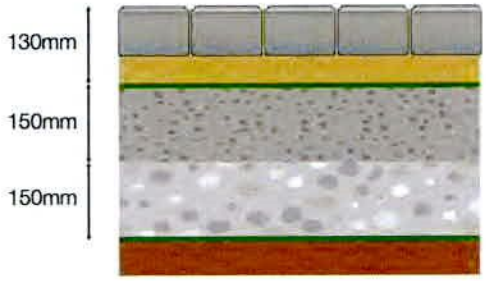

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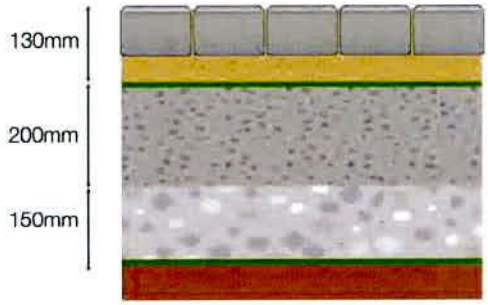

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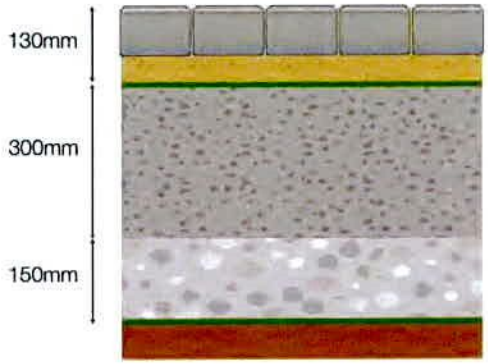

Alternative build up / materials may be used depending on project specific details.

For load categories 3-6 the hydraulically-bound coarse graded aggregate (porous no fines concrete) layer may be replaced with 80mm depth of DBM Macadam to act as a stiffening layer. The macadam layer should be punctured at 750mm centres on grid. Further details on the DBM macadam layer are given on page 19.

Where the depth of aggregate sub-base is in excess of 350mm for the given loading category, it may be possible to reduce the depth of aggregate required and provide a more cost effective design with the use of an appropriate and approved geo-grid. This can be appraised at design stage.

System C (Fully Tanked/Bunded)

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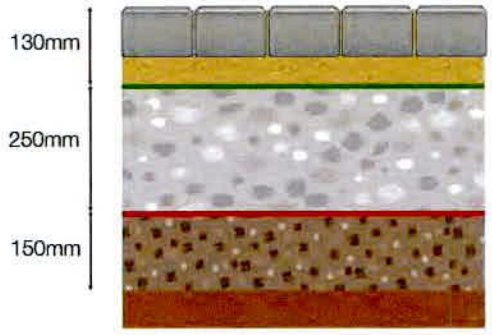

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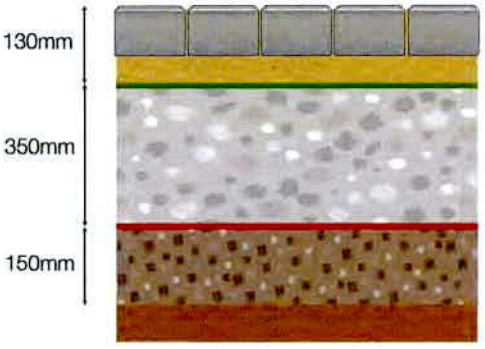

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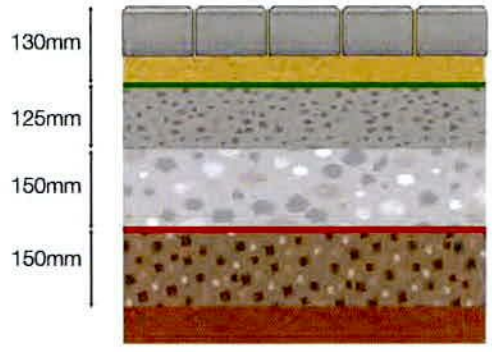

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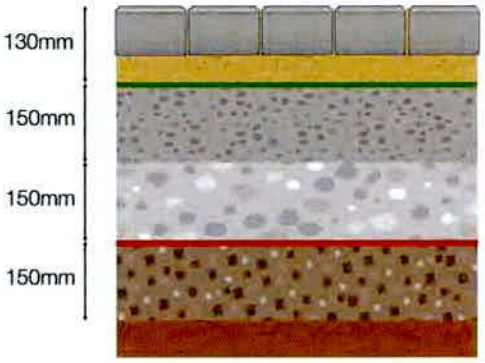

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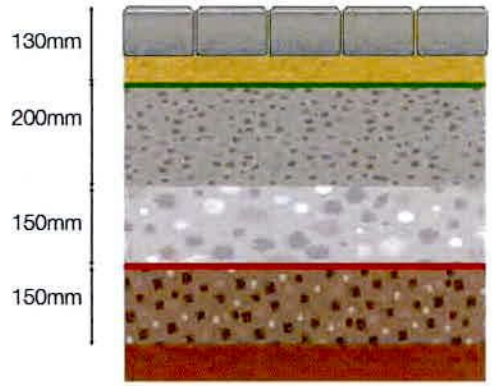

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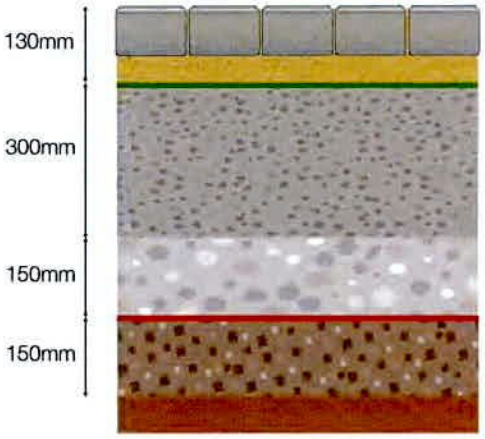
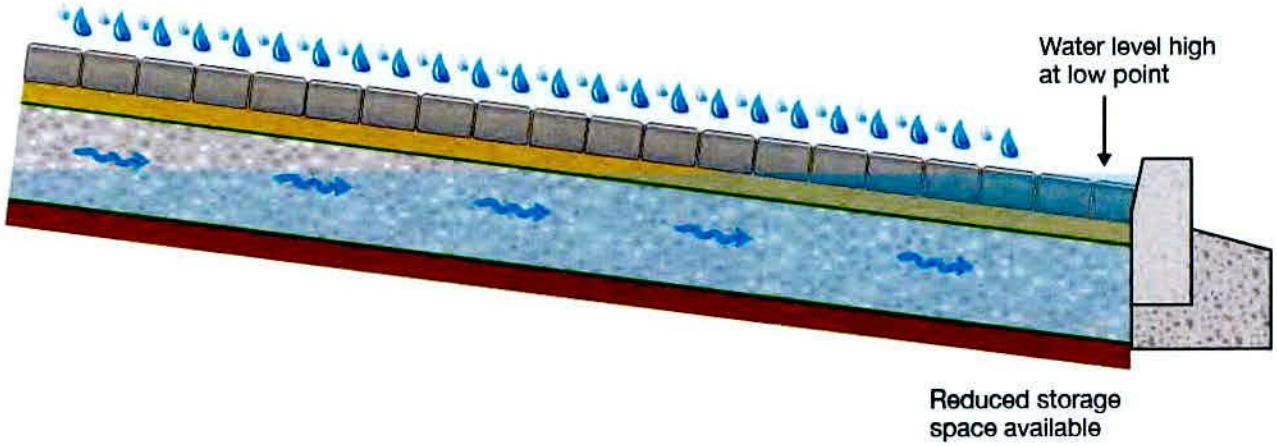


In the case of System C (fully tanked permeable pavements) there is always a requirement for 150mm depth of capping to be used beneath the impermeable membrane as shown above. The capping material should be approved by the Engineer and should comply with either the NRA Specification for Roadworks Series 600 or the Specification for Highway Works Series 600. The material should be tested before and during supply for full compliance, and should be compacted in accordance with the series 600 requirements. The capping layer should be blinded immediately before laying the impermeable membrane to prevent puncturing the membrane.

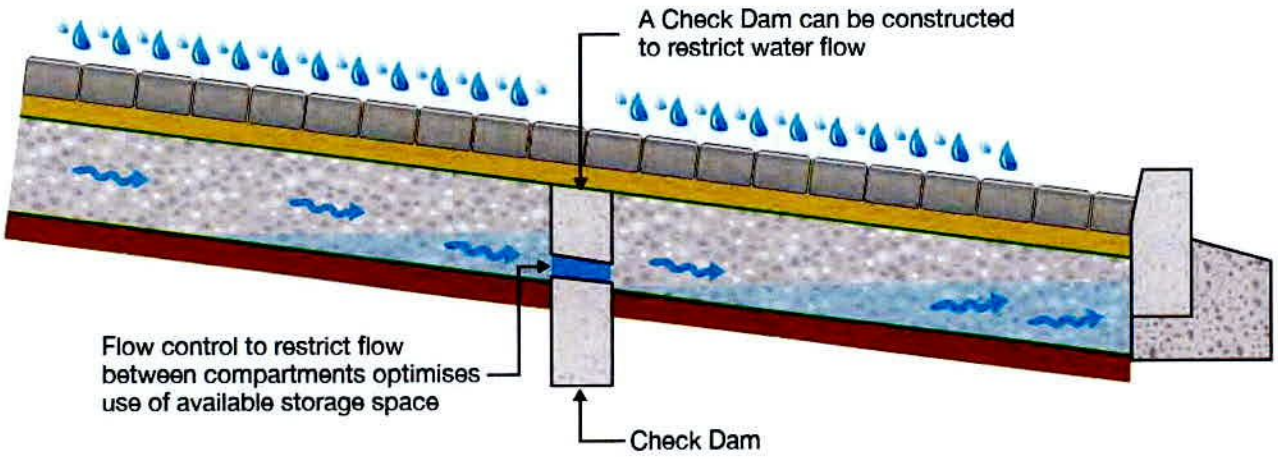
The requirement for using capping material may be eliminated by carrying out a design using an appropriate geo-grid which would negate the requirement for both the capping material and may also reduce the total depth of sub-base stone required.

Sloping Sites

On sloping sites water will naturally collect at the lowest point of the pavement. If sharp falls are allowed on site this will reduce the effective water storage capacity of the sub-base aggregate. In order to minimise this effect, gradients should be at a maximum 1 in 20 and preferably 1 in 30 or better.



Where sloping sites are unavoidable due to site layout, it will be necessary to reduce any sharp falls to maintain the water attenuation capacity of the system. This can be achieved by creating 'dams' in the sub-base of the pavement which will 'step' the pavement sub-base and reduce the overall falls. On extreme slopes, the pavement can be terraced with a step down and a dam between the two levels to restrict water flow.



Construction & Maintenance Guidelines

Construction

To ensure correct performance and durability of a permeable pavement, a fully detailed design should be carried out in accordance with BS 7533-13:2009 taking into account all site specific requirements for the project. Construction should be carried out strictly in accordance with BS 7533-13:2009 and BS 7533-3. All materials to be used shall be tested for full compliance to the above standard both before supply and during construction. It is also advised not to use any of the layers of permeable pavement construction for site traffic unless the build-up has been specifically designed to accommodate this. Additionally site equipment such as tele-handlers and forklifts should not be used on the paving surface after construction has been completed unless the pavement has been designed to accommodate this.

Maintenance

Permeable pavements should not be contaminated with soft landscaping materials, soil, detritus or general dirt as this may wash into the pavement. Also the pavement should not be trafficked by construction traffic or unsuitably heavy vehicles above that for which the pavement was designed.

To keep any growths or weeds to a minimum it is advised that the installed permeable paving be sealed with an appropriate sealer. Where the paved area is beneath overhanging trees or in a very damp area, an annual treatment of an environmentally friendly weed killer can be applied. Note the weed killer should be applied as directed by the supplier and only in very dry weather where rain is not expected, active weed killer could be washed into the sub-system otherwise. The manufacturer's instructions for all treatment products should be followed in detail.

The pavement should be inspected on a routine basis and carefully swept as required using a mechanical sweeper or by hand for smaller areas. The sweeping action may remove some of the jointing grit from the surface, the joints must be topped up after sweeping if required.

Should silting or blocking of the joints occur after a period of years, the use of a suitable jet wash and suction sweeper should be used to remove the defective material. It is likely that the jetting of the pavement will remove some grit. This grit should be replaced as required.

As with conventional block pavements, depressions, rutting and cracked or broken blocks which may be a structural concern or a hazard to users should be remedied as soon as possible. All joints must be maintained full at all times.

Permeable pavements will drain relatively quickly compared with other types of surfacing, and are not as liable to freezing over of standing water, hoar frosts may occur which can cause surface slip on any material. The use of de-icing salts on permeable pavements, as with any other concrete surface, should be kept to a minimum as the chlorides in the salt will penetrate the concrete and excessive use will damage the surface. Any de-icing material applied should not cause blockage or clogging of the permeable pavement joints (if blockage occurs in localised areas this will need to be removed by suction sweeper and joints topped up with appropriate jointing grit). It should also be considered that any de-icing material used will drain into either the sub-grade or the drainage system through the permeable pavement. Care should be taken to ensure no contamination of water courses or drainage systems. De-icing materials should be applied to the paving surface before ice or snow covers the surface to prevent damage.

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