Kevin McShane Ltd

Engineering Drainage Assessment Report

Proposed Extension to Kiltipper Woods Care Home
At
Tallaght, Dublin

Kevin McShane Ltd.
555 Lisburn Road
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Kevin McShane Ltd

Prepared by: .....
Brian Pope
Chartered Civil Engineer

Checked by: .....
K McShane
Managing Director

Approved by: .....
K McShane
Managing Director

Rev No	Comments	Checked by	Approved by	Date

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Telephone: 004428 9560 9798

Job No: 21-182

Date Created 14 Feb 22

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Contents

Table of Figures

Kevin McShane Ltd.
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1. Introduction

Kevin McShane Ltd. were commissioned to undertake an Engineering Drainage Assessment report for a proposed extension of the Kiltipper Woods Care Home, located at an existing site at Tallaght, Dublin. The development comprises of the new building extension and access road with footway.

This Drainage Assessment will provide an account of the site's existing and proposed surface water run-offs, and the proposed drainage connections for the development. It will identify potential impacts and will discuss the mitigation for the development. It will also address the requests raised in point 1 of the South Dublin County Council Planning decision letter, dated 14 December 2021.

The storm water drainage has been designed in accordance with the Greater Dublin Regional Code of Practice and 'Sewers for Adoption' published by WRC, UK. To comply with the principles of Sustainable Urban Drainage Systems it is proposed to incorporate attenuation systems into the surface water drainage design which will assist in minimising the impact on the proposed discharge of surface waters from site and mimic greenfield runoff criteria.

This report describes the criteria used in the design of the proposed foul and storm water drainage systems. It is proposed that the foul outfall connection point will be to the existing public sewer connection for the existing care home. The foul outfall will be a 150mm diameter pipe as shown on the proposed drainage plan included in Appendix 2.

The proposed site storm drainage will be attenuated within the site and a restricted discharge (125l/s storm discharge for the whole site and agreed 6 l/s restriction with the drainage authority) with be to the existing surface water discharge manhole (CL.115.60, IL.113.70) located to the south-west corner of the site, adjacent to the existing Storm Tec attenuation tank and then discharging to the River Dodder.

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2. Description of Site

Site Location

The proposed is located on the northern east corner of the Kiltipper Woods Care Home, at Tallaght, Dublin. The existing site is 1.11Ha in area and is currently a care home. The Site Location Plan is presented in Figure 2-1.

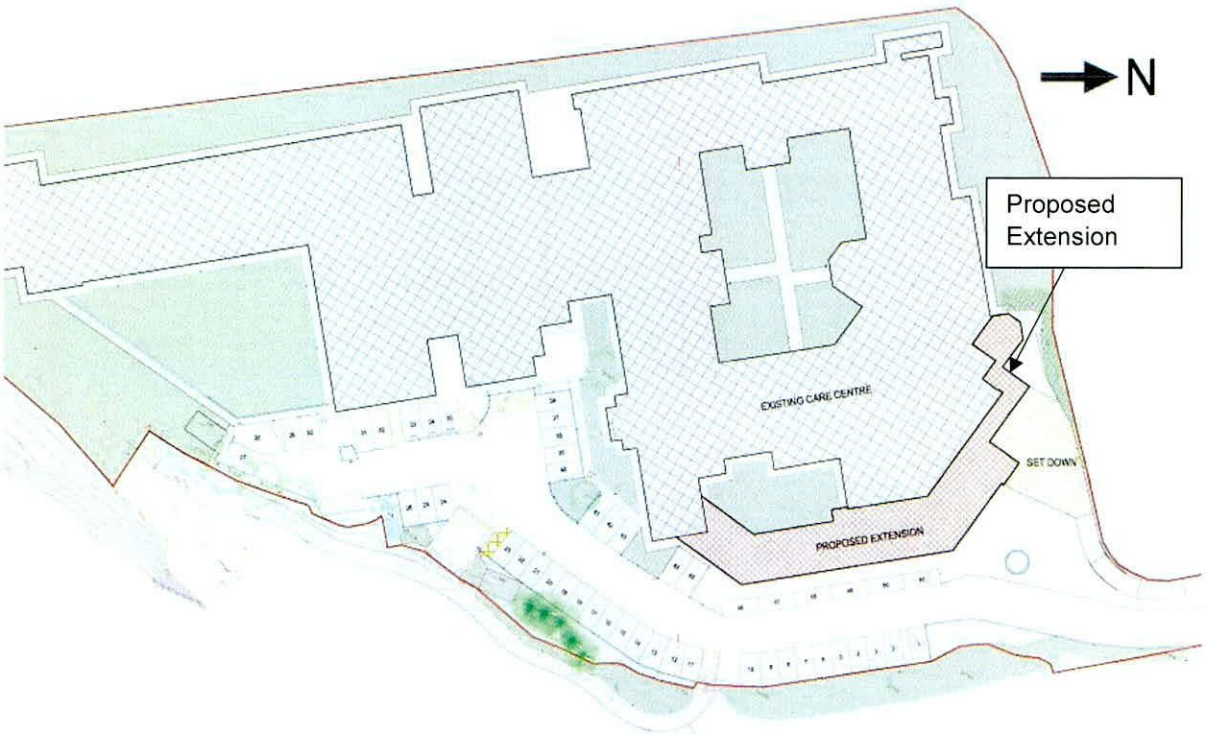

Figure 2-1: Site Location Plan

The proposed extension is currently located in an area of existing hard and soft landscaping. Levels are shown on the existing drainage plan in Appendix 1. There is an existing 225mm diameter foul sewer located directly to the east of the extension which flows due north to connect with the public drainage network. The storm drainage is collected and connected to two Storm Tec attenuation tanks located to the south of the site each collecting storm from either side of the building. These operate with a constrained discharge in a 375mm diameter pipe (0.123m3/sec and the whole site at an agreed 6 l/s restriction on each tank (total of 12 l/s) with the drainage authority) to the adjacent River Dodder.

A Pre-Connection Enquiry has been submitted to Irish Water (IW) in relation to the connection of both foul and surface water drainage from the proposed site to the existing foul sewer in Kiltipper Road and storm pipe to the south next to Ellensborough View. A response is currently awaited from Irish Water.

The position of existing storm water attenuation tanks and outfall is shown in Figure 2.2 below.

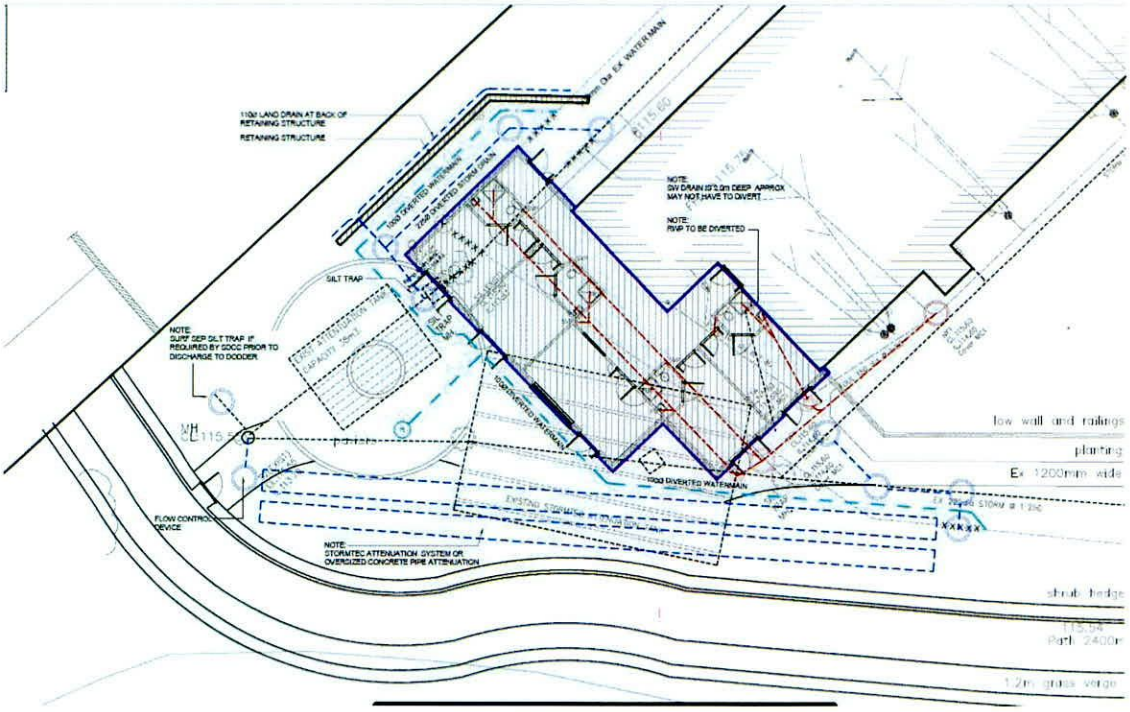

Figure 2-2: Existing Site Storm Drainage Tanks

3. Proposed Surface Water Drainage

Any planning permission will be required to comply with Local Authority requirements and the Greater Dublin Strategic Drainage Study (GDSDS). It is a requirement for all surface waters to be able to be retained, within the site boundaries, for up to the more extreme 1 in 100 year storm event, or 1.0% AEP. The performance of the proposed surface water drainage system will also ensure that there is no flooding under the 1 in 30 storm event. The GDSDS also requires that storm water is reviewed under four criteria – river water quality protection, river regime protection, level of service (flooding) site and river flood protection.

In the existing situation there are two underground storm water attenuation tanks installed in the south-west corner of the site. The first tank to the south-west has a volume of 38m^3 and the second StormTec tank, located directly to the north of this first tank, has a volume of 73m^3. It is understood that there is surface water flow control of 12 l/s from the site which is equivalent to approximately 10.8 l/sec/Ha greenfield flow.

Sustainable Urban Drainage Systems (SUDS) have been used to alleviate the detrimental impacts of traditional urban storm water drainage systems. The proposed surface water for this application will include an enlargement of the existing underground StormTec attenuation tank . Surface water and foul drainage systems have been separated within the site.

Additional SUDS in the form of green roofs and porous paving or swales has been considered but given the current roof structure and relatively modest increase in hardstanding areas, of 247m^2, the most efficient SUDS solution is the enlargement of the existing SUDS attenuation tank. Furthermore, this increased area is roof area, with a decrease in the existing roads area so there will be no increase in risk of pollutants entering the drainage system.

The rainfall design parameters for the site are M5-60 (mm) storm is 18.4, Ration-R is 0.27. SAAR is 800mm.

The proposed building extension (400m^2) is largely to be located within an existing roads and parking area and therefore the net increase of hardstanding area is just 247m^2.

A drainage design and modelling exercise has been undertaken for the site and a drainage plan is included in Appendix 2. It should be noted that the above areas were used to determine an estimate of storm runoff generated from the site using Causeway FLOW drainage design software for a number of

rainfall events and durations. The resulting drainage calculations (The Modified Rational Method) indicate that the flow rates for the existing site, for the critical storm durations for the 1 in 2 year Storm Event was 103 l/s, and 160 l/s for the 1 in 30 year Storm Event.

The design of the proposed storm drainage system will include a restricted discharge rate of 12.0 l/s which will be achieved by means of a Hydro-brake (Refer to typical detail included in Appendix 2) and an enlarged underground attenuation tank which will store excess storm water up to the 1 in 30 year storm event including 20% Climate Change allowance and retaining surface waters up to 1 in 100 year storm return period within the site boundary.

Existing Site

The runoff from the existing area is listed below and areas are shown in plans in Appendix 3:

The area of the existing storm drainage:

a. The area of the roof = 4173m^2

b. The area of the roads / car parking = 2401 m^2

c. The area of pedestrian hardstanding drained areas = 326m^2

d. The area of grassed areas and isolated footways = 4224m^2

This would give a total impervious drainage area on the existing site of **6,900m^2**. This is equivalent to corresponding run-off coefficients of 90% of hardstanding/roof areas and 10% of grass, soft landscaping and remote undrained footways.

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Proposed Site

The runoff from the proposed area is listed below. The additional 400m^2 roof footprint of the building extension would result in an additional **247m^2** of hardstanding area.

The area of the proposed storm drainage:

e. The area of the roof = 4573m^2

f. The area of the roads / car parking = 2151 m^2

g. The area of pedestrian hardstanding drained area = 423m^2

h. The area of grassed areas and isolated footways = 4088m^2

This would give a total impervious drainage area on the existing site of **7,147m^2**. This is equivalent to corresponding run-off coefficients of 90% of hardstanding/roof areas and 10% of grass, soft landscaping and remote undrained footways.

The following drainage calculations indicate that the site can be successfully drained and the finalised drainage arrangements can be agreed with Wicklow County Council.

An enlarged underground attenuation system is proposed to the south of the site as part of the existing Storm Tec tank, as indicated on the drainage plan included in Appendix 2. Storm Water attenuation is provided to cater for a range of storm durations and intensities including the 1 in 30 year storm including climate change allowance and the system has been simulated to assess the more extreme 1 in 100 year storm event (exceedance event).

A summary of the proposed Causeway FLOW calculations for both the existing and proposed drainage is included in Appendix 4 and Appendix 5. These indicate that the surface water runoff associated with the two storm return periods indicated above can be accommodated within the design, ensuring that there is no flooding during the 1 in 30 years storm event with 20% Climate Change allowance and only limited surcharging of pipes due to the historic drainage system and site levels. Also it ensures no flooding outside of the site during the more extreme 1 in 100 year storm event. During the more extreme 1 in 100 year storm event only minor flooding of 12m^3 occurred within the roads and hardstanding areas. As a precaution to the risk of blockage a high level 100mm diameter overflow pipe should be included in the final manhole. It is therefore proposed that the existing StormTec attenuation tank is increased in volume

by **12 m³** (second tank increased from 73m³ to 85m³) and extension pipes are upsized to 300mm in diameter as shown on proposed drainage plans in Appendix 2.

It is also proposed that the management company responsible for the development will put in place a long-term maintenance and inspection regime for the storm attenuation and flow control system.

4. Proposed Foul Drainage

Foul water discharge for the proposed building extension will be required and will comprise effluent from the new extension. The proposed foul water drainage has been based on the Code of Practice for Wastewater Supply (July 2020) published by Irish Water.

A Pre-Connection Enquiry is being submitted to Irish Water (IW) in relation to the connection of foul water drainage from the proposed site to the existing public sewer. A reply is currently awaited.

Drains will be PE to Irish Water specification or concrete socket and spigot pipes and laid to comply with Building Regulations 2010 and in accordance with the associated technical guidance documents (Section H).

The estimated flow rates generated from the proposed care home development are as follows:

Ground floor additional 7 new bedrooms / bathrooms and day care centre and office. On the first floor 5 new bedrooms / bathrooms and dining / day space with an allowance of one staff member per resident and visitor 0.75 per resident. Based on the proposed foul discharge rate of 150 l/person(room)/day and a total of 33 persons and allowance of 10 for day care facility the estimated average foul discharge rate from the site is 6,450 l/day or **0.075 l/s**.

Including the application of Peak Factor of 6 (in accordance with the code of practice for wastewater supply) for this development the estimate peak foul design flow rate is **0.45 l/s**.

The outfall pipe will connect to the existing site foul drainage system adjacent to the new extension block as shown in the drainage plans in Appendix 2. It will be a 150mm diameter pipe paid at a min gradient of 1 in 60.

Kevin McShane Ltd

5. Conclusions and Recommendations

This assessment has been carried out in accordance with best practice and the guidance set out in the Code of Practice for Wastewater Supply (July 2020) published by Irish Water

The Drainage Assessment presented a review of the existing base conditions on the site.

The proposed drainage modelling carried out as part of this report indicates that surface water from the proposed building extension can be attenuated (additional 12.0m^3) on site and new 300mm diameter storm drains for the new extension, and based on the current restricted discharge rate from the site at 12 l/s. It is proposed that this storm water is connected to the existing external discharge.

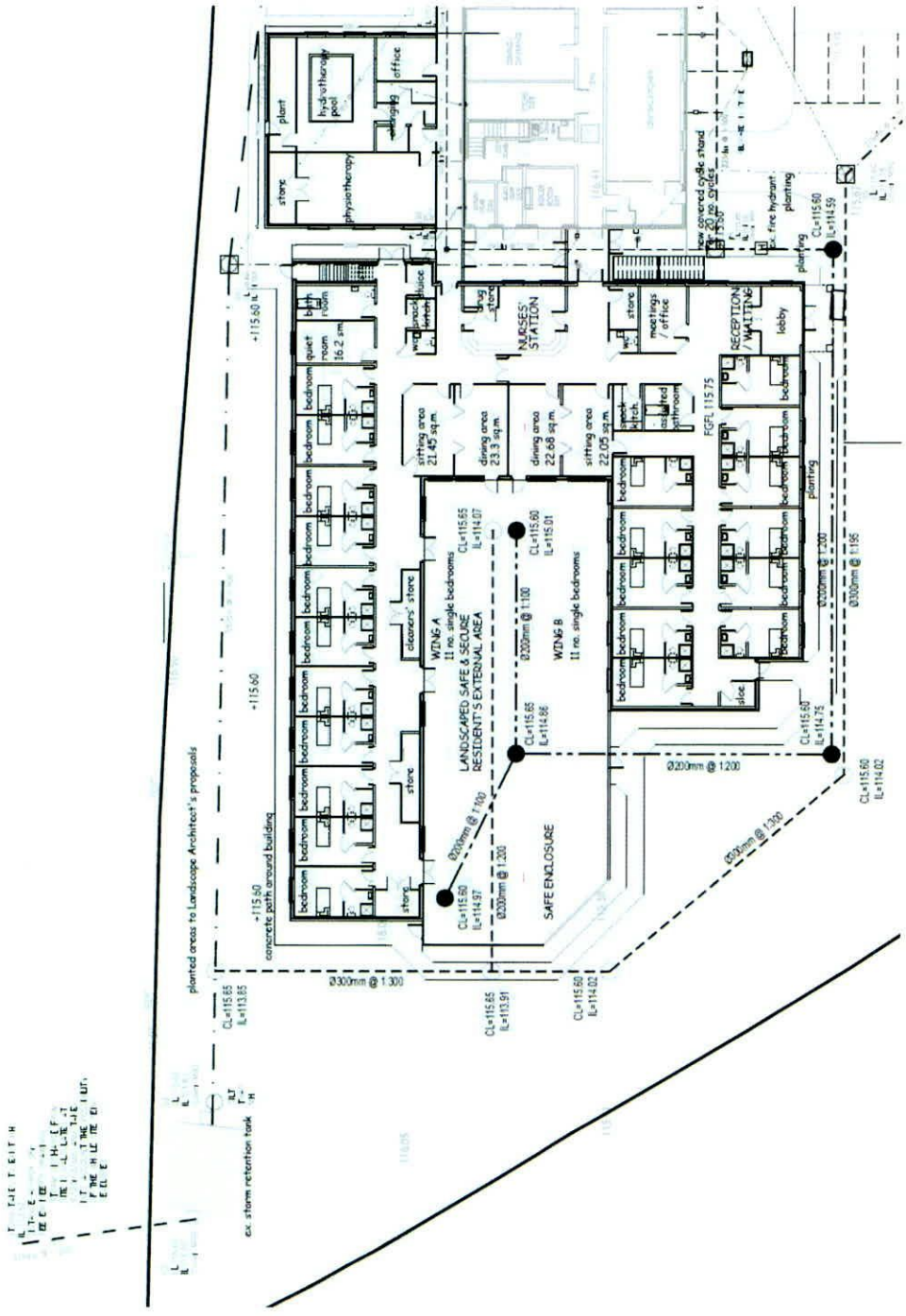
Exceedance flows on the site have also been considered and storm run-off up to the 1 in 100 return period can be accommodated within the site in the hardstanding areas. A 100mm high level overflow pipe is also to be provided at the discharge manhole to reduce the risk of flooding as a result of any blockage.

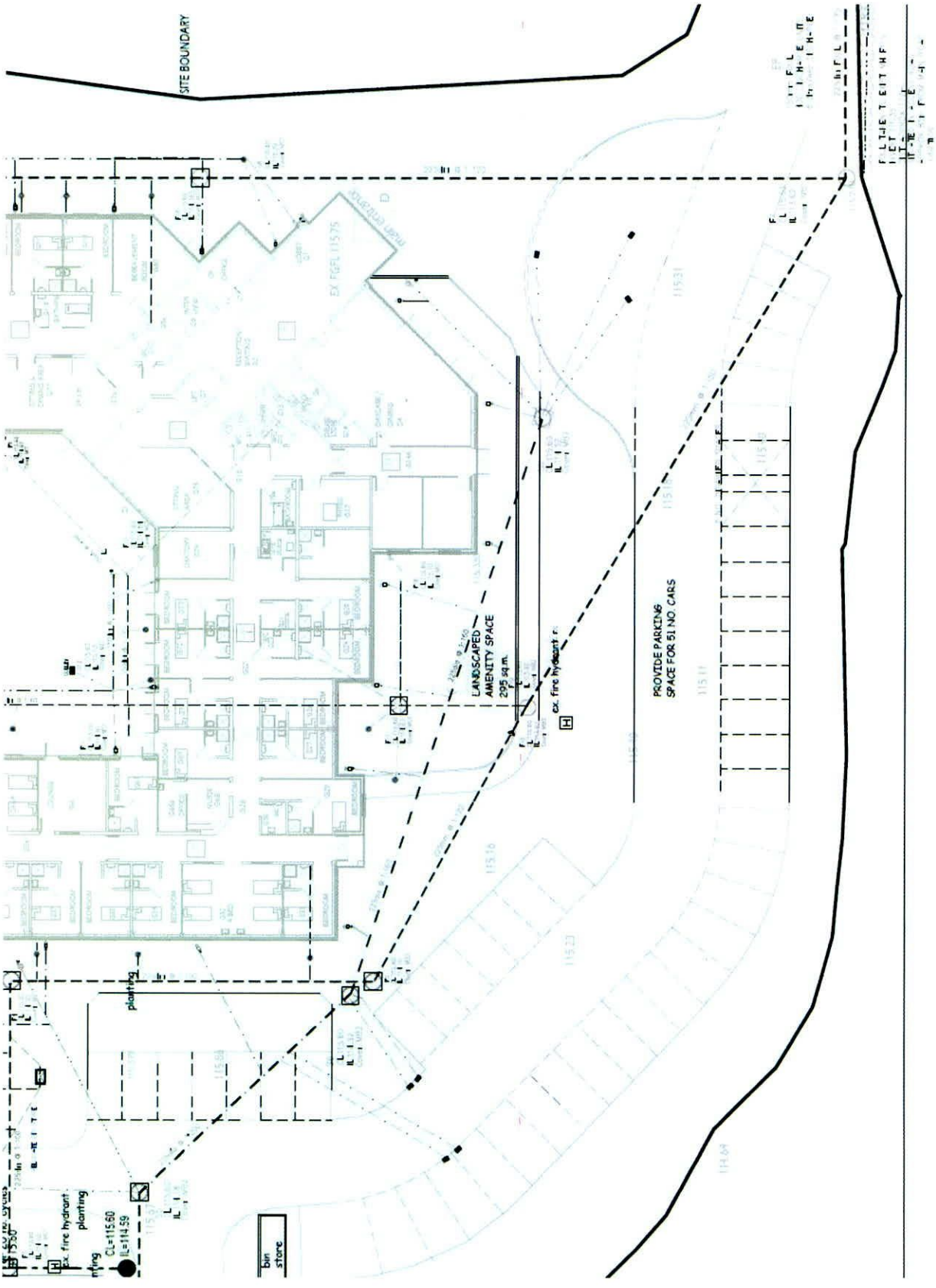
Calculations have been carried out for the estimated existing and proposed foul discharge from the site and it is proposed that this is connected to the external public combined sewer subject to Irish Water confirmation.

The Management Team of the site will be made aware of any residual drainage risks, mitigation measures, and the long-term maintenance requirements.

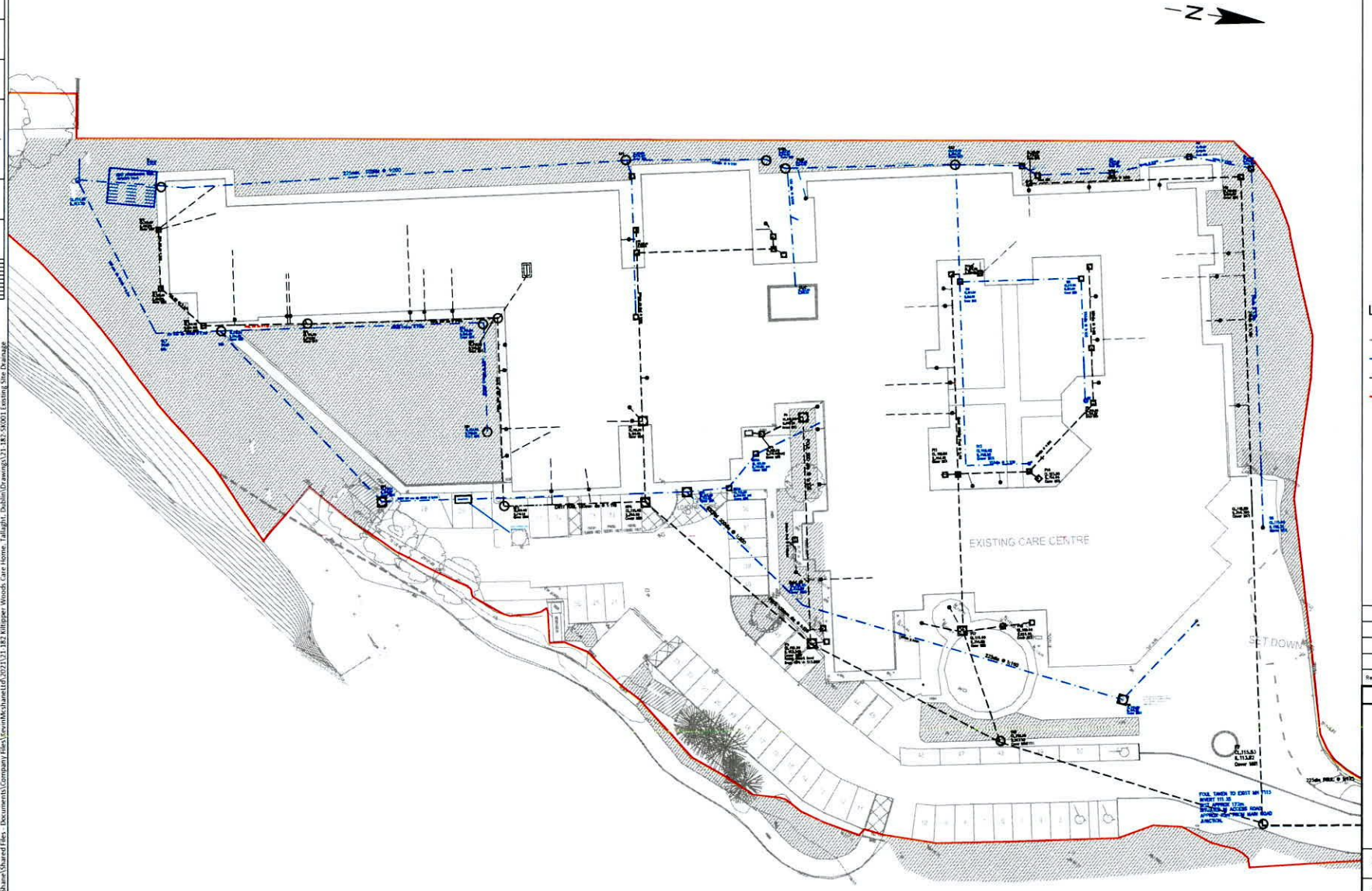
Kevin McShane Ltd

Appendix 1: Existing Drainage Plan




SITE BOUNDARY
LANDSCAPED AMENITY SPACE 295 sq m.
ex. fire hydrant
PROVIDE PARKING SPACE FOR 51 NO. CARS
planting
ex. fire hydrant
planting
CL=11560
IL=11459
bin store

100 Millimetres 0 10



NOTES:

1. EXISTING INFORMATION PROVIDED BY OTHERS AND NO GUARANTEE AS TO THE ACCURACY IS GIVEN BY KEVIN MCSHANE LTD.

LEGEND:

- TOPOGRAPHICAL SURVEY
- EXISTING STORM DRAINAGE
- EXISTING FOUL DRAINAGE
- SITE BOUNDARY

Rev.	Date	Description	By	Chkd	Appd

STATUS: SKETCH

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client: MR D MCDERMOTT

project: KILTIPPER WOODS CARE CENTRE
KILTIPPER ROAD
DUBLIN

drawing: EXISTING SITE & DRAINAGE PLAN

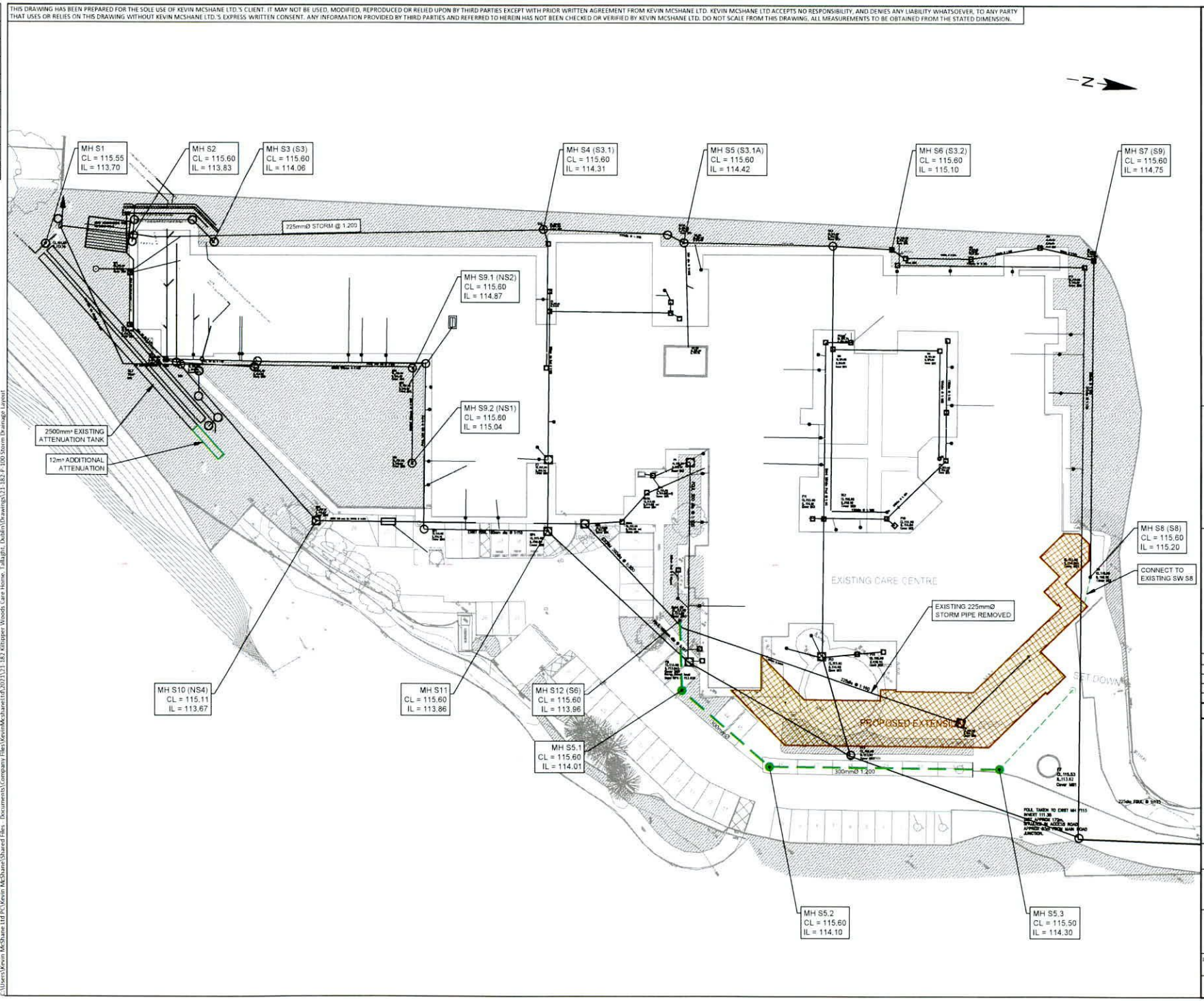
DRAFT

project no.	drg no.	rev no.
21-182	21-182-SK001	-
drawn	scale	date
SMG	1:500 @ A3	02-02-2022

21-182-SK001 EXISTING SITE DRAINAGE
C:\Users\Kevin McShane Ltd PC\Kevin McShane\Shared Files - Documents\Company Files\KevinMcShaneLtd\2021\21-182 Kiltipper Woods Care Home, Tallaght, Dublin\Drawings\21-182-SK001 Existing Site Drainage

Kevin McShane Ltd

Appendix 2: Proposed Drainage Plan



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LEGEND:

- TOPOGRAPHICAL SURVEY
- EXISTING DRAINAGE
- PROPOSED EXTENSION
- PROPOSED STORM DRAINAGE
- DOMESTIC STORM CONNECTION
- PROPOSED ATTENUATION EXTENSION

SCALE
0 2.5 5 10 20m

PAGE SIZE (A1) 1:250 @ A1 1:500 @ A3

Rev.	Date	Description	By	Chk'd	Appr'd

STATUS: PRELIMINARY

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project: KILTIPPER WOODS CARE CENTRE
KILTIPPER ROAD
DUBLIN

drawing: DRAINAGE LAYOUT
PROPOSED STORM WATER DRAINAGE

project no.	drg no.	rev no.
21-182	21-182-P-100	-
drawn	scale	date
SMG	1:250 @ A1	15-02-2022

21-182-P-100 STORM DRAINAGE LAYOUT
C:\Users\Kevin McShane Ltd PC\Kevin McShane\Shared Files - Documents\Company Files\KevinMcshane1ft\2021\21-182 Kiltipper Woods Care Home, Tallaght, Dublin\Drawings\21-182-P-100 Storm Drainage Layout

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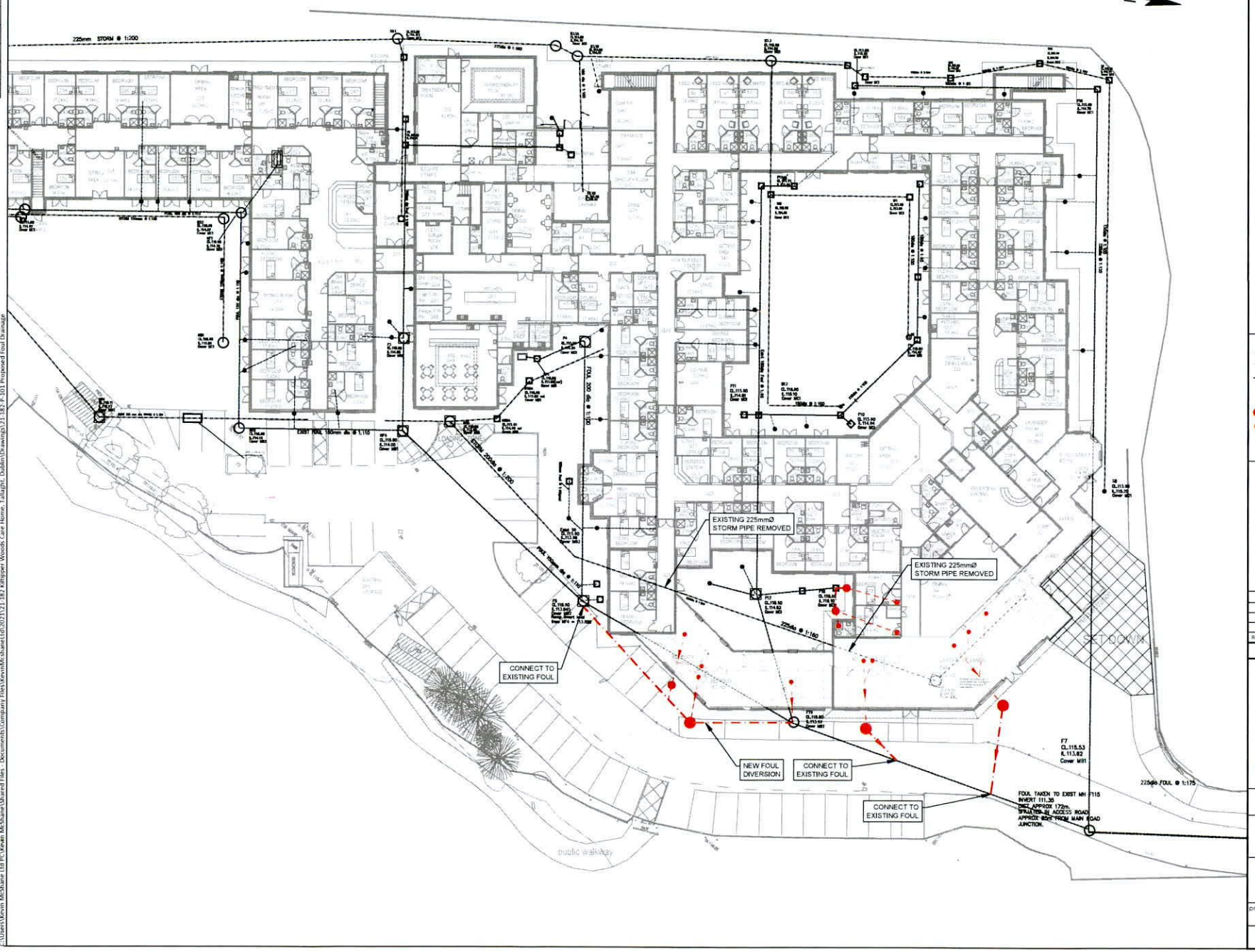

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LEGEND:

- TOPOGRAPHICAL SURVEY
- EXISTING DRAINAGE
- PROPOSED EXTENSION
- PROPOSED FOUL DRAINAGE
- DOMESTIC FOUL CONNECTION

SCALE 0 2 4 8 16m

PAGE SIZE (A1) 1:200 @ A1 1:400 @ A3

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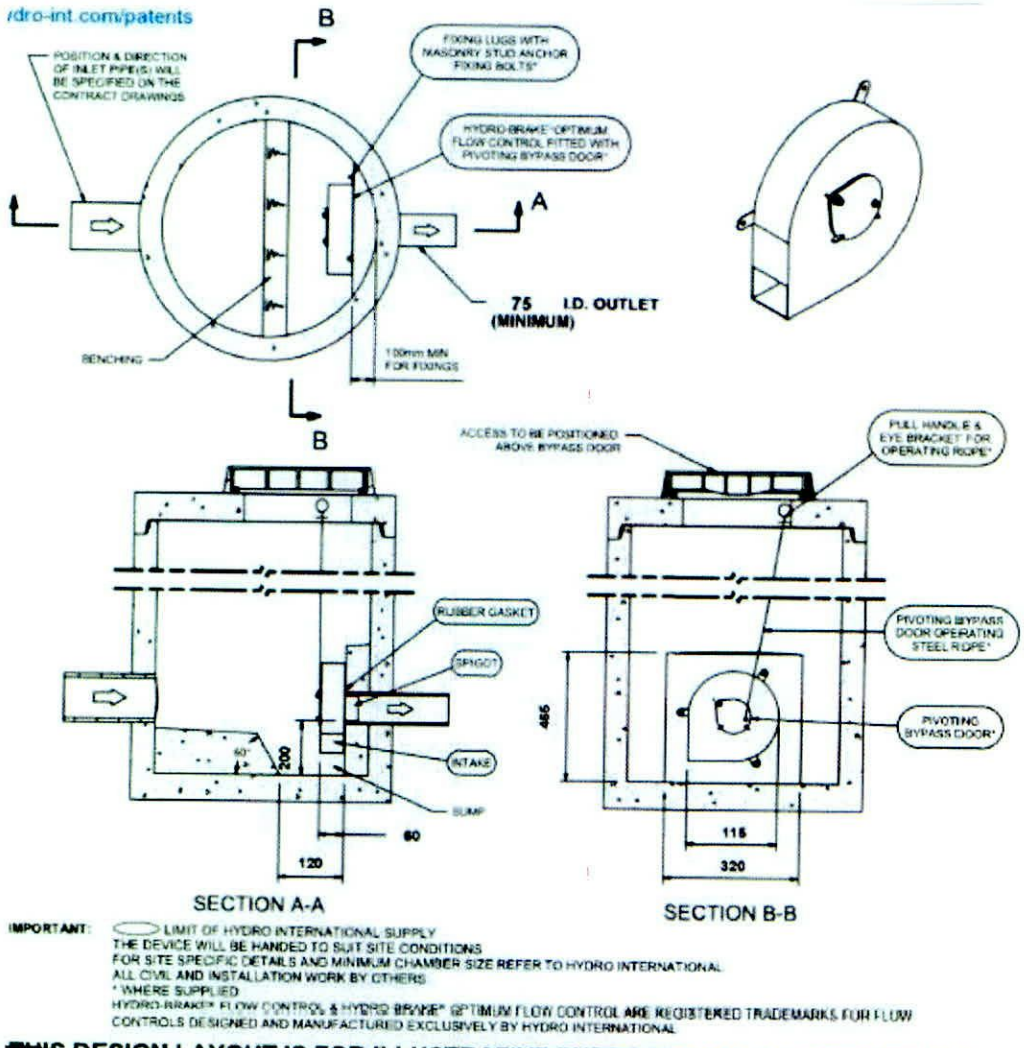
project: KILTIPPER WOODS CARE CENTRE
KILTIPPER ROAD
DUBLIN

drawing: DRAINAGE LAYOUT
PROPOSED FOUL DRAINAGE

project no.	drg no.	rev no.
21-182	21-182-P-101	-
drawn	scale	date
SMG	1:200 @ A1	15-02-2022

21-182-P-101 PROPOSED FOUL DRAINAGE
C:\Users\Kevin McShane Ltd PC\Kevin McShane\Shared Files - Documents\Company Files\KevinMcshane\z0\2021\21-182 Kiltipper Woods Care Home, Tallaght, Dublin\Drawings\21-182-P-101 Proposed Foul Drainage



Typical Hydro-brake Detail

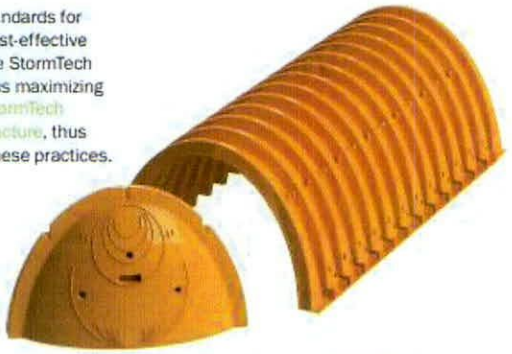
Kevin McShane Ltd

StormTech

ADS

STORMTECH SC-740 CHAMBER

Designed to meet the most stringent industry performance standards for superior structural integrity while providing designers with a cost-effective method to save valuable land and protect water resources. The StormTech system is designed primarily to be used under parking lots, thus maximizing land usage for private (commercial) and public applications. StormTech chambers can also be used in conjunction with Green Infrastructure, thus enhancing the performance and extending the service life of these practices.



STORMTECH SC-740 CHAMBER
(not to scale)

Nominal Chamber Specifications

Size (L x W x H)
85.4" x 51" x 30"
2,170 mm x 1,295 mm x 762 mm

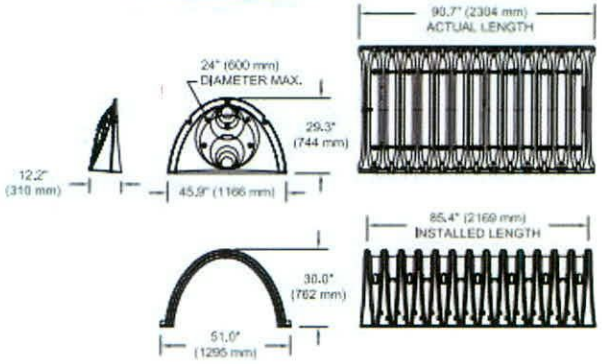
Chamber Storage
45.9 ft³ (1.30 m³)

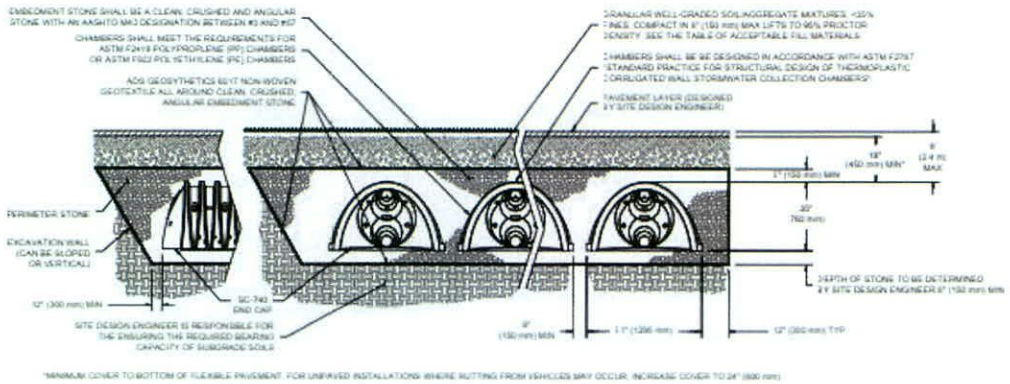
Min. Installed Storage*
74.9 ft³ (2.12 m³)

Weight
74.0 lbs (33.6 kg)

Shipping
30 chambers/pallet
60 end caps/pallet
12 pallets/truck

*Assumes 6" (150 mm) stone above, below and between chambers and 40% stone porosity.





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Appendix 3: Existing and Proposed Areas Plans

NOTES:

1. EXISTING INFORMATION PROVIDED BY OTHERS AND NO GUARANTEE AS TO THE ACCURACY IS GIVEN BY KEVIN MCSHANE LTD.

LEGEND:

- GRASS / VEGETATION = 3,155m2
- ROAD / CAR PARKING = 2,401m2
- ROOFS = 4,173m2
- PEDESTRIAN AREAS = 1,396m2

TOTAL = 11,125m2

100 Millimetres 0 10

21-182-SK004-SK005 SITE AREAS FOR DRAINAGE
C:\Users\Kevin McShane Ltd PC\Kevin McShane\Shared Files - Documents\Company Files\KevinMcshane\d\2021\21-182 Kiltipper Woods Care Home, Tallaght, Dublin\Drawings\21-182-SK004-SK005 Site Areas For Drainage

Rev.	Date	Description	By	Chkd	Appd

STATUS: SKETCH

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client: MR D MCDERMOTT

project: KILTIPPER WOODS CARE CENTRE
KILTIPPER ROAD
DUBLIN

drawing: SITE AREAS FOR DRAINAGE
EXISTING SITE

project no.	drg no.	rev no.
21-182	21-182-SK004	-
drawn: SMG	scale: 1:500 @ A3	date: 02-02-2022

100
Millimetres
0 10

NOTES:

1. EXISTING INFORMATION PROVIDED BY OTHERS AND NO GUARANTEE AS TO THE ACCURACY IS GIVEN BY KEVIN MCSHANE LTD.

LEGEND:

- GRASS / VEGETATION = 2908m2
- ROAD / CAR PARKING = 2,151m2
- ROOFS = 4,573m2
- PEDESTRIAN AREAS = 1,506m2

TOTAL = 11,138m2

- PROPOSED EXTENSION

247m2 GRASS/VEGETATION REMOVED & REPLACED BY HARDSTANDING/ROOF

250.5m2 ROAD/CAR PARKING REMOVED & REPLACED BY HARDSTANDING/ROOF

110m2 PEDESTRIAN AREAS ADDED BY HARDSTANDING

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DUBLIN

drawing: SITE AREAS FOR DRAINAGE
PROPOSED SITE

project no.	drg no.	rev no.
21-182	21-182-SK005	-
drawn	scale	date
SMG	1:500 @ A3	02-02-2022

21-182-SK004-SK005 SITE AREAS FOR DRAINAGE
C:\Users\Kevin McShane Ltd PC\Kevin McShane\Shared Files - Documents\Company Files\KevinMcShaneLtd\2021\21-182 Kiltipper Woods Care Home - Tallaght, Dublin\Drawings\21-182-SK004-SK005 Site Areas For Drainage

Kevin McShane Ltd

Appendix 4: Existing Drainage Calculations

CAUSEWAY

Rainfall Methodology	FSR
Return Period (years)	2
Additional Flow (%)	0
FSR Region	Scotland and Ireland
M5-60 (mm)	18.400
Ratio-R	0.270
CV	0.750
Time of Entry (mins)	3.00
Maximum Time of Concentration (mins)	30.00
Maximum Rainfall (mm/hr)	50.0
Minimum Velocity (m/s)	1.00
Connection Type	Level Soffits
Minimum Backdrop Height (m)	0.200
Preferred Cover Depth (m)	1.200
Enforce best practice design rules	

CAUSEWAY

Flow v7.0 Design Report: Nodes

Name	Area (ha)	T of E (mins)	Add Inflow (l/s)	Cover Level (m)	Node Type	Manhole Type	Diameter (mm)	Width (mm)	Easting (m)	Northing (m)	Depth (m)	Notes
s1.1				115.550	Manhole	Adoptable	1200				2.186	
s1				115.600	Manhole	Adoptable	1500				2.156	
s2				115.600	Manhole	Adoptable	1500				1.840	
s3	0.041	3.00		115.600	Manhole	Adoptable	1200				1.715	
s3.1	0.042	3.00		115.600	Manhole	Adoptable	1200				1.465	
s3.1a	0.041	3.00		115.600	Manhole	Adoptable	1200				1.355	
s3.2	0.041	3.00		115.600	Manhole	Adoptable	1200				1.215	
s9	0.042	3.00		115.600	Manhole	Adoptable	1200				0.850	
s8	0.041	3.00		115.600	Manhole	Adoptable	1200				0.400	
s10	0.073	3.00		115.600	Manhole	Adoptable	1500				2.021	
ns4	0.074	3.00		115.600	Manhole	Adoptable	1200				1.889	
ns5	0.073	3.00		115.600	Manhole	Adoptable	1200				1.634	
s5	0.074	3.00		115.600	Manhole	Adoptable	1200				1.542	
s6	0.073	3.00		115.600	Manhole	Adoptable	1200				1.280	
ns2				115.600	Manhole	Adoptable	1200				0.710	
ns1	0.073	3.00		115.600	Manhole	Adoptable	1200				0.560	
s9.3		3.00		115.600	Manhole	Adoptable	1500				1.700	
s2.1		3.00		115.600	Manhole	Adoptable	1500				1.500	

CAUSEWAY

Flow v7.0 Design Report: Links (Input)

Name	US Node	DS Node	Length (m)	ks (mm) / n	Velocity Equation	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	Link Type	T of C (mins)	Rain (mm/hr)	Con Offset (m)	Min DS IL (m)	Lateral Area (ha)	Lateral Ins Point (%)	Lateral T of E (mins)
1.000	s8	s9	45.000	0.600	Colebrook-White	115.200	114.750	0.450	100.0	150	Circular	3.75	50.0					
1.001	s9	s3.2	29.000	0.600	Colebrook-White	114.750	114.460	0.290	100.0	150	Circular	4.23	50.0					
1.002	s3.2	s3.1a	28.000	0.600	Colebrook-White	114.385	114.245	0.140	200.0	225	Circular	4.73	50.0					
1.003	s3.1a	s3.1	22.000	0.600	Colebrook-White	114.245	114.135	0.110	200.0	225	Circular	5.13	50.0					
1.004	s3.1	s3	50.000	0.600	Colebrook-White	114.135	113.885	0.250	200.0	225	Circular	6.04	50.0					
1.005	s3	s2	10.000	0.600	Colebrook-White	113.885	113.835	0.050	200.0	225	Circular	6.22	50.0					
1.006	s2	s1	15.000	0.600	Colebrook-White	113.760	113.685	0.075	200.0	300	Circular	6.44	49.7					
2.000	s2.1	s2	60.000	0.600	Colebrook-White	114.100	113.920	0.180	333.0	900	Circular	3.58	50.0					
3.000	s6	s5	42.000	0.600	Colebrook-White	114.320	114.058	0.262	160.0	225	Circular	3.68	50.0					
3.001	s5	ns5	23.000	0.600	Colebrook-White	114.058	113.966	0.092	250.0	225	Circular	4.15	50.0					
3.002	ns5	ns4	45.000	0.600	Colebrook-White	113.966	113.786	0.180	250.0	225	Circular	5.06	50.0					
3.003	ns4	s10	33.000	0.600	Colebrook-White	113.711	113.579	0.132	250.0	300	Circular	5.61	50.0					
4.000	ns1	ns2	15.000	0.600	Colebrook-White	115.040	114.890	0.150	100.0	150	Circular	3.25	50.0					
4.001	ns2	s10	43.000	0.600	Colebrook-White	114.890	114.460	0.430	100.0	150	Circular	3.96	50.0					
5.000	s9.3	s10	65.000	0.600	Colebrook-White	113.900	113.770	0.130	500.0	1200	Circular	3.65	50.0					
3.004	s10	s1	20.000	0.600	Colebrook-White	113.579	113.519	0.060	333.0	300	Circular	6.00	50.0					
1.007	s1	s1.1	20.000	0.600	Colebrook-White	113.444	113.364	0.080	250.0	375	Circular	6.74	48.5					

CAUSEWAY

Rainfall Methodology	FSR		Return Period (years)	Climate Change (%)
FSR Region	Scotland and Ireland		2	20
M5-60 (mm)	18.400		30	20
Ratio-R	0.270		100	0
Summer CV	0.750			
Winter CV	0.840			
Analysis Speed	Normal			
Drain Down Time (mins)	240			
Additional Storage (m³/ha)	20.0			
Storm Durations (mins)	15			
	30			
	60			
	120			
	180			
	240			
	360			
	480			
	600			
	720			
	960			
	1440			
Check Discharge Rate(s)	x			

CAUSEWAY

Depth/Flow

Node	Flap Valve	Online / Offline	Replaces Downstream Link	Loop to Node	Invert Level (m)	Design Depth (m)	Design Flow (l/s)	Depth (m)	Flow (l/s)
s1.1	x	Online			113.364	1.000	12.0	1.000	12.000

CAUSEWAY

Flow v7.0 Design Report: 2 year +20% Critical

Results for 2 year +20% Critical Storm Duration. Lowest mass balance: 99.21%

Event	US Node ID	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status	Link ID	DS Node ID	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
180 minute winter	s1.1	132	114.443	1.079	12.1	1.2201	0.0000	OK	Depth/Flow		12.0				161.0
180 minute winter	s1	132	114.444	1.000	12.3	1.7667	0.0000	SURCHARGED	1.007	s1.1	12.1	0.332	0.096	2.2059	
180 minute winter	s2	132	114.444	0.684	12.1	1.2090	0.0000	SURCHARGED	1.006	s1	5.7	0.500	0.073	1.0563	
180 minute winter	s3	132	114.445	0.560	12.9	0.9014	0.0000	SURCHARGED	1.005	s2	12.1	0.607	0.331	0.3977	
180 minute winter	s3.1	132	114.448	0.313	11.3	0.5331	0.0000	SURCHARGED	1.004	s3	10.7	0.610	0.294	1.9886	
15 minute winter	s3.1a	11	114.461	0.216	31.8	0.3744	0.0000	OK	1.003	s3.1	31.3	0.899	0.856	0.8684	
15 minute summer	s3.2	10	114.523	0.138	24.5	0.2495	0.0000	OK	1.002	s3.1a	24.7	0.824	0.675	0.8336	
15 minute summer	s9	10	114.871	0.121	17.9	0.2562	0.0000	OK	1.001	s3.2	16.6	1.119	0.933	0.4291	
15 minute summer	s8	9	115.273	0.073	9.3	0.2312	0.0000	OK	1.000	s9	8.5	0.752	0.477	0.5324	
180 minute winter	s10	132	114.445	0.866	22.3	2.1564	0.0000	SURCHARGED	3.004	s1	9.2	0.485	0.152	1.4084	
180 minute winter	ns4	132	114.446	0.735	14.8	1.4060	0.0000	SURCHARGED	3.003	s10	14.4	0.391	0.206	2.3238	
180 minute winter	ns5	128	114.448	0.482	11.1	0.9760	0.0000	SURCHARGED	3.002	ns4	10.8	0.539	0.329	1.7897	
180 minute winter	s5	128	114.449	0.391	8.1	0.8176	0.0000	SURCHARGED	3.001	ns5	7.2	0.531	0.220	0.9147	
180 minute winter	s6	128	114.449	0.129	4.0	0.2937	0.0000	OK	3.000	s5	4.0	0.437	0.097	1.3306	
15 minute summer	ns2	10	114.999	0.109	15.3	0.1235	0.0000	OK	4.001	s10	15.0	1.114	0.845	0.5792	
15 minute summer	ns1	9	115.157	0.117	16.5	0.4363	0.0000	OK	4.000	ns2	15.3	1.134	0.864	0.2104	
180 minute winter	s9.3	132	114.445	0.545	6.8	0.9631	0.0000	OK	5.000	s10	-6.8	-0.079	-0.004	37.3974	
180 minute winter	s2.1	132	114.444	0.344	4.4	0.6083	0.0000	OK	2.000	s2	-4.4	-0.057	-0.004	18.1839	

Results for 30 year +20% Critical Storm Duration. Lowest mass balance: 99.21%

Event	US Node ID	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status	Link ID	DS Node ID	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
240 minute winter	s1.1	172	115.550	2.186	19.8	2.4724	3.7801	FLOOD	Depth/Flow		12.0				291.6
180 minute winter	s1	132	115.553	2.109	17.7	3.7269	0.0000	FLOOD RISK	1.007	s1.1	17.8	0.369	0.141	2.2059	
180 minute winter	s2	132	115.554	1.794	20.6	3.1700	0.0000	FLOOD RISK	1.006	s1	8.2	0.572	0.104	1.0563	
180 minute winter	s3	132	115.557	1.672	21.1	2.6895	0.0000	FLOOD RISK	1.005	s2	20.6	0.603	0.562	0.3977	
180 minute winter	s3.1	132	115.565	1.430	17.8	2.4365	0.0000	FLOOD RISK	1.004	s3	17.3	0.582	0.473	1.9886	
180 minute winter	s3.1a	132	115.568	1.323	14.6	2.2960	0.0000	FLOOD RISK	1.003	s3.1	13.9	0.711	0.381	0.8750	
180 minute winter	s3.2	132	115.570	1.185	11.8	2.1392	0.0000	FLOOD RISK	1.002	s3.1a	10.7	0.686	0.292	1.1136	
240 minute winter	s9	172	115.577	0.827	6.5	1.7515	0.0000	FLOOD RISK	1.001	s3.2	6.5	0.909	0.366	0.5105	
240 minute winter	s8	172	115.579	0.379	3.3	1.2043	0.0000	FLOOD RISK	1.000	s9	3.2	0.578	0.180	0.7922	
180 minute winter	s10	132	115.558	1.979	39.4	4.9265	0.0000	FLOOD RISK	3.004	s1	11.8	0.496	0.195	1.4084	
180 minute winter	ns4	132	115.561	1.850	25.9	3.5407	0.0000	FLOOD RISK	3.003	s10	25.3	0.447	0.362	2.3238	
180 minute winter	ns5	132	115.571	1.605	19.5	3.2476	0.0000	FLOOD RISK	3.002	ns4	18.8	0.556	0.577	1.7897	
180 minute winter	s5	132	115.573	1.515	13.3	3.1684	0.0000	FLOOD RISK	3.001	ns5	12.5	0.519	0.384	0.9147	
180 minute winter	s6	132	115.575	1.256	7.0	2.8507	0.0000	FLOOD RISK	3.000	s5	6.2	0.440	0.151	1.6704	
180 minute winter	ns2	132	115.566	0.676	7.0	0.7645	0.0000	FLOOD RISK	4.001	s10	7.1	0.930	0.399	0.7570	
180 minute winter	ns1	132	115.569	0.529	7.0	1.9770	0.0000	FLOOD RISK	4.000	ns2	7.0	0.919	0.393	0.2641	
180 minute winter	s9.3	132	115.558	1.658	13.6	2.9288	0.0000	FLOOD RISK	5.000	s10	-13.6	-0.041	-0.007	73.2361	
180 minute winter	s2.1	132	115.554	1.454	9.9	2.5691	0.0000	FLOOD RISK	2.000	s2	-9.9	-0.063	-0.009	38.0264	

Appendix 5: Proposed Drainage Calculations

CAUSEWAY

Rainfall Methodology	FSR
Return Period (years)	2
Additional Flow (%)	0
FSR Region	Scotland and Ireland
M5-60 (mm)	18.400
Ratio-R	0.270
CV	0.750
Time of Entry (mins)	3.00
Maximum Time of Concentration (mins)	30.00
Maximum Rainfall (mm/hr)	50.0
Minimum Velocity (m/s)	1.00
Connection Type	Level Soffits
Minimum Backdrop Height (m)	0.200
Preferred Cover Depth (m)	1.200
Enforce best practice design rules	

CAUSEWAY

Flow v7.0 Design Report: Nodes

Name	Area (ha)	T of E (mins)	Add Inflow (l/s)	Cover Level (m)	Node Type	Manhole Type	Diameter (mm)	Width (mm)	Easting (m)	Northing (m)	Depth (m)	Notes
s1.1				115.550	Manhole	Adoptable	1200				2.154	
s1				115.600	Manhole	Adoptable	1500				2.184	
s2				115.600	Manhole	Adoptable	1500				1.840	
s3	0.041	3.00		115.600	Manhole	Adoptable	1200				1.715	
s3.1	0.042	3.00		115.600	Manhole	Adoptable	1200				1.465	
s3.1a	0.041	3.00		115.600	Manhole	Adoptable	1200				1.355	
s3.2	0.041	3.00		115.600	Manhole	Adoptable	1200				1.215	
s9	0.042	3.00		115.600	Manhole	Adoptable	1200				0.850	
s8	0.043	3.00		115.600	Manhole	Adoptable	1200				0.400	
s10	0.073	3.00		115.600	Manhole	Adoptable	1500				2.124	
ns4	0.074	3.00		115.600	Manhole	Adoptable	1200				2.014	
ns5	0.073	3.00		115.600	Manhole	Adoptable	1200				1.834	
s5	0.074	3.00		115.600	Manhole	Adoptable	1200				1.667	
s5.3	0.047	3.00		115.600	Manhole	Adoptable	1200				1.300	
ns2				115.600	Manhole	Adoptable	1200				0.710	
ns1	0.073	3.00		115.600	Manhole	Adoptable	1200				0.560	
s9.3		3.00		115.600	Manhole	Adoptable	1500				1.700	
s2.1		3.00		115.600	Manhole	Adoptable	1500				1.500	
s5.2	0.045	3.00		115.600	Manhole	Adoptable	1200				1.519	
s5.1	0.004	3.00		115.600	Manhole	Adoptable	1200				1.608	

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Flow v7.0 Design Report: Links (Input)

	Name	US Node	DS Node	Length (m)	ks (mm) / n	Velocity Equation	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	Link Type	T of C (mins)	Rain (mm/hr)	Con Offset (m)	Min DS IL (m)	Lateral Area (ha)	Lateral Inf Point (%)	Lateral T of E (mins)
P	1.000	s8	s9	45.000	0.600	Colebrook-White	115.200	114.760	0.440	100.0	150	Circular	3.75	50.0					
P	1.001	s9	s3.2	29.000	0.600	Colebrook-White	114.750	114.460	0.290	100.0	150	Circular	4.23	50.0					
P	1.002	s3.2	s3.1a	28.000	0.600	Colebrook-White	114.385	114.245	0.140	200.0	225	Circular	4.73	50.0					
P	1.003	s3.1a	s3.1	22.000	0.600	Colebrook-White	114.245	114.135	0.110	200.0	225	Circular	5.13	50.0					
P	1.004	s3.1	s3	50.000	0.600	Colebrook-White	114.135	113.885	0.250	200.0	225	Circular	6.04	50.0					
P	1.005	s3	s2	10.000	0.600	Colebrook-White	113.885	113.835	0.050	200.0	225	Circular	6.22	50.0					
	1.006	s2	s1	15.000	0.600	Colebrook-White	113.760	113.685	0.075	200.0	300	Circular	6.44	49.7					
P	2.000	s2.1	s2	60.000	0.600	Colebrook-White	114.100	113.926	0.180	333.0	900	Circular	3.55	50.0					
P	3.000	s5.3	s5.2	35.000	0.600	Colebrook-White	114.300	114.081	0.219	160.0	300	Circular	3.47	50.0					
	3.001	s5.2	s5.1	15.000	0.600	Colebrook-White	114.081	113.992	0.089	168.5	300	Circular	3.58	50.0					
	3.002	s5.1	s5	10.000	0.600	Colebrook-White	113.992	113.933	0.059	169.5	300	Circular	3.62	50.0					
P	3.003	s5	ns5	23.000	0.600	Colebrook-White	113.933	113.841	0.092	250.0	225	Circular	4.28	50.0					
P	3.004	ns5	ns4	45.000	0.600	Colebrook-White	113.766	113.586	0.180	250.0	300	Circular	5.04	50.0					
P	3.005	ns4	s10	33.000	0.600	Colebrook-White	113.586	113.476	0.110	300.0	300	Circular	5.65	50.0					
P	4.000	ns1	ns2	15.000	0.600	Colebrook-White	115.040	114.890	0.150	100.0	150	Circular	3.25	50.0					
P	4.001	ns2	s10	43.000	0.600	Colebrook-White	114.890	114.460	0.430	100.0	150	Circular	3.96	50.0					
P	5.000	s9.3	s10	76.000	0.600	Colebrook-White	113.900	113.748	0.152	500.0	1200	Circular	3.76	50.0					
P	3.006	s10	s1	20.000	0.600	Colebrook-White	113.476	113.416	0.060	333.0	375	Circular	5.99	50.0					
	1.007	s1	s1.1	5.000	0.600	Colebrook-White	113.416	113.396	0.020	250.0	375	Circular	6.52	49.5					

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Rainfall Methodology	FSR		Return Period (years)	Climate Change (%)
FSR Region	Scotland and Ireland		2	20
M5-60 (mm)	18.400		30	20
Ratio-R	0.270		100	0
Summer CV	0.750			
Winter CV	0.840			
Analysis Speed	Normal			
Drain Down Time (mins)	240			
Additional Storage (m³/ha)	20.0			
Storm Durations (mins)	15			
	30			
	60			
	120			
	180			
	240			
	360			
	480			
	600			
	720			
	960			
	1440			
Check Discharge Rate(s)	x			
1 year (l/s)				
30 year (l/s)				
100 year (l/s)				
Check Discharge Volume	x			
100 year 360 minute (m³)				

CAUSEWAY

Depth/Flow

Node	Flap Valve	Online / Offline	Replaces Downstream Link	Loop to Node	Invert Level (m)	Design Depth (m)	Design Flow (l/s)	Depth (m)	Flow (l/s)
s1.1	x	Online			113.396	1.000	12.0	1.000	12.000

CAUSEWAY

Results for 2 year +20% Critical Storm Duration. Lowest mass balance: 99.31%

Event	US Node ID	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status	Link ID	DS Node ID	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
180 minute winter	s1.1	132	114.423	1.027	12.5	1.1617	0.0000	OK	Depth/Flow		12.0				166.8
180 minute winter	s1	132	114.424	1.008	12.1	1.7806	0.0000	SURCHARGED	1.007	s1.1	12.5	0.142	0.100	0.5515	
180 minute winter	s2	132	114.424	0.664	12.3	1.1736	0.0000	SURCHARGED	1.006	s1	5.9	0.500	0.075	1.0563	
180 minute winter	s3	132	114.425	0.540	13.1	0.8692	0.0000	SURCHARGED	1.005	s2	12.3	0.639	0.335	0.3977	
180 minute winter	s3.1	132	114.428	0.293	11.5	0.4992	0.0000	SURCHARGED	1.004	s3	10.9	0.609	0.297	1.9886	
15 minute winter	s3.1a	11	114.451	0.206	32.1	0.3577	0.0000	OK	1.003	s3.1	31.5	0.900	0.861	0.8569	
15 minute summer	s3.2	10	114.525	0.140	24.9	0.2520	0.0000	OK	1.002	s3.1a	25.0	0.826	0.683	0.8416	
15 minute summer	s9	10	114.873	0.123	18.3	0.2615	0.0000	OK	1.001	s3.2	16.9	1.123	0.951	0.4370	
15 minute summer	s8	10	115.275	0.075	9.7	0.2448	0.0000	OK	1.000	s9	8.9	0.768	0.500	0.5456	
180 minute winter	s10	132	114.424	0.948	22.1	2.3279	0.0000	SURCHARGED	3.006	s1	8.6	0.365	0.079	2.2059	
180 minute winter	ns4	132	114.425	0.839	14.5	1.5656	0.0000	SURCHARGED	3.005	s10	14.3	0.390	0.223	2.3238	
180 minute winter	ns5	132	114.426	0.660	10.8	1.2711	0.0000	SURCHARGED	3.004	ns4	10.5	0.402	0.150	3.1689	
180 minute winter	s5	132	114.426	0.493	7.2	0.9962	0.0000	SURCHARGED	3.003	ns5	7.0	0.556	0.213	0.9147	
180 minute winter	s5.3	132	114.426	0.126	2.6	0.2344	0.0000	OK	3.000	s5.2	2.6	0.410	0.029	1.7256	
15 minute summer	ns2	10	114.999	0.109	15.3	0.1235	0.0000	OK	4.001	s10	15.0	1.114	0.945	0.5792	
15 minute summer	ns1	9	115.157	0.117	16.4	0.4363	0.0000	OK	4.000	ns2	15.3	1.135	0.864	0.2104	
180 minute winter	s9.3	132	114.424	0.524	7.5	0.9265	0.0000	OK	5.000	s10	-7.5	-0.099	-0.004	42.8447	
180 minute winter	s2.1	132	114.424	0.324	4.0	0.5731	0.0000	OK	2.000	s2	-4.0	-0.078	-0.004	17.1316	
180 minute winter	s5.2	132	114.427	0.345	5.1	0.5953	0.0000	SURCHARGED	3.001	s5.1	4.2	0.582	0.049	1.0563	
180 minute winter	s5.1	132	114.427	0.434	4.4	0.5131	0.0000	SURCHARGED	3.002	s5	3.6	0.392	0.042	0.7042	

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CAUSEWAY

Results for 30 year +20% Critical Storm Duration. Lowest mass balance: 99.31%

Event	US Node ID	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status	Link ID	DS Node ID	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
240 minute winter	s1.1	188	115.484	2.088	12.5	2.3613	0.0000	OK	Depth/Flow		12.0				291.4
240 minute winter	s1	188	115.484	2.067	13.5	3.6533	0.0000	FLOOD RISK	1.007	s1.1	12.5	0.284	0.100	0.5515	
240 minute winter	s2	188	115.485	1.725	17.5	3.0473	0.0000	FLOOD RISK	1.006	s1	7.0	0.557	0.089	1.0563	
240 minute winter	s3	188	115.486	1.600	17.9	2.5752	0.0000	FLOOD RISK	1.005	s2	17.5	0.578	0.479	0.3977	
240 minute winter	s3.1	188	115.488	1.353	15.2	2.3057	0.0000	FLOOD RISK	1.004	s3	14.7	0.560	0.403	1.9886	
240 minute winter	s3.1a	188	115.489	1.244	12.3	2.1596	0.0000	FLOOD RISK	1.003	s3.1	11.9	0.688	0.325	0.8750	
240 minute winter	s3.2	188	115.490	1.105	9.9	1.9949	0.0000	FLOOD RISK	1.002	s3.1a	9.1	0.868	0.250	1.1136	
240 minute winter	s9	188	115.492	0.742	6.7	1.5718	0.0000	FLOOD RISK	1.001	s3.2	6.7	0.915	0.377	0.5105	
15 minute winter	s8	12	115.585	0.385	16.8	1.2821	0.0000	FLOOD RISK	1.000	s9	13.2	0.812	0.745	0.7922	
240 minute winter	s10	188	115.485	2.009	33.2	4.9313	0.0000	FLOOD RISK	3.006	s1	11.3	0.333	0.104	2.2059	
240 minute winter	ns4	188	115.485	1.899	22.3	3.5443	0.0000	FLOOD RISK	3.005	s10	21.8	0.357	0.341	2.3238	
240 minute winter	ns5	188	115.486	1.720	17.0	3.3145	0.0000	FLOOD RISK	3.004	ns4	16.5	0.442	0.235	3.1689	
240 minute winter	s5	188	115.487	1.554	11.8	3.1371	0.0000	FLOOD RISK	3.003	ns5	11.3	0.500	0.345	0.9147	
240 minute winter	s5.3	188	115.487	1.187	3.7	2.2007	0.0000	FLOOD RISK	3.000	s5.2	3.1	0.400	0.036	2.4647	
240 minute winter	ns2	188	115.487	0.597	5.7	0.6751	0.0000	FLOOD RISK	4.001	s10	5.7	0.891	0.321	0.7570	
240 minute winter	ns1	188	115.488	0.448	5.7	1.6737	0.0000	FLOOD RISK	4.000	ns2	5.7	0.878	0.321	0.2641	
240 minute winter	s9.3	188	115.485	1.585	12.1	2.8000	0.0000	FLOOD RISK	5.000	s10	-12.1	-0.036	-0.006	85.6299	
240 minute winter	s2.1	188	115.485	1.385	7.4	2.4465	0.0000	FLOOD RISK	2.000	s2	-7.4	-0.062	-0.007	38.0264	
240 minute winter	s5.2	188	115.487	1.406	6.5	2.4223	0.0000	FLOOD RISK	3.001	s5.1	6.1	0.545	0.072	1.0563	
240 minute winter	s5.1	188	115.487	1.495	6.4	1.7654	0.0000	FLOOD RISK	3.002	s5	6.1	0.383	0.072	0.7042	

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CAUSEWAY

Results for 100 year Critical Storm Duration. Lowest mass balance: 99.31%

Event	US Node ID	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status	Link ID	DS Node ID	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
240 minute winter	s1.1	160	115.550	2.154	27.4	2.4362	12.2981	FLOOD	Depth/Flow		12.0				293.9
240 minute winter	s1	168	115.553	2.137	25.9	3.7754	0.0000	FLOOD RISK	1.007	s1.1	27.4	0.284	0.217	0.5515	
240 minute winter	s2	160	115.555	1.795	18.7	3.1715	0.0000	FLOOD RISK	1.006	s1	9.4	0.562	0.120	1.0563	
180 minute winter	s3	128	115.559	1.674	22.7	2.6932	0.0000	FLOOD RISK	1.005	s2	22.1	0.619	0.605	0.3977	
180 minute winter	s3.1	128	115.572	1.437	19.2	2.4489	0.0000	FLOOD RISK	1.004	s3	18.6	0.586	0.508	1.9886	
180 minute winter	s3.1a	128	115.576	1.331	15.7	2.3113	0.0000	FLOOD RISK	1.003	s3.1	15.0	0.711	0.410	0.8750	
180 minute winter	s3.2	128	115.580	1.195	12.6	2.1573	0.0000	FLOOD RISK	1.002	s3.1a	11.6	0.700	0.316	1.1136	
180 minute winter	s9	128	115.592	0.842	8.6	1.7848	0.0000	FLOOD RISK	1.001	s3.2	8.5	0.960	0.480	0.5105	
15 minute winter	s8	11	115.600	0.400	18.1	1.3124	0.5859	FLOOD	1.000	s9	14.3	0.865	0.807	0.7922	
240 minute winter	s10	160	115.555	2.079	35.2	5.1049	0.0000	FLOOD RISK	3.006	s1	16.5	0.333	0.151	2.2059	
240 minute winter	ns4	160	115.558	1.972	23.7	3.6803	0.0000	FLOOD RISK	3.005	s10	23.2	0.357	0.364	2.3238	
120 minute winter	ns5	94	115.562	1.796	28.8	3.4602	0.0000	FLOOD RISK	3.004	ns4	27.9	0.523	0.399	3.1689	
120 minute winter	s5	94	115.567	1.634	20.1	3.2991	0.0000	FLOOD RISK	3.003	ns5	19.2	0.576	0.587	0.9147	
120 minute winter	s5.3	94	115.570	1.270	6.2	2.3542	0.0000	FLOOD RISK	3.000	s5.2	5.3	0.461	0.061	2.4647	
180 minute winter	ns2	128	115.566	0.676	7.4	0.7648	0.0000	FLOOD RISK	4.001	s10	7.4	0.944	0.418	0.7570	
180 minute winter	ns1	128	115.571	0.531	7.4	1.9851	0.0000	FLOOD RISK	4.000	ns2	7.4	0.935	0.415	0.2641	
240 minute winter	s9.3	160	115.556	1.656	13.0	2.9254	0.0000	FLOOD RISK	5.000	s10	-13.0	-0.039	-0.007	85.6299	
240 minute winter	s2.1	160	115.555	1.455	8.2	2.5713	0.0000	FLOOD RISK	2.000	s2	-8.2	-0.058	-0.008	38.0264	
120 minute winter	s5.2	94	115.569	1.488	11.2	2.5833	0.0000	FLOOD RISK	3.001	s5.1	10.5	0.619	0.122	1.0563	
120 minute winter	s5.1	94	115.568	1.576	11.0	1.8610	0.0000	FLOOD RISK	3.002	s5	10.4	0.420	0.122	0.7042	

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