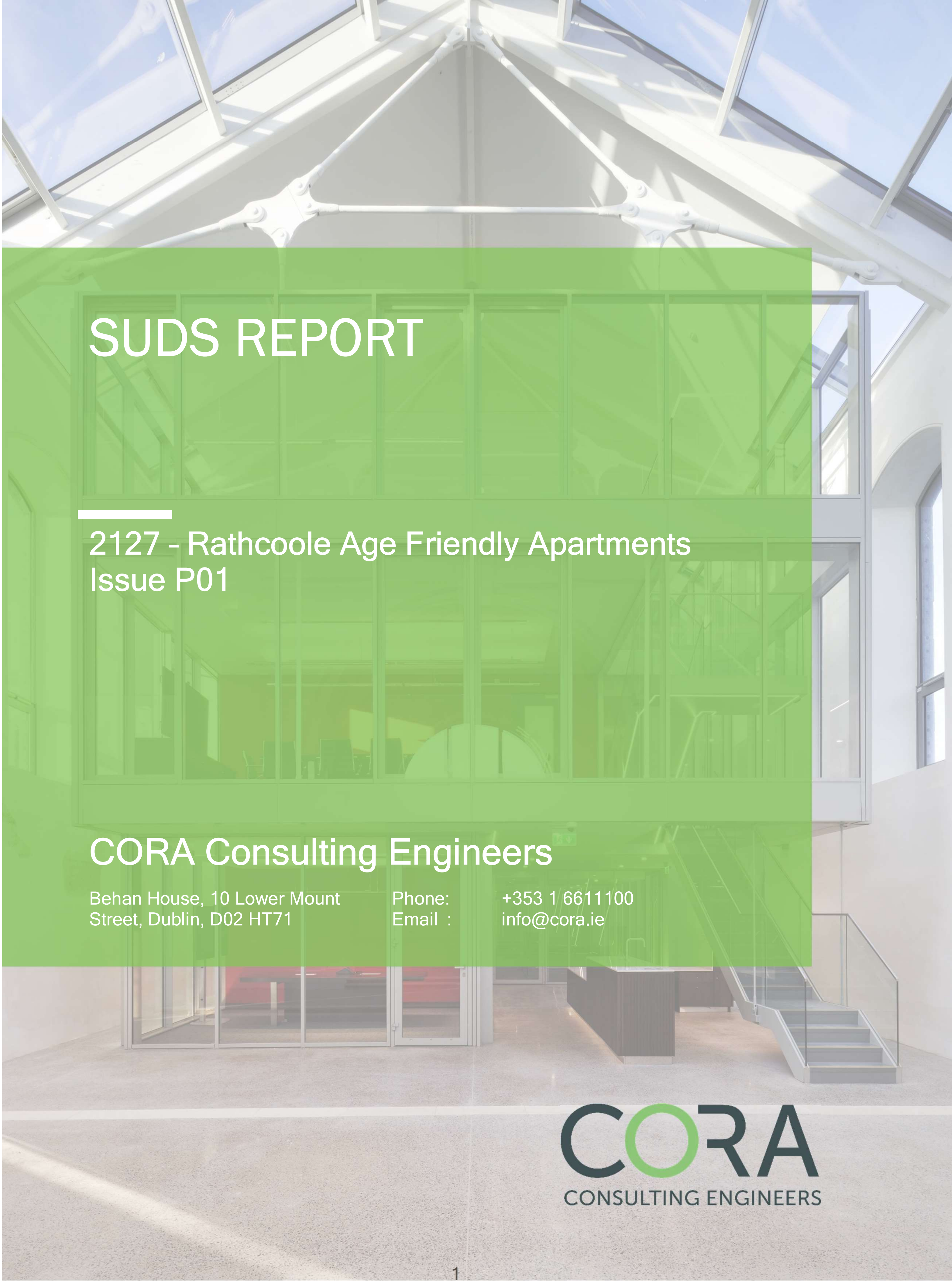

# SUDS REPORT

2127 – Rathcoole Age Friendly Apartments
Issue P01

## CORA Consulting Engineers

Behan House, 10 Lower Mount Street, Dublin, D02 HT71
Phone: +353 1 6611100
Email : info@cora.ie

## Table of Contents


Introduction ........ 3
Project Description ........ 3
Site Conditions ........ 4
SuDS Measures and Rationale ........ 5
Chosen SuDS Measures ........ 5
Benefits of Chosen SuDS Measures ........ 7
Site Surfaces Layout ........ 8
Soakaway Rationale ........ 9
Site Attenuation Calculations ........ 10
Appendix A ........ 11
SuDS Attenuation Volume Calculations ........ 11
Appendix B ........ 12
Infiltration Calculations ........ 12
Appendix C ........ 16
Drawing C030 - SuDS Features Plan and Sections ........ 16


| Revision | Author | Reviewed by | Approved by | Issue Date |
|---|---|---|---|---|
| P01 | AZ | JP | JP | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

# Introduction

CORA Consulting Engineers have been appointed by Riverside Projects as the Structural Engineers for the proposed construction of a four-storey age-friendly apartment block in the area east of Thay Lane, Newcastle Road, Rathcoole, Dublin 24. As part of Compliance Condition no. 7, the design team is required to provide additional information regarding the drainage and SUDS (Sustainable Urban Drainage) features of the proposed development.

This report will outline the proposed SUDS measures to be incorporated in the design, the rationale behind the design and the relevant calculations. It will also propose the reconsideration of the use of a soakaway for this facility. This report provides requested supplementary information and should be read in conjunction with the Sustainable Urban Drainage Management Plan issue by CORA Consulting Engineers as part of the planning application process.

## Project Description

The development at the lands located to the east of Tay Lane, Newcastle Road, Rathcoole consists of a 4 storey apartment block, community facility, and ancillary accommodations such as bike stores, plant rooms, etc. Surrounding the buildings there will be a landscaped public open area, communal outdoor spaces, a  nature walk and car parking spaces.

The facilities have been designed as age-friendly with the accessibility requirements and social needs of its residents in mind. The facilities will be run by a single entity, providing the necessary maintenance, as well as care and help to the residents.

*Figure 1: Model of Proposed Development, supplied by PAC Studio Architects.*

## Site Conditions

The site is of approximately 4759m$^2$ in area, and is currently mostly covered in vegetation. The site slopes down from east to west. There is currently no water mains of foul sewers servicing the site. The existing Irish Water infrastructure runs along the west boundary of the site.

The west extent of the site is located in a 0.1% Annual Exceedance Probability Flood Extent Area. This risk has been taken into account during the drainage design of the site.

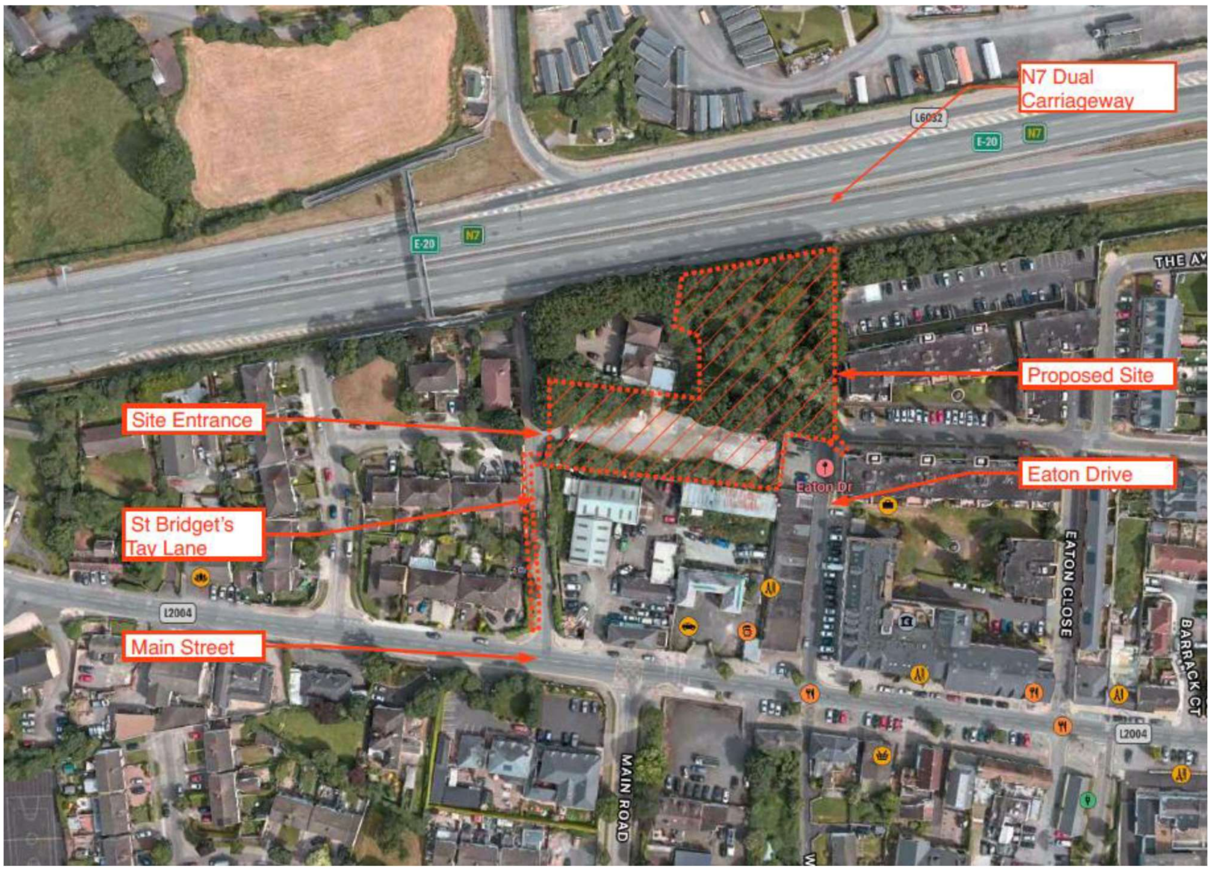


*Figure 2: Site location. Image from Google Maps.*

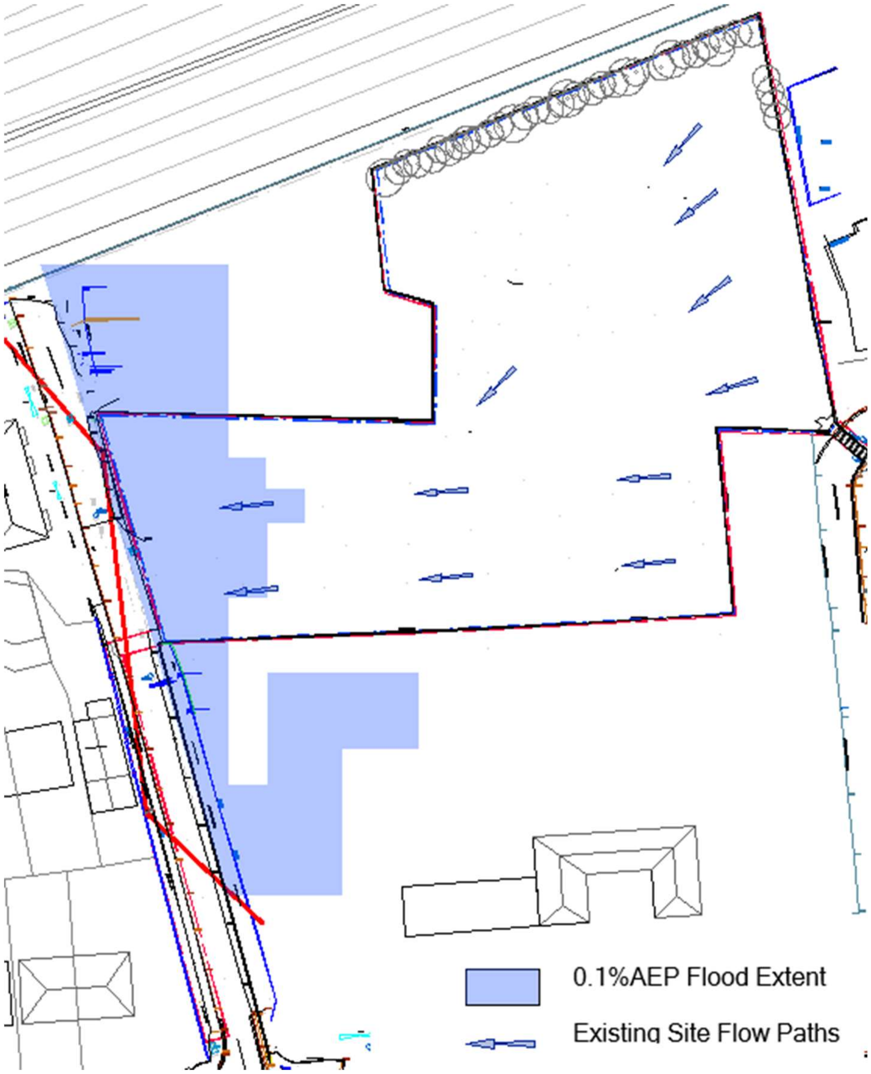


*Figure 3: Existing site layout showing the areas at risk of flooding and the current site flow path.*

# SuDS Measures and Rationale

## Chosen SuDS Measures

The SuDS measures to be incorporated on site have been chosen with consideration of the landscape architects' plans, the layout of the site and its intended use. Since the age-friendly apartments will be inhabited by residents of varying mobility and needs, their comfort and safety was considered to be the utmost priority. As a result, some potential SuDS measures were seen as unsuitable, due to potential health and safety risks. These mainly include measures which include slopes, uneven terrain and areas accessible to the public where deep water may accumulate during adverse weather conditions.

An outline of the proposed SuDS measures, the rationale behind their use, their surface areas and attenuation volumes have been outlined in Table 1 below. The attenuation volume calculations are presented in Appendix A and B.

*Table 1: SuDS Measures and Rationale*

| SuDS Measures | Measures used | Rationale | Feature Surface area ($m^2$) | Feature attenuation Volume ($m^3$) |
|---|---|---|---|---|
| Swales | No | Areas of uneven ground and standing water may be a hazard to the residents. | 0 | 0 |
| Integrated Constructed tree pits | Yes | The proposed landscape plans already incorporate trees throughout the site. The addition of tree pits will improve drainage and the trees' growth. | 116 | 12 |
| Green Roofs | Yes | Green roofs promote more biodiversity than blue roofs. Idea large flat area on top of apartments. | 1145 | 43.5 |
| Permeable Pavements | Yes | Various surfaces throughout site - paving, asphalt, etc. specified as permeable. | 995 | 74.6 |
| Permeable Tarmacs | Yes | Various surfaces throughout site - paving, asphalt, etc. specified as permeable. | 712 | 42.7 |
| Green Walls | No | Not accounted for in structural design. | 0 | 0 |
| Filter Strips | No | Areas of uneven ground and standing water may be a hazard to the residents. | 0 | 0 |
| Bio-retention systems/raingardens | No | Areas of uneven ground and standing water may be a hazard to the residents. | 0 | 0 |
| Blue Roofs | No | Green/Blue roof chosen instead due to improved biodiversity. | 0 | 0 |
| Detention/Retention Basins | No | Areas of uneven ground and standing water may be a hazard to the residents. | 0 | 0 |
| Ponds/wetlands | No | Areas of uneven ground and standing water may be a hazard to the residents. | 0 | 0 |
| Soakaway | Yes | Appropriate for this development since facilities will be managed by one entity. Will remove need for discharge of run off from site to existing services. | 120 | 91.2 |
| Total | | | | 264 |

The plan and sections of the proposed SuDS measures for the site can be found in Appendix C – drawing C030, of this document.

## Benefits of Chosen SuDS Measures

*Treatment Train*

- Prevention: In order to reduce the need for positive drainage throughout the site, the majority of surfaces have been specified as permeable. A large portion of the site is covered in lawns and planting areas. The permeable pavements and asphalts specified throughout the site will allow rainfall to infiltrate down into the ground. The maintenance measures outlined in the Sustainable Urban Drainage Management Plan, such as the upkeep and cleaning of permeable pavements, avoidance of the use of pesticides and de-icing agents, etc., will minimise the pollutants entering the drainage system.

- Source Control: The main apartment block will have a green roof. Here the rain will be intercepted and a portion will be absorbed by vegetation or evaporate off its surface. Similarly, tree pits located throughout the site will collect rainwater from their surroundings, where it will be used for the watering of trees. As such, the volume and rate of runoff will be reduced.

- Site Control: A soakaway will provide additional storage for the site. Excess rainfall from the roofs will be stored in the soakaway and gradually drain into the soils on site. This will avoid any surface water being discharged into the public sewer system.

The Conveyance and Regional Control Measures treatment train principles are not applicable for this site.

*Biodiversity Value*

The incorporation of green areas, vegetation and permeable surfaces will encourage and support the development of plants, insects and wildlife. The inclusion of a green roof will mitigate some of the environmental impact caused by the new development. The presence of vegetation will also benefit the air quality in the area and combat carbon emissions.

*Amenity Value*

The open green areas will be greatly beneficial to the residents of the facility. The surrounding nature will encourage spending time outside, as well as improve the residents' quality of life and well-being. Communal outside areas will encourage socialising and a sense of community. Improved air quality will have positive health benefits.

# Site Surfaces Layout

A layout of the site showing the incorporated surface types has been shown in Figure 4. The approximate areas of each surface type have been extracted from the AutoCAD model and are included in Table 2.

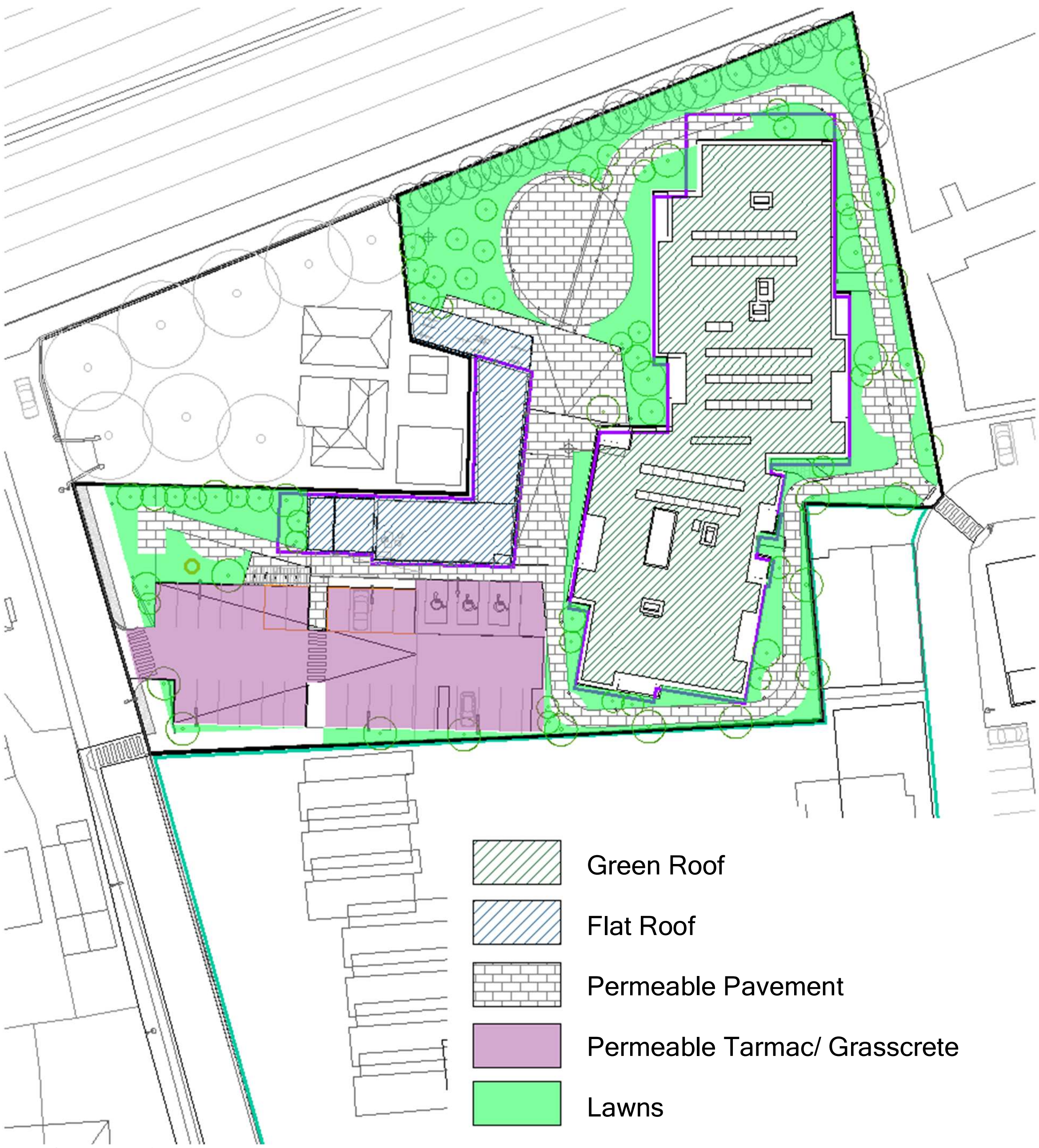


*Figure 4: Layout of surface area types on site.*

*Table 2: Surface types, their areas and runoff coefficients.*

| Surface Area Type | Surface Area ($m^2$) | Runoff Coefficient | Equivalent Area ($m^2$) |
|---|---|---|---|
| Green Roof | 1145 | 0.6 | 687 |
| Conventional Flat Roof | 320 | 0.8 | 256 |
| Permeable Pavement | 995 | 0.6 | 597 |
| Permeable Tarmac/Grasscrete | 712 | 0.6 | 427.2 |
| Lawns | 1587 | 0.15 | 238.05 |
| Total | 4759 | - | **2205.25** |

The runoff coefficient for the first four surface types has been obtained from the SuDS Manual published by CIRIA, whereas the runoff coefficient of lawns has been estimated according to the Sustainable Drainage Design & Evaluation Guide published by Dublin City Council.

The Equivalent Area of Impermeable Surface for the site is 2205.25$m^2$.

The permeable pavements and tarmacs have an inbuilt attenuation volume, as outline in Table 1. Therefore, excess runoff from these features which does not infiltrate into the ground immediately can be stored locally. The excess runoff from the remaining surface types, namely the green roof, conventional roof and the lawns, will be attenuated in the proposed soakaway.

# Soakaway Rationale

As outlined in the existing site conditions, the west of the site is in danger of flooding. The existing sewer services near the site are already at risk of surcharging. It would therefore be beneficial to minimise the additional strain caused by the new development on the existing nearby waste water infrastructure. The implementation of a soakaway was therefore proposed for the site. The designed soakaway, as outlined in the Sustainable Urban Drainage Management Plan issued, has sufficient storage capacity to collect the surface water from all roofs on the site. This allows for the rainwater to be stored on site and be allowed to slowly dissipate into the surrounding soils. This will result in no additional surface water from the proposed development being discharged into the wastewater systems.

Although soakaways are generally not used in apartment buildings due to the need for an individual owner, the unique nature of this facility would nullify this issue. As stated before, the apartment building will be managed and operated by a single entity. As stated in the application and in the Executive Order, the 'development is intended for operation and management by Clann Housing, the dedicated age-friendly housing service of Clúid'. It is also stated that:

*'The permitted development shall be operated only as an age friendly housing scheme. No separate sales or equivalent disposal of any individual residential units shall take place. The residential development shall be owned and operated by a single institutional entity except where otherwise agreed in writing by the Local Authority.'*

Thus, any maintenance, repairs or costs associated with the soakaway will be settled by them. The condition of a single owner for the soakaway is therefore met and there is no reason for its use to be denied.

# Site Attenuation Calculations

As mentioned priorly, the purpose of the soakaway is to store the excess runoff from the green roof, conventional roof and lawns on site. The equivalent impermeable area of these surfaces sums to 1181.05m$^2$.

*Table 3: Surface areas contributing to soakaway.*

| Surface Area Type | Surface Area (m$^2$) | Runoff Coefficient | Equivalent Area (m$^2$) |
|---|---|---|---|
| Green Roof | 1145 | 0.6 | 687 |
| Conventional Flat Roof | 320 | 0.8 | 256 |
| Lawns | 1587 | 0.15 | 238.05 |
| Total | 3052 | - | **1181.05** |

The M100-60min, the rainfall depth for a 60 minute duration event with a return period of 100 years, according to the Rathcoole Rainfall Data provided by Met Éireann, is 50.3mm. With this rainfall depth, the total runoff from the areas contributing to the soakaway would be 59.4m$^3$. The attenuation volume of 91.2m$^3$ provided by the soakaway is sufficient to store this runoff with room to spare.

The total equivalent impermeable area of the site of 2205.25m$^2$ gives a total runoff of 110.9m$^3$ at a rainfall depth of 50.3mm. The attenuation volume provided by the tree pits, green roof, permeable surfaces and soakaway combined sums to 264m$^3$, over double the required amount. The calculated times to emptying the attenuation volumes to half their capacity, shown in Appendix B and based on the measured infiltration sites, are also satisfactory. The calculated 6 hours for the soakaway, 9 hours for the permeable tarmac and 8 hours for the permeable pavements are all well withing the 12 hour time limit.

It is therefore clear that the site has sufficient rainfall attenuation capacity for a 60 minute duration rainfall which statistically happens once in a hundred years, thus mitigating any reasonable potential risk of flooding.

*Table 4: Runoff generated from each surface type equivalent area due to rainfall of 50.3mm.*

| Surface Area Type | Equivalent Area (m$^2$) | Runoff (m$^3$) |
|---|---|---|
| Green Roof | 687 | 34.56 |
| Conventional Flat Roof | 256 | 12.88 |
| Permeable Pavement | 597 | 30.03 |
| Permeable Tarmac/Grasscrete | 427.2 | 21.49 |
| Lawns | 238.05 | 11.97 |
| Total | 2205.25 | 110.93 |
| | | |
| Total Attenuation Volume Available on Site | | 264 |
| Excess Attenuation Volume | | 153.07 |

# Appendix A
## SuDS Attenuation Volume Calculations

*Constructed Tree Pits:*

Surface Area = 116 $m^2$
Depth of Aggregate = 0.35m
Aggregate Void Ratio = 0.3
Attenuation Volume = 116 $m^2$ x 0.35m x 0.3 = **12.18 $m^3$**

*Green Roof:*

Surface Area = 1145 $m^2$
Depth of Reservoir= 0.04m
Void Ratio = 0.95
Attenuation Volume = 1145 $m^2$ x 0.04m x 0.95= **43.51 $m^3$**

*Permeable Pavements:*

Surface Area = 995 $m^2$
Depth of Aggregate = 0.25m
Aggregate Void Ratio = 0.3
Attenuation Volume = 995 $m^2$ x 0.25m x 0.3 = **74.625 $m^3$**

*Permeable Tarmacs:*

Surface Area = 712 $m^2$
Depth of Aggregate = 0.2m
Aggregate Void Ratio = 0.3
Attenuation Volume = 712 $m^2$ x 0.2m x 0.3 = **42.72 $m^3$**

*Soakaway:*

Length = 12m
Width = 10m
Depth = 0.8m
Void Ratio = 0.95
Attenuation Volume = 12m x 10m x 0.8m x 0.95 = **91.2 $m^3$**

**Total Site Attenuation Volume = 264.235 $m^3$**

# Appendix B
## Infiltration Calculations

| | | | | | |
|---|---|---|---|---|---|
| CORA Consulting Engineers<br>Behan House<br>10 Lower Mount Street<br>Dublin D02 HT71 | Project<br>Tay Lane, Rathcoole | | | | Job no.<br>2127 |
| | Calcs for<br>Surface Water Soakaway | | | | Start page no./Revision<br>1 /B |
| | Calcs by<br>KF | Calcs date<br>12/12/2024 | Checked by | Checked date | Approved by / Approved date |

**SOAKAWAY DESIGN**

**In accordance with BRE Digest 365 - Soakaway design**

Tedds calculation version 2.0.06

**Design rainfall intensity**

| | |
|---|---|
| Location of catchment area | Other |
| Impermeable area drained to the system | $A = \mathbf{1181.1}\ m^2$ |
| Return period | Period = **100** yr |
| Ratio 60 min to 2 day rainfall of 5 yr return period | r = **0.266** |
| 5-year return period rainfall of 60 minutes duration | M5_60min = **19.8** mm |
| Increase of rainfall intensity due to global warming | $p_{climate}$ = **20** % |

**Soakaway / infiltration trench details**

| | |
|---|---|
| Soakaway type | Rectangular |
| Minimum depth of pit (below incoming invert) | d = **1060** mm |
| Width of pit | w = **10100** mm |
| Length of pit | l = **12000** mm |
| Percentage free volume | $V_{free}$ = **71** % |

**Soil infiltration rate (BRE digest 365)**

| | |
|---|---|
| Length of trial pit | $l_{trial}$ = **1000** mm |
| Width of trial pit | $b_{trial}$ = **1000** mm |
| Depth of trial pit (below invert) | $d_{trial}$ = **1000** mm |
| Free volume (if fill used) | $V_{trial}$ = **100** % |
| 75% depth of pit | $d_{75} = (d_{trial} \times 0.75)$ = **750.00** mm |
| 50% depth of pit | $d_{50} = (d_{trial} \times 0.50)$ = **500.00** mm |
| 25% depth of pit | $d_{25} = (d_{trial} \times 0.25)$ = **250.00** mm |
| Test 1 - time to fall from 75% depth to 25% depth | T1 = **41** min |
| Test 2 - time to fall from 75% depth to 25% depth | T2 = **45** min |
| Test 3 - time to fall from 75% depth to 25% depth | T3 = **45** min |
| Longest time to fall from 75% depth to 25% depth | $t_g$ = max(T1, T2, T3) = **45** min |
| Storage volume from 75% to 25% depth | $V_{p75\_25} = (l_{trial} \times b_{trial} \times (d_{75} - d_{25})) \times V_{trial} = \mathbf{0.50}\ m^3$ |
| Internal surface area to 50% depth | $a_{p50} = ((l_{trial} \times b_{trial}) + (l_{trial} + b_{trial}) \times 2 \times d_{50}) = \mathbf{3.00}\ m^2$ |
| Surface area of soakaway to 50% storage depth | $A_{s50} = 2 \times (l_{trial} + b_{trial}) \times d_{trial} / 2 = \mathbf{2.000}\ m^2$ |
| Soil infiltration rate | $f = V_{p75\_25} / (a_{p50} \times t_g) = \mathbf{61.7 \times 10^{-6}}$ m/s |
| Wetted area of pit 50% full | $a_{s50} = l \times d + w \times d = \mathbf{23426000}\ mm^2$ |

**Table equations**

| | |
|---|---|
| Inflow (cl.3.3.1) | $I = M100 \times A$ |
| Outflow (cl.3.3.2) | $O = a_{s50} \times f \times D$ |
| Storage (cl.3.3.3) | $S = I - O$ |

| Duration, D (min) | Growth factor Z1 | M5 rainfalls (mm) | Growth factor Z2 | 100 year rainfall, M100 (mm) | Inflow ($m^3$) | Outflow ($m^3$) | Storage required ($m^3$) |
|---|---|---|---|---|---|---|---|
| 5 | 0.33; | 7.8; | 1.92; | 14.9; | 17.65; | 0.43; | 17.21 |
| 10 | 0.48; | 11.3; | 1.97; | 22.4; | 26.42; | 0.87; | 25.56 |
| 15 | 0.58; | 13.7; | 1.98; | 27.1; | 32.04; | 1.30; | 30.73 |

*Figure 5: Surface Water Soakaway Infiltration Calculations.*

| CORA Consulting Engineers<br>Behan House<br>10 Lower Mount Street<br>Dublin D02 HT71 | Project<br>Tay Lane, Rathcoole | | | Job no.<br>2127 | |
|---|---|---|---|---|---|
| | Calcs for<br>Surface Water Soakaway | | | Start page no./Revision<br>2 /B | |
| | Calcs by<br>KF | Calcs date<br>12/12/2024 | Checked by | Checked date | Approved by | Approved date |

| Duration, D (min) | Growth factor Z1 | M5 rainfalls (mm) | Growth factor Z2 | 100 year rainfall, M100 (mm) | Inflow ($m^3$) | Outflow ($m^3$) | Storage required ($m^3$) |
|---|---|---|---|---|---|---|---|
| 30 | 0.76; | 18.0; | 1.95; | 35.1; | 41.51; | 2.60; | 38.91 |
| 60 | 1.00; | 23.8; | 1.90; | 45.1; | 53.32; | 5.21; | 48.11 |
| 120 | 1.27; | 30.3; | 1.85; | 55.9; | 66.06; | 10.41; | 55.65 |
| 240 | 1.65; | 39.2; | 1.78; | 69.6; | 82.22; | 20.82; | 61.40 |
| 360 | 1.90; | 45.0; | 1.74; | 78.6; | 92.83; | 31.23; | 61.60 |
| 600 | 2.26; | 53.7; | 1.71; | 91.6; | 108.20; | 52.06; | 56.14 |
| 1440 | 3.13; | 74.4; | 1.62; | 120.8; | 142.64; | 124.94; | 17.70 |

Required storage volume $S_{req}$ = **61.60** $m^3$

Soakaway storage volume $S_{act} = l \times d \times w \times V_{free}$ = **91.22** $m^3$

***PASS - Soakaway storage volume***

Time for emptying soakaway to half volume $t_{s50} = S_{req} \times 0.5 / (a_{s50} \times f)$ = 5hr 55min

***PASS - Soakaway discharge time less than or equal to 24 hours***

*Figure 6: Surface Water Soakaway Infiltration Calculations continued.*

| CORA Consulting Engineers<br>Behan House<br>10 Lower Mount Street<br>Dublin 2 | Project<br>Tay Lane, Rathcoole | | | | Job no.<br>2127 | |
|---|---|---|---|---|---|---|
| | Calcs for<br>Infiltration - Tarmac Hard Standing | | | | Start page no./Revision<br>1 | |
| | Calcs by<br>JP | Calcs date<br>12/12/2024 | Checked by | Checked date | Approved by | Approved date |

**SOAKAWAY DESIGN**

**In accordance with BRE Digest 365 - Soakaway design**

Tedds calculation version 2.0.06

**Design rainfall intensity**

Location of catchment area — Other

Impermeable area drained to the system — A = **712.0** $m^2$

Return period — Period = **100** yr

Ratio 60 min to 2 day rainfall of 5 yr return period — r = **0.266**

5-year return period rainfall of 60 minutes duration — M5_60min = **19.8** mm

Increase of rainfall intensity due to global warming — $p_{climate}$ = **20** %

**Soakaway / infiltration trench details**

Soakaway type — Rectangular

Minimum depth of pit (below incoming invert) — d = **200** mm

Width of pit — w = **26500** mm

Length of pit — l = **26500** mm

Percentage free volume — $V_{free}$ = **30** %

Soil infiltration rate — f = **61.7×10$^{-6}$** m/s

Wetted area of pit 50% full — $a_{s50} = l \times d + w \times d$ = **10600000** $mm^2$

**Table equations**

Inflow (cl.3.3.1) — $I = M100 \times A$

Outflow (cl.3.3.2) — $O = a_{s50} \times f \times D$

Storage (cl.3.3.3) — $S = I - O$

| Duration, D (min) | Growth factor Z1 | M5 rainfalls (mm) | Growth factor Z2 | 100 year rainfall, M100 (mm) | Inflow ($m^3$) | Outflow ($m^3$) | Storage required ($m^3$) |
|---|---|---|---|---|---|---|---|
| 5 | 0.33; | 7.8; | 1.92; | 14.9; | 10.64; | 0.20; | 10.44 |
| 10 | 0.48; | 11.3; | 1.97; | 22.4; | 15.93; | 0.39; | 15.54 |
| 15 | 0.58; | 13.7; | 1.98; | 27.1; | 19.31; | 0.59; | 18.72 |
| 30 | 0.76; | 18.0; | 1.95; | 35.1; | 25.02; | 1.18; | 23.85 |
| 60 | 1.00; | 23.8; | 1.90; | 45.1; | 32.14; | 2.35; | 29.79 |
| 120 | 1.27; | 30.3; | 1.85; | 55.9; | 39.83; | 4.71; | 35.12 |
| 240 | 1.65; | 39.2; | 1.78; | 69.6; | 49.57; | 9.42; | 40.15 |
| 360 | 1.90; | 45.0; | 1.74; | 78.6; | 55.96; | 14.13; | 41.84 |
| 600 | 2.26; | 53.7; | 1.71; | 91.6; | 65.23; | 23.54; | 41.68 |
| 1440 | 3.13; | 74.4; | 1.62; | 120.8; | 85.99; | 56.51; | 29.48 |

Required storage volume — $S_{req}$ = **41.84** $m^3$

Soakaway storage volume — $S_{act} = l \times d \times w \times V_{free}$ = **42.14** $m^3$

***PASS - Soakaway storage volume***

Time for emptying soakaway to half volume — $t_{s50} = S_{req} \times 0.5 / (a_{s50} \times f)$ = 8hr 53min 7s

***PASS - Soakaway discharge time less than or equal to 24 hours***

*Figure 7: Tarmac Infiltration Calculations.*

| CORA Consulting Engineers<br>Behan House<br>10 Lower Mount Street<br>Dublin 2 | Project<br>Tay Lane, Rathcoole | | | | Job no.<br>2127 | |
|---|---|---|---|---|---|---|
| | Calcs for<br>Infiltration - Permeable Pavement | | | | Start page no./Revision<br>1 | |
| | Calcs by<br>JP | Calcs date<br>12/12/2024 | Checked by | Checked date | Approved by | Approved date |

## SOAKAWAY DESIGN

**In accordance with BRE Digest 365 - Soakaway design**

Tedds calculation version 2.0.06

**Design rainfall intensity**

Location of catchment area — Other

Impermeable area drained to the system — $A = \mathbf{995.0}\ m^2$

Return period — Period = **100** yr

Ratio 60 min to 2 day rainfall of 5 yr return period — r = **0.266**

5-year return period rainfall of 60 minutes duration — M5_60min = **19.8** mm

Increase of rainfall intensity due to global warming — $p_{climate} = \mathbf{20}\ \%$

**Soakaway / infiltration trench details**

Soakaway type — Rectangular

Minimum depth of pit (below incoming invert) — d = **250** mm

Width of pit — w = **31500** mm

Length of pit — l = **31500** mm

Percentage free volume — $V_{free} = \mathbf{30}\ \%$

Soil infiltration rate — $f = \mathbf{61.7 \times 10^{-6}}\ m/s$

Wetted area of pit 50% full — $a_{s50} = l \times d + w \times d = \mathbf{15750000}\ mm^2$

**Table equations**

Inflow (cl.3.3.1) — $I = M100 \times A$

Outflow (cl.3.3.2) — $O = a_{s50} \times f \times D$

Storage (cl.3.3.3) — $S = I - O$

| Duration, D (min) | Growth factor Z1 | M5 rainfalls (mm) | Growth factor Z2 | 100 year rainfall, M100 (mm) | Inflow ($m^3$) | Outflow ($m^3$) | Storage required ($m^3$) |
|---|---|---|---|---|---|---|---|
| 5 | 0.33; | 7.8; | 1.92; | 14.9; | 14.87; | 0.29; | 14.58 |
| 10 | 0.48; | 11.3; | 1.97; | 22.4; | 22.26; | 0.58; | 21.68 |
| 15 | 0.58; | 13.7; | 1.98; | 27.1; | 26.99; | 0.87; | 26.12 |
| 30 | 0.76; | 18.0; | 1.95; | 35.1; | 34.97; | 1.75; | 33.22 |
| 60 | 1.00; | 23.8; | 1.90; | 45.1; | 44.92; | 3.50; | 41.42 |
| 120 | 1.27; | 30.3; | 1.85; | 55.9; | 55.65; | 7.00; | 48.66 |
| 240 | 1.65; | 39.2; | 1.78; | 69.6; | 69.27; | 13.99; | 55.28 |
| 360 | 1.90; | 45.0; | 1.74; | 78.6; | 78.21; | 20.99; | 57.22 |
| 600 | 2.26; | 53.7; | 1.71; | 91.6; | 91.15; | 34.98; | 56.17 |
| 1440 | 3.13; | 74.4; | 1.62; | 120.8; | 120.17; | 83.96; | 36.20 |

Required storage volume — $S_{req} = \mathbf{57.22}\ m^3$

Soakaway storage volume — $S_{act} = l \times d \times w \times V_{free} = \mathbf{74.42}\ m^3$

***PASS - Soakaway storage volume***

Time for emptying soakaway to half volume — $t_{s50} = S_{req} \times 0.5 / (a_{s50} \times f)$ = 8hr 10min 41s

***PASS - Soakaway discharge time less than or equal to 24 hours***

*Figure 8: Permeable Pavement Infiltration Calculations.*

# Appendix C

## Drawing C030 – SuDS Features Plan and Sections