outlined in the confirmation of feasibility which is enclosed in Appendix B within this document.

Water services department have made the following observations/comments.

*Item 1.1) Submit a report and show in table format the area of the site, and area of different surface types, from green roofs, buildings, roads, permeable paving paths, grass landscape in m2 and their respective run-off co-efficient. Show what surface water attenuation is required in m3 and what surface water is provided in m3.*

L&D Response:
Table 4.4.1 has been added to section 4.4 of this report. This table outlines the surface area of each surface type that can be found on site with its relevant run-off coefficient. This table also highlights the total surface area of each of these surface types. Table 4.4.2 has also been added to section 4.4 of this report, this table highlights the required attenuation volume, factored catchment areas, and provided attenuation volume of each SuDS feature located within the development.

Water services department have made the following observations/comments.

*Item 1.2*) *Minimize the use of road gullies and pipes to drain surface water. Where possible surface water from hard standing areas and roads should flow into the surface of SuDS (Sustainable Drainage Systems) such as tree pits and grass swales areas or grass detention areas.*

L&D Response:
Use of road gullies has been minimized. Road gullies are only proposed as a last resort, where surface water cannot naturally, at surface level, be conveyed into a natural above ground SuDS feature. Road gullies previously proposed along the southern frontage cycling lane have been removed, surface water will be conveyed into the proposed tree pits above ground level, by use of allowable cycle lane crossfalls and a

flat kerb combination. Surface water will not be piped into the tree pits. Please refer to drawing No. "20189-LDE-07-00-DR-SC-1C01a".

Water services department have made the following observations/comments in regard to flood risk.

*The developer shall ensure that there is complete separation of the foul and surface drainage for the proposed development.*

L&D Response:
Complete separation between the foul and surface drainage has been implemented throughout the site. A separate sewer line for each sewer has been proposed throughout the site. The foul sewer has been proposed to discharge to an existing manhole along the Greenhills road while the surface water sewer has been proposed to outfall into an existing surface water sewer within the Greenhills industrial estate. Details of this can be seen in drawings No. "20189-LDE-07-00-DR-SC-1C01a" and "20189-LDE-07-00-DR-SC-1C01d". Also refer to drawings No. "20189-LDE-07-00-DR-SC-3C02a-b" and "20189-LDE-07-00-DR-SC-3C03a-d" for the full longitudinal sections of both the proposed foul sewer and proposed surface water sewer. All of these drawings read in conjunction with one another shows how complete separation between the two proposed sewer lines was always maintained, and how separation was still maintained at any crossovers between the two lines.

Water services department have made the following observations/comments in regard to flood risk.

*All works for this development shall comply with the requirements of the Greater Dublin Regional Code of practice for Drainage work.*

L&D Response:
All drainage works for this development will comply with the requirements of the Greater Dublin Regional Code of Practice for Drainage Work.

Roads department have made the following observations/comments in regard to drainage.

*The applicant shall be required to upgrade the surface course and any drainage of the existing Beechlawn Industrial estate road along the entire Southern boundary of the development.*

L&D Response:

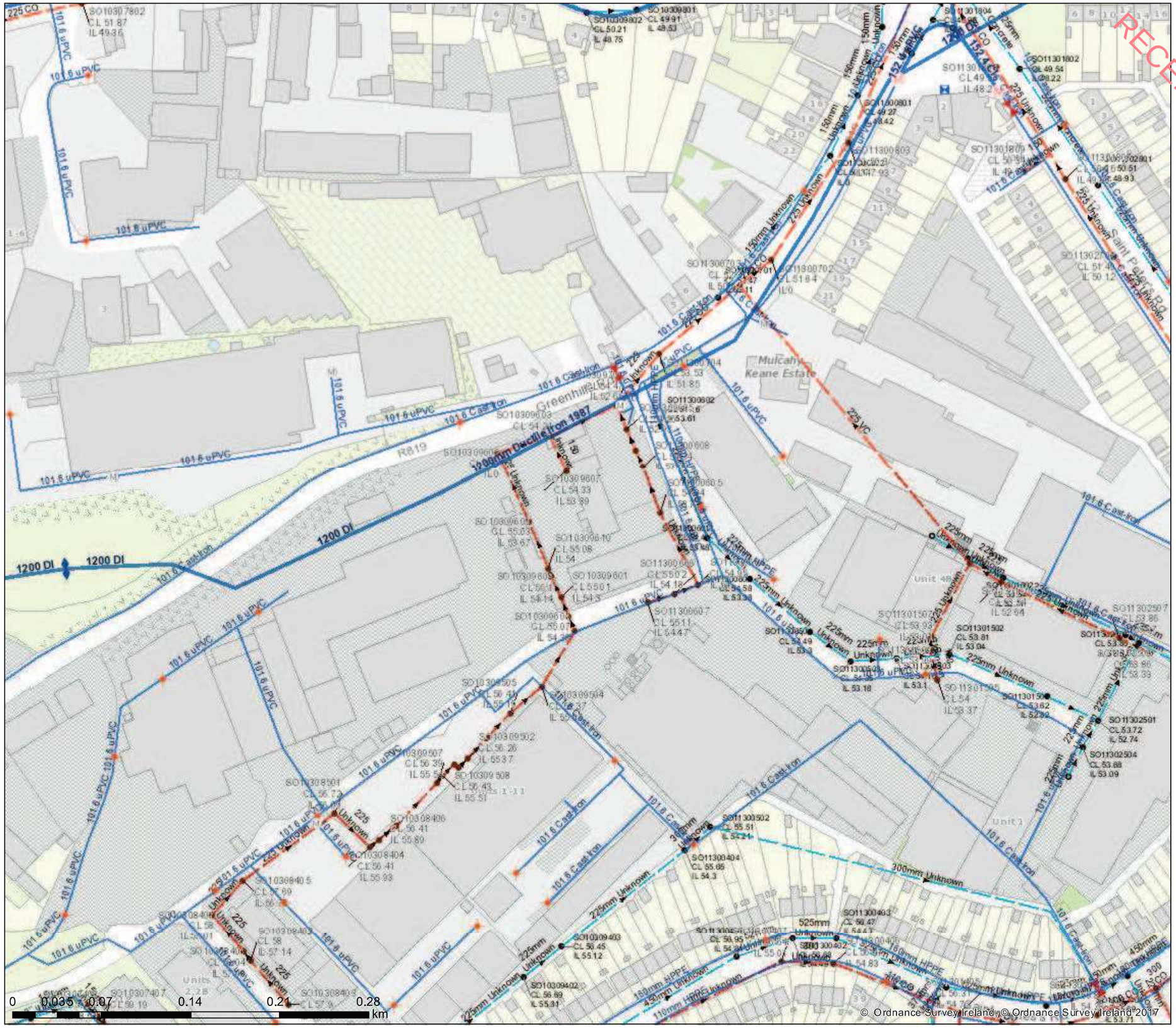
The Beechlawn industrial estate road that traverses along the Southern boundary of the site is a privately owned road, therefore upgrading the surface course is outside the scope or control of the applicant. However, there are proposed works along this road to facilitate the Main vehicle Access Road and the three proposed access junctions, so if any of these proposed works impacts the existing drainage along the Beechlawn Industrial estate road, then these will be repaired as necessary.

**Mr. Edvinas Valadka B.Eng.,**
Engineer,
For Lohan & Donnelly Consulting Engineers.

**Date: 9th May. 2025**

# Appendix A – South Dublin City Council Drainage Records

# Irish Water Web Map




RECEIVED 16/12/2020

UISCE ÉIREANN : IRISH WATER

Print Date: 16/12/2020

Printed by:Irish Water



**Water Distribution Network**
- Water Treatment Plant
- Water Pump Station
- Storage Cell/Tower
- Dosing Point
- Meter Station
- Abstraction Point
- Telemetry Kiosk

**Reservoir**
- Potable
- Raw Water

**Water Distribution Mains**
- Irish Water
- Private

**Trunk Water Mains**
- Irish Water
- Private

**Water Lateral Lines**
- Irish Water
- Non IW
- Water Casings
- Water Abandoned Lines
- Boundary Meter
- Bulk/Check Meter
- Group Scheme
- Source Meter
- Waste Meter
- Unknown Meter ; Other Meter
- Non-Return
- PRV
- PSV
- Sluice Line Valve Open/Closed
- Butterfly Line Valve Open/Closed
- Sluice Boundary Valve Open/Closed
- Butterfly Boundary Valve Open/Closed
- Scour Valves
- Single Air Control Valve
- Double Air Control Valve
- Water Stop Valves
- Water Service Connections
- Water Distribution Chambers
- Water Network Junctions
- Pressure Monitoring Point
- Fire Hydrant
- Fire Hydrant/Washout

**Water Fittings**
- Cap
- Reducer
- Tap
- Other Fittings

**Sewer Foul Combined Network**
- Waste Water Treatment Plant
- Waste Water Pump station

**Sewer Mains Irish Water**
- Gravity - Combined
- Gravity - Foul
- Gravity - Unknown
- Pumping - Combined
- Pumping - Foul
- Pumping - Unknown
- Syphon - Combined
- Syphon - Foul
- Overflow

**Sewer Mains Private**
- Gravity - Combined
- Gravity - Foul
- Gravity - Unknown
- Pumping - Combined
- Pumping - Foul
- Pumping - Unknown
- Syphon - Combined
- Syphon - Foul
- Overflow
- Sewer Lateral Lines
- Sewer Casings

**Sewer Manholes**
- Standard
- Backdrop
- Cascade
- Catchpit
- Bifurcation
- Hatchbox
- Lamphole
- Hydrobrake
- Other; Unknown

**Discharge Type**
- Outfall
- Overflow
- Soakaway
- Standard Outlet
- Other; Unknown

**Cleanout Type**
- Rodding Eye
- Flushing Structure
- Other; Unknown

**Sewer Inlets**
- Catchpit
- Gully
- Standard
- Other; Unknown

**Sewer Fittings**
- Vent/Col
- Other; Unknown

**Storm Water Network**

**Surface Water Mains**
- Surface Gravity Mains
- Surface Gravity Mains Private
- Surface Water Pressurised Mains
- Surface Water Pressurised Mains Private

**Inlet Type**
- Gully
- Standard
- Other; Unknown

**Storm Manholes**
- Standard
- Backdrop
- Cascade
- Catchpit
- Bifurcation
- Hatchbox
- Lamphole
- Hydrobrake
- Other; Unknown
- Storm Culverts
- Storm Clean Outs
- Stormwater Chambers

**Discharge Type**
- Outfall
- Overflow
- Soakaway
- Other; Unknown

**Gas Networks Ireland**
- Transmission High Pressure Gasline
- Distribution Medium Pressure Gasline
- Distribution Low Pressure Gasline

**ESB Networks**

**ESB HV Lines**
- HV Underground
- HV Overhead
- HV Abandoned

**ESB MVLV Lines**
- MV Overhead Three Phase
- MV Overhead Single Phase
- LV Overhead Three Phase
- LV Overhead Single Phase
- MVLV Underground
- Abandoned

**Non Service Categories**
- Proposed
- Under Construction
- Out of Service
- Decommissioned

**Water Non Service Assets**
- Water Point Feature
- Water Pipe
- Water Structure

**Waste Non Service Assets**
- Waste Point Feature
- Sewer
- Waste Structure

# Appendix B – Confirmation of Feasibility (Irish Water)

## CONFIRMATION OF FEASIBILITY



Uisce Éireann
Bosca OP 448
Oifig Sheachadta na
Cathrach Theas
Lathair Chorcaí

Uisce Éireann
PO Box 448
South City
Delivery Office
Cork City

www.water.ie

Edvinas Valadka

Lohan & Donnelly Consulting Engineers
13 Gardiner Place
Mountjoy Square
Dublin 1
D01VOT8

8 January 2024

**Our Ref: CDS23008409 Pre-Connection Enquiry**
**Site at, Greenhills Road, Walkinstown, Dublin**

Dear Applicant/Agent,

## We have completed the review of the Pre-Connection Enquiry.

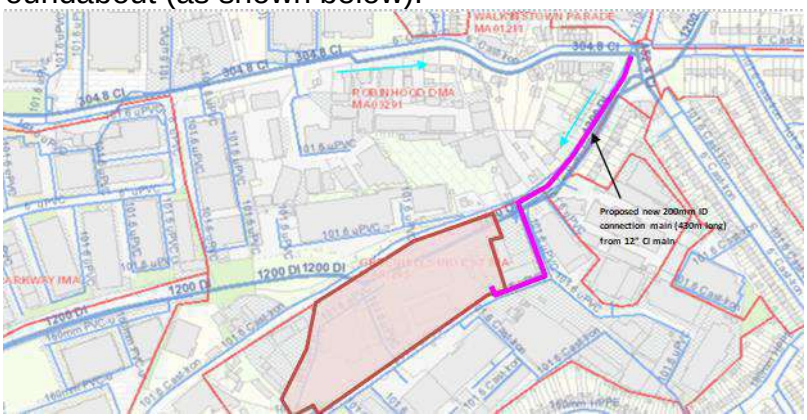
Uisce Éireann has reviewed the pre-connection enquiry in relation to a Water & Wastewater connection for a Multi/Mixed Use Development of 637 unit(s) at Site at, Greenhills Road, Walkinstown, Dublin, (the **Development)**.

Based upon the details provided we can advise the following regarding connecting to the networks;

- **Water Connection** - Feasible Subject to upgrades

- In order to accommodate the proposed connection, approximately 430m of a new 200mm ID pipe is required to be laid and connect the site development to the existing 12''CI main near Walkinstown Cross roundabout (as shown below).

-



- These works are not currently on Uisce Éireann investment plan therefore, the applicant will be required to fund these local network upgrades. At connection application stage, the network upgrade requirements will be reviewed, and you will be provided with a quote for these works.
- A bulk meter to be installed on the connection main.
- The proposed Development indicates that Uisce Éireann assets are present on the site. The Developer has to demonstrate that proposed structures and works will not inhibit access for maintenance or endanger structural or functional integrity of the assets during and after the works. Drawings (showing clearance distances, changing to ground levels) and Method Statements should be included in the Detailed Design of the Development. A wayleave in favour of Uisce Éireann will be required over the assets that are not located within the Public Space. For design submissions and queries related to diversion/build near or over, please contact UÉ Diversion Team via email address diversions@water.ie



- **Wastewater Connection** - Feasible Subject to upgrades

- In order to accommodate the proposed connection, upgrade works are required to increase the capacity of Uisce Éireann network in the area. Uisce Éireann currently has a project which will provide the necessary upgrade and capacity. The Walkinstown Road Upgrade Project is in an early (route optioneering) phase and currently, there is no delivery time available.
- The proposed Development indicates that Uisce Éireann assets are present on the site. The Developer has to demonstrate that proposed structures and works will not inhibit access for maintenance or endanger structural or functional integrity of the assets during and after the works. Drawings (showing clearance distances, changing to ground levels) and Method Statements should be included in the Detailed Design of the Development. A wayleave in favour of Uisce Éireann will be required over the assets that are not located within the Public Space. For design submissions and queries related to diversion/build near or over, please contact UÉ Diversion Team via email address diversions@water.ie

This letter does not constitute an offer, in whole or in part, to provide a connection to any Uisce Éireann infrastructure. Before the Development can be connected to our network(s) you must submit a connection application and be granted and sign a connection agreement with Uisce Éireann.

As the network capacity changes constantly, this review is only valid at the time of its completion. As soon as planning permission has been granted for the Development, a completed connection application should be submitted. The connection application is available at www.water.ie/connections/get-connected/

## Where can you find more information?



- **Section A -** What is important to know?
- **Section B -** Details of Uisce Éireann's Network(s)

**This letter is issued to provide information about the current feasibility of the proposed connection(s) to Uisce Éireann's network(s). This is not a connection offer and capacity in Uisce Éireann's network(s) may only be secured by entering into a connection agreement with Uisce Éireann.**

For any further information, visit **www.water.ie/connections**, **email** **newconnections@water.ie** or contact 1800 278 278**.**

Yours sincerely,

**Dermot Phelan**
**Connections Delivery Manager**

## Section A - What is important to know?

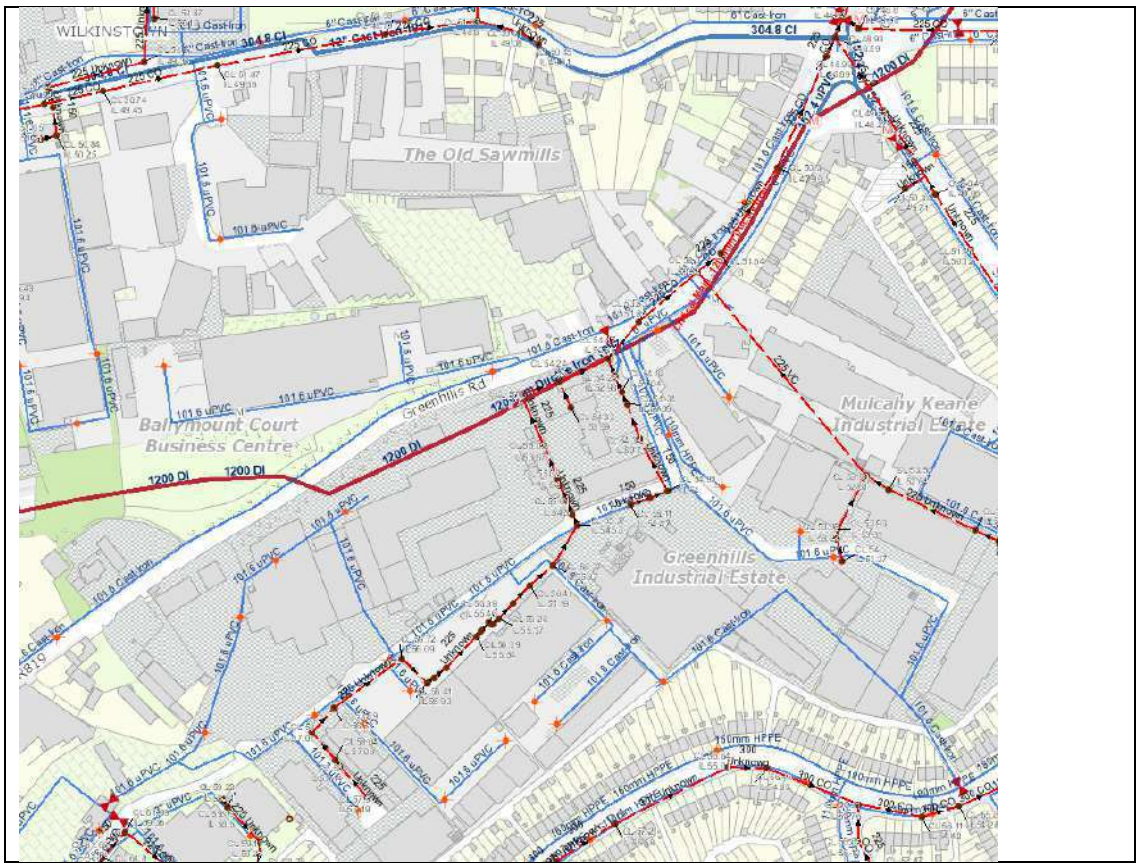


| What is important to know? | Why is this important? |
|---|---|
| **Do you need a contract to connect?** | • Yes, a contract is required to connect. This letter does not constitute a contract or an offer in whole or in part to provide a connection to Uisce Éireann's network(s).<br>• Before the Development can connect to Uisce Éireann's network(s), you must submit a connection application and be granted and sign a connection agreement with Uisce Éireann. |
| **When should I submit a Connection Application?** | • A connection application should only be submitted after planning permission has been granted. |
| **Where can I find information on connection charges?** | • Uisce Éireann connection charges can be found at: https://www.water.ie/connections/information/charges/ |
| **Who will carry out the connection work?** | • All works to Uisce Éireann's network(s), including works in the public space, must be carried out by Uisce Éireann*.<br>*Where a Developer has been granted specific permission and has been issued a connection offer for Self-Lay in the Public Road/Area, they may complete the relevant connection works |
| **Fire flow Requirements** | • The Confirmation of Feasibility does not extend to fire flow requirements for the Development. Fire flow requirements are a matter for the Developer to determine.<br>• **What to do?** - Contact the relevant Local Fire Authority |
| **Plan for disposal of storm water** | • The Confirmation of Feasibility does not extend to the management or disposal of storm water or ground waters.<br>• **What to do?** - Contact the relevant Local Authority to discuss the management or disposal of proposed storm water or ground water discharges. |
| **Where do I find details of Uisce Éireann's network(s)?** | • Requests for maps showing Uisce Éireann's network(s) can be submitted to: datarequests@water.ie |

| | |
|---|---|
| **What are the design requirements for the connection(s)?** | • The design and construction of the Water & Wastewater pipes and related infrastructure to be installed in this Development shall comply with ***the Uisce Éireann Connections and Developer Services Standard Details and Codes of Practice,*** available at www.water.ie/connections |
| **Trade Effluent Licensing** | • Any person discharging trade effluent** to a sewer, must have a Trade Effluent Licence issued pursuant to section 16 of the Local Government (Water Pollution) Act, 1977 (as amended).<br>• More information and an application form for a Trade Effluent License can be found at the following link:<br>https://www.water.ie/business/trade-effluent/about/<br>**trade effluent is defined in the Local Government (Water Pollution) Act, 1977 (as amended) |

## Section B – Details of Uisce Éireann's Network(s)

**The map included below outlines the current Uisce Éireann infrastructure adjacent the Development:** To access Uisce Éireann Maps email datarequests@water.ie






**Note:** The information provided on the included maps as to the position of Uisce Éireann's underground network(s) is provided as a general guide only. The information is based on the best available information provided by each Local Authority in Ireland to Uisce Éireann.

Whilst every care has been taken in respect of the information on Uisce Éireann's network(s), Uisce Éireann assumes no responsibility for and gives no guarantees, undertakings or warranties concerning the accuracy, completeness or up to date nature of the information provided, nor does it accept any liability whatsoever arising from or out of any errors or omissions. This information should not be solely relied upon in the event of excavations or any other works being carried out in the vicinity of Uisce Éireann's underground network(s). The onus is on the parties carrying out excavations or any other works to ensure the exact location of Uisce Éireann's underground network(s) is identified prior to excavations or any other works being carried out. Service connection pipes are not generally shown but their presence should be anticipated.

# Appendix C – Foul Water Calculations

| LOHAN & DONNELLY<br>Consulting Civil & Structural Engineers<br>13 Gardiner Place, Mountjoy Square, Dublin 1 | Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | | Project No.: | 20189 |
|---|---|---|---|---|---|
| | Element: | Foul Water Drainage | | Calc'd: | E.V |
| | Checked: | G.P | Date: 07/02/25 | Page: | 1 |



**Outfall Manhole: FW01** **To Existing Manhole: EX.FW01**

Assume: 300 dia. pipe @ 1: 300
flow capacity: 60.50 l/sec.)

Length of Run: 195 m.

**Residential (Appartments)**

| | | |
|---|---|---|
| Occupancy: | 1588 | persons. |
| Daily Flow (DWF): | 262020 | l/day. |
| 6 x DWF: | 1572120 | l/day. |
| Flow per second: DWF | 3.0326389 | l/sec. |
| Flow per Second: 6 DWF | 18.196 | l/sec. |

**Commercial (1814.46m2)**

| | | |
|---|---|---|
| Occupancy: | 60 | persons. |
| Daily Flow (DWF): | 3300 | l/day. |
| 6 x DWF: | 19800 | l/day. |
| Flow per second: DWF | 0.0381944 | l/sec. |
| Flow per Second: 6 DWF | 0.229 | l/sec. |

**Residential Amenity (614.14m2)**

| | | |
|---|---|---|
| Occupancy: | 446 | persons. |
| Daily Flow (DWF): | 19624 | l/day. |
| 6 x DWF: | 117744 | l/day. |
| Flow per second: DWF | 0.2271296 | l/sec. |
| Flow per Second: 6 DWF | 1.363 | l/sec. |

**Creche (570.91m2)**

| | | |
|---|---|---|
| Occupancy: | 74 | persons. |
| Daily Flow (DWF): | 4070 | l/day. |
| 6 x DWF: | 24420 | l/day. |
| Flow per second: DWF | 0.0471065 | l/sec. |
| Flow per Second: 6 DWF | 0.283 | l/sec. |

**Total**

| | | |
|---|---|---|
| Flow per Second: DWF | 3.3450694 | l/sec. |
| Flow per Second: 6 DWF | 20.070 | l/sec. |

**Therefore** **300 Dia. Pipe @ 1:300** **O.K.**

**Note:** 10% extra for infiltration allowance to be included, as per section 3.6.3 and section 2.2.4 of Appendix B within Irish Water "Code of practice for wastewater infrastructure (IW-CDS-5030-03)" document

# Appendix D – Attenuation Calculations

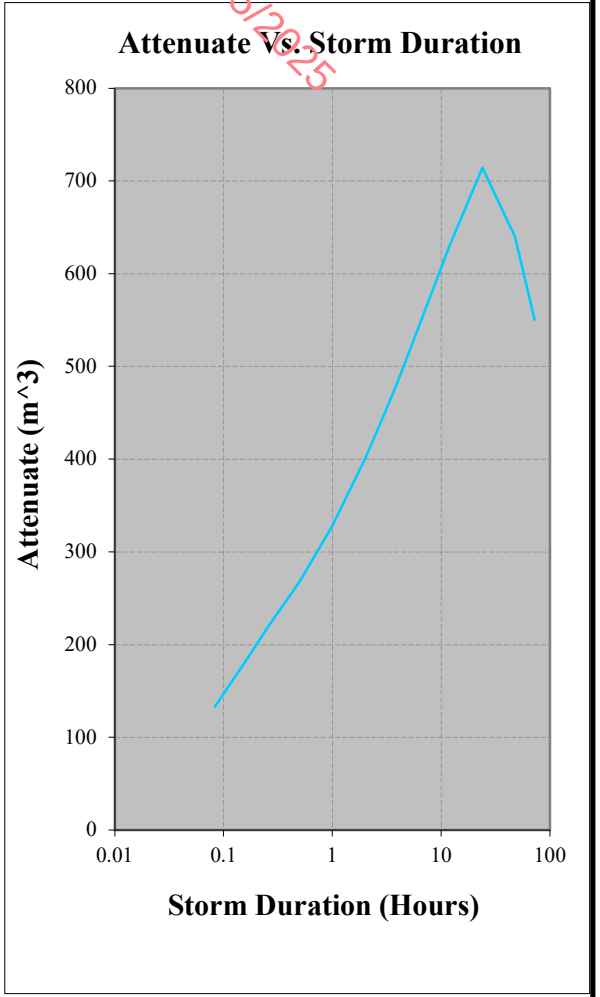
LOHAN & DONNELLY
Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| | | | |
|---|---|---|---|
| Blue Roof Attenuation | Project: BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Job No: | 20189 |
| | | Page No: | 1 |
| Page: 1 | Date: 07/02/2025 Calc'd by: E.V | Checked by: | G.P |



Hard Area: 0 $m^2$ Permeable: 0 $m^2$ Grassed: 0 $m^2$ Blue Roof 13105 $m^2$ Green Podium: 0 $m^2$ Equivalent Impermeable Area: 7863 $m^2$ Attenuated Flow Rate: 2 l/s
I. Factor: 0.80 I. Factor: 0.60 I. Factor: 0.15 I. Factor: 0.6 I. Factor: 0.6
Tree Pits: 0 $m^2$ I. Factor: 0.6

| Storm Duration (Hours) | Rainfall (mm) | Total Surface Water ($m^3$) | Allowable Discharge ($m^3$) | Attenuate ($m^3$) |
|---|---|---|---|---|
| 0.083 | 17.00 | 133.67 | 0.5976 | 133.07 |
| 0.166 | 23.70 | 186.35 | 1.1952 | 185.16 |
| 0.25 | 27.90 | 219.38 | 1.8 | 217.58 |
| 0.50 | 34.50 | 271.27 | 3.6 | 267.67 |
| 1.00 | 42.60 | 334.96 | 7.2 | 327.76 |
| 2.00 | 52.70 | 414.38 | 14.4 | 399.98 |
| 3.00 | 59.70 | 469.42 | 21.6 | 447.82 |
| 4.00 | 65.20 | 512.67 | 28.8 | 483.87 |
| 6.00 | 73.80 | 580.29 | 43.2 | 537.09 |
| 12.00 | 91.20 | 717.11 | 86.4 | 630.71 |
| 24.00 | 112.80 | 886.95 | 172.8 | 714.15 |
| 48.00 | 125.30 | 985.23 | 345.6 | 639.63 |
| 72.00 | 135.90 | 1068.58 | 518.4 | 550.18 |




Maximum Volume of Attenuate: 714.15 $m^3$ Climate Change/Urban Expansion: 1.3 Required Attenuation Volume = 928.39 $m^3$

**Note: This spreadsheet calculates the Volume of Attenuate based on a Return Period of: 100 years.**

LOHAN & DONNELLY
Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

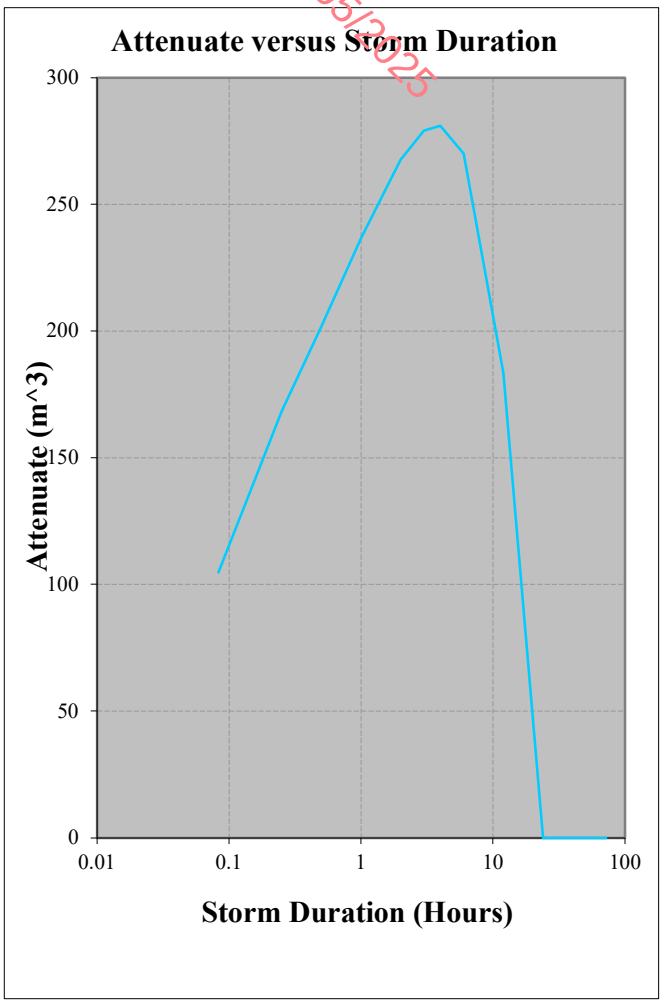
| | | | |
|---|---|---|---|
| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Job No: | 20189 |
| Subject | Permeable Paving Attenuation | Page No: | 1 |
| Date: 07/02/2025 | Calc'd by: E.V | Checked by: | G.P |



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hard Area | 0 $m^2$ | Permeable: | 6319 $m^2$ | Other: | 0 $m^2$ | Equivalent Impermeable Area: | 6319 $m^2$ |
| I. Factor: | 1.00 | I. Factor: | 1.00 | I. Factor: | 1 | | |

Attenuated Flow Rate: 9.09 l/s

| Storm Duration (Hours) | Rainfall (mm) | Total Surface Water ($m^3$) | Allowable Discharge ($m^3$) | Attenuate ($m^3$) |
|---|---|---|---|---|
| 0.083 | 17.00 | 107.42 | 2.717000651 | 104.71 |
| 0.166 | 23.70 | 149.76 | 5.434001302 | 144.33 |
| 0.25 | 27.90 | 176.30 | 8.1837369 | 168.12 |
| 0.50 | 34.50 | 218.01 | 16.3674738 | 201.64 |
| 1.00 | 42.60 | 269.19 | 32.7349476 | 236.45 |
| 2.00 | 52.70 | 333.01 | 65.4698952 | 267.54 |
| 3.00 | 59.70 | 377.24 | 98.2048428 | 279.04 |
| 4.00 | 65.20 | 412.00 | 130.9397904 | 281.06 |
| 6.00 | 73.80 | 466.34 | 196.4096856 | 269.93 |
| 12.00 | 91.20 | 576.29 | 392.8193712 | 183.47 |
| 24.00 | 112.80 | 712.78 | 785.6387424 | 0 |
| 48.00 | 125.30 | 791.77 | 1571.277485 | 0 |
| 72.00 | 135.90 | 858.75 | 2356.916227 | 0 |




Maximum Volume of Attenuate: 281.06 $m^3$ Climate Change = 1.3 Required Attenuation Volume = 365.38 $m^3$

**Note: This spreadsheet calculates the Volume of Attenuate based on a Return Period of: 100 years.**

LOHAN & DONNELLY
Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| | | | |
|---|---|---|---|
| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Job No: | 20189 |
| Subject: | Permeable Paving Infilitration | Page No: | 1 |
| Date: | 07/02/2025 | Calc'd by: E.V | Checked by: G.P |



## Plane Infiltration Area Design to CIRIA 156

| Definition | Label | Measurement | | Label | Value |
|---|---|---|---|---|---|
| Site Infiltration Rate | q | m/hr | | q = | 0.0518040 |
| Porosity of Material | n | N/A | | n = | 0.3 |
| Storm Duration | D | per hr | | | |
| Intensity | i | m/hr | | | |
| Ratio of Drained Area to Infiltration Area | R | m2 | | R = | 1 |
| Area to be Drained | $A_D$ | m2 | | $A_D$ = | 6319 |
| Area of Infiltration System | $A_b$ | m2 | | $A_b$ = | 6319 |
| Factor of Safety | F | N/A | | F = | 10 |
| Highest Water Level | $h_{max}$ | m | | | |
| Return Period | RP | years | | RP | 100 |
| **Formula** | R = | $A_D/A_b$ | | | |
| | $h_{max}$ = | D/n * (Ri-q/F) | | | |
| | i = | m/hr | | | |
| Plane Infiltration Rate for Attenuation = | | (Ab * q)/F | | PIR = | 9.093041 |
| Max Attenuation Vol Required (m3) | | | | | 365.376712 |
| Actual depth = | 0.25 | m | | | |
| Actual storage Provided = | 473.93 | m3 | | | |
| Time for half-emptying | n x Hmax/2 x q | 0.626 | hrs | | |
| 24 > | 0.626 hrs | O.K. | | | |

**Table of Content**

| i (m/hr) | D (hr) | $h_{max}$ (m) | Volume Stored |
|---|---|---|---|
| 0.26627 | 0.08 | 0.07 | 456.44 |
| 0.18560 | 0.17 | 0.10 | 630.85 |
| 0.14508 | 0.25 | 0.12 | 736.69 |
| 0.08970 | 0.50 | 0.14 | 890.13 |
| 0.05538 | 1.00 | 0.17 | 1057.37 |
| 0.03426 | 2.00 | 0.19 | 1224.82 |
| 0.02587 | 3.00 | 0.21 | 1307.38 |
| 0.02119 | 4.00 | 0.21 | 1348.86 |
| 0.01599 | 6.00 | 0.22 | 1366.12 |
| 0.00988 | 12.00 | 0.19 | 1187.87 |
| 0.00611 | 24.00 | 0.07 | 469.93 |
| 0.00339 | 48.00 | -0.29 | -1806.59 |
| 0.00245 | 72.00 | -0.65 | -4135.13 |
| MAX | | 0.22 | 1366.12 |

LOHAN & DONNELLY
Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

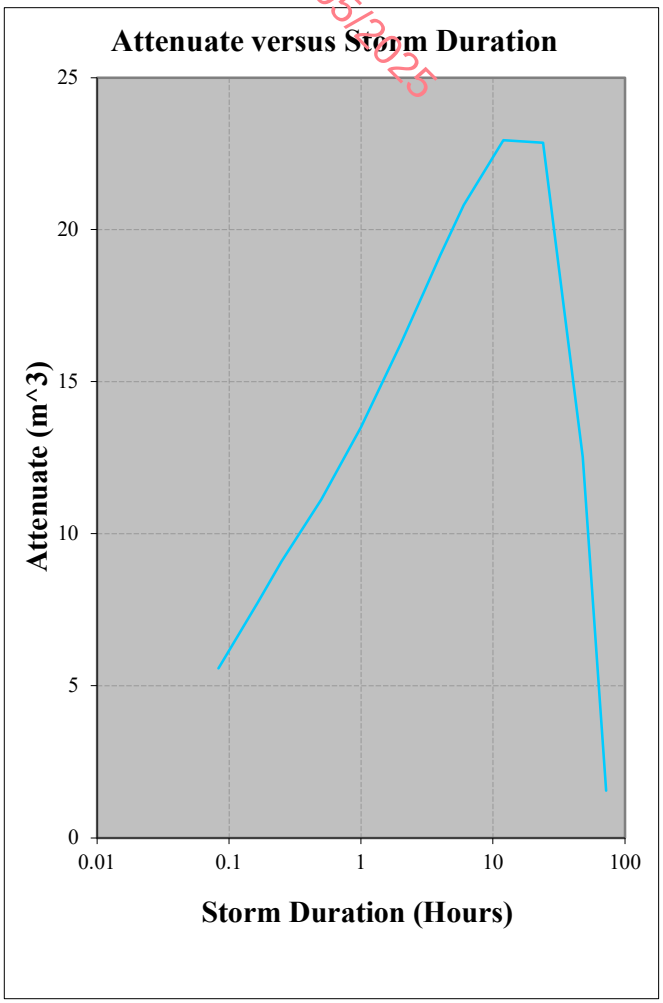
| | | | |
|---|---|---|---|
| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Raingarden 1 Attenuation |
| Date: | 29/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hard Area | 268.1 $m^2$ | Rain Gardens | 116.4 $m^2$ | Grass | 0 $m^2$ | Equivalent Impermeable Area: | 330.8616 $m^2$ |
| I. Factor: | 0.80 | I. Factor: | 1.00 | I. Factor: | 0.15 | | |

Attenuated Flow Rate: 0.17 l/s

| Storm Duration (Hours) | Rainfall (mm) | Total Surface Water ($m^3$) | Allowable Discharge ($m^3$) | Attenuate ($m^3$) |
|---|---|---|---|---|
| 0.083 | 17.00 | 5.62 | 0.050043721 | 5.57 |
| 0.166 | 23.70 | 7.84 | 0.100087442 | 7.74 |
| 0.25 | 27.90 | 9.23 | 0.150734099 | 9.08 |
| 0.50 | 34.50 | 11.41 | 0.301468198 | 11.11 |
| 1.00 | 42.60 | 14.09 | 0.602936395 | 13.49 |
| 2.00 | 52.70 | 17.44 | 1.20587279 | 16.23 |
| 3.00 | 59.70 | 19.75 | 1.808809186 | 17.94 |
| 4.00 | 65.20 | 21.57 | 2.411745581 | 19.16 |
| 6.00 | 73.80 | 24.42 | 3.617618371 | 20.80 |
| 12.00 | 91.20 | 30.17 | 7.235236742 | 22.94 |
| 24.00 | 112.80 | 37.32 | 14.47047348 | 22.85 |
| 48.00 | 125.30 | 41.46 | 28.94094697 | 12.52 |
| 72.00 | 135.90 | 44.96 | 43.41142045 | 1.55 |




Maximum Volume of Attenuate: 22.94 $m^3$ Climate Change = 1.3 Required Attenuation Volume = 29.821 $m^3$

**Note: This spreadsheet calculates the Volume of Attenuate based on a Return Period of: 100 years.**

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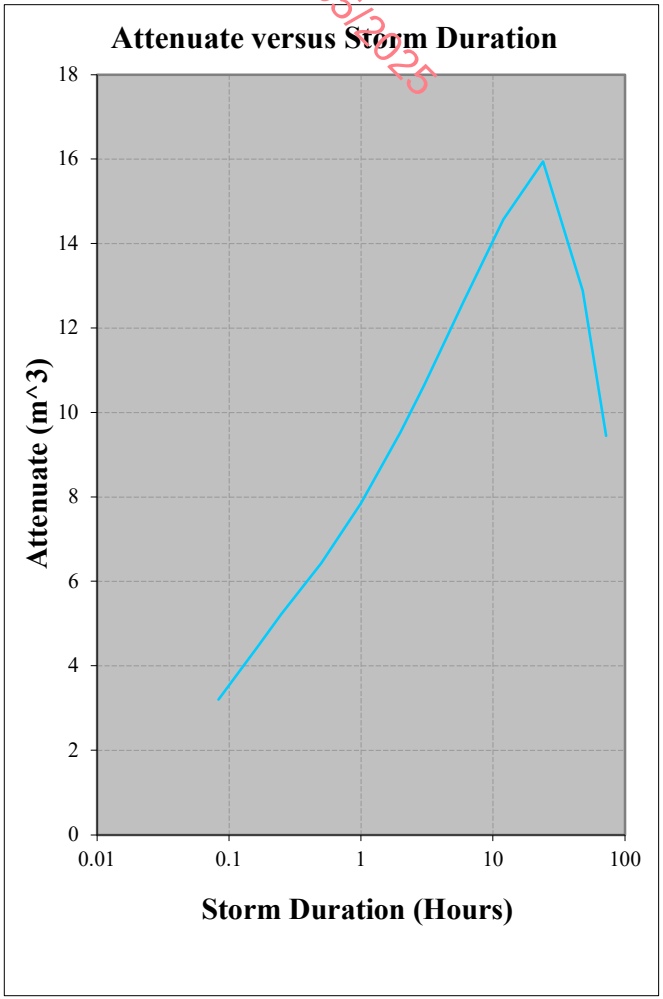
Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| | | | | | |
|---|---|---|---|---|---|
| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | | | Subject: | Raingarden 2 Attenuation |
| Date: | 29/01/2025 | Calc'd by: | E.V | Checked by: | G.P |



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hard Area | 182.3 $m^2$ | Rain Gardens | 43.75 $m^2$ | Grass | 0 $m^2$ | Equivalent Impermeable Area: | 189.5612 $m^2$ |
| I. Factor: | 0.80 | I. Factor: | 1.00 | I. Factor: | 0.15 | Attenuated Flow Rate: | 0.06 l/s |

| Storm Duration (Hours) | Rainfall (mm) | Total Surface Water ($m^3$) | Allowable Discharge ($m^3$) | Attenuate ($m^3$) |
|---|---|---|---|---|
| 0.083 | 17.00 | 3.22 | 0.018809608 | 3.20 |
| 0.166 | 23.70 | 4.49 | 0.037619215 | 4.45 |
| 0.25 | 27.90 | 5.29 | 0.056655445 | 5.23 |
| 0.50 | 34.50 | 6.54 | 0.113310889 | 6.43 |
| 1.00 | 42.60 | 8.08 | 0.226621778 | 7.85 |
| 2.00 | 52.70 | 9.99 | 0.453243557 | 9.54 |
| 3.00 | 59.70 | 11.32 | 0.679865335 | 10.64 |
| 4.00 | 65.20 | 12.36 | 0.906487114 | 11.45 |
| 6.00 | 73.80 | 13.99 | 1.35973067 | 12.63 |
| 12.00 | 91.20 | 17.29 | 2.719461341 | 14.57 |
| 24.00 | 112.80 | 21.38 | 5.438922682 | 15.94 |
| 48.00 | 125.30 | 23.75 | 10.87784536 | 12.87 |
| 72.00 | 135.90 | 25.76 | 16.31676804 | 9.44 |




Maximum Volume of Attenuate: 15.94 $m^3$ Climate Change = 1.3 Required Attenuation Volume = 20.727 $m^3$

**Note: This spreadsheet calculates the Volume of Attenuate based on a Return Period of: 100 years.**

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Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

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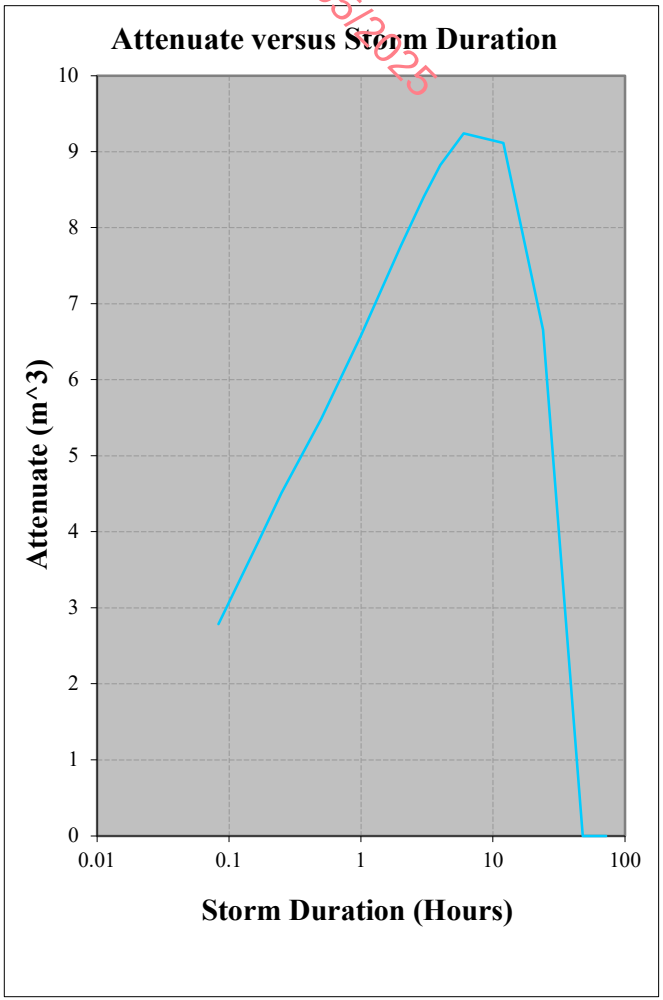
|---|---|---|---|
| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Raingarden 3 Attenuation |
| Date: | 29/01/2025 | Calc'd by: E.V | Checked by: G.P |



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hard Area | 0 $m^2$ | Rain Gardens | 97.26 $m^2$ | Grass | 459.5 $m^2$ | Equivalent Impermeable Area: | 166.19025 $m^2$ |
| I. Factor: | 0.80 | I. Factor: | 1.00 | I. Factor: | 0.15 | Attenuated Flow Rate: | 0.14 l/s |

| Storm Duration (Hours) | Rainfall (mm) | Total Surface Water ($m^3$) | Allowable Discharge ($m^3$) | Attenuate ($m^3$) |
|---|---|---|---|---|
| 0.083 | 17.00 | 2.83 | 0.041819193 | 2.78 |
| 0.166 | 23.70 | 3.94 | 0.083638387 | 3.86 |
| 0.25 | 27.90 | 4.64 | 0.125961426 | 4.51 |
| 0.50 | 34.50 | 5.73 | 0.251922852 | 5.48 |
| 1.00 | 42.60 | 7.08 | 0.503845704 | 6.58 |
| 2.00 | 52.70 | 8.76 | 1.007691408 | 7.75 |
| 3.00 | 59.70 | 9.92 | 1.511537112 | 8.41 |
| 4.00 | 65.20 | 10.84 | 2.015382816 | 8.82 |
| 6.00 | 73.80 | 12.26 | 3.023074224 | 9.24 |
| 12.00 | 91.20 | 15.16 | 6.046148448 | 9.11 |
| 24.00 | 112.80 | 18.75 | 12.0922969 | 6.65 |
| 48.00 | 125.30 | 20.82 | 24.18459379 | 0 |
| 72.00 | 135.90 | 22.59 | 36.27689069 | 0 |




Maximum Volume of Attenuate: 9.24 $m^3$ Climate Change = 1.3 Required Attenuation Volume = 12.014 $m^3$

**Note: This spreadsheet calculates the Volume of Attenuate based on a Return Period of: 100 years.**

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Consulting Engineers
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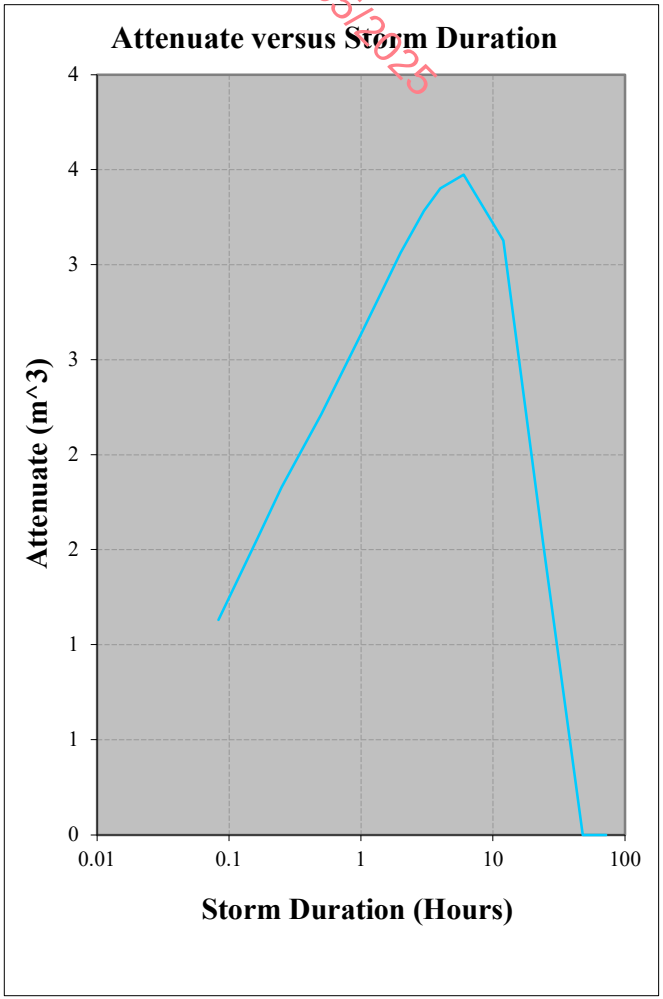
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| | | | |
|---|---|---|---|
| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Raingarden 4 Attenuation |
| Date: | 29/01/2025 | Calc'd by: E.V | Checked by: G.P |



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hard Area | 0 $m^2$ | Rain Gardens | 49.13 $m^2$ | Grass | 124.3 $m^2$ | Equivalent Impermeable Area: | 67.7723 $m^2$ |
| I. Factor: | 0.80 | I. Factor: | 1.00 | I. Factor: | 0.15 | Attenuated Flow Rate: | 0.07 l/s |

| Storm Duration (Hours) | Rainfall (mm) | Total Surface Water ($m^3$) | Allowable Discharge ($m^3$) | Attenuate ($m^3$) |
|---|---|---|---|---|
| 0.083 | 17.00 | 1.15 | 0.021125873 | 1.13 |
| 0.166 | 23.70 | 1.61 | 0.042251746 | 1.56 |
| 0.25 | 27.90 | 1.89 | 0.063632148 | 1.83 |
| 0.50 | 34.50 | 2.34 | 0.127264297 | 2.21 |
| 1.00 | 42.60 | 2.89 | 0.254528593 | 2.63 |
| 2.00 | 52.70 | 3.57 | 0.509057186 | 3.06 |
| 3.00 | 59.70 | 4.05 | 0.76358578 | 3.28 |
| 4.00 | 65.20 | 4.42 | 1.018114373 | 3.40 |
| 6.00 | 73.80 | 5.00 | 1.527171559 | 3.47 |
| 12.00 | 91.20 | 6.18 | 3.054343118 | 3.13 |
| 24.00 | 112.80 | 7.64 | 6.108686237 | 1.54 |
| 48.00 | 125.30 | 8.49 | 12.21737247 | 0 |
| 72.00 | 135.90 | 9.21 | 18.32605871 | 0 |




Maximum Volume of Attenuate: 3.47 $m^3$ Climate Change = 1.3 Required Attenuation Volume = 4.5168 $m^3$

**Note: This spreadsheet calculates the Volume of Attenuate based on a Return Period of: 100 years.**

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Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

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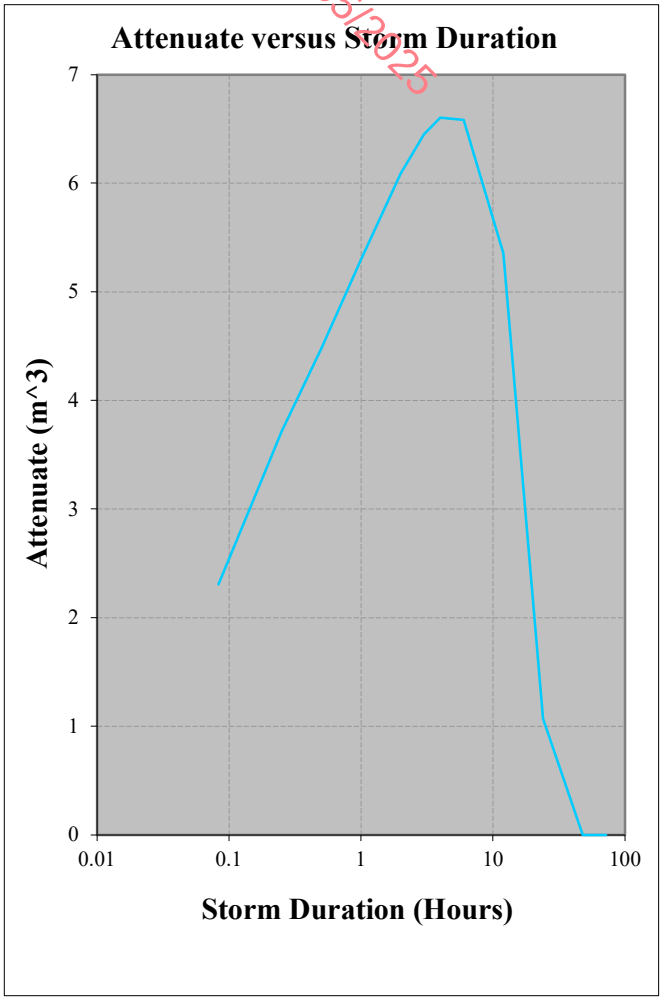
|---|---|---|---|
| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Raingarden 5 Attenuation |
| Date: | 29/01/2025 | Calc'd by: E.V | Checked by: G.P |



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hard Area | 0 $m^2$ | Rain Gardens | 117.1 $m^2$ | Grass | 142.9 $m^2$ | Equivalent Impermeable Area: | 138.49315 $m^2$ |
| I. Factor: | 0.80 | I. Factor: | 1.00 | I. Factor: | 0.15 | | |

Attenuated Flow Rate: 0.17 l/s

| Storm Duration (Hours) | Rainfall (mm) | Total Surface Water ($m^3$) | Allowable Discharge ($m^3$) | Attenuate ($m^3$) |
|---|---|---|---|---|
| 0.083 | 17.00 | 2.35 | 0.050331803 | 2.30 |
| 0.166 | 23.70 | 3.28 | 0.100663606 | 3.18 |
| 0.25 | 27.90 | 3.86 | 0.151601816 | 3.71 |
| 0.50 | 34.50 | 4.78 | 0.303203632 | 4.47 |
| 1.00 | 42.60 | 5.90 | 0.606407263 | 5.29 |
| 2.00 | 52.70 | 7.30 | 1.212814526 | 6.09 |
| 3.00 | 59.70 | 8.27 | 1.81922179 | 6.45 |
| 4.00 | 65.20 | 9.03 | 2.425629053 | 6.60 |
| 6.00 | 73.80 | 10.22 | 3.638443579 | 6.58 |
| 12.00 | 91.20 | 12.63 | 7.276887158 | 5.35 |
| 24.00 | 112.80 | 15.62 | 14.55377432 | 1.07 |
| 48.00 | 125.30 | 17.35 | 29.10754863 | 0 |
| 72.00 | 135.90 | 18.82 | 43.66132295 | 0 |




Maximum Volume of Attenuate: 6.60 $m^3$ Climate Change = 1.3 Required Attenuation Volume = 8.5854 $m^3$

**Note: This spreadsheet calculates the Volume of Attenuate based on a Return Period of: 100 years.**

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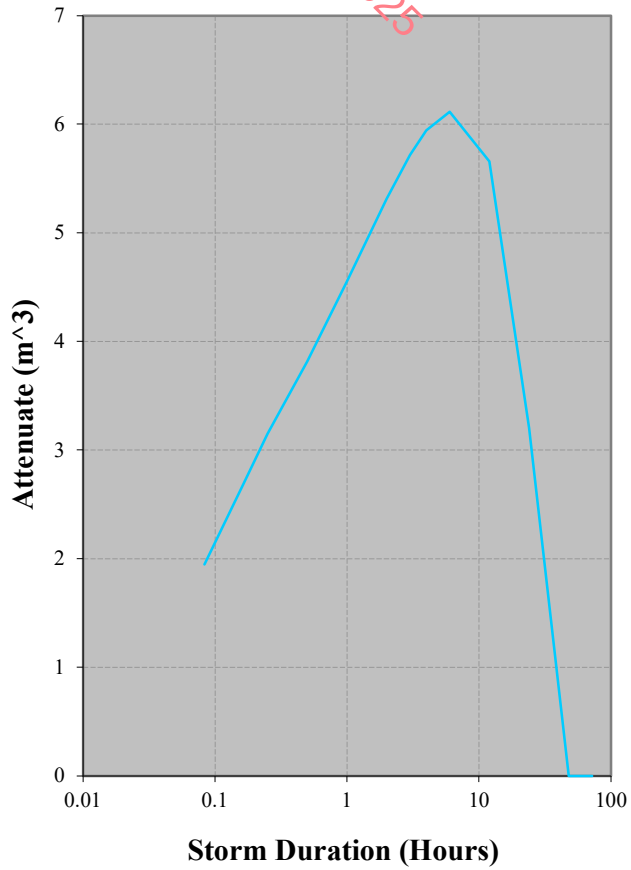
| | | | |
|---|---|---|---|
| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Raingarden 6 Attenuation |
| Date: | 29/01/2025 | Calc'd by: E.V | Checked by: G.P |



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hard Area | 0 $m^2$ | Rain Gardens | 79.97 $m^2$ | Grass | 243.8 $m^2$ | Equivalent Impermeable Area: | 116.5372 $m^2$ |
| I. Factor: | 0.80 | I. Factor: | 1.00 | I. Factor: | 0.15 | | |

Attenuated Flow Rate: 0.12 l/s

| Storm Duration (Hours) | Rainfall (mm) | Total Surface Water ($m^3$) | Allowable Discharge ($m^3$) | Attenuate ($m^3$) |
|---|---|---|---|---|
| 0.083 | 17.00 | 1.98 | 0.034384527 | 1.95 |
| 0.166 | 23.70 | 2.76 | 0.068769054 | 2.69 |
| 0.25 | 27.90 | 3.25 | 0.103567852 | 3.15 |
| 0.50 | 34.50 | 4.02 | 0.207135704 | 3.81 |
| 1.00 | 42.60 | 4.96 | 0.414271408 | 4.55 |
| 2.00 | 52.70 | 6.14 | 0.828542815 | 5.31 |
| 3.00 | 59.70 | 6.96 | 1.242814223 | 5.71 |
| 4.00 | 65.20 | 7.60 | 1.65708563 | 5.94 |
| 6.00 | 73.80 | 8.60 | 2.485628446 | 6.11 |
| 12.00 | 91.20 | 10.63 | 4.971256891 | 5.66 |
| 24.00 | 112.80 | 13.15 | 9.942513782 | 3.20 |
| 48.00 | 125.30 | 14.60 | 19.88502756 | 0 |
| 72.00 | 135.90 | 15.84 | 29.82754135 | 0 |




Maximum Volume of Attenuate: 6.11 $m^3$ Climate Change = 1.3 Required Attenuation Volume = 7.9493 $m^3$

**Note: This spreadsheet calculates the Volume of Attenuate based on a Return Period of: 100 years.**

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Consulting Engineers
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W: www.lohan-donnelly.com E: info@lohan-donnelly.com

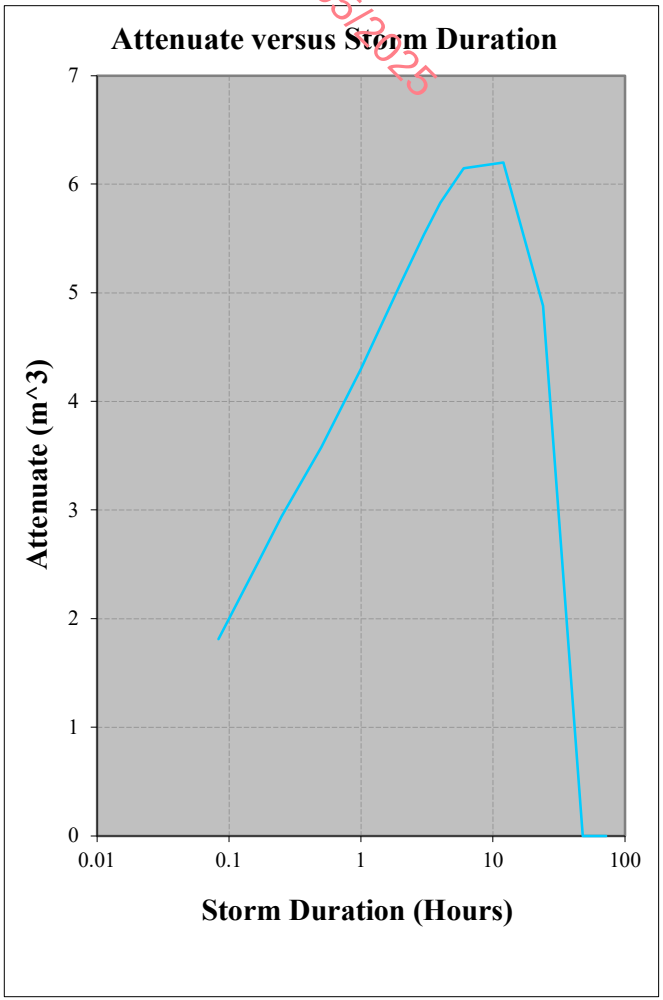
| | | | |
|---|---|---|---|
| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Raingarden 7 Attenuation |
| Date: | 29/01/2025 | Calc'd by: E.V | Checked by: G.P |



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hard Area | 0 $m^2$ | Rain Gardens | 58.79 $m^2$ | Grass | 328.4 $m^2$ | Equivalent Impermeable Area: | 108.044 $m^2$ |
| I. Factor: | 0.80 | I. Factor: | 1.00 | I. Factor: | 0.15 | | |

Attenuated Flow Rate: 0.08 l/s

| Storm Duration (Hours) | Rainfall (mm) | Total Surface Water ($m^3$) | Allowable Discharge ($m^3$) | Attenuate ($m^3$) |
|---|---|---|---|---|
| 0.083 | 17.00 | 1.84 | 0.025276835 | 1.81 |
| 0.166 | 23.70 | 2.56 | 0.050553669 | 2.51 |
| 0.25 | 27.90 | 3.01 | 0.076135044 | 2.94 |
| 0.50 | 34.50 | 3.73 | 0.152270087 | 3.58 |
| 1.00 | 42.60 | 4.60 | 0.304540175 | 4.30 |
| 2.00 | 52.70 | 5.69 | 0.60908035 | 5.08 |
| 3.00 | 59.70 | 6.45 | 0.913620524 | 5.54 |
| 4.00 | 65.20 | 7.04 | 1.218160699 | 5.83 |
| 6.00 | 73.80 | 7.97 | 1.827241049 | 6.15 |
| 12.00 | 91.20 | 9.85 | 3.654482098 | 6.20 |
| 24.00 | 112.80 | 12.19 | 7.308964195 | 4.88 |
| 48.00 | 125.30 | 13.54 | 14.61792839 | 0 |
| 72.00 | 135.90 | 14.68 | 21.92689259 | 0 |




Maximum Volume of Attenuate: 6.20 $m^3$ Climate Change = 1.3 Required Attenuation Volume = 8.0589 $m^3$

**Note: This spreadsheet calculates the Volume of Attenuate based on a Return Period of: 100 years.**

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Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

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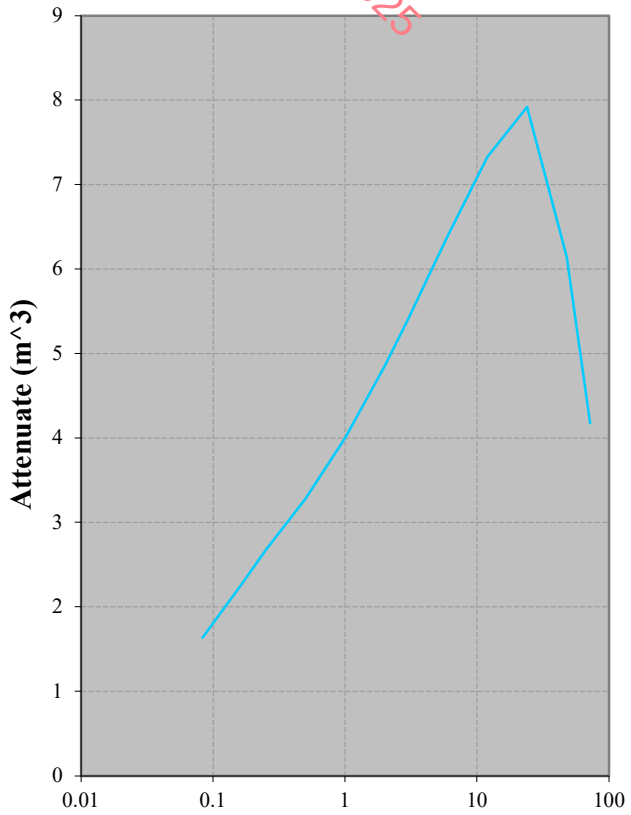
|---|---|---|---|
| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Raingarden 8 Attenuation |
| Date: | 29/01/2025 | Calc'd by: E.V | Checked by: G.P |



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hard Area | 0 $m^2$ | Rain Gardens | 24.06 $m^2$ | Grass | 484.5 $m^2$ | Equivalent Impermeable Area: | 96.73185 $m^2$ |
| I. Factor: | 0.80 | I. Factor: | 1.00 | I. Factor: | 0.15 | | |

Attenuated Flow Rate: 0.03 l/s

| Storm Duration (Hours) | Rainfall (mm) | Total Surface Water ($m^3$) | Allowable Discharge ($m^3$) | Attenuate ($m^3$) |
|---|---|---|---|---|
| 0.083 | 17.00 | 1.64 | 0.010345155 | 1.63 |
| 0.166 | 23.70 | 2.29 | 0.02069031 | 2.27 |
| 0.25 | 27.90 | 2.70 | 0.031160106 | 2.67 |
| 0.50 | 34.50 | 3.34 | 0.062320212 | 3.27 |
| 1.00 | 42.60 | 4.12 | 0.124640424 | 4.00 |
| 2.00 | 52.70 | 5.10 | 0.249280848 | 4.85 |
| 3.00 | 59.70 | 5.77 | 0.373921272 | 5.40 |
| 4.00 | 65.20 | 6.31 | 0.498561696 | 5.81 |
| 6.00 | 73.80 | 7.14 | 0.747842544 | 6.39 |
| 12.00 | 91.20 | 8.82 | 1.495685088 | 7.33 |
| 24.00 | 112.80 | 10.91 | 2.991370176 | 7.92 |
| 48.00 | 125.30 | 12.12 | 5.982740352 | 6.14 |
| 72.00 | 135.90 | 13.15 | 8.974110528 | 4.17 |




Maximum Volume of Attenuate: 7.92 $m^3$ Climate Change = 1.3 Required Attenuation Volume = 10.296 $m^3$

**Note: This spreadsheet calculates the Volume of Attenuate based on a Return Period of: 100 years.**

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Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

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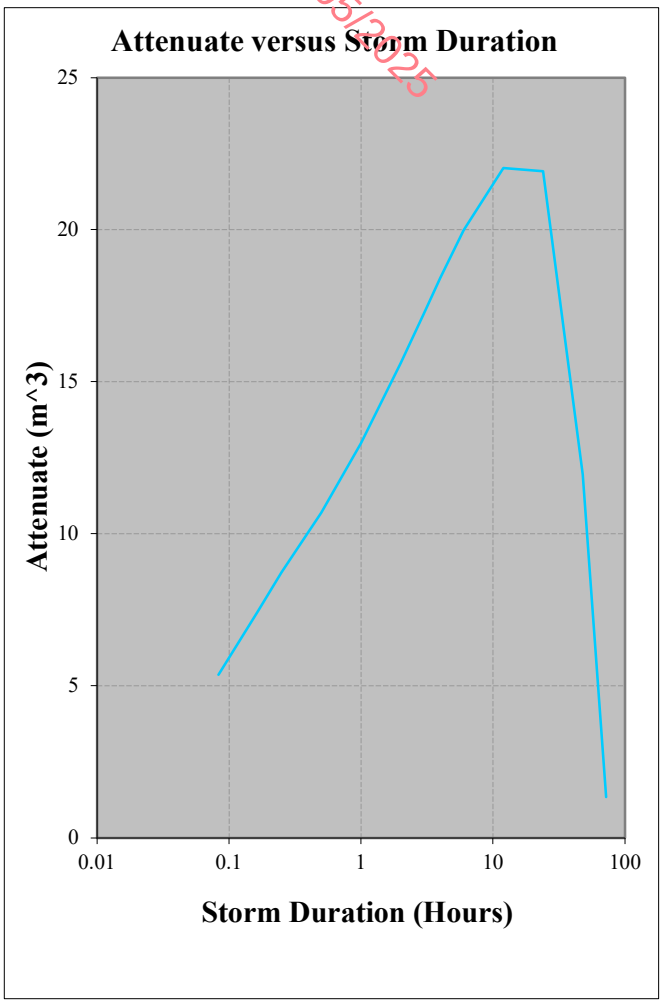
|---|---|---|---|
| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Raingarden 9 Attenuation |
| Date: | 29/01/2025 | Calc'd by: E.V | Checked by: G.P |



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hard Area | 0 $m^2$ | Rain Gardens | 112.3 $m^2$ | Grass | 1372 $m^2$ | Equivalent Impermeable Area: | 318.065 $m^2$ |
| I. Factor: | 0.80 | I. Factor: | 1.00 | I. Factor: | 0.15 | | |

Attenuated Flow Rate: 0.16 l/s

| Storm Duration (Hours) | Rainfall (mm) | Total Surface Water ($m^3$) | Allowable Discharge ($m^3$) | Attenuate ($m^3$) |
|---|---|---|---|---|
| 0.083 | 17.00 | 5.41 | 0.048276101 | 5.36 |
| 0.166 | 23.70 | 7.54 | 0.096552202 | 7.44 |
| 0.25 | 27.90 | 8.87 | 0.145409943 | 8.73 |
| 0.50 | 34.50 | 10.97 | 0.290819885 | 10.68 |
| 1.00 | 42.60 | 13.55 | 0.581639771 | 12.97 |
| 2.00 | 52.70 | 16.76 | 1.163279542 | 15.60 |
| 3.00 | 59.70 | 18.99 | 1.744919312 | 17.24 |
| 4.00 | 65.20 | 20.74 | 2.326559083 | 18.41 |
| 6.00 | 73.80 | 23.47 | 3.489838625 | 19.98 |
| 12.00 | 91.20 | 29.01 | 6.97967725 | 22.03 |
| 24.00 | 112.80 | 35.88 | 13.9593545 | 21.92 |
| 48.00 | 125.30 | 39.85 | 27.918709 | 11.93 |
| 72.00 | 135.90 | 43.23 | 41.8780635 | 1.35 |




Maximum Volume of Attenuate: 22.03 $m^3$ Climate Change = 1.3 Required Attenuation Volume = 28.636 $m^3$

**Note: This spreadsheet calculates the Volume of Attenuate based on a Return Period of: 100 years.**

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13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

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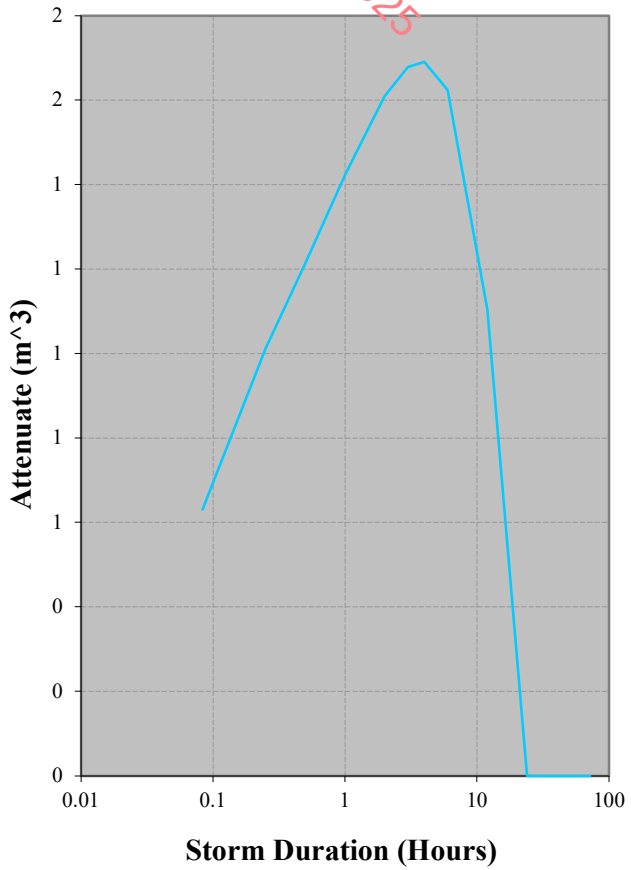
|---|---|---|---|
| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Raingarden 10 Attenuation |
| Date: | 29/01/2025 | Calc'd by: E.V | Checked by: G.P |



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hard Area | 0 $m^2$ | Rain Gardens | 38 $m^2$ | Grass | 0 $m^2$ | Equivalent Impermeable Area: | 38.004 $m^2$ |
| I. Factor: | 0.80 | I. Factor: | 1.00 | I. Factor: | 0.15 | | |

Attenuated Flow Rate: 0.05 l/s

| Storm Duration (Hours) | Rainfall (mm) | Total Surface Water ($m^3$) | Allowable Discharge ($m^3$) | Attenuate ($m^3$) |
|---|---|---|---|---|
| 0.083 | 17.00 | 0.65 | 0.016340701 | 0.63 |
| 0.166 | 23.70 | 0.90 | 0.032681403 | 0.87 |
| 0.25 | 27.90 | 1.06 | 0.04921898 | 1.01 |
| 0.50 | 34.50 | 1.31 | 0.098437961 | 1.21 |
| 1.00 | 42.60 | 1.62 | 0.196875922 | 1.42 |
| 2.00 | 52.70 | 2.00 | 0.393751843 | 1.61 |
| 3.00 | 59.70 | 2.27 | 0.590627765 | 1.68 |
| 4.00 | 65.20 | 2.48 | 0.787503686 | 1.69 |
| 6.00 | 73.80 | 2.80 | 1.18125553 | 1.62 |
| 12.00 | 91.20 | 3.47 | 2.362511059 | 1.10 |
| 24.00 | 112.80 | 4.29 | 4.725022118 | 0 |
| 48.00 | 125.30 | 4.76 | 9.450044237 | 0 |
| 72.00 | 135.90 | 5.16 | 14.17506636 | 0 |




Maximum Volume of Attenuate: 1.69 $m^3$ Climate Change = 1.3 Required Attenuation Volume = 2.1975 $m^3$

**Note: This spreadsheet calculates the Volume of Attenuate based on a Return Period of: 100 years.**

LOHAN & DONNELLY
Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

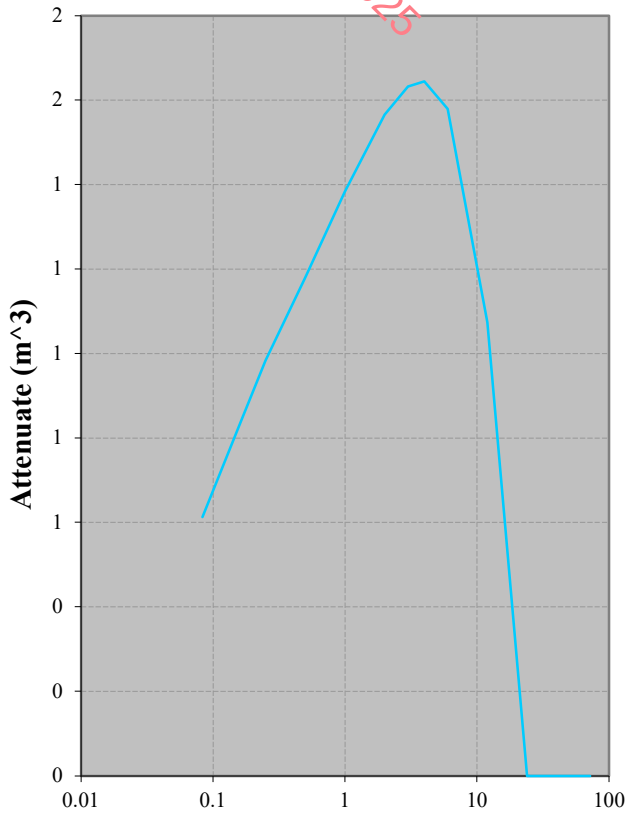
| | | | |
|---|---|---|---|
| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Raingarden 11 Attenuation |
| Date: | 29/01/2025 | Calc'd by: E.V | Checked by: G.P |



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hard Area | 0 $m^2$ | Rain Gardens | 36.96 $m^2$ | Grass | 0 $m^2$ | Equivalent Impermeable Area: | 36.962 $m^2$ |
| I. Factor: | 0.80 | I. Factor: | 1.00 | I. Factor: | 0.15 | | |

Attenuated Flow Rate: 0.05 l/s

| Storm Duration (Hours) | Rainfall (mm) | Total Surface Water ($m^3$) | Allowable Discharge ($m^3$) | Attenuate ($m^3$) |
|---|---|---|---|---|
| 0.083 | 17.00 | 0.63 | 0.015892669 | 0.61 |
| 0.166 | 23.70 | 0.88 | 0.031785339 | 0.84 |
| 0.25 | 27.90 | 1.03 | 0.047869486 | 0.98 |
| 0.50 | 34.50 | 1.28 | 0.095738972 | 1.18 |
| 1.00 | 42.60 | 1.57 | 0.191477945 | 1.38 |
| 2.00 | 52.70 | 1.95 | 0.38295589 | 1.56 |
| 3.00 | 59.70 | 2.21 | 0.574433834 | 1.63 |
| 4.00 | 65.20 | 2.41 | 0.765911779 | 1.64 |
| 6.00 | 73.80 | 2.73 | 1.148867669 | 1.58 |
| 12.00 | 91.20 | 3.37 | 2.297735338 | 1.07 |
| 24.00 | 112.80 | 4.17 | 4.595470675 | 0 |
| 48.00 | 125.30 | 4.63 | 9.19094135 | 0 |
| 72.00 | 135.90 | 5.02 | 13.78641203 | 0 |




Maximum Volume of Attenuate: 1.64 $m^3$ Climate Change = 1.3 Required Attenuation Volume = 2.1372 $m^3$

**Note: This spreadsheet calculates the Volume of Attenuate based on a Return Period of: 100 years.**

LOHAN & DONNELLY
Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Raingarden 1 Infiltration |
|---|---|---|---|
| Date: | 30/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



## Plane Infiltration Area Design to CIRIA 156

| Definition | Label | Measurement | | Label | Value |
|---|---|---|---|---|---|
| Site Infiltration Rate | q | m/hr | | q = | 0.0518040 |
| Porosity of Material | n | N/A | | n = | 0.3 |
| Storm Duration | D | per hr | | | |
| Intensity | i | m/hr | | | |
| Ratio of Drained Area to Infiltration Area | R | m2 | | R = | 2.84261168 |
| Area to be Drained | $A_D$ | m2 | | $A_D$ = | 330.88 |
| Area of Infiltration System | $A_b$ | m2 | | $A_b$ = | 116.4 |
| Factor of Safety | F | N/A | | F = | 10 |
| Highest Water Level | $h_{max}$ | m | | | |
| Return Period | RP | years | | RP | 100 |
| **Formula** | R = | $A_D/A_b$ | | | |
| | $h_{max}$ = | D/n * (Ri-q/F) | | | |
| | i = | m/hr | | | |
| Plane Infiltration Rate for Attenuation = | | (Ab * q)/F | | PIR = | 0.167500 |
| Max Attenuation Vol Required (m3) | | | | | 29.8223553 |
| Actual depth = | 1 | m | | | |
| Actual storage Provided = | 34.92 | m3 | | | |
| Time for half-emptying | n x Hmax/2 x q | 2.823 | hrs | | |
| 24 > | 2.8232 hrs | O.K. | | | |

**Table of Content**

| i (m/hr) | D (hr) | $h_{max}$ (m) | Volume Stored |
|---|---|---|---|
| 0.26627 | 0.08 | 0.21 | 24.21 |
| 0.18560 | 0.17 | 0.29 | 33.65 |
| 0.14508 | 0.25 | 0.34 | 39.50 |
| 0.08970 | 0.50 | 0.42 | 48.46 |
| 0.05538 | 1.00 | 0.51 | 59.07 |
| 0.03426 | 2.00 | 0.61 | 71.54 |
| 0.02587 | 3.00 | 0.68 | 79.57 |
| 0.02119 | 4.00 | 0.73 | 85.44 |
| 0.01599 | 6.00 | 0.81 | 93.76 |
| 0.00988 | 12.00 | 0.92 | 106.64 |
| 0.00611 | 24.00 | 0.98 | 113.49 |
| 0.00339 | 48.00 | 0.71 | 83.18 |
| 0.00245 | 72.00 | 0.43 | 50.14 |
| MAX | | 0.98 | 113.49 |

LOHAN & DONNELLY
Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Raingarden 2 Infiltration |
|---|---|---|---|
| Date: | 30/01/2025 | Calc'd by: | E.V Checked by: G.P |



## Plane Infiltration Area Design to CIRIA 156

| Definition | Label | Measurement | | Label | Value |
|---|---|---|---|---|---|
| Site Infiltration Rate | q | m/hr | | q = | 0.0518040 |
| Porosity of Material | n | N/A | | n = | 0.3 |
| Storm Duration | D | per hr | | | |
| Intensity | i | m/hr | | | |
| Ratio of Drained Area to Infiltration Area | R | m2 | | R = | 4.33348571 |
| Area to be Drained | $A_D$ | m2 | | $A_D$ = | 189.59 |
| Area of Infiltration System | $A_b$ | m2 | | $A_b$ = | 43.75 |
| Factor of Safety | F | N/A | | F = | 10 |
| Highest Water Level | $h_{max}$ | m | | | |
| Return Period | RP | years | | RP | 100 |
| **Formula** | R = | $A_D/A_b$ | | | |
| | $h_{max}$ = | D/n * (Ri-q/F) | | | |
| | i = | m/hr | | | |
| Plane Infiltration Rate for Attenuation = | | (Ab * q)/F | | PIR = | 0.062956 |
| Max Attenuation Vol Required (m3) | | | | | 20.7302316 |
| Actual depth = | 1.75 | m | | | |
| Actual storage Provided = | 22.969 | m3 | | | |
| Time for half-emptying | n x Hmax/2 x q | | 4.933 | hrs | |
| 24 > | 4.9333 hrs | | O.K. | | |

**Table of Content**

| i (m/hr) | D (hr) | $h_{max}$ (m) | Volume Stored |
|---|---|---|---|
| 0.26627 | 0.08 | 0.32 | 13.90 |
| 0.18560 | 0.17 | 0.44 | 19.35 |
| 0.14508 | 0.25 | 0.52 | 22.73 |
| 0.08970 | 0.50 | 0.64 | 27.97 |
| 0.05538 | 1.00 | 0.78 | 34.24 |
| 0.03426 | 2.00 | 0.96 | 41.79 |
| 0.02587 | 3.00 | 1.07 | 46.78 |
| 0.02119 | 4.00 | 1.16 | 50.54 |
| 0.01599 | 6.00 | 1.28 | 56.10 |
| 0.00988 | 12.00 | 1.51 | 65.86 |
| 0.00611 | 24.00 | 1.70 | 74.54 |
| 0.00339 | 48.00 | 1.52 | 66.68 |
| 0.00245 | 72.00 | 1.31 | 57.26 |
| MAX | | 1.70 | 74.54 |

LOHAN & DONNELLY
Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Raingarden 3 Infiltration |
|---|---|---|---|
| Date: | 29/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



## Plane Infiltration Area Design to CIRIA 156

| Definition | Label | Measurement | | Label | Value |
|---|---|---|---|---|---|
| Site Infiltration Rate | q | m/hr | | q = | 0.0518040 |
| Porosity of Material | n | N/A | | n = | 0.3 |
| Storm Duration | D | per hr | | | |
| Intensity | i | m/hr | | | |
| Ratio of Drained Area to Infiltration Area | R | m2 | | R = | 1.70872147 |
| Area to be Drained | $A_D$ | m2 | | $A_D$ = | 166.19 |
| Area of Infiltration System | $A_b$ | m2 | | $A_b$ = | 97.26 |
| Factor of Safety | F | N/A | | F = | 10 |
| Highest Water Level | $h_{max}$ | m | | | |
| Return Period | RP | years | | RP | 100 |
| **Formula** | R = | $A_D/A_b$ | | | |
| | $h_{max}$ = | D/n * (Ri-q/F) | | | |
| | i = | m/hr | | | |
| Plane Infiltration Rate for Attenuation = | | (Ab * q)/F | | PIR = | 0.139957 |
| Max Attenuation Vol Required (m3) | | | | | 12.0142961 |
| Actual depth = | 0.5 | m | | | |
| Actual storage Provided = | 14.589 | m3 | | | |
| Time for half-emptying | n x Hmax/2 x q | 1.355 | hrs | | |
| 24 > | 1.3553 hrs | O.K. | | | |

**Table of Content**

| i (m/hr) | D (hr) | $h_{max}$ (m) | Volume Stored |
|---|---|---|---|
| 0.26627 | 0.08 | 0.12 | 12.10 |
| 0.18560 | 0.17 | 0.17 | 16.79 |
| 0.14508 | 0.25 | 0.20 | 19.67 |
| 0.08970 | 0.50 | 0.25 | 24.01 |
| 0.05538 | 1.00 | 0.30 | 29.00 |
| 0.03426 | 2.00 | 0.36 | 34.59 |
| 0.02587 | 3.00 | 0.39 | 37.95 |
| 0.02119 | 4.00 | 0.41 | 40.24 |
| 0.01599 | 6.00 | 0.44 | 43.07 |
| 0.00988 | 12.00 | 0.47 | 45.52 |
| 0.00611 | 24.00 | 0.42 | 40.93 |
| 0.00339 | 48.00 | 0.10 | 9.62 |
| 0.00245 | 72.00 | -0.24 | -23.05 |
| MAX | | 0.47 | 45.52 |

LOHAN & DONNELLY
Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Raingarden 4 Infiltration |
|---|---|---|---|
| Date: | 29/01/2025 | Calc'd by: | E.V Checked by: G.P |



## Plane Infiltration Area Design to CIRIA 156

| Definition | Label | Measurement | | Label | Value |
|---|---|---|---|---|---|
| Site Infiltration Rate | q | m/hr | | q = | 0.0518040 |
| Porosity of Material | n | N/A | | n = | 0.3 |
| Storm Duration | D | per hr | | | |
| Intensity | i | m/hr | | | |
| Ratio of Drained Area to Infiltration Area | R | m2 | | R = | 1.37936417 |
| Area to be Drained | $A_D$ | m2 | | $A_D$ = | 67.77 |
| Area of Infiltration System | $A_b$ | m2 | | $A_b$ = | 49.133 |
| Factor of Safety | F | N/A | | F = | 10 |
| Highest Water Level | $h_{max}$ | m | | | |
| Return Period | RP | years | | RP | 100 |
| **Formula** | R = | $A_D/A_b$ | | | |
| | $h_{max}$ = | D/n * (Ri-q/F) | | | |
| | i = | m/hr | | | |
| Plane Infiltration Rate for Attenuation = | | (Ab * q)/F | | PIR = | 0.070702 |
| Max Attenuation Vol Required (m3) | | | | | 4.51675144 |
| Actual depth = | 0.5 | m | | | |
| Actual storage Provided = | 7.37 | m3 | | | |
| Time for half-emptying | n x Hmax/2 x q | 0.978 | hrs | | |
| 24 > | 0.9784 hrs | O.K. | | | |

**Table of Content**

| i (m/hr) | D (hr) | $h_{max}$ (m) | Volume Stored |
|---|---|---|---|
| 0.26627 | 0.08 | 0.10 | 4.92 |
| 0.18560 | 0.17 | 0.14 | 6.82 |
| 0.14508 | 0.25 | 0.16 | 7.98 |
| 0.08970 | 0.50 | 0.20 | 9.71 |
| 0.05538 | 1.00 | 0.24 | 11.66 |
| 0.03426 | 2.00 | 0.28 | 13.78 |
| 0.02587 | 3.00 | 0.31 | 14.99 |
| 0.02119 | 4.00 | 0.32 | 15.75 |
| 0.01599 | 6.00 | 0.34 | 16.58 |
| 0.00988 | 12.00 | 0.34 | 16.60 |
| 0.00611 | 24.00 | 0.26 | 12.76 |
| 0.00339 | 48.00 | -0.08 | -3.93 |
| 0.00245 | 72.00 | -0.43 | -21.18 |
| MAX | | 0.34 | 16.60 |

LOHAN & DONNELLY
Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Raingarden 5 Infiltration |
|---|---|---|---|
| Date: | 29/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



## Plane Infiltration Area Design to CIRIA 156

| Definition | Label | Measurement | | Label | Value |
|---|---|---|---|---|---|
| Site Infiltration Rate | q | m/hr | | q = | 0.0518040 |
| Porosity of Material | n | N/A | | n = | 0.3 |
| Storm Duration | D | per hr | | | |
| Intensity | i | m/hr | | | |
| Ratio of Drained Area to Infiltration Area | R | m2 | | R = | 1.18311563 |
| Area to be Drained | $A_D$ | m2 | | $A_D$ = | 138.49 |
| Area of Infiltration System | $A_b$ | m2 | | $A_b$ = | 117.058 |
| Factor of Safety | F | N/A | | F = | 10 |
| Highest Water Level | $h_{max}$ | m | | | |
| Return Period | RP | years | | RP | 100 |
| **Formula** | R = | $A_D/A_b$ | | | |
| | $h_{max}$ = | D/n * (Ri-q/F) | | | |
| | i = | m/hr | | | |
| Plane Infiltration Rate for Attenuation = | | (Ab * q)/F | | PIR = | 0.168446 |
| Max Attenuation Vol Required (m3) | | | | | 8.58536163 |
| Actual depth = | 0.5 | m | | | |
| Actual storage Provided = | 17.559 | m3 | | | |
| Time for half-emptying | n x Hmax/2 x q | 0.796 | hrs | | |
| 24 > | 0.7956 hrs | O.K. | | | |

**Table of Content**

| i (m/hr) | D (hr) | $h_{max}$ (m) | Volume Stored |
|---|---|---|---|
| 0.26627 | 0.08 | 0.09 | 10.03 |
| 0.18560 | 0.17 | 0.12 | 13.89 |
| 0.14508 | 0.25 | 0.14 | 16.24 |
| 0.08970 | 0.50 | 0.17 | 19.69 |
| 0.05538 | 1.00 | 0.20 | 23.54 |
| 0.03426 | 2.00 | 0.24 | 27.58 |
| 0.02587 | 3.00 | 0.25 | 29.76 |
| 0.02119 | 4.00 | 0.27 | 31.04 |
| 0.01599 | 6.00 | 0.27 | 32.16 |
| 0.00988 | 12.00 | 0.26 | 30.48 |
| 0.00611 | 24.00 | 0.16 | 19.18 |
| 0.00339 | 48.00 | -0.19 | -21.83 |
| 0.00245 | 72.00 | -0.55 | -63.98 |
| MAX | | 0.27 | 32.16 |

LOHAN & DONNELLY
Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Raingarden 6 Infiltration |
|---|---|---|---|
| Date: | 29/01/2025 | Calc'd by: | E.V | Checked by: | G.P |



## Plane Infiltration Area Design to CIRIA 156

| Definition | Label | Measurement | | Label | Value |
|---|---|---|---|---|---|
| Site Infiltration Rate | q | m/hr | | q = | 0.0518040 |
| Porosity of Material | n | N/A | | n = | 0.3 |
| Storm Duration | D | per hr | | | |
| Intensity | i | m/hr | | | |
| Ratio of Drained Area to Infiltration Area | R | m2 | | R = | 1.4572797 |
| Area to be Drained | $A_D$ | m2 | | $A_D$ = | 116.54 |
| Area of Infiltration System | $A_b$ | m2 | | $A_b$ = | 79.969 |
| Factor of Safety | F | N/A | | F = | 10 |
| Highest Water Level | $h_{max}$ | m | | | |
| Return Period | RP | years | | RP | 100 |
| **Formula** | R = | $A_D/A_b$ | | | |
| | $h_{max}$ = | D/n * (Ri-q/F) | | | |
| | i = | m/hr | | | |
| Plane Infiltration Rate for Attenuation = | | (Ab * q)/F | | PIR = | 0.115075 |
| Max Attenuation Vol Required (m3) | | | | | 7.94926199 |
| Actual depth = | 0.5 | m | | | |
| Actual storage Provided = | 11.995 | m3 | | | |
| Time for half-emptying | n x Hmax/2 x q | 1.068 | hrs | | |
| 24 > | 1.0676 hrs | O.K. | | | |

**Table of Content**

| i (m/hr) | D (hr) | $h_{max}$ (m) | Volume Stored |
|---|---|---|---|
| 0.26627 | 0.08 | 0.11 | 8.47 |
| 0.18560 | 0.17 | 0.15 | 11.74 |
| 0.14508 | 0.25 | 0.17 | 13.74 |
| 0.08970 | 0.50 | 0.21 | 16.73 |
| 0.05538 | 1.00 | 0.25 | 20.13 |
| 0.03426 | 2.00 | 0.30 | 23.85 |
| 0.02587 | 3.00 | 0.33 | 26.01 |
| 0.02119 | 4.00 | 0.34 | 27.40 |
| 0.01599 | 6.00 | 0.36 | 28.98 |
| 0.00988 | 12.00 | 0.37 | 29.48 |
| 0.00611 | 24.00 | 0.30 | 23.82 |
| 0.00339 | 48.00 | -0.04 | -3.01 |
| 0.00245 | 72.00 | -0.39 | -30.80 |
| MAX | | 0.37 | 29.48 |

LOHAN & DONNELLY
Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Raingarden 7 Infiltration |
|---|---|---|---|
| Date: | 29/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



## Plane Infiltration Area Design to CIRIA 156

| Definition | Label | Measurement | | Label | Value |
|---|---|---|---|---|---|
| Site Infiltration Rate | q | m/hr | | q = | 0.0518040 |
| Porosity of Material | n | N/A | | n = | 0.3 |
| Storm Duration | D | per hr | | | |
| Intensity | i | m/hr | | | |
| Ratio of Drained Area to Infiltration Area | R | m2 | | R = | 1.83788933 |
| Area to be Drained | $A_D$ | m2 | | $A_D$ = | 108.04 |
| Area of Infiltration System | $A_b$ | m2 | | $A_b$ = | 58.787 |
| Factor of Safety | F | N/A | | F = | 10 |
| Highest Water Level | $h_{max}$ | m | | | |
| Return Period | RP | years | | RP | 100 |
| **Formula** | R = | $A_D/A_b$ | | | |
| | $h_{max}$ = | D/n * (Ri-q/F) | | | |
| | i = | m/hr | | | |
| Plane Infiltration Rate for Attenuation = | | (Ab * q)/F | | PIR = | 0.084594 |
| Max Attenuation Vol Required (m3) | | | | | 8.05886991 |
| Actual depth = | 0.5 | m | | | |
| Actual storage Provided = | 8.8181 | m3 | | | |
| Time for half-emptying | n x Hmax/2 x q | 1.503 | hrs | | |
| 24 > | 1.5031 hrs | O.K. | | | |

**Table of Content**

| i (m/hr) | D (hr) | $h_{max}$ (m) | Volume Stored |
|---|---|---|---|
| 0.26627 | 0.08 | 0.13 | 7.87 |
| 0.18560 | 0.17 | 0.19 | 10.93 |
| 0.14508 | 0.25 | 0.22 | 12.81 |
| 0.08970 | 0.50 | 0.27 | 15.65 |
| 0.05538 | 1.00 | 0.32 | 18.93 |
| 0.03426 | 2.00 | 0.39 | 22.64 |
| 0.02587 | 3.00 | 0.42 | 24.91 |
| 0.02119 | 4.00 | 0.45 | 26.47 |
| 0.01599 | 6.00 | 0.48 | 28.46 |
| 0.00988 | 12.00 | 0.52 | 30.52 |
| 0.00611 | 24.00 | 0.48 | 28.45 |
| 0.00339 | 48.00 | 0.17 | 9.94 |
| 0.00245 | 72.00 | -0.16 | -9.46 |
| MAX | | 0.52 | 30.52 |

LOHAN & DONNELLY
Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Raingarden 2 Infiltration |
|---|---|---|---|
| Date: | 30/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



## Plane Infiltration Area Design to CIRIA 156

| Definition | Label | Measurement | | Label | Value |
|---|---|---|---|---|---|
| Site Infiltration Rate | q | m/hr | | q = | 0.0518040 |
| Porosity of Material | n | N/A | | n = | 0.3 |
| Storm Duration | D | per hr | | | |
| Intensity | i | m/hr | | | |
| Ratio of Drained Area to Infiltration Area | R | m2 | | R = | 4.02057357 |
| Area to be Drained | $A_D$ | m2 | | $A_D$ = | 96.74 |
| Area of Infiltration System | $A_b$ | m2 | | $A_b$ = | 24.06 |
| Factor of Safety | F | N/A | | F = | 10 |
| Highest Water Level | $h_{max}$ | m | | | |
| Return Period | RP | years | | RP | 100 |
| **Formula** | R = | $A_D/A_b$ | | | |
| | $h_{max}$ = | D/n * (Ri-q/F) | | | |
| | i = | m/hr | | | |
| Plane Infiltration Rate for Attenuation = | | (Ab * q)/F | | PIR = | 0.034622 |
| Max Attenuation Vol Required (m3) | | | | | 10.2964392 |
| Actual depth = | 1.5 | m | | | |
| Actual storage Provided = | 10.827 | m3 | | | |
| Time for half-emptying | n x Hmax/2 x q | | 4.49 | hrs | |
| 24 > | 4.4905 | hrs | O.K. | | |

**Table of Content**

| i (m/hr) | D (hr) | $h_{max}$ (m) | Volume Stored |
|---|---|---|---|
| 0.26627 | 0.08 | 0.29 | 7.09 |
| 0.18560 | 0.17 | 0.41 | 9.87 |
| 0.14508 | 0.25 | 0.48 | 11.59 |
| 0.08970 | 0.50 | 0.59 | 14.25 |
| 0.05538 | 1.00 | 0.72 | 17.44 |
| 0.03426 | 2.00 | 0.88 | 21.26 |
| 0.02587 | 3.00 | 0.99 | 23.78 |
| 0.02119 | 4.00 | 1.07 | 25.67 |
| 0.01599 | 6.00 | 1.18 | 28.44 |
| 0.00988 | 12.00 | 1.38 | 33.24 |
| 0.00611 | 24.00 | 1.55 | 37.31 |
| 0.00339 | 48.00 | 1.35 | 32.58 |
| 0.00245 | 72.00 | 1.12 | 27.05 |
| MAX | | 1.55 | 37.31 |

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Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
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| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Raingarden 9 Infiltration |
|---|---|---|---|
| Date: | 30/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



## Plane Infiltration Area Design to CIRIA 156

| Definition | Label | Measurement | | Label | Value |
|---|---|---|---|---|---|
| Site Infiltration Rate | q | m/hr | | q = | 0.0518040 |
| Porosity of Material | n | N/A | | n = | 0.3 |
| Storm Duration | D | per hr | | | |
| Intensity | i | m/hr | | | |
| Ratio of Drained Area to Infiltration Area | R | m2 | | R = | 2.83259127 |
| Area to be Drained | $A_D$ | m2 | | $A_D$ = | 318.10 |
| Area of Infiltration System | $A_b$ | m2 | | $A_b$ = | 112.3 |
| Factor of Safety | F | N/A | | F = | 10 |
| Highest Water Level | $h_{max}$ | m | | | |
| Return Period | RP | years | | RP | 100 |
| **Formula** | R = | $A_D/A_b$ | | | |
| | $h_{max}$ = | D/n * (Ri-q/F) | | | |
| | i = | m/hr | | | |
| Plane Infiltration Rate for Attenuation = | | (Ab * q)/F | | PIR = | 0.161600 |
| Max Attenuation Vol Required (m3) | | | | | 28.6384968 |
| Actual depth = | 1 | m | | | |
| Actual storage Provided = | 33.69 | m3 | | | |
| Time for half-emptying | n x Hmax/2 x q | 2.809 | hrs | | |
| 24 > | 2.8091 hrs | O.K. | | | |

**Table of Content**

| i (m/hr) | D (hr) | $h_{max}$ (m) | Volume Stored |
|---|---|---|---|
| 0.26627 | 0.08 | 0.21 | 23.27 |
| 0.18560 | 0.17 | 0.29 | 32.35 |
| 0.14508 | 0.25 | 0.34 | 37.97 |
| 0.08970 | 0.50 | 0.41 | 46.59 |
| 0.05538 | 1.00 | 0.51 | 56.78 |
| 0.03426 | 2.00 | 0.61 | 68.77 |
| 0.02587 | 3.00 | 0.68 | 76.47 |
| 0.02119 | 4.00 | 0.73 | 82.12 |
| 0.01599 | 6.00 | 0.80 | 90.09 |
| 0.00988 | 12.00 | 0.91 | 102.44 |
| 0.00611 | 24.00 | 0.97 | 108.95 |
| 0.00339 | 48.00 | 0.71 | 79.64 |
| 0.00245 | 72.00 | 0.42 | 47.71 |
| MAX | | 0.97 | 108.95 |

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Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Raingarden 10 Infiltration |
|---|---|---|---|
| Date: | 29/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



## Plane Infiltration Area Design to CIRIA 156

| Definition | Label | Measurement | | Label | Value |
|---|---|---|---|---|---|
| Site Infiltration Rate | q | m/hr | | q = | 0.0518040 |
| Porosity of Material | n | N/A | | n = | 0.3 |
| Storm Duration | D | per hr | | | |
| Intensity | i | m/hr | | | |
| Ratio of Drained Area to Infiltration Area | R | m2 | | R = | 1 |
| Area to be Drained | $A_D$ | m2 | | $A_D$ = | 38.00 |
| Area of Infiltration System | $A_b$ | m2 | | $A_b$ = | 38.004 |
| Factor of Safety | F | N/A | | F = | 10 |
| Highest Water Level | $h_{max}$ | m | | | |
| Return Period | RP | years | | RP | 100 |
| **Formula** | R = | $A_D/A_b$ | | | |
| | $h_{max}$ = | D/n * (Ri-q/F) | | | |
| | i = | m/hr | | | |
| Plane Infiltration Rate for Attenuation = | | (Ab * q)/F | | PIR = | 0.054688 |
| | | | | | |
| Max Attenuation Vol Required (m3) | | | | | 2.19746425 |
| | | | | | |
| Actual depth = | 0.5 | m | | | |
| Actual storage Provided = | 5.7006 | m3 | | | |
| | | | | | |
| Time for half-emptying | n x Hmax/2 x q | 0.626 | hrs | | |
| | | | | | |
| 24 > | 0.626 hrs | O.K. | | | |

**Table of Content**

| i (m/hr) | D (hr) | $h_{max}$ (m) | Volume Stored |
|---|---|---|---|
| 0.26627 | 0.08 | 0.07 | 2.75 |
| 0.18560 | 0.17 | 0.10 | 3.79 |
| 0.14508 | 0.25 | 0.12 | 4.43 |
| 0.08970 | 0.50 | 0.14 | 5.35 |
| 0.05538 | 1.00 | 0.17 | 6.36 |
| 0.03426 | 2.00 | 0.19 | 7.37 |
| 0.02587 | 3.00 | 0.21 | 7.86 |
| 0.02119 | 4.00 | 0.21 | 8.11 |
| 0.01599 | 6.00 | 0.22 | 8.22 |
| 0.00988 | 12.00 | 0.19 | 7.14 |
| 0.00611 | 24.00 | 0.07 | 2.83 |
| 0.00339 | 48.00 | -0.29 | -10.87 |
| 0.00245 | 72.00 | -0.65 | -24.87 |
| MAX | | 0.22 | 8.22 |

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Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
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| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Raingarden 11 Infiltration |
|---|---|---|---|
| Date: | 29/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



## Plane Infiltration Area Design to CIRIA 156

| Definition | Label | Measurement | | Label | Value |
|---|---|---|---|---|---|
| Site Infiltration Rate | q | m/hr | | q = | 0.0518040 |
| Porosity of Material | n | N/A | | n = | 0.3 |
| Storm Duration | D | per hr | | | |
| Intensity | i | m/hr | | | |
| Ratio of Drained Area to Infiltration Area | R | m2 | | R = | 1 |
| Area to be Drained | $A_D$ | m2 | | $A_D$ = | 36.96 |
| Area of Infiltration System | $A_b$ | m2 | | $A_b$ = | 36.962 |
| Factor of Safety | F | N/A | | F = | 10 |
| Highest Water Level | $h_{max}$ | m | | | |
| Return Period | RP | years | | RP | 100 |
| **Formula** | R = | $A_D/A_b$ | | | |
| | $h_{max}$ = | D/n * (Ri-q/F) | | | |
| | i = | m/hr | | | |
| Plane Infiltration Rate for Attenuation = | | (Ab * q)/F | | PIR = | 0.053188 |
| | | | | | |
| Max Attenuation Vol Required (m3) | | | | | 2.13721381 |
| | | | | | |
| Actual depth = | 0.5 | m | | | |
| Actual storage Provided = | 5.5443 | m3 | | | |
| | | | | | |
| Time for half-emptying | n x Hmax/2 x q | 0.626 | hrs | | |
| | | | | | |
| 24 > | 0.626 hrs | O.K. | | | |

**Table of Content**

| i (m/hr) | D (hr) | $h_{max}$ (m) | Volume Stored |
|---|---|---|---|
| 0.26627 | 0.08 | 0.07 | 2.67 |
| 0.18560 | 0.17 | 0.10 | 3.69 |
| 0.14508 | 0.25 | 0.12 | 4.31 |
| 0.08970 | 0.50 | 0.14 | 5.21 |
| 0.05538 | 1.00 | 0.17 | 6.18 |
| 0.03426 | 2.00 | 0.19 | 7.16 |
| 0.02587 | 3.00 | 0.21 | 7.65 |
| 0.02119 | 4.00 | 0.21 | 7.89 |
| 0.01599 | 6.00 | 0.22 | 7.99 |
| 0.00988 | 12.00 | 0.19 | 6.95 |
| 0.00611 | 24.00 | 0.07 | 2.75 |
| 0.00339 | 48.00 | -0.29 | -10.57 |
| 0.00245 | 72.00 | -0.65 | -24.19 |
| MAX | | 0.22 | 7.99 |

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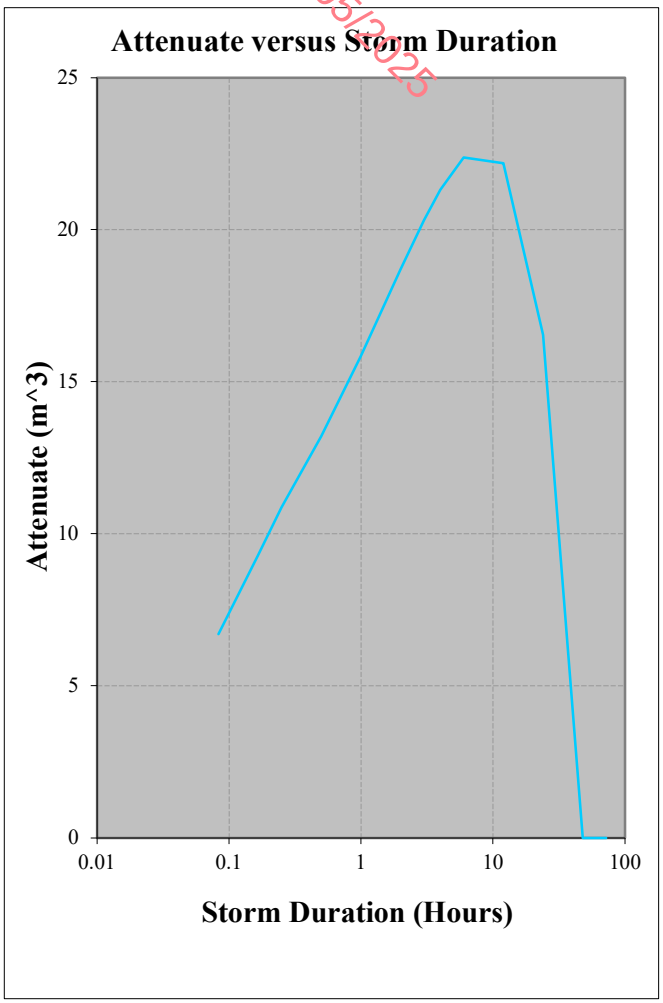
Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Tree Pit 1 Attenuation |
|---|---|---|---|
| Date: | 31/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hard Area | 212.6 $m^2$ | Grassed: | 0 $m^2$ | Tree Pit: | 229.8 $m^2$ | Equivalent Impermeable Area: | 399.902 $m^2$ |
| I. Factor: | 0.80 | I. Factor: | 1.00 | I. Factor: | 1.00 | Attenuated Flow Rate: | 0.33 l/s |

| Storm Duration (Hours) | Rainfall (mm) | Total Surface Water ($m^3$) | Allowable Discharge ($m^3$) | Attenuate ($m^3$) |
|---|---|---|---|---|
| 0.083 | 17.00 | 6.80 | 0.098817301 | 6.70 |
| 0.166 | 23.70 | 9.48 | 0.197634602 | 9.28 |
| 0.25 | 27.90 | 11.16 | 0.297642472 | 10.86 |
| 0.50 | 34.50 | 13.80 | 0.595284944 | 13.20 |
| 1.00 | 42.60 | 17.04 | 1.190569889 | 15.85 |
| 2.00 | 52.70 | 21.07 | 2.381139778 | 18.69 |
| 3.00 | 59.70 | 23.87 | 3.571709666 | 20.30 |
| 4.00 | 65.20 | 26.07 | 4.762279555 | 21.31 |
| 6.00 | 73.80 | 29.51 | 7.143419333 | 22.37 |
| 12.00 | 91.20 | 36.47 | 14.28683867 | 22.18 |
| 24.00 | 112.80 | 45.11 | 28.57367733 | 16.54 |
| 48.00 | 125.30 | 50.11 | 57.14735466 | 0 |
| 72.00 | 135.90 | 54.35 | 85.72103199 | 0 |




Maximum Volume of Attenuate: 22.37 $m^3$ Climate Change = 1.3 Required Attenuation Volume = 29.08 $m^3$

**Note: This spreadsheet calculates the Volume of Attenuate based on a Return Period of: 100 years.**

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13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
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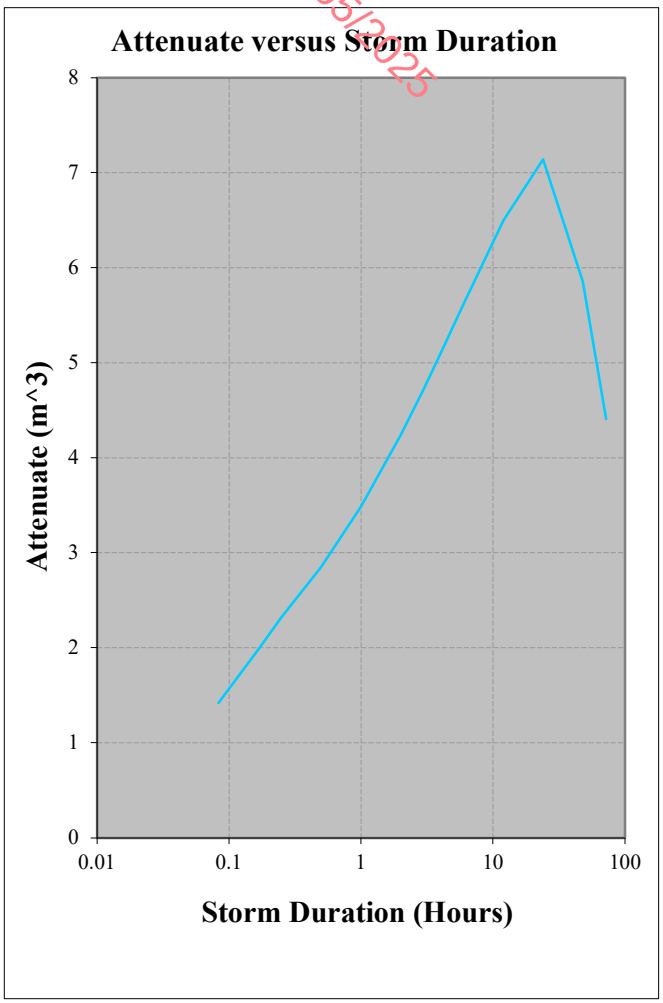
| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Tree Pit 2 Attenuation |
|---|---|---|---|
| Date: | 31/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hard Area | 81.54 $m^2$ | Grassed: | 0 $m^2$ | Tree Pit: | 18.81 $m^2$ | Equivalent Impermeable Area: | 84.0364 $m^2$ |
| I. Factor: | 0.80 | I. Factor: | 1.00 | I. Factor: | 1.00 | | |

Attenuated Flow Rate: 0.03 l/s

| Storm Duration (Hours) | Rainfall (mm) | Total Surface Water ($m^3$) | Allowable Discharge ($m^3$) | Attenuate ($m^3$) |
|---|---|---|---|---|
| 0.083 | 17.00 | 1.43 | 0.008086076 | 1.42 |
| 0.166 | 23.70 | 1.99 | 0.016172152 | 1.98 |
| 0.25 | 27.90 | 2.34 | 0.024355651 | 2.32 |
| 0.50 | 34.50 | 2.90 | 0.048711301 | 2.85 |
| 1.00 | 42.60 | 3.58 | 0.097422602 | 3.48 |
| 2.00 | 52.70 | 4.43 | 0.194845205 | 4.23 |
| 3.00 | 59.70 | 5.02 | 0.292267807 | 4.72 |
| 4.00 | 65.20 | 5.48 | 0.38969041 | 5.09 |
| 6.00 | 73.80 | 6.20 | 0.584535614 | 5.62 |
| 12.00 | 91.20 | 7.66 | 1.169071229 | 6.50 |
| 24.00 | 112.80 | 9.48 | 2.338142458 | 7.14 |
| 48.00 | 125.30 | 10.53 | 4.676284915 | 5.85 |
| 72.00 | 135.90 | 11.42 | 7.014427373 | 4.41 |




Maximum Volume of Attenuate: 7.14 $m^3$ Climate Change = 1.3 Required Attenuation Volume = 9.2835 $m^3$

**Note: This spreadsheet calculates the Volume of Attenuate based on a Return Period of: 100 years.**

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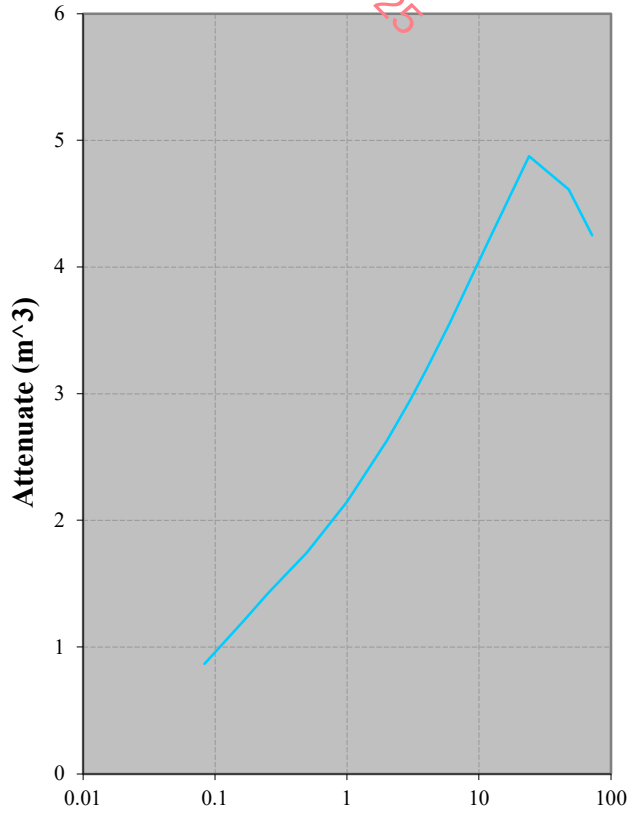
| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Tree Pit 3 Attenuation |
|---|---|---|---|
| Date: | 31/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hard Area | 54.94 $m^2$ | Grassed: | 0 $m^2$ | Tree Pit: | 7.276 $m^2$ | Equivalent Impermeable Area: | 51.2304 $m^2$ |
| I. Factor: | 0.80 | I. Factor: | 1.00 | I. Factor: | 1.00 | Attenuated Flow Rate: | 0.01 l/s |

| Storm Duration (Hours) | Rainfall (mm) | Total Surface Water ($m^3$) | Allowable Discharge ($m^3$) | Attenuate ($m^3$) |
|---|---|---|---|---|
| 0.083 | 17.00 | 0.87 | 0.003128485 | 0.87 |
| 0.166 | 23.70 | 1.21 | 0.00625697 | 1.21 |
| 0.25 | 27.90 | 1.43 | 0.009423148 | 1.42 |
| 0.50 | 34.50 | 1.77 | 0.018846295 | 1.75 |
| 1.00 | 42.60 | 2.18 | 0.03769259 | 2.14 |
| 2.00 | 52.70 | 2.70 | 0.075385181 | 2.62 |
| 3.00 | 59.70 | 3.06 | 0.113077771 | 2.95 |
| 4.00 | 65.20 | 3.34 | 0.150770362 | 3.19 |
| 6.00 | 73.80 | 3.78 | 0.226155542 | 3.55 |
| 12.00 | 91.20 | 4.67 | 0.452311085 | 4.22 |
| 24.00 | 112.80 | 5.78 | 0.90462217 | 4.87 |
| 48.00 | 125.30 | 6.42 | 1.809244339 | 4.61 |
| 72.00 | 135.90 | 6.96 | 2.713866509 | 4.25 |




Maximum Volume of Attenuate: 4.87 $m^3$ Climate Change = 1.3 Required Attenuation Volume = 6.3364 $m^3$

**Note: This spreadsheet calculates the Volume of Attenuate based on a Return Period of: 100 years.**

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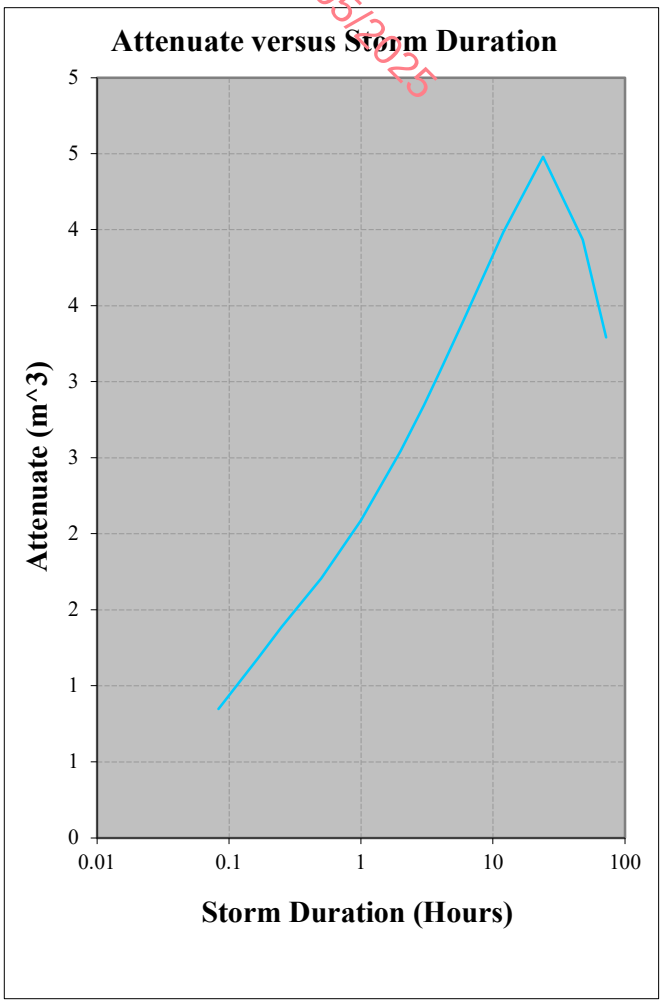
| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Tree Pit 4 Attenuation |
|---|---|---|---|
| Date: | 31/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hard Area | 50.85 $m^2$ | Grassed: | 0 $m^2$ | Tree Pit: | 9.438 $m^2$ | Equivalent Impermeable Area: | 50.114 $m^2$ |
| I. Factor: | 0.80 | I. Factor: | 1.00 | I. Factor: | 1.00 | Attenuated Flow Rate: | 0.01 l/s |

| Storm Duration (Hours) | Rainfall (mm) | Total Surface Water ($m^3$) | Allowable Discharge ($m^3$) | Attenuate ($m^3$) |
|---|---|---|---|---|
| 0.083 | 17.00 | 0.85 | 0.004058087 | 0.85 |
| 0.166 | 23.70 | 1.19 | 0.008116174 | 1.18 |
| 0.25 | 27.90 | 1.40 | 0.012223154 | 1.39 |
| 0.50 | 34.50 | 1.73 | 0.024446308 | 1.70 |
| 1.00 | 42.60 | 2.13 | 0.048892615 | 2.09 |
| 2.00 | 52.70 | 2.64 | 0.09778523 | 2.54 |
| 3.00 | 59.70 | 2.99 | 0.146677846 | 2.85 |
| 4.00 | 65.20 | 3.27 | 0.195570461 | 3.07 |
| 6.00 | 73.80 | 3.70 | 0.293355691 | 3.41 |
| 12.00 | 91.20 | 4.57 | 0.586711382 | 3.98 |
| 24.00 | 112.80 | 5.65 | 1.173422765 | 4.48 |
| 48.00 | 125.30 | 6.28 | 2.34684553 | 3.93 |
| 72.00 | 135.90 | 6.81 | 3.520268294 | 3.29 |




Maximum Volume of Attenuate: 4.48 $m^3$ Climate Change = 1.3 Required Attenuation Volume = 5.8233 $m^3$

**Note: This spreadsheet calculates the Volume of Attenuate based on a Return Period of: 100 years.**

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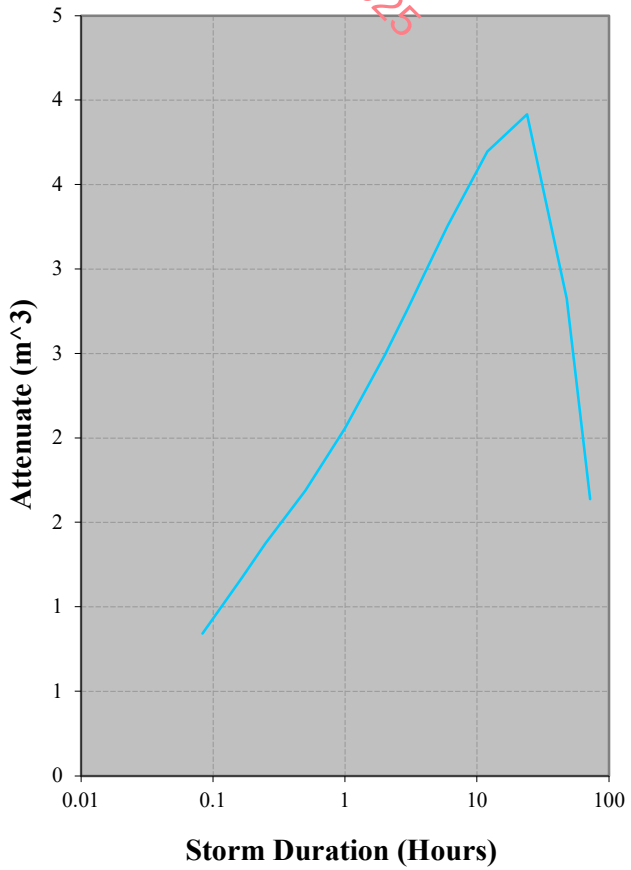
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Tree Pit 5 Attenuation |
|---|---|---|---|
| Date: | 31/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Hard Area | 45.15 $m^2$ | Grassed: | 0 $m^2$ | Tree Pit: | 13.8 $m^2$ | Equivalent Impermeable Area: | 49.92 $m^2$ | Attenuated Flow Rate: 0.02 l/s |
| I. Factor: | 0.80 | I. Factor: | 1.00 | I. Factor: | 1.00 | | | |

| Storm Duration (Hours) | Rainfall (mm) | Total Surface Water ($m^3$) | Allowable Discharge ($m^3$) | Attenuate ($m^3$) |
|---|---|---|---|---|
| 0.083 | 17.00 | 0.85 | 0.00593363 | 0.84 |
| 0.166 | 23.70 | 1.18 | 0.01186726 | 1.17 |
| 0.25 | 27.90 | 1.39 | 0.01787238 | 1.37 |
| 0.50 | 34.50 | 1.72 | 0.03574476 | 1.69 |
| 1.00 | 42.60 | 2.13 | 0.07148952 | 2.06 |
| 2.00 | 52.70 | 2.63 | 0.14297904 | 2.49 |
| 3.00 | 59.70 | 2.98 | 0.21446856 | 2.77 |
| 4.00 | 65.20 | 3.25 | 0.28595808 | 2.97 |
| 6.00 | 73.80 | 3.68 | 0.42893712 | 3.26 |
| 12.00 | 91.20 | 4.55 | 0.85787424 | 3.69 |
| 24.00 | 112.80 | 5.63 | 1.71574848 | 3.92 |
| 48.00 | 125.30 | 6.25 | 3.43149696 | 2.82 |
| 72.00 | 135.90 | 6.78 | 5.14724544 | 1.64 |




Maximum Volume of Attenuate: 3.92 $m^3$ Climate Change = 1.3 Required Attenuation Volume = 5.0898 $m^3$

**Note: This spreadsheet calculates the Volume of Attenuate based on a Return Period of: 100 years.**

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W: www.lohan-donnelly.com E: info@lohan-donnelly.com

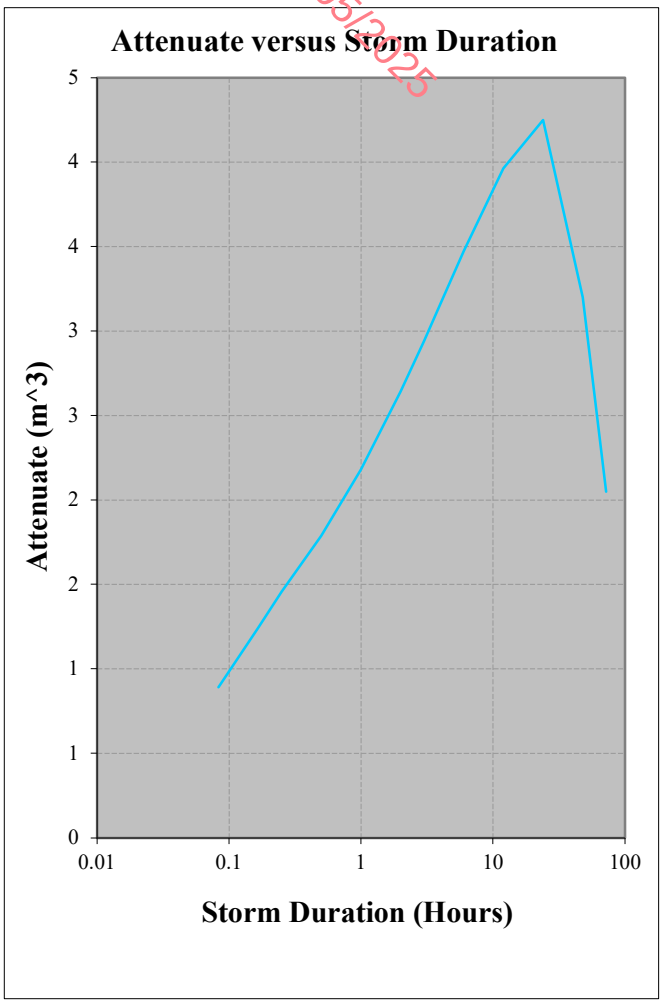
| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Tree Pit 6 Attenuation |
|---|---|---|---|
| Date: | 31/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hard Area | 48.83 $m^2$ | Grassed: | 0 $m^2$ | Tree Pit: | 13.75 $m^2$ | Equivalent Impermeable Area: | 52.8212 $m^2$ |
| I. Factor: | 0.80 | I. Factor: | 1.00 | I. Factor: | 1.00 | | |

Attenuated Flow Rate: 0.02 l/s

| Storm Duration (Hours) | Rainfall (mm) | Total Surface Water ($m^3$) | Allowable Discharge ($m^3$) | Attenuate ($m^3$) |
|---|---|---|---|---|
| 0.083 | 17.00 | 0.90 | 0.005913851 | 0.89 |
| 0.166 | 23.70 | 1.25 | 0.011827703 | 1.24 |
| 0.25 | 27.90 | 1.47 | 0.017812805 | 1.46 |
| 0.50 | 34.50 | 1.82 | 0.035625611 | 1.79 |
| 1.00 | 42.60 | 2.25 | 0.071251222 | 2.18 |
| 2.00 | 52.70 | 2.78 | 0.142502443 | 2.64 |
| 3.00 | 59.70 | 3.15 | 0.213753665 | 2.94 |
| 4.00 | 65.20 | 3.44 | 0.285004886 | 3.16 |
| 6.00 | 73.80 | 3.90 | 0.42750733 | 3.47 |
| 12.00 | 91.20 | 4.82 | 0.855014659 | 3.96 |
| 24.00 | 112.80 | 5.96 | 1.710029318 | 4.25 |
| 48.00 | 125.30 | 6.62 | 3.420058637 | 3.20 |
| 72.00 | 135.90 | 7.18 | 5.130087955 | 2.05 |




Maximum Volume of Attenuate: 4.25 $m^3$ Climate Change = 1.3 Required Attenuation Volume = 5.5227 $m^3$

**Note: This spreadsheet calculates the Volume of Attenuate based on a Return Period of: 100 years.**

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13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

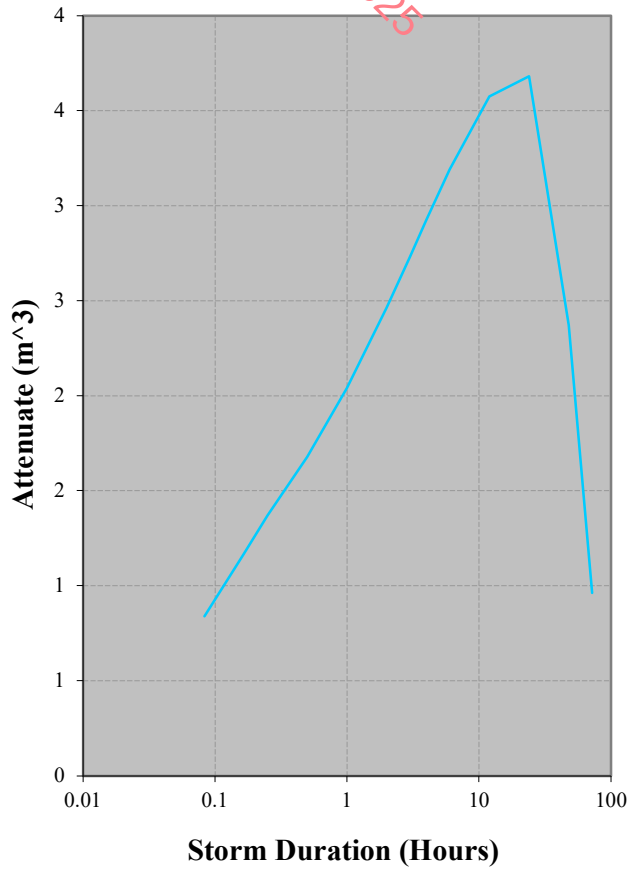
| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Tree Pit 7 Attenuation |
|---|---|---|---|
| Date: | 31/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hard Area | 42.79 $m^2$ | Grassed: | 0 $m^2$ | Tree Pit: | 15.56 $m^2$ | Equivalent Impermeable Area: | 49.789 $m^2$ |
| I. Factor: | 0.80 | I. Factor: | 1.00 | I. Factor: | 1.00 | | |

Attenuated Flow Rate: 0.02 l/s

| Storm Duration (Hours) | Rainfall (mm) | Total Surface Water ($m^3$) | Allowable Discharge ($m^3$) | Attenuate ($m^3$) |
|---|---|---|---|---|
| 0.083 | 17.00 | 0.85 | 0.006690813 | 0.84 |
| 0.166 | 23.70 | 1.18 | 0.013381626 | 1.17 |
| 0.25 | 27.90 | 1.39 | 0.020153051 | 1.37 |
| 0.50 | 34.50 | 1.72 | 0.040306102 | 1.68 |
| 1.00 | 42.60 | 2.12 | 0.080612204 | 2.04 |
| 2.00 | 52.70 | 2.62 | 0.161224409 | 2.46 |
| 3.00 | 59.70 | 2.97 | 0.241836613 | 2.73 |
| 4.00 | 65.20 | 3.25 | 0.322448818 | 2.92 |
| 6.00 | 73.80 | 3.67 | 0.483673226 | 3.19 |
| 12.00 | 91.20 | 4.54 | 0.967346453 | 3.57 |
| 24.00 | 112.80 | 5.62 | 1.934692906 | 3.68 |
| 48.00 | 125.30 | 6.24 | 3.869385811 | 2.37 |
| 72.00 | 135.90 | 6.77 | 5.804078717 | 0.96 |




Maximum Volume of Attenuate: 3.68 $m^3$ Climate Change = 1.3 Required Attenuation Volume = 4.786 $m^3$

**Note: This spreadsheet calculates the Volume of Attenuate based on a Return Period of: 100 years.**

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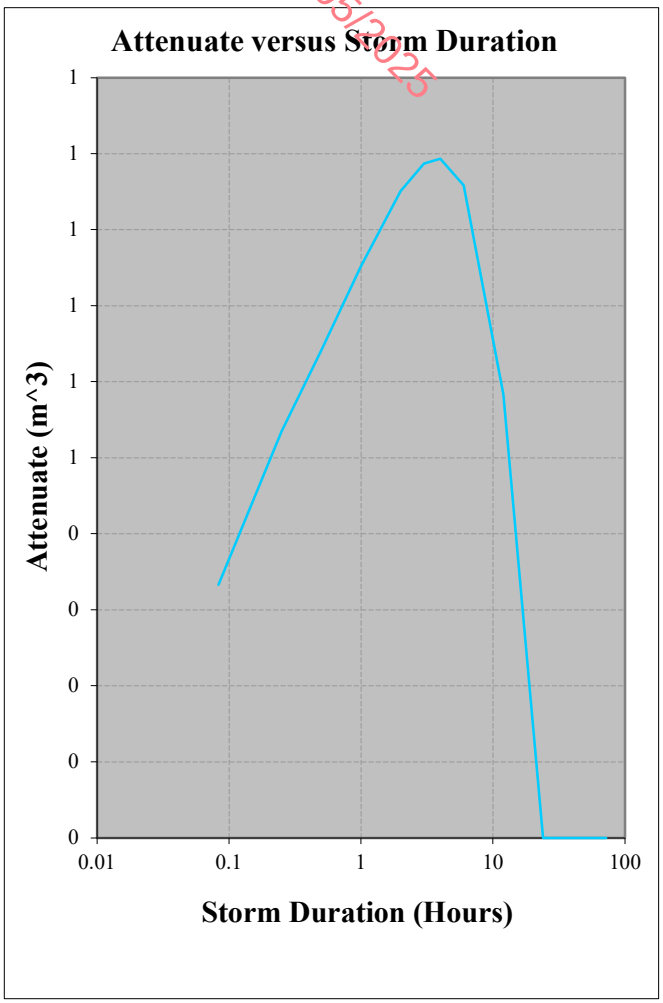
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | | Subject: | Tree Pit 8 Attenuation |
|---|---|---|---|---|
| Date: | 31/01/2025 | Calc'd by: E.V | Checked by: | G.P |



| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Hard Area | 0 $m^2$ | Grassed: | 0 $m^2$ | Tree Pit: | 20.09 $m^2$ | Equivalent Impermeable Area: | 20.086 $m^2$ | Attenuated Flow Rate: 0.03 l/s |
| I. Factor: | 0.80 | I. Factor: | 1.00 | I. Factor: | 1.00 | | | |

| Storm Duration (Hours) | Rainfall (mm) | Total Surface Water ($m^3$) | Allowable Discharge ($m^3$) | Attenuate ($m^3$) |
|---|---|---|---|---|
| 0.083 | 17.00 | 0.34 | 0.008636442 | 0.33 |
| 0.166 | 23.70 | 0.48 | 0.017272883 | 0.46 |
| 0.25 | 27.90 | 0.56 | 0.026013379 | 0.53 |
| 0.50 | 34.50 | 0.69 | 0.052026757 | 0.64 |
| 1.00 | 42.60 | 0.86 | 0.104053514 | 0.75 |
| 2.00 | 52.70 | 1.06 | 0.208107029 | 0.85 |
| 3.00 | 59.70 | 1.20 | 0.312160543 | 0.89 |
| 4.00 | 65.20 | 1.31 | 0.416214058 | 0.89 |
| 6.00 | 73.80 | 1.48 | 0.624321086 | 0.86 |
| 12.00 | 91.20 | 1.83 | 1.248642173 | 0.58 |
| 24.00 | 112.80 | 2.27 | 2.497284346 | 0 |
| 48.00 | 125.30 | 2.52 | 4.994568691 | 0 |
| 72.00 | 135.90 | 2.73 | 7.491853037 | 0 |




Maximum Volume of Attenuate: 0.89 $m^3$ Climate Change = 1.3 Required Attenuation Volume = 1.1614 $m^3$

**Note: This spreadsheet calculates the Volume of Attenuate based on a Return Period of: 100 years.**

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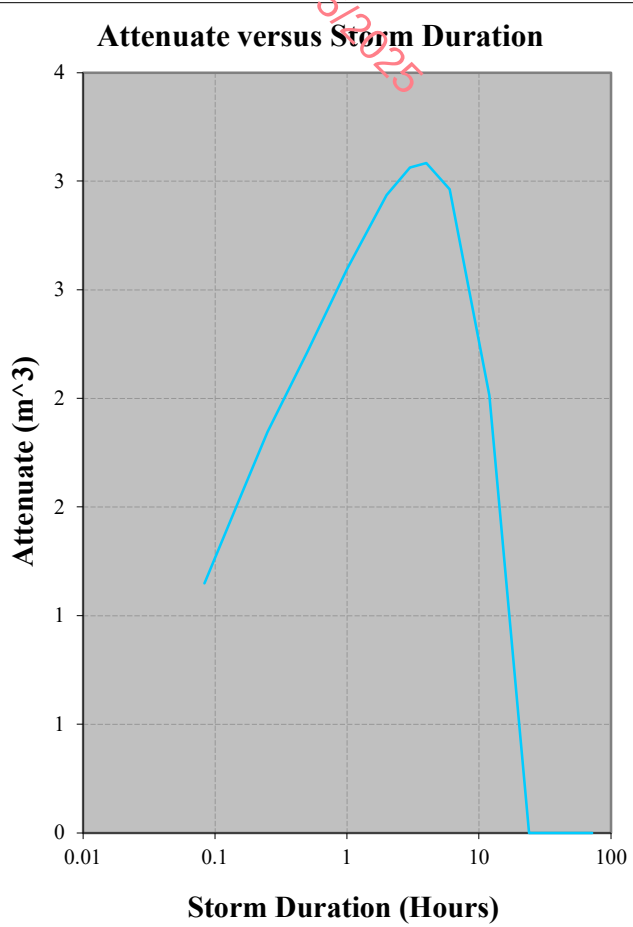
Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Tree Pit 9 Attenuation |
|---|---|---|---|
| Date: | 31/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hard Area | 0 $m^2$ | Grassed: | 0 $m^2$ | Tree Pit: | 69.34 $m^2$ | Equivalent Impermeable Area: | 69.337 $m^2$ |
| I. Factor: | 0.80 | I. Factor: | 1.00 | I. Factor: | 1.00 | Attenuated Flow Rate: | 0.1 l/s |

| Storm Duration (Hours) | Rainfall (mm) | Total Surface Water ($m^3$) | Allowable Discharge ($m^3$) | Attenuate ($m^3$) |
|---|---|---|---|---|
| 0.083 | 17.00 | 1.18 | 0.029813052 | 1.15 |
| 0.166 | 23.70 | 1.64 | 0.059626104 | 1.58 |
| 0.25 | 27.90 | 1.93 | 0.089798349 | 1.84 |
| 0.50 | 34.50 | 2.39 | 0.179596697 | 2.21 |
| 1.00 | 42.60 | 2.95 | 0.359193395 | 2.59 |
| 2.00 | 52.70 | 3.65 | 0.71838679 | 2.94 |
| 3.00 | 59.70 | 4.14 | 1.077580184 | 3.06 |
| 4.00 | 65.20 | 4.52 | 1.436773579 | 3.08 |
| 6.00 | 73.80 | 5.12 | 2.155160369 | 2.96 |
| 12.00 | 91.20 | 6.32 | 4.310320738 | 2.01 |
| 24.00 | 112.80 | 7.82 | 8.620641475 | 0 |
| 48.00 | 125.30 | 8.69 | 17.24128295 | 0 |
| 72.00 | 135.90 | 9.42 | 25.86192443 | 0 |




Maximum Volume of Attenuate: 3.08 $m^3$ Climate Change = 1.3 Required Attenuation Volume = 4.0092 $m^3$

**Note: This spreadsheet calculates the Volume of Attenuate based on a Return Period of: 100 years.**

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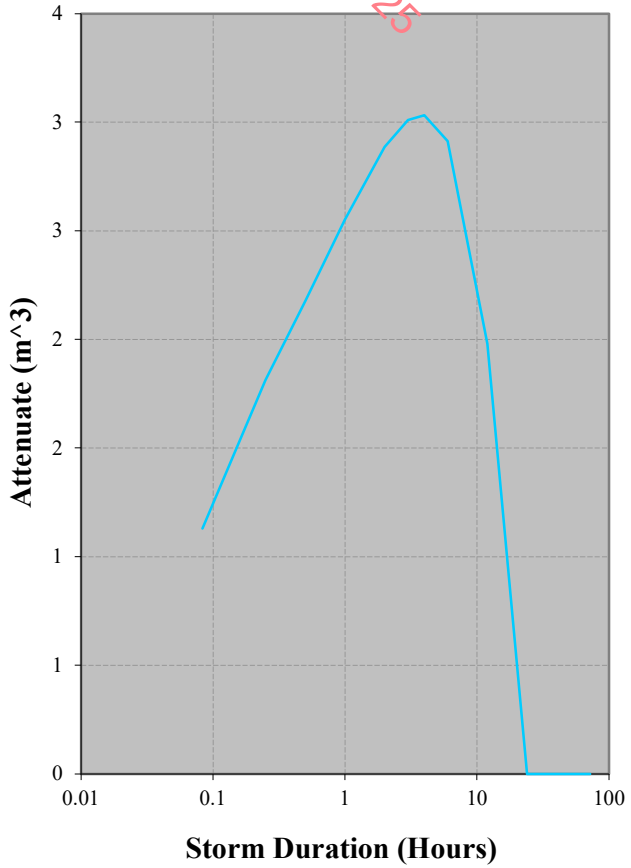
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | | Subject: | Tree Pit 10 Attenuation |
|---|---|---|---|---|
| Date: | 31/01/2025 | Calc'd by: E.V | Checked by: | G.P |



| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Hard Area | 0 $m^2$ | Grassed: | 0 $m^2$ | Tree Pit: | 68.16 $m^2$ | Equivalent Impermeable Area: | 68.16 $m^2$ | Attenuated Flow Rate: 0.1 l/s |
| I. Factor: | 0.80 | I. Factor: | 1.00 | I. Factor: | 1.00 | | | |

| Storm Duration (Hours) | Rainfall (mm) | Total Surface Water ($m^3$) | Allowable Discharge ($m^3$) | Attenuate ($m^3$) |
|---|---|---|---|---|
| 0.083 | 17.00 | 1.16 | 0.029306973 | 1.13 |
| 0.166 | 23.70 | 1.62 | 0.058613947 | 1.56 |
| 0.25 | 27.90 | 1.90 | 0.088274016 | 1.81 |
| 0.50 | 34.50 | 2.35 | 0.176548032 | 2.17 |
| 1.00 | 42.60 | 2.90 | 0.353096064 | 2.55 |
| 2.00 | 52.70 | 3.59 | 0.706192128 | 2.89 |
| 3.00 | 59.70 | 4.07 | 1.059288192 | 3.01 |
| 4.00 | 65.20 | 4.44 | 1.412384256 | 3.03 |
| 6.00 | 73.80 | 5.03 | 2.118576384 | 2.91 |
| 12.00 | 91.20 | 6.22 | 4.237152768 | 1.98 |
| 24.00 | 112.80 | 7.69 | 8.474305536 | 0 |
| 48.00 | 125.30 | 8.54 | 16.94861107 | 0 |
| 72.00 | 135.90 | 9.26 | 25.42291661 | 0 |




Maximum Volume of Attenuate: 3.03 $m^3$ Climate Change = 1.3 Required Attenuation Volume = 3.9411 $m^3$

**Note: This spreadsheet calculates the Volume of Attenuate based on a Return Period of: 100 years.**

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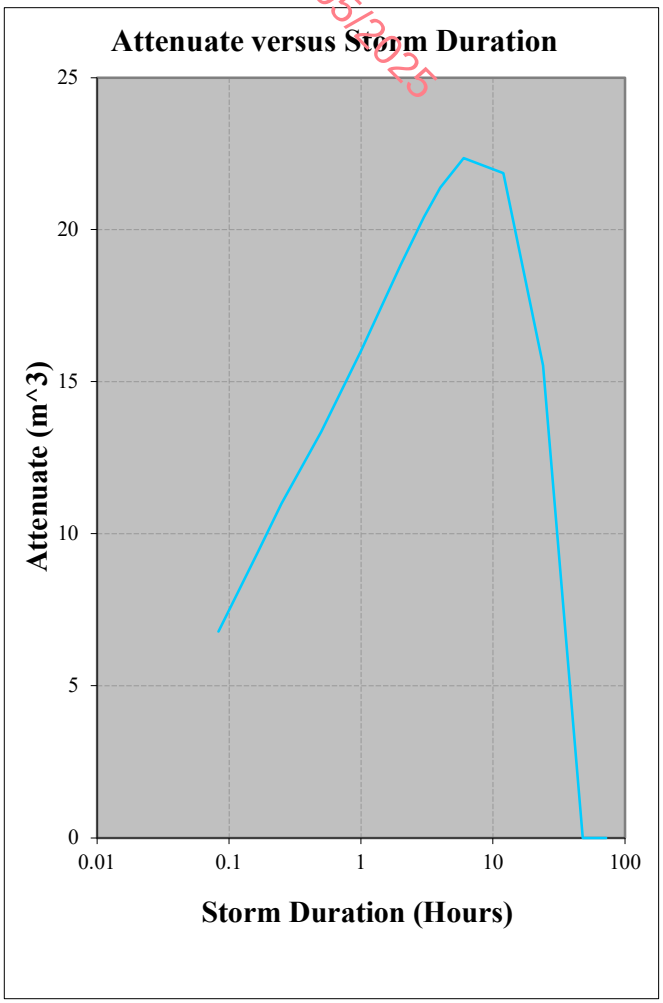
Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Tree Pit 11 Attenuation |
|---|---|---|---|
| Date: | 31/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Hard Area | 203 $m^2$ | Grassed: | 0 $m^2$ | Tree Pit: | 242.6 $m^2$ | Equivalent Impermeable Area: | 405.0726 $m^2$ | Attenuated Flow Rate: | 0.35 l/s |
| I. Factor: | 0.80 | I. Factor: | 1.00 | I. Factor: | 1.00 | | | | |

| Storm Duration (Hours) | Rainfall (mm) | Total Surface Water ($m^3$) | Allowable Discharge ($m^3$) | Attenuate ($m^3$) |
|---|---|---|---|---|
| 0.083 | 17.00 | 6.89 | 0.104329987 | 6.78 |
| 0.166 | 23.70 | 9.60 | 0.208659974 | 9.39 |
| 0.25 | 27.90 | 11.30 | 0.314246949 | 10.99 |
| 0.50 | 34.50 | 13.98 | 0.628493899 | 13.35 |
| 1.00 | 42.60 | 17.26 | 1.256987797 | 16.00 |
| 2.00 | 52.70 | 21.35 | 2.513975594 | 18.83 |
| 3.00 | 59.70 | 24.18 | 3.770963392 | 20.41 |
| 4.00 | 65.20 | 26.41 | 5.027951189 | 21.38 |
| 6.00 | 73.80 | 29.89 | 7.541926783 | 22.35 |
| 12.00 | 91.20 | 36.94 | 15.08385357 | 21.86 |
| 24.00 | 112.80 | 45.69 | 30.16770713 | 15.52 |
| 48.00 | 125.30 | 50.76 | 60.33541427 | 0 |
| 72.00 | 135.90 | 55.05 | 90.5031214 | 0 |




Maximum Volume of Attenuate: 22.35 $m^3$ Climate Change = 1.3 Required Attenuation Volume = 29.058 $m^3$

**Note: This spreadsheet calculates the Volume of Attenuate based on a Return Period of: 100 years.**

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Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

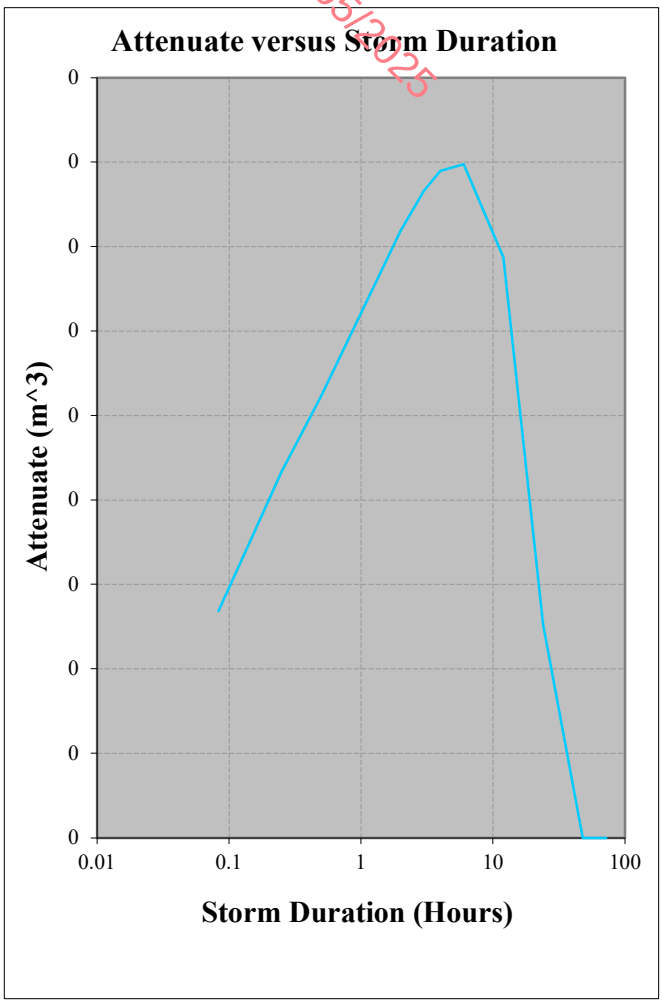
| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Tree Pit 12 Attenuation |
|---|---|---|---|
| Date: | 31/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hard Area | 2.205 $m^2$ | Grassed: | 0 $m^2$ | Tree Pit: | 6.288 $m^2$ | Equivalent Impermeable Area: | 8.052 $m^2$ |
| I. Factor: | 0.80 | I. Factor: | 1.00 | I. Factor: | 1.00 | | |

Attenuated Flow Rate: 0.01 l/s

| Storm Duration (Hours) | Rainfall (mm) | Total Surface Water ($m^3$) | Allowable Discharge ($m^3$) | Attenuate ($m^3$) |
|---|---|---|---|---|
| 0.083 | 17.00 | 0.14 | 0.002703671 | 0.13 |
| 0.166 | 23.70 | 0.19 | 0.005407343 | 0.19 |
| 0.25 | 27.90 | 0.22 | 0.008143589 | 0.22 |
| 0.50 | 34.50 | 0.28 | 0.016287178 | 0.26 |
| 1.00 | 42.60 | 0.34 | 0.032574355 | 0.31 |
| 2.00 | 52.70 | 0.42 | 0.06514871 | 0.36 |
| 3.00 | 59.70 | 0.48 | 0.097723066 | 0.38 |
| 4.00 | 65.20 | 0.52 | 0.130297421 | 0.39 |
| 6.00 | 73.80 | 0.59 | 0.195446131 | 0.40 |
| 12.00 | 91.20 | 0.73 | 0.390892262 | 0.34 |
| 24.00 | 112.80 | 0.91 | 0.781784525 | 0.13 |
| 48.00 | 125.30 | 1.01 | 1.56356905 | 0 |
| 72.00 | 135.90 | 1.09 | 2.345353574 | 0 |




Maximum Volume of Attenuate: 0.40 $m^3$ Climate Change = 1.3 Required Attenuation Volume = 0.5184 $m^3$

**Note: This spreadsheet calculates the Volume of Attenuate based on a Return Period of: 100 years.**

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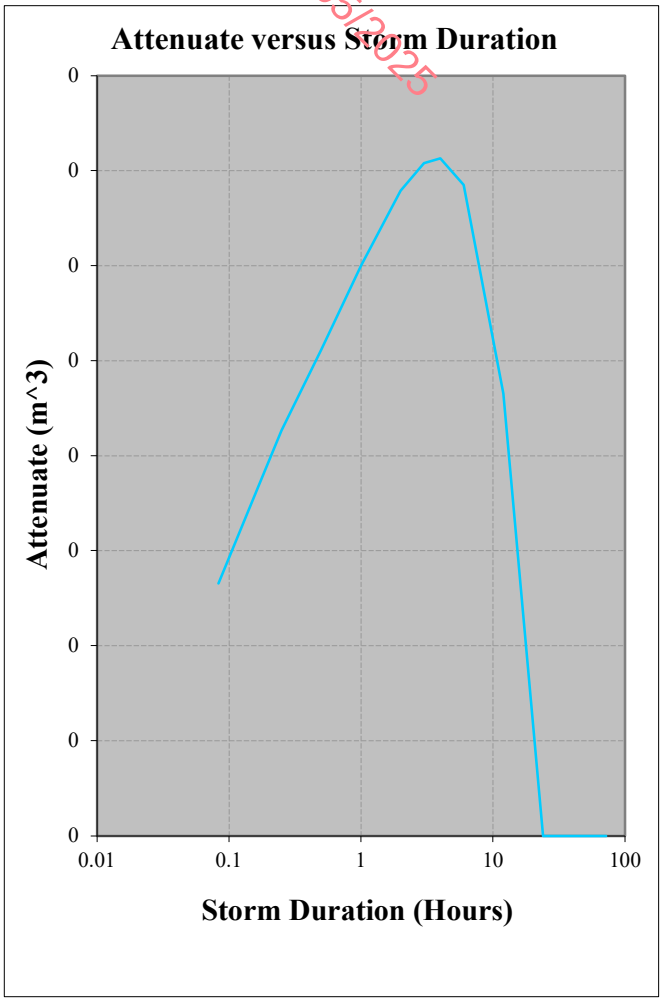
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | | Subject: | Tree Pit 13 Attenuation |
|---|---|---|---|---|
| Date: | 31/01/2025 | Calc'd by: E.V | Checked by: | G.P |



| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Hard Area | 0 $m^2$ | Grassed: | 0 $m^2$ | Tree Pit: | 8.014 $m^2$ | Equivalent Impermeable Area: | 8.014 $m^2$ | Attenuated Flow Rate: 0.01 l/s |
| I. Factor: | 0.80 | I. Factor: | 1.00 | I. Factor: | 1.00 | | | |

| Storm Duration (Hours) | Rainfall (mm) | Total Surface Water ($m^3$) | Allowable Discharge ($m^3$) | Attenuate ($m^3$) |
|---|---|---|---|---|
| 0.083 | 17.00 | 0.14 | 0.003445805 | 0.13 |
| 0.166 | 23.70 | 0.19 | 0.00689161 | 0.18 |
| 0.25 | 27.90 | 0.22 | 0.010378931 | 0.21 |
| 0.50 | 34.50 | 0.28 | 0.020757863 | 0.26 |
| 1.00 | 42.60 | 0.34 | 0.041515726 | 0.30 |
| 2.00 | 52.70 | 0.42 | 0.083031451 | 0.34 |
| 3.00 | 59.70 | 0.48 | 0.124547177 | 0.35 |
| 4.00 | 65.20 | 0.52 | 0.166062902 | 0.36 |
| 6.00 | 73.80 | 0.59 | 0.249094354 | 0.34 |
| 12.00 | 91.20 | 0.73 | 0.498188707 | 0.23 |
| 24.00 | 112.80 | 0.90 | 0.996377414 | 0 |
| 48.00 | 125.30 | 1.00 | 1.992754829 | 0 |
| 72.00 | 135.90 | 1.09 | 2.989132243 | 0 |




Maximum Volume of Attenuate: 0.36 $m^3$ Climate Change = 1.3 Required Attenuation Volume = 0.4634 $m^3$

**Note: This spreadsheet calculates the Volume of Attenuate based on a Return Period of: 100 years.**

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W: www.lohan-donnelly.com E: info@lohan-donnelly.com

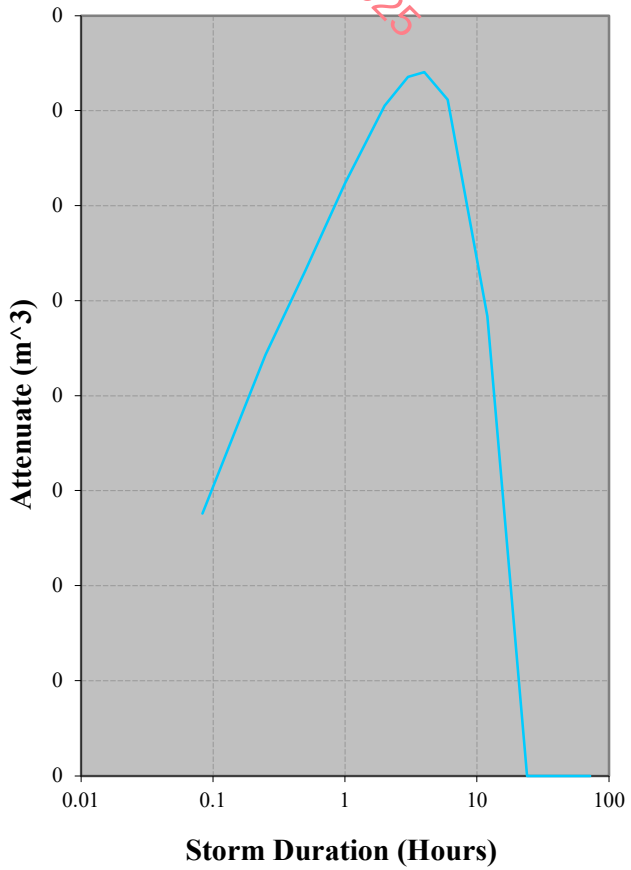
| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Tree Pit 14 Attenuation |
|---|---|---|---|
| Date: | 31/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hard Area | 0 $m^2$ | Grassed: | 0 $m^2$ | Tree Pit: | 8.326 $m^2$ | Equivalent Impermeable Area: | 8.326 $m^2$ |
| I. Factor: | 0.80 | I. Factor: | 1.00 | I. Factor: | 1.00 | | |

Attenuated Flow Rate: 0.01 l/s

| Storm Duration (Hours) | Rainfall (mm) | Total Surface Water ($m^3$) | Allowable Discharge ($m^3$) | Attenuate ($m^3$) |
|---|---|---|---|---|
| 0.083 | 17.00 | 0.14 | 0.003579957 | 0.14 |
| 0.166 | 23.70 | 0.20 | 0.007159914 | 0.19 |
| 0.25 | 27.90 | 0.23 | 0.010783003 | 0.22 |
| 0.50 | 34.50 | 0.29 | 0.021566005 | 0.27 |
| 1.00 | 42.60 | 0.35 | 0.04313201 | 0.31 |
| 2.00 | 52.70 | 0.44 | 0.086264021 | 0.35 |
| 3.00 | 59.70 | 0.50 | 0.129396031 | 0.37 |
| 4.00 | 65.20 | 0.54 | 0.172528042 | 0.37 |
| 6.00 | 73.80 | 0.61 | 0.258792062 | 0.36 |
| 12.00 | 91.20 | 0.76 | 0.517584125 | 0.24 |
| 24.00 | 112.80 | 0.94 | 1.03516825 | 0 |
| 48.00 | 125.30 | 1.04 | 2.070336499 | 0 |
| 72.00 | 135.90 | 1.13 | 3.105504749 | 0 |




Maximum Volume of Attenuate: 0.37 $m^3$ Climate Change = 1.3 Required Attenuation Volume = 0.4814 $m^3$

**Note: This spreadsheet calculates the Volume of Attenuate based on a Return Period of: 100 years.**

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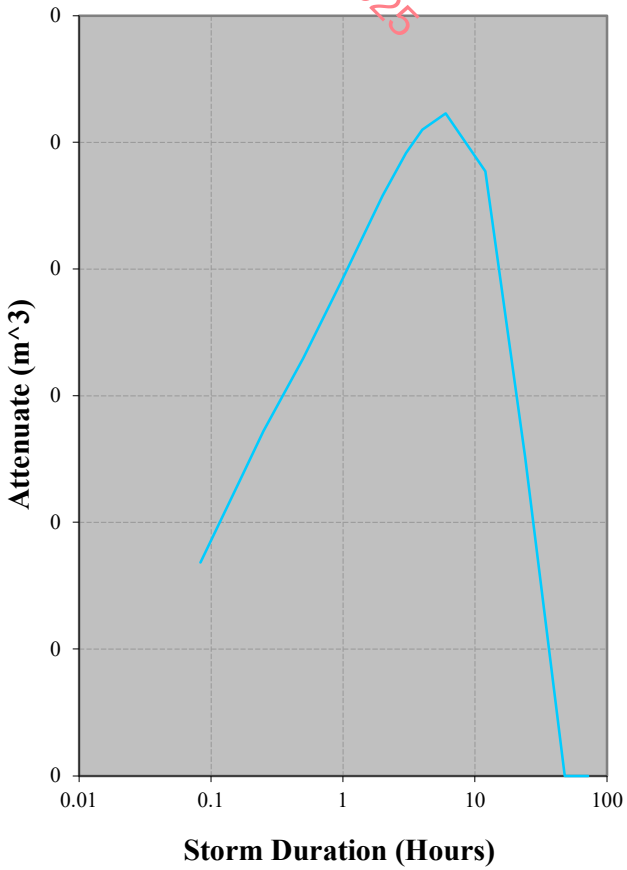
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Tree Pit 15 Attenuation |
|---|---|---|---|
| Date: | 31/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hard Area | 1.851 $m^2$ | Grassed: | 0 $m^2$ | Tree Pit: | 3.562 $m^2$ | Equivalent Impermeable Area: | 5.0428 $m^2$ |
| I. Factor: | 0.80 | I. Factor: | 1.00 | I. Factor: | 1.00 | Attenuated Flow Rate: | 0.01 l/s |

| Storm Duration (Hours) | Rainfall (mm) | Total Surface Water ($m^3$) | Allowable Discharge ($m^3$) | Attenuate ($m^3$) |
|---|---|---|---|---|
| 0.083 | 17.00 | 0.09 | 0.001531565 | 0.08 |
| 0.166 | 23.70 | 0.12 | 0.003063129 | 0.12 |
| 0.25 | 27.90 | 0.14 | 0.004613146 | 0.14 |
| 0.50 | 34.50 | 0.17 | 0.009226292 | 0.16 |
| 1.00 | 42.60 | 0.21 | 0.018452585 | 0.20 |
| 2.00 | 52.70 | 0.27 | 0.03690517 | 0.23 |
| 3.00 | 59.70 | 0.30 | 0.055357754 | 0.25 |
| 4.00 | 65.20 | 0.33 | 0.073810339 | 0.25 |
| 6.00 | 73.80 | 0.37 | 0.110715509 | 0.26 |
| 12.00 | 91.20 | 0.46 | 0.221431018 | 0.24 |
| 24.00 | 112.80 | 0.57 | 0.442862035 | 0.13 |
| 48.00 | 125.30 | 0.63 | 0.88572407 | 0 |
| 72.00 | 135.90 | 0.69 | 1.328586106 | 0 |




Maximum Volume of Attenuate: 0.26 $m^3$ Climate Change = 1.3 Required Attenuation Volume = 0.3399 $m^3$

**Note: This spreadsheet calculates the Volume of Attenuate based on a Return Period of: 100 years.**

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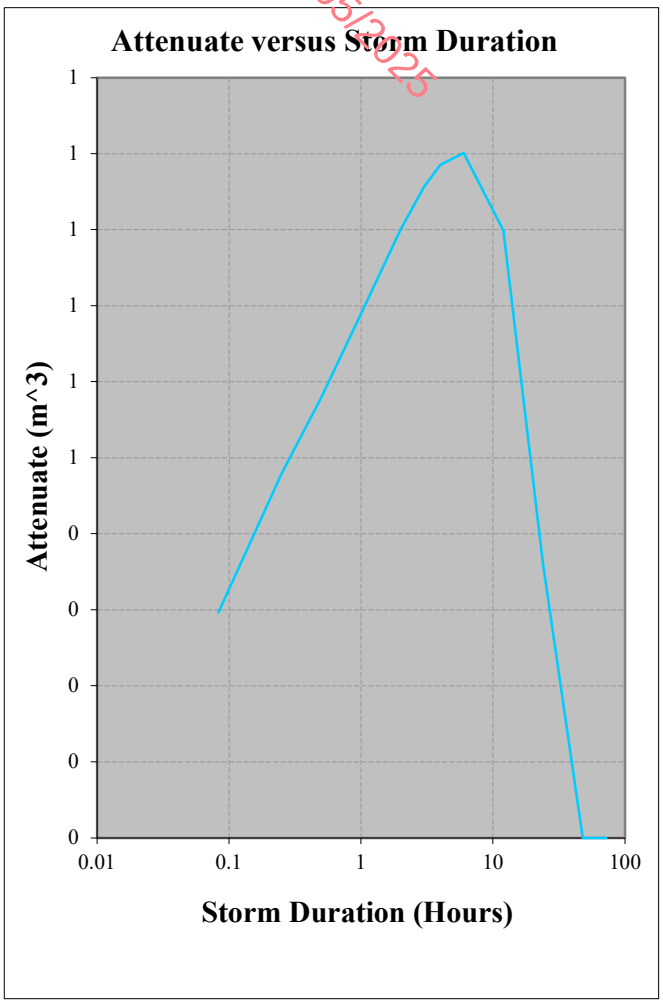
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| | | | | | |
|---|---|---|---|---|---|
| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | | | Subject: | Tree Pit 16 Attenuation |
| Date: | 31/01/2025 | Calc'd by: | E.V | Checked by: | G.P |



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hard Area | 5.677 $m^2$ | Grassed: | 0 $m^2$ | Tree Pit: | 13.24 $m^2$ | Equivalent Impermeable Area: | 17.7826 $m^2$ |
| I. Factor: | 0.80 | I. Factor: | 1.00 | I. Factor: | 1.00 | Attenuated Flow Rate: | 0.02 l/s |

| Storm Duration (Hours) | Rainfall (mm) | Total Surface Water ($m^3$) | Allowable Discharge ($m^3$) | Attenuate ($m^3$) |
|---|---|---|---|---|
| 0.083 | 17.00 | 0.30 | 0.005693275 | 0.30 |
| 0.166 | 23.70 | 0.42 | 0.01138655 | 0.41 |
| 0.25 | 27.90 | 0.50 | 0.017148419 | 0.48 |
| 0.50 | 34.50 | 0.61 | 0.034296838 | 0.58 |
| 1.00 | 42.60 | 0.76 | 0.068593676 | 0.69 |
| 2.00 | 52.70 | 0.94 | 0.137187353 | 0.80 |
| 3.00 | 59.70 | 1.06 | 0.205781029 | 0.86 |
| 4.00 | 65.20 | 1.16 | 0.274374706 | 0.89 |
| 6.00 | 73.80 | 1.31 | 0.411562058 | 0.90 |
| 12.00 | 91.20 | 1.62 | 0.823124117 | 0.80 |
| 24.00 | 112.80 | 2.01 | 1.646248234 | 0.36 |
| 48.00 | 125.30 | 2.23 | 3.292496467 | 0 |
| 72.00 | 135.90 | 2.42 | 4.938744701 | 0 |




Maximum Volume of Attenuate: 0.90 $m^3$ Climate Change = 1.3 Required Attenuation Volume = 1.171 $m^3$

**Note: This spreadsheet calculates the Volume of Attenuate based on a Return Period of: 100 years.**

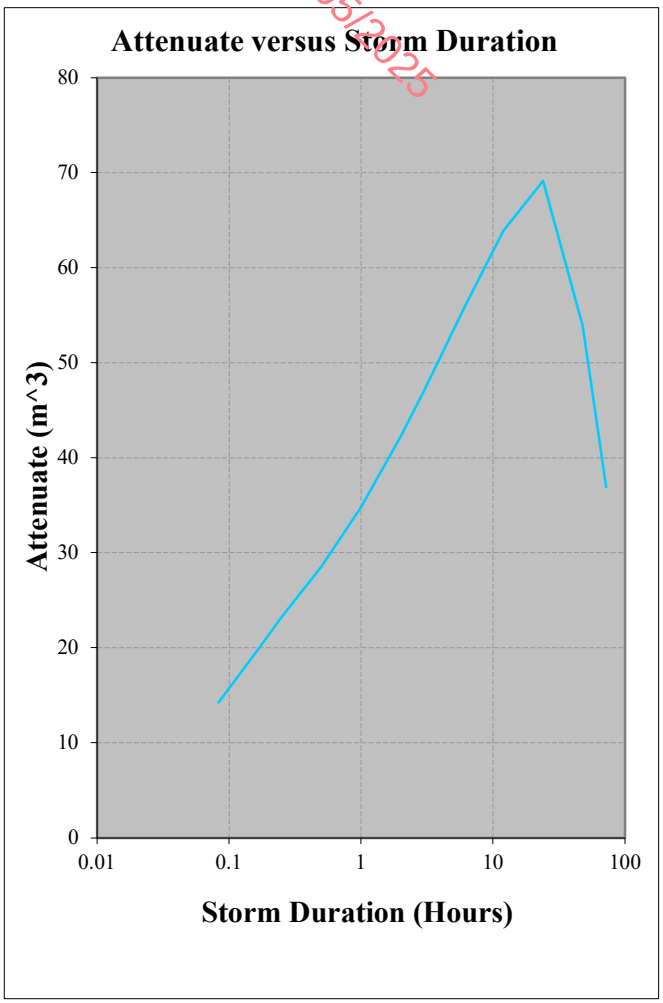
LOHAN & DONNELLY
Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Tree Pit 17 Attenuation |
|---|---|---|---|
| Date: | 31/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Hard Area | 792.6 $m^2$ | Grassed: | 0 $m^2$ | Tree Pit: | 207.7 $m^2$ | Equivalent Impermeable Area: | 841.7606 $m^2$ | Attenuated Flow Rate: 0.3 l/s |
| I. Factor: | 0.80 | I. Factor: | 1.00 | I. Factor: | 1.00 | | | |

| Storm Duration (Hours) | Rainfall (mm) | Total Surface Water ($m^3$) | Allowable Discharge ($m^3$) | Attenuate ($m^3$) |
|---|---|---|---|---|
| 0.083 | 17.00 | 14.31 | 0.089305004 | 14.22 |
| 0.166 | 23.70 | 19.95 | 0.178610007 | 19.77 |
| 0.25 | 27.90 | 23.49 | 0.268990975 | 23.22 |
| 0.50 | 34.50 | 29.04 | 0.53798195 | 28.50 |
| 1.00 | 42.60 | 35.86 | 1.0759639 | 34.78 |
| 2.00 | 52.70 | 44.36 | 2.151927799 | 42.21 |
| 3.00 | 59.70 | 50.25 | 3.227891699 | 47.03 |
| 4.00 | 65.20 | 54.88 | 4.303855598 | 50.58 |
| 6.00 | 73.80 | 62.12 | 6.455783398 | 55.67 |
| 12.00 | 91.20 | 76.77 | 12.9115668 | 63.86 |
| 24.00 | 112.80 | 94.95 | 25.82313359 | 69.13 |
| 48.00 | 125.30 | 105.47 | 51.64626718 | 53.83 |
| 72.00 | 135.90 | 114.40 | 77.46940077 | 36.93 |




Maximum Volume of Attenuate: 69.13 $m^3$ Climate Change = 1.3 Required Attenuation Volume = 89.866 $m^3$

**Note: This spreadsheet calculates the Volume of Attenuate based on a Return Period of: 100 years.**

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Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Tree Pit 1 Infiltration |
|---|---|---|---|
| Date: | 31/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



## Plane Infiltration Area Design to CIRIA 156

| Definition | Label | Measurement | | Label | Value |
|---|---|---|---|---|---|
| Site Infiltration Rate | q | m/hr | | q = | 0.0518040 |
| Porosity of Material | n | N/A | | n = | 0.3 |
| Storm Duration | D | per hr | | | |
| Intensity | i | m/hr | | | |
| Ratio of Drained Area to Infiltration Area | R | m2 | | R = | 1.740051 |
| Area to be Drained | $A_D$ | m2 | | $A_D$ = | 399.902 |
| Area of Infiltration System | $A_b$ | m2 | | $A_b$ = | 229.822 |
| Factor of Safety | F | N/A | | F = | 10 |
| Highest Water Level | $h_{max}$ | m | | | |
| Return Period | RP | years | | RP | 100 |
| **Formula** | R = | $A_D/A_b$ | | | |
| | $h_{max}$ = | D/n * (Ri-q/F) | | | |
| | i = | m/hr | | | |
| Plane Infiltration Rate for Attenuation = | | (Ab * q)/F | | PIR = | 0.330714 |
| | | | | | |
| Max Attenuation Vol Required (m3) | | | | | 29.0801527 |
| | | | | | |
| Actual depth = | 1.35 | m | | | |
| Actual storage Provided = | 93.078 | m3 | | | |
| | | | | | |
| Time for half-emptying | n x Hmax/2 x q | 1.391 | hrs | | |
| | | | | | |
| 24 > | 1.3912 hrs | O.K. | | | |

**Table of Content**

| i (m/hr) | D (hr) | $h_{max}$ (m) | Volume Stored |
|---|---|---|---|
| 0.26627 | 0.08 | 0.13 | 29.13 |
| 0.18560 | 0.17 | 0.18 | 40.41 |
| 0.14508 | 0.25 | 0.21 | 47.36 |
| 0.08970 | 0.50 | 0.25 | 57.80 |
| 0.05538 | 1.00 | 0.30 | 69.85 |
| 0.03426 | 2.00 | 0.36 | 83.39 |
| 0.02587 | 3.00 | 0.40 | 91.55 |
| 0.02119 | 4.00 | 0.42 | 97.11 |
| 0.01599 | 6.00 | 0.45 | 104.08 |
| 0.00988 | 12.00 | 0.48 | 110.42 |
| 0.00611 | 24.00 | 0.44 | 100.23 |
| 0.00339 | 48.00 | 0.12 | 26.64 |
| 0.00245 | 72.00 | -0.22 | -50.23 |
| MAX | | 0.48 | 110.42 |

LOHAN & DONNELLY
Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Tree Pit 2 Infiltration |
|---|---|---|---|
| Date: | 31/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



## Plane Infiltration Area Design to CIRIA 156

| Definition | Label | Measurement | | Label | Value |
|---|---|---|---|---|---|
| Site Infiltration Rate | q | m/hr | | q = | 0.0518040 |
| Porosity of Material | n | N/A | | n = | 0.3 |
| Storm Duration | D | per hr | | | |
| Intensity | i | m/hr | | | |
| Ratio of Drained Area to Infiltration Area | R | m2 | | R = | 4.46859513 |
| Area to be Drained | $A_D$ | m2 | | $A_D$ = | 84.036 |
| Area of Infiltration System | $A_b$ | m2 | | $A_b$ = | 18.806 |
| Factor of Safety | F | N/A | | F = | 10 |
| Highest Water Level | $h_{max}$ | m | | | |
| Return Period | RP | years | | RP | 100 |
| **Formula** | R = | $A_D/A_b$ | | | |
| | $h_{max}$ = | D/n * (Ri-q/F) | | | |
| | i = | m/hr | | | |
| Plane Infiltration Rate for Attenuation = | | (Ab * q)/F | | PIR = | 0.027062 |
| Max Attenuation Vol Required (m3) | | | | | 9.2835125 |
| Actual depth = | 1.75 | m | | | |
| Actual storage Provided = | 9.8732 | m3 | | | |
| Time for half-emptying | n x Hmax/2 x q | 5.125 | hrs | | |
| 24 > | 5.1246 hrs | O.K. | | | |

**Table of Content**

| i (m/hr) | D (hr) | $h_{max}$ (m) | Volume Stored |
|---|---|---|---|
| 0.26627 | 0.08 | 0.33 | 6.16 |
| 0.18560 | 0.17 | 0.46 | 8.58 |
| 0.14508 | 0.25 | 0.54 | 10.08 |
| 0.08970 | 0.50 | 0.66 | 12.40 |
| 0.05538 | 1.00 | 0.81 | 15.19 |
| 0.03426 | 2.00 | 0.99 | 18.54 |
| 0.02587 | 3.00 | 1.10 | 20.77 |
| 0.02119 | 4.00 | 1.19 | 22.44 |
| 0.01599 | 6.00 | 1.33 | 24.93 |
| 0.00988 | 12.00 | 1.56 | 29.31 |
| 0.00611 | 24.00 | 1.77 | 33.28 |
| 0.00339 | 48.00 | 1.60 | 30.04 |
| 0.00245 | 72.00 | 1.39 | 26.11 |
| MAX | | 1.77 | 33.28 |

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Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Tree Pit 3 Infiltration |
|---|---|---|---|
| Date: | 31/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



## Plane Infiltration Area Design to CIRIA 156

| Definition | Label | Measurement | | Label | Value |
|---|---|---|---|---|---|
| Site Infiltration Rate | q | m/hr | | q = | 0.0518040 |
| Porosity of Material | n | N/A | | n = | 0.3 |
| Storm Duration | D | per hr | | | |
| Intensity | i | m/hr | | | |
| Ratio of Drained Area to Infiltration Area | R | m2 | | R = | 7.04101154 |
| Area to be Drained | $A_D$ | m2 | | $A_D$ = | 51.230 |
| Area of Infiltration System | $A_b$ | m2 | | $A_b$ = | 7.276 |
| Factor of Safety | F | N/A | | F = | 10 |
| Highest Water Level | $h_{max}$ | m | | | |
| Return Period | RP | years | | RP | 100 |
| **Formula** | R = | $A_D/A_b$ | | | |
| | $h_{max}$ = | D/n * (Ri-q/F) | | | |
| | i = | m/hr | | | |
| Plane Infiltration Rate for Attenuation = | | (Ab * q)/F | | PIR = | 0.010470 |
| Max Attenuation Vol Required (m3) | | | | | 6.33641704 |
| Actual depth = | 3 | m | | | |
| Actual storage Provided = | 6.5484 | m3 | | | |
| Time for half-emptying | n x Hmax/2 x q | | 8.765 | hrs | |
| 24 > | 8.7654 hrs | | O.K. | | |

**Table of Content**

| i (m/hr) | D (hr) | $h_{max}$ (m) | Volume Stored |
|---|---|---|---|
| 0.26627 | 0.08 | 0.52 | 3.76 |
| 0.18560 | 0.17 | 0.72 | 5.24 |
| 0.14508 | 0.25 | 0.85 | 6.16 |
| 0.08970 | 0.50 | 1.04 | 7.60 |
| 0.05538 | 1.00 | 1.28 | 9.33 |
| 0.03426 | 2.00 | 1.57 | 11.45 |
| 0.02587 | 3.00 | 1.77 | 12.88 |
| 0.02119 | 4.00 | 1.92 | 13.97 |
| 0.01599 | 6.00 | 2.15 | 15.63 |
| 0.00988 | 12.00 | 2.58 | 18.74 |
| 0.00611 | 24.00 | 3.03 | 22.03 |
| 0.00339 | 48.00 | 2.99 | 21.79 |
| 0.00245 | 72.00 | 2.90 | 21.12 |
| MAX | | 3.03 | 22.03 |

LOHAN & DONNELLY
Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Tree Pit 4 Infiltration |
|---|---|---|---|
| Date: | 31/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



## Plane Infiltration Area Design to CIRIA 156

| Definition | Label | Measurement | | Label | Value |
|---|---|---|---|---|---|
| Site Infiltration Rate | q | m/hr | | q = | 0.0518040 |
| Porosity of Material | n | N/A | | n = | 0.3 |
| Storm Duration | D | per hr | | | |
| Intensity | i | m/hr | | | |
| Ratio of Drained Area to Infiltration Area | R | m2 | | R = | 5.3098114 |
| Area to be Drained | $A_D$ | m2 | | $A_D$ = | 50.114 |
| Area of Infiltration System | $A_b$ | m2 | | $A_b$ = | 9.438 |
| Factor of Safety | F | N/A | | F = | 10 |
| Highest Water Level | $h_{max}$ | m | | | |
| Return Period | RP | years | | RP | 100 |
| **Formula** | R = | $A_D/A_b$ | | | |
| | $h_{max}$ = | D/n * (Ri-q/F) | | | |
| | i = | m/hr | | | |
| Plane Infiltration Rate for Attenuation = | | (Ab * q)/F | | PIR = | 0.013581 |
| Max Attenuation Vol Required (m3) | | | | | 5.82326737 |
| Actual depth = | 2.25 | m | | | |
| Actual storage Provided = | 6.3707 | m3 | | | |
| Time for half-emptying | n x Hmax/2 x q | | 6.315 | hrs | |
| 24 > | 6.3152 hrs | | O.K. | | |

**Table of Content**

| i (m/hr) | D (hr) | $h_{max}$ (m) | Volume Stored |
|---|---|---|---|
| 0.26627 | 0.08 | 0.39 | 3.68 |
| 0.18560 | 0.17 | 0.54 | 5.12 |
| 0.14508 | 0.25 | 0.64 | 6.02 |
| 0.08970 | 0.50 | 0.79 | 7.41 |
| 0.05538 | 1.00 | 0.96 | 9.09 |
| 0.03426 | 2.00 | 1.18 | 11.12 |
| 0.02587 | 3.00 | 1.32 | 12.48 |
| 0.02119 | 4.00 | 1.43 | 13.51 |
| 0.01599 | 6.00 | 1.59 | 15.05 |
| 0.00988 | 12.00 | 1.89 | 17.85 |
| 0.00611 | 24.00 | 2.18 | 20.58 |
| 0.00339 | 48.00 | 2.05 | 19.39 |
| 0.00245 | 72.00 | 1.88 | 17.78 |
| MAX | | 2.18 | 20.58 |

LOHAN & DONNELLY
Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Tree Pit 5 Infiltration |
|---|---|---|---|
| Date: | 31/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



## Plane Infiltration Area Design to CIRIA 156

| Definition | Label | Measurement | | Label | Value |
|---|---|---|---|---|---|
| Site Infiltration Rate | q | m/hr | | q = | 0.0518040 |
| Porosity of Material | n | N/A | | n = | 0.3 |
| Storm Duration | D | per hr | | | |
| Intensity | i | m/hr | | | |
| Ratio of Drained Area to Infiltration Area | R | m2 | | R = | 3.6173913 |
| Area to be Drained | $A_D$ | m2 | | $A_D$ = | 49.920 |
| Area of Infiltration System | $A_b$ | m2 | | $A_b$ = | 13.8 |
| Factor of Safety | F | N/A | | F = | 10 |
| Highest Water Level | $h_{max}$ | m | | | |
| Return Period | RP | years | | RP | 100 |
| **Formula** | R = | $A_D/A_b$ | | | |
| | $h_{max}$ = | D/n * (Ri-q/F) | | | |
| | i = | m/hr | | | |
| Plane Infiltration Rate for Attenuation = | | (Ab * q)/F | | PIR = | 0.019858 |
| Max Attenuation Vol Required (m3) | | | | | 5.08979578 |
| Actual depth = | 1.35 | m | | | |
| Actual storage Provided = | 5.589 | m3 | | | |
| Time for half-emptying | n x Hmax/2 x q | | 3.92 | hrs | |
| 24 > | 3.9198 | hrs | O.K. | | |

**Table of Content**

| i (m/hr) | D (hr) | $h_{max}$ (m) | Volume Stored |
|---|---|---|---|
| 0.26627 | 0.08 | 0.27 | 3.66 |
| 0.18560 | 0.17 | 0.37 | 5.09 |
| 0.14508 | 0.25 | 0.43 | 5.98 |
| 0.08970 | 0.50 | 0.53 | 7.34 |
| 0.05538 | 1.00 | 0.65 | 8.98 |
| 0.03426 | 2.00 | 0.79 | 10.92 |
| 0.02587 | 3.00 | 0.88 | 12.20 |
| 0.02119 | 4.00 | 0.95 | 13.15 |
| 0.01599 | 6.00 | 1.05 | 14.53 |
| 0.00988 | 12.00 | 1.22 | 16.87 |
| 0.00611 | 24.00 | 1.35 | 18.68 |
| 0.00339 | 48.00 | 1.14 | 15.67 |
| 0.00245 | 72.00 | 0.89 | 12.24 |
| MAX | | 1.35 | 18.68 |

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Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Tree Pit 6 Infiltration |
|---|---|---|---|
| Date: | 31/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



## Plane Infiltration Area Design to CIRIA 156

| Definition | Label | Measurement | | Label | Value |
|---|---|---|---|---|---|
| Site Infiltration Rate | q | m/hr | | q = | 0.0518040 |
| Porosity of Material | n | N/A | | n = | 0.3 |
| Storm Duration | D | per hr | | | |
| Intensity | i | m/hr | | | |
| Ratio of Drained Area to Infiltration Area | R | m2 | | R = | 3.8404246 |
| Area to be Drained | $A_D$ | m2 | | $A_D$ = | 52.821 |
| Area of Infiltration System | $A_b$ | m2 | | $A_b$ = | 13.754 |
| Factor of Safety | F | N/A | | F = | 10 |
| Highest Water Level | $h_{max}$ | m | | | |
| Return Period | RP | years | | RP | 100 |
| **Formula** | R = | $A_D/A_b$ | | | |
| | $h_{max}$ = | D/n * (Ri-q/F) | | | |
| | i = | m/hr | | | |
| Plane Infiltration Rate for Attenuation = | | (Ab * q)/F | | PIR = | 0.019792 |
| Max Attenuation Vol Required (m3) | | | | | 5.52266265 |
| Actual depth = | 1.5 | m | | | |
| Actual storage Provided = | 6.1893 | m3 | | | |
| Time for half-emptying | n x Hmax/2 x q | | 4.235 | hrs | |
| 24 > | 4.2355 hrs | | O.K. | | |

**Table of Content**

| i (m/hr) | D (hr) | $h_{max}$ (m) | Volume Stored |
|---|---|---|---|
| 0.26627 | 0.08 | 0.28 | 3.87 |
| 0.18560 | 0.17 | 0.39 | 5.39 |
| 0.14508 | 0.25 | 0.46 | 6.33 |
| 0.08970 | 0.50 | 0.57 | 7.78 |
| 0.05538 | 1.00 | 0.69 | 9.51 |
| 0.03426 | 2.00 | 0.84 | 11.59 |
| 0.02587 | 3.00 | 0.94 | 12.95 |
| 0.02119 | 4.00 | 1.02 | 13.97 |
| 0.01599 | 6.00 | 1.12 | 15.47 |
| 0.00988 | 12.00 | 1.31 | 18.02 |
| 0.00611 | 24.00 | 1.46 | 20.12 |
| 0.00339 | 48.00 | 1.26 | 17.28 |
| 0.00245 | 72.00 | 1.02 | 14.01 |
| MAX | | 1.46 | 20.12 |

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Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Tree Pit 7 Infiltration |
|---|---|---|---|
| Date: | 31/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



## Plane Infiltration Area Design to CIRIA 156

| Definition | Label | Measurement | | Label | Value |
|---|---|---|---|---|---|
| Site Infiltration Rate | q | m/hr | | q = | 0.0518040 |
| Porosity of Material | n | N/A | | n = | 0.3 |
| Storm Duration | D | per hr | | | |
| Intensity | i | m/hr | | | |
| Ratio of Drained Area to Infiltration Area | R | m2 | | R = | 3.19960157 |
| Area to be Drained | $A_D$ | m2 | | $A_D$ = | 49.789 |
| Area of Infiltration System | $A_b$ | m2 | | $A_b$ = | 15.561 |
| Factor of Safety | F | N/A | | F = | 10 |
| Highest Water Level | $h_{max}$ | m | | | |
| Return Period | RP | years | | RP | 100 |
| **Formula** | R = | $A_D/A_b$ | | | |
| | $h_{max}$ = | D/n * (Ri-q/F) | | | |
| | i = | m/hr | | | |
| Plane Infiltration Rate for Attenuation = | | (Ab * q)/F | | PIR = | 0.022392 |
| Max Attenuation Vol Required (m3) | | | | | 4.78595818 |
| Actual depth = | 1.35 | m | | | |
| Actual storage Provided = | 6.3022 | m3 | | | |
| Time for half-emptying | n x Hmax/2 x q | 3.329 | hrs | | |
| 24 > | 3.3285 hrs | O.K. | | | |

**Table of Content**

| i (m/hr) | D (hr) | $h_{max}$ (m) | Volume Stored |
|---|---|---|---|
| 0.26627 | 0.08 | 0.23 | 3.65 |
| 0.18560 | 0.17 | 0.33 | 5.07 |
| 0.14508 | 0.25 | 0.38 | 5.95 |
| 0.08970 | 0.50 | 0.47 | 7.31 |
| 0.05538 | 1.00 | 0.57 | 8.92 |
| 0.03426 | 2.00 | 0.70 | 10.83 |
| 0.02587 | 3.00 | 0.78 | 12.07 |
| 0.02119 | 4.00 | 0.83 | 12.99 |
| 0.01599 | 6.00 | 0.92 | 14.31 |
| 0.00988 | 12.00 | 1.06 | 16.45 |
| 0.00611 | 24.00 | 1.15 | 17.89 |
| 0.00339 | 48.00 | 0.91 | 14.14 |
| 0.00245 | 72.00 | 0.64 | 9.97 |
| MAX | | 1.15 | 17.89 |

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Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Tree Pit 8 Infiltration |
|---|---|---|---|
| Date: | 31/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



## Plane Infiltration Area Design to CIRIA 156

| Definition | Label | Measurement | | Label | Value |
|---|---|---|---|---|---|
| Site Infiltration Rate | q | m/hr | | q = | 0.0518040 |
| Porosity of Material | n | N/A | | n = | 0.3 |
| Storm Duration | D | per hr | | | |
| Intensity | i | m/hr | | | |
| Ratio of Drained Area to Infiltration Area | R | m2 | | R = | 1 |
| Area to be Drained | $A_D$ | m2 | | $A_D$ = | 20.086 |
| Area of Infiltration System | $A_b$ | m2 | | $A_b$ = | 20.086 |
| Factor of Safety | F | N/A | | F = | 10 |
| Highest Water Level | $h_{max}$ | m | | | |
| Return Period | RP | years | | RP | 100 |
| **Formula** | R = | $A_D/A_b$ | | | |
| | $h_{max}$ = | D/n * (Ri-q/F) | | | |
| | i = | m/hr | | | |
| Plane Infiltration Rate for Attenuation = | | (Ab * q)/F | | PIR = | 0.028904 |
| Max Attenuation Vol Required (m3) | | | | | 1.16141109 |
| Actual depth = | 1.35 | m | | | |
| Actual storage Provided = | 8.1348 | m3 | | | |
| Time for half-emptying | n x Hmax/2 x q | 0.626 | hrs | | |
| 24 > | 0.626 hrs | O.K. | | | |

**Table of Content**

| i (m/hr) | D (hr) | $h_{max}$ (m) | Volume Stored |
|---|---|---|---|
| 0.26627 | 0.08 | 0.07 | 1.45 |
| 0.18560 | 0.17 | 0.10 | 2.01 |
| 0.14508 | 0.25 | 0.12 | 2.34 |
| 0.08970 | 0.50 | 0.14 | 2.83 |
| 0.05538 | 1.00 | 0.17 | 3.36 |
| 0.03426 | 2.00 | 0.19 | 3.89 |
| 0.02587 | 3.00 | 0.21 | 4.16 |
| 0.02119 | 4.00 | 0.21 | 4.29 |
| 0.01599 | 6.00 | 0.22 | 4.34 |
| 0.00988 | 12.00 | 0.19 | 3.78 |
| 0.00611 | 24.00 | 0.07 | 1.49 |
| 0.00339 | 48.00 | -0.29 | -5.74 |
| 0.00245 | 72.00 | -0.65 | -13.14 |
| MAX | | 0.22 | 4.34 |

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Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Tree Pit 9 Infiltration |
|---|---|---|---|
| Date: | 31/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



## Plane Infiltration Area Design to CIRIA 156

| Definition | Label | Measurement | | Label | Value |
|---|---|---|---|---|---|
| Site Infiltration Rate | q | m/hr | | q = | 0.0518040 |
| Porosity of Material | n | N/A | | n = | 0.3 |
| Storm Duration | D | per hr | | | |
| Intensity | i | m/hr | | | |
| Ratio of Drained Area to Infiltration Area | R | m2 | | R = | 1 |
| Area to be Drained | $A_D$ | m2 | | $A_D$ = | 69.337 |
| Area of Infiltration System | $A_b$ | m2 | | $A_b$ = | 69.337 |
| Factor of Safety | F | N/A | | F = | 10 |
| Highest Water Level | $h_{max}$ | m | | | |
| Return Period | RP | years | | RP | 100 |
| **Formula** | R = | $A_D/A_b$ | | | |
| | $h_{max}$ = | D/n * (Ri-q/F) | | | |
| | i = | m/hr | | | |
| Plane Infiltration Rate for Attenuation = | | (Ab * q)/F | | PIR = | 0.099776 |
| Max Attenuation Vol Required (m3) | | | | | 4.00919847 |
| Actual depth = | 1.35 | m | | | |
| Actual storage Provided = | 28.081 | m3 | | | |
| Time for half-emptying | n x Hmax/2 x q | | 0.626 | hrs | |
| 24 > | 0.626 | hrs | O.K. | | |

**Table of Content**

| i (m/hr) | D (hr) | $h_{max}$ (m) | Volume Stored |
|---|---|---|---|
| 0.26627 | 0.08 | 0.07 | 5.01 |
| 0.18560 | 0.17 | 0.10 | 6.92 |
| 0.14508 | 0.25 | 0.12 | 8.08 |
| 0.08970 | 0.50 | 0.14 | 9.77 |
| 0.05538 | 1.00 | 0.17 | 11.60 |
| 0.03426 | 2.00 | 0.19 | 13.44 |
| 0.02587 | 3.00 | 0.21 | 14.35 |
| 0.02119 | 4.00 | 0.21 | 14.80 |
| 0.01599 | 6.00 | 0.22 | 14.99 |
| 0.00988 | 12.00 | 0.19 | 13.03 |
| 0.00611 | 24.00 | 0.07 | 5.16 |
| 0.00339 | 48.00 | -0.29 | -19.82 |
| 0.00245 | 72.00 | -0.65 | -45.37 |
| MAX | | 0.22 | 14.99 |

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Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Tree Pit 10 Infiltration |
|---|---|---|---|
| Date: | 31/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



## Plane Infiltration Area Design to CIRIA 156

| Definition | Label | Measurement | | Label | Value |
|---|---|---|---|---|---|
| Site Infiltration Rate | q | m/hr | | q = | 0.0518040 |
| Porosity of Material | n | N/A | | n = | 0.3 |
| Storm Duration | D | per hr | | | |
| Intensity | i | m/hr | | | |
| Ratio of Drained Area to Infiltration Area | R | m2 | | R = | 1 |
| Area to be Drained | $A_D$ | m2 | | $A_D$ = | 68.160 |
| Area of Infiltration System | $A_b$ | m2 | | $A_b$ = | 68.16 |
| Factor of Safety | F | N/A | | F = | 10 |
| Highest Water Level | $h_{max}$ | m | | | |
| Return Period | RP | years | | RP | 100 |
| **Formula** | R = | $A_D/A_b$ | | | |
| | $h_{max}$ = | D/n * (Ri-q/F) | | | |
| | i = | m/hr | | | |
| Plane Infiltration Rate for Attenuation = | | (Ab * q)/F | | PIR = | 0.098082 |
| Max Attenuation Vol Required (m3) | | | | | 3.94114207 |
| Actual depth = | 1.35 | m | | | |
| Actual storage Provided = | 27.605 | m3 | | | |
| Time for half-emptying | n x Hmax/2 x q | | 0.626 | hrs | |
| 24 > | 0.626 | hrs | O.K. | | |

### Table of Content

| i (m/hr) | D (hr) | $h_{max}$ (m) | Volume Stored |
|---|---|---|---|
| 0.26627 | 0.08 | 0.07 | 4.92 |
| 0.18560 | 0.17 | 0.10 | 6.80 |
| 0.14508 | 0.25 | 0.12 | 7.95 |
| 0.08970 | 0.50 | 0.14 | 9.60 |
| 0.05538 | 1.00 | 0.17 | 11.41 |
| 0.03426 | 2.00 | 0.19 | 13.21 |
| 0.02587 | 3.00 | 0.21 | 14.10 |
| 0.02119 | 4.00 | 0.21 | 14.55 |
| 0.01599 | 6.00 | 0.22 | 14.74 |
| 0.00988 | 12.00 | 0.19 | 12.81 |
| 0.00611 | 24.00 | 0.07 | 5.07 |
| 0.00339 | 48.00 | -0.29 | -19.49 |
| 0.00245 | 72.00 | -0.65 | -44.60 |
| MAX | | 0.22 | 14.74 |

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Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Tree Pit 11 Infiltration |
|---|---|---|---|
| Date: | 31/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



## Plane Infiltration Area Design to CIRIA 156

| Definition | Label | Measurement | | Label | Value |
|---|---|---|---|---|---|
| Site Infiltration Rate | q | m/hr | | q = | 0.0518040 |
| Porosity of Material | n | N/A | | n = | 0.3 |
| Storm Duration | D | per hr | | | |
| Intensity | i | m/hr | | | |
| Ratio of Drained Area to Infiltration Area | R | m2 | | R = | 1.66941803 |
| Area to be Drained | $A_D$ | m2 | | $A_D$ = | 405.073 |
| Area of Infiltration System | $A_b$ | m2 | | $A_b$ = | 242.643 |
| Factor of Safety | F | N/A | | F = | 10 |
| Highest Water Level | $h_{max}$ | m | | | |
| Return Period | RP | years | | RP | 100 |
| **Formula** | R = | $A_D/A_b$ | | | |
| | $h_{max}$ = | D/n * (Ri-q/F) | | | |
| | i = | m/hr | | | |
| Plane Infiltration Rate for Attenuation = | | (Ab * q)/F | | PIR = | 0.349163 |
| Max Attenuation Vol Required (m3) | | | | | 29.0581604 |
| Actual depth = | 1.35 | m | | | |
| Actual storage Provided = | 98.27 | m3 | | | |
| Time for half-emptying | n x Hmax/2 x q | 1.31 | hrs | | |
| 24 > | 1.3103 hrs | O.K. | | | |

**Table of Content**

| i (m/hr) | D (hr) | $h_{max}$ (m) | Volume Stored |
|---|---|---|---|
| 0.26627 | 0.08 | 0.12 | 29.49 |
| 0.18560 | 0.17 | 0.17 | 40.91 |
| 0.14508 | 0.25 | 0.20 | 47.93 |
| 0.08970 | 0.50 | 0.24 | 58.46 |
| 0.05538 | 1.00 | 0.29 | 70.59 |
| 0.03426 | 2.00 | 0.35 | 84.13 |
| 0.02587 | 3.00 | 0.38 | 92.22 |
| 0.02119 | 4.00 | 0.40 | 97.69 |
| 0.01599 | 6.00 | 0.43 | 104.40 |
| 0.00988 | 12.00 | 0.45 | 109.81 |
| 0.00611 | 24.00 | 0.40 | 97.44 |
| 0.00339 | 48.00 | 0.08 | 18.82 |
| 0.00245 | 72.00 | -0.26 | -63.13 |
| MAX | | 0.45 | 109.81 |

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Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Tree Pit 12 Infiltration |
|---|---|---|---|
| Date: | 31/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



## Plane Infiltration Area Design to CIRIA 156

| Definition | Label | Measurement | | Label | Value |
|---|---|---|---|---|---|
| Site Infiltration Rate | q | m/hr | | q = | 0.0518040 |
| Porosity of Material | n | N/A | | n = | 0.3 |
| Storm Duration | D | per hr | | | |
| Intensity | i | m/hr | | | |
| Ratio of Drained Area to Infiltration Area | R | m2 | | R = | 1.28053435 |
| Area to be Drained | $A_D$ | m2 | | $A_D$ = | 8.052 |
| Area of Infiltration System | $A_b$ | m2 | | $A_b$ = | 6.288 |
| Factor of Safety | F | N/A | | F = | 10 |
| Highest Water Level | $h_{max}$ | m | | | |
| Return Period | RP | years | | RP | 100 |
| **Formula** | R = | $A_D/A_b$ | | | |
| | $h_{max}$ = | D/n * (Ri-q/F) | | | |
| | i = | m/hr | | | |
| Plane Infiltration Rate for Attenuation = | | (Ab * q)/F | | PIR = | 0.009048 |
| | | | | | |
| Max Attenuation Vol Required (m3) | | | | | 0.51842891 |
| | | | | | |
| Actual depth = | 1.35 | m | | | |
| Actual storage Provided = | 2.5466 | m3 | | | |
| | | | | | |
| Time for half-emptying | n x Hmax/2 x q | 0.886 | hrs | | |
| | | | | | |
| 24 > | 0.8858 hrs | O.K. | | | |

**Table of Content**

| i (m/hr) | D (hr) | $h_{max}$ (m) | Volume Stored |
|---|---|---|---|
| 0.26627 | 0.08 | 0.09 | 0.58 |
| 0.18560 | 0.17 | 0.13 | 0.81 |
| 0.14508 | 0.25 | 0.15 | 0.95 |
| 0.08970 | 0.50 | 0.18 | 1.15 |
| 0.05538 | 1.00 | 0.22 | 1.38 |
| 0.03426 | 2.00 | 0.26 | 1.62 |
| 0.02587 | 3.00 | 0.28 | 1.76 |
| 0.02119 | 4.00 | 0.29 | 1.84 |
| 0.01599 | 6.00 | 0.31 | 1.92 |
| 0.00988 | 12.00 | 0.30 | 1.88 |
| 0.00611 | 24.00 | 0.21 | 1.33 |
| 0.00339 | 48.00 | -0.13 | -0.84 |
| 0.00245 | 72.00 | -0.49 | -3.08 |
| MAX | | 0.31 | 1.92 |

LOHAN & DONNELLY
Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Tree Pit 13 Infiltration |
|---|---|---|---|
| Date: | 31/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



## Plane Infiltration Area Design to CIRIA 156

| Definition | Label | Measurement | | Label | Value |
|---|---|---|---|---|---|
| Site Infiltration Rate | q | m/hr | | q = | 0.0518040 |
| Porosity of Material | n | N/A | | n = | 0.3 |
| Storm Duration | D | per hr | | | |
| Intensity | i | m/hr | | | |
| Ratio of Drained Area to Infiltration Area | R | m2 | | R = | 1 |
| Area to be Drained | $A_D$ | m2 | | $A_D$ = | 8.014 |
| Area of Infiltration System | $A_b$ | m2 | | $A_b$ = | 8.014 |
| Factor of Safety | F | N/A | | F = | 10 |
| Highest Water Level | $h_{max}$ | m | | | |
| Return Period | RP | years | | RP | 100 |
| **Formula** | R = | $A_D/A_b$ | | | |
| | $h_{max}$ = | D/n * (Ri-q/F) | | | |
| | i = | m/hr | | | |
| Plane Infiltration Rate for Attenuation = | | (Ab * q)/F | | PIR = | 0.011532 |
| Max Attenuation Vol Required (m3) | | | | | 0.46338487 |
| Actual depth = | 1.35 | m | | | |
| Actual storage Provided = | 3.2457 | m3 | | | |
| Time for half-emptying | n x Hmax/2 x q | 0.626 | hrs | | |
| 24 > | 0.626 hrs | O.K. | | | |

**Table of Content**

| i (m/hr) | D (hr) | $h_{max}$ (m) | Volume Stored |
|---|---|---|---|
| 0.26627 | 0.08 | 0.07 | 0.58 |
| 0.18560 | 0.17 | 0.10 | 0.80 |
| 0.14508 | 0.25 | 0.12 | 0.93 |
| 0.08970 | 0.50 | 0.14 | 1.13 |
| 0.05538 | 1.00 | 0.17 | 1.34 |
| 0.03426 | 2.00 | 0.19 | 1.55 |
| 0.02587 | 3.00 | 0.21 | 1.66 |
| 0.02119 | 4.00 | 0.21 | 1.71 |
| 0.01599 | 6.00 | 0.22 | 1.73 |
| 0.00988 | 12.00 | 0.19 | 1.51 |
| 0.00611 | 24.00 | 0.07 | 0.60 |
| 0.00339 | 48.00 | -0.29 | -2.29 |
| 0.00245 | 72.00 | -0.65 | -5.24 |
| MAX | | 0.22 | 1.73 |

LOHAN & DONNELLY
Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Tree Pit 14 Infiltration |
|---|---|---|---|
| Date: | 31/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



## Plane Infiltration Area Design to CIRIA 156

| Definition | Label | Measurement | | Label | Value |
|---|---|---|---|---|---|
| Site Infiltration Rate | q | m/hr | | q = | 0.0518040 |
| Porosity of Material | n | N/A | | n = | 0.3 |
| Storm Duration | D | per hr | | | |
| Intensity | i | m/hr | | | |
| Ratio of Drained Area to Infiltration Area | R | m2 | | R = | 1 |
| Area to be Drained | $A_D$ | m2 | | $A_D$ = | 8.326 |
| Area of Infiltration System | $A_b$ | m2 | | $A_b$ = | 8.326 |
| Factor of Safety | F | N/A | | F = | 10 |
| Highest Water Level | $h_{max}$ | m | | | |
| Return Period | RP | years | | RP | 100 |
| **Formula** | R = | $A_D/A_b$ | | | |
| | $h_{max}$ = | D/n * (Ri-q/F) | | | |
| | i = | m/hr | | | |
| Plane Infiltration Rate for Attenuation = | | (Ab * q)/F | | PIR = | 0.011981 |
| Max Attenuation Vol Required (m3) | | | | | 0.48142531 |
| Actual depth = | 1.35 | m | | | |
| Actual storage Provided = | 3.372 | m3 | | | |
| Time for half-emptying | n x Hmax/2 x q | 0.626 | hrs | | |
| 24 > | 0.626 hrs | O.K. | | | |

**Table of Content**

| i (m/hr) | D (hr) | $h_{max}$ (m) | Volume Stored |
|---|---|---|---|
| 0.26627 | 0.08 | 0.07 | 0.60 |
| 0.18560 | 0.17 | 0.10 | 0.83 |
| 0.14508 | 0.25 | 0.12 | 0.97 |
| 0.08970 | 0.50 | 0.14 | 1.17 |
| 0.05538 | 1.00 | 0.17 | 1.39 |
| 0.03426 | 2.00 | 0.19 | 1.61 |
| 0.02587 | 3.00 | 0.21 | 1.72 |
| 0.02119 | 4.00 | 0.21 | 1.78 |
| 0.01599 | 6.00 | 0.22 | 1.80 |
| 0.00988 | 12.00 | 0.19 | 1.57 |
| 0.00611 | 24.00 | 0.07 | 0.62 |
| 0.00339 | 48.00 | -0.29 | -2.38 |
| 0.00245 | 72.00 | -0.65 | -5.45 |
| MAX | | 0.22 | 1.80 |

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Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Tree Pit 15 Infiltration |
|---|---|---|---|
| Date: | 31/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



## Plane Infiltration Area Design to CIRIA 156

| Definition | Label | Measurement | | Label | Value |
|---|---|---|---|---|---|
| Site Infiltration Rate | q | m/hr | | q = | 0.0518040 |
| Porosity of Material | n | N/A | | n = | 0.3 |
| Storm Duration | D | per hr | | | |
| Intensity | i | m/hr | | | |
| Ratio of Drained Area to Infiltration Area | R | m2 | | R = | 1.4157215 |
| Area to be Drained | $A_D$ | m2 | | $A_D$ = | 5.043 |
| Area of Infiltration System | $A_b$ | m2 | | $A_b$ = | 3.562 |
| Factor of Safety | F | N/A | | F = | 10 |
| Highest Water Level | $h_{max}$ | m | | | |
| Return Period | RP | years | | RP | 100 |
| **Formula** | R = | $A_D/A_b$ | | | |
| | $h_{max}$ = | D/n * (Ri-q/F) | | | |
| | i = | m/hr | | | |
| Plane Infiltration Rate for Attenuation = | | (Ab * q)/F | | PIR = | 0.005126 |
| | | | | | |
| Max Attenuation Vol Required (m3) | | | | | 0.33987607 |
| | | | | | |
| Actual depth = | 1.35 | m | | | |
| Actual storage Provided = | 1.4426 | m3 | | | |
| | | | | | |
| Time for half-emptying | n x Hmax/2 x q | 1.02 | hrs | | |
| | | | | | |
| 24 > | 1.02 hrs | O.K. | | | |

**Table of Content**

| i (m/hr) | D (hr) | $h_{max}$ (m) | Volume Stored |
|---|---|---|---|
| 0.26627 | 0.08 | 0.10 | 0.37 |
| 0.18560 | 0.17 | 0.14 | 0.51 |
| 0.14508 | 0.25 | 0.17 | 0.59 |
| 0.08970 | 0.50 | 0.20 | 0.72 |
| 0.05538 | 1.00 | 0.24 | 0.87 |
| 0.03426 | 2.00 | 0.29 | 1.03 |
| 0.02587 | 3.00 | 0.31 | 1.12 |
| 0.02119 | 4.00 | 0.33 | 1.18 |
| 0.01599 | 6.00 | 0.35 | 1.24 |
| 0.00988 | 12.00 | 0.35 | 1.25 |
| 0.00611 | 24.00 | 0.28 | 0.99 |
| 0.00339 | 48.00 | -0.06 | -0.21 |
| 0.00245 | 72.00 | -0.41 | -1.46 |
| MAX | | 0.35 | 1.25 |

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Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Tree Pit 16 Infiltration |
|---|---|---|---|
| Date: | 31/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



## Plane Infiltration Area Design to CIRIA 156

| Definition | Label | Measurement | | Label | Value |
|---|---|---|---|---|---|
| Site Infiltration Rate | q | m/hr | | q = | 0.0518040 |
| Porosity of Material | n | N/A | | n = | 0.3 |
| Storm Duration | D | per hr | | | |
| Intensity | i | m/hr | | | |
| Ratio of Drained Area to Infiltration Area | R | m2 | | R = | 1.34299524 |
| Area to be Drained | $A_D$ | m2 | | $A_D$ = | 17.783 |
| Area of Infiltration System | $A_b$ | m2 | | $A_b$ = | 13.241 |
| Factor of Safety | F | N/A | | F = | 10 |
| Highest Water Level | $h_{max}$ | m | | | |
| Return Period | RP | years | | RP | 100 |
| **Formula** | R = | $A_D/A_b$ | | | |
| | $h_{max}$ = | D/n * (Ri-q/F) | | | |
| | i = | m/hr | | | |
| Plane Infiltration Rate for Attenuation = | | (Ab * q)/F | | PIR = | 0.019054 |
| | | | | | |
| Max Attenuation Vol Required (m3) | | | | | 1.17103197 |
| | | | | | |
| Actual depth = | 1.35 | m | | | |
| Actual storage Provided = | 5.3626 | m3 | | | |
| | | | | | |
| Time for half-emptying | n x Hmax/2 x q | 0.944 | hrs | | |
| | | | | | |
| 24 > | 0.9436 hrs | O.K. | | | |

**Table of Content**

| i (m/hr) | D (hr) | $h_{max}$ (m) | Volume Stored |
|---|---|---|---|
| 0.26627 | 0.08 | 0.10 | 1.29 |
| 0.18560 | 0.17 | 0.14 | 1.79 |
| 0.14508 | 0.25 | 0.16 | 2.09 |
| 0.08970 | 0.50 | 0.19 | 2.54 |
| 0.05538 | 1.00 | 0.23 | 3.05 |
| 0.03426 | 2.00 | 0.27 | 3.60 |
| 0.02587 | 3.00 | 0.30 | 3.91 |
| 0.02119 | 4.00 | 0.31 | 4.11 |
| 0.01599 | 6.00 | 0.33 | 4.32 |
| 0.00988 | 12.00 | 0.32 | 4.28 |
| 0.00611 | 24.00 | 0.24 | 3.20 |
| 0.00339 | 48.00 | -0.10 | -1.32 |
| 0.00245 | 72.00 | -0.45 | -5.99 |
| MAX | | 0.33 | 4.32 |

LOHAN & DONNELLY
Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Subject: | Tree Pit 17 Infiltration |
|---|---|---|---|
| Date: | 31/01/2025 | Calc'd by: | E.V |
| | | Checked by: | G.P |



## Plane Infiltration Area Design to CIRIA 156

| Definition | Label | Measurement | | Label | Value |
|---|---|---|---|---|---|
| Site Infiltration Rate | q | m/hr | | q = | 0.0518040 |
| Porosity of Material | n | N/A | | n = | 0.3 |
| Storm Duration | D | per hr | | | |
| Intensity | i | m/hr | | | |
| Ratio of Drained Area to Infiltration Area | R | m2 | | R = | 4.05279082 |
| Area to be Drained | $A_D$ | m2 | | $A_D$ = | 841.761 |
| Area of Infiltration System | $A_b$ | m2 | | $A_b$ = | 207.699 |
| Factor of Safety | F | N/A | | F = | 10 |
| Highest Water Level | $h_{max}$ | m | | | |
| Return Period | RP | years | | RP | 100 |
| **Formula** | R = | $A_D/A_b$ | | | |
| | $h_{max}$ = | D/n * (Ri-q/F) | | | |
| | i = | m/hr | | | |
| Plane Infiltration Rate for Attenuation = | | (Ab * q)/F | | PIR = | 0.298879 |
| Max Attenuation Vol Required (m3) | | | | | 89.8657007 |
| Actual depth = | 1.75 | m | | | |
| Actual storage Provided = | 109.04 | m3 | | | |
| Time for half-emptying | n x Hmax/2 x q | 4.536 | hrs | | |
| 24 > | 4.5361 hrs | O.K. | | | |

**Table of Content**

| i (m/hr) | D (hr) | $h_{max}$ (m) | Volume Stored |
|---|---|---|---|
| 0.26627 | 0.08 | 0.30 | 61.71 |
| 0.18560 | 0.17 | 0.41 | 85.85 |
| 0.14508 | 0.25 | 0.49 | 100.87 |
| 0.08970 | 0.50 | 0.60 | 124.05 |
| 0.05538 | 1.00 | 0.73 | 151.80 |
| 0.03426 | 2.00 | 0.89 | 185.06 |
| 0.02587 | 3.00 | 1.00 | 207.00 |
| 0.02119 | 4.00 | 1.08 | 223.48 |
| 0.01599 | 6.00 | 1.19 | 247.68 |
| 0.00988 | 12.00 | 1.39 | 289.63 |
| 0.00611 | 24.00 | 1.57 | 325.38 |
| 0.00339 | 48.00 | 1.37 | 284.89 |
| 0.00245 | 72.00 | 1.14 | 237.48 |
| MAX | | 1.57 | 325.38 |

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Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

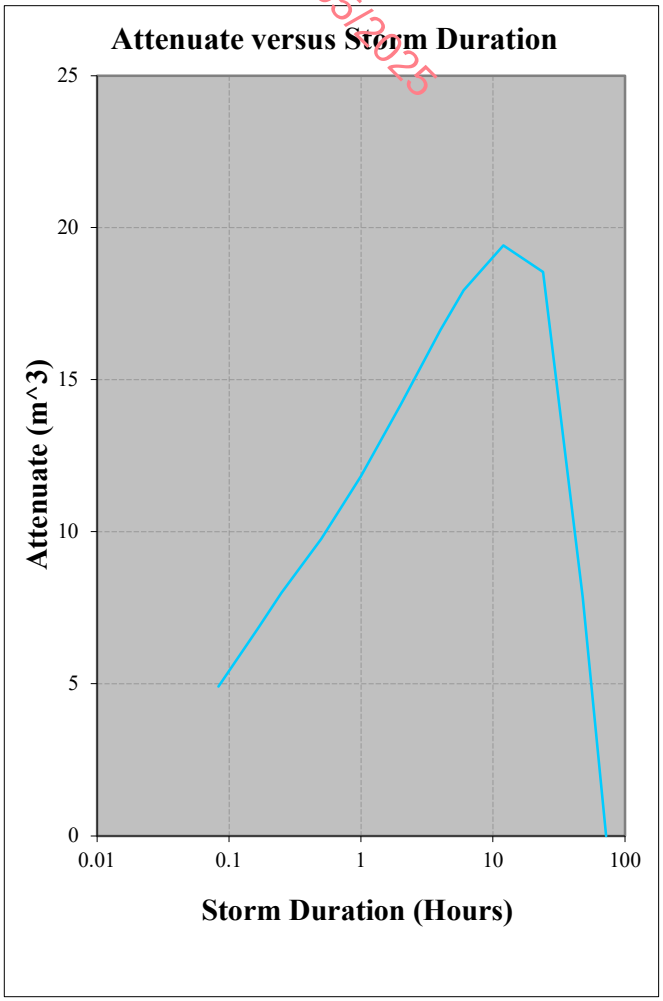
| | | | |
|---|---|---|---|
| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Job No: | 20189 |
| Subject: | Swale Attenuation | Page No: | 1 |
| Date: 07/02/2025 | Calc'd by: E.V | Checked by: | G.P |



| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hard Area | 0 $m^2$ | Dry Swale | 227 $m^2$ | Grass | 430.8 $m^2$ | Equivalent Impermeable Area: | 291.6131 $m^2$ |
| I. Factor: | 1.00 | I. Factor: | 1.00 | I. Factor: | 0.15 | | |

Attenuated Flow Rate: 0.17 l/s

| Storm Duration (Hours) | Rainfall (mm) | Total Surface Water ($m^3$) | Allowable Discharge ($m^3$) | Attenuate ($m^3$) |
|---|---|---|---|---|
| 0.083 | 17.00 | 4.96 | 0.049629455 | 4.91 |
| 0.166 | 23.70 | 6.91 | 0.09925891 | 6.81 |
| 0.25 | 27.90 | 8.14 | 0.14948631 | 7.99 |
| 0.50 | 34.50 | 10.06 | 0.29897262 | 9.76 |
| 1.00 | 42.60 | 12.42 | 0.59794524 | 11.82 |
| 2.00 | 52.70 | 15.37 | 1.19589048 | 14.17 |
| 3.00 | 59.70 | 17.41 | 1.79383572 | 15.62 |
| 4.00 | 65.20 | 19.01 | 2.39178096 | 16.62 |
| 6.00 | 73.80 | 21.52 | 3.58767144 | 17.93 |
| 12.00 | 91.20 | 26.60 | 7.17534288 | 19.42 |
| 24.00 | 112.80 | 32.89 | 14.35068576 | 18.54 |
| 48.00 | 125.30 | 36.54 | 28.70137152 | 7.84 |
| 72.00 | 135.90 | 39.63 | 43.05205728 | 0 |




Maximum Volume of Attenuate: 19.42 $m^3$ Climate Change = 1.3 Required Attenuation Volume = 25.246 $m^3$

**Note: This spreadsheet calculates the Volume of Attenuate based on a Return Period of: 100 years.**

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Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| | | | |
|---|---|---|---|
| Project: | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | Job No: | 20189 |
| Subject: | Swale Infiltration | Page No: | 1 |
| Date: 07/02/2025 | Calc'd by: E.V | Checked by: | G.P |



## Plane Infiltration Area Design to CIRIA 156

| Definition | Label | Measurement | | Label | Value |
|---|---|---|---|---|---|
| Site Infiltration Rate | q | m/hr | | q = | 0.0263412 |
| Porosity of Material | n | N/A | | n = | 0.3 |
| Storm Duration | D | per hr | | | |
| Intensity | i | m/hr | | | |
| Ratio of Drained Area to Infiltration Area | R | m2 | | R = | 1.28463921 |
| Area to be Drained | $A_D$ | m2 | | $A_D$ = | 292 |
| Area of Infiltration System | $A_b$ | m2 | | $A_b$ = | 227 |
| Factor of Safety | F | N/A | | F = | 10 |
| Highest Water Level | $h_{max}$ | m | | | |
| Return Period | RP | years | | RP | 100 |
| **Formula** | R = | $A_D/A_b$ | | | |
| | $h_{max}$ = | D/n * (Ri-q/F) | | | |
| | i = | m/hr | | | |
| Plane Infiltration Rate for Attenuation = | | (Ab * q)/F | | PIR = | 0.166096 |
| Max Attenuation Vol Required (m3) | | | | | 25.2457034 |
| Actual depth = | 1 | m | | | |
| Actual storage Provided = | 68.1 | m3 | | | |
| Time for half-emptying | n x Hmax/2 x q | | 2.376 | hrs | |
| 24 > | 2.3758 | hrs | OK | | |

**Table of Content**

| i (m/hr) | D (hr) | $h_{max}$ (m) | Volume Stored |
|---|---|---|---|
| 0.26627 | 0.08 | 0.09 | 21.32 |
| 0.18560 | 0.17 | 0.13 | 29.62 |
| 0.14508 | 0.25 | 0.15 | 34.76 |
| 0.08970 | 0.50 | 0.19 | 42.60 |
| 0.05538 | 1.00 | 0.23 | 51.84 |
| 0.03426 | 2.00 | 0.28 | 62.61 |
| 0.02587 | 3.00 | 0.31 | 69.46 |
| 0.02119 | 4.00 | 0.33 | 74.42 |
| 0.01599 | 6.00 | 0.36 | 81.30 |
| 0.00988 | 12.00 | 0.40 | 91.33 |
| 0.00611 | 24.00 | 0.42 | 94.70 |
| 0.00339 | 48.00 | 0.28 | 62.66 |
| 0.00245 | 72.00 | 0.12 | 28.22 |
| MAX | | 0.42 | 94.70 |

# Appendix E – Q-Bar Calculations

LOHAN & DONNELLY
Consulting Engineers
13 Gardiner Place, Mountjoy Square, Dublin 1. T: 01 8787770
W: www.lohan-donnelly.com E: info@lohan-donnelly.com

| | | | |
|---|---|---|---|
| Project | BTR Residential Development, at Greenhills Road, Walkinstown, Dublin 12 | | |
| Element | Q-Bar Calculation | | |
| By: E.V. | Date: 07/02/2025 | Proj. No.: 20189 | |
| Chk'd: G.P | Date: 07/02/2025 | Sht. No.: 1 | of: 1 |



| Ref. | Calculations | Output |
|---|---|---|

The site is greater than 1 hectare and less than 50 hectares, linear interpolation will therefore be used to determine the surface water discharge rate (Qbar).

**Qbar for for 50 hectare site:**

| | | |
|---|---|---|
| Area (sq km) | 0.5 | |
| SAAR (mm) | 700 | Typical for Dublin |
| Soil value | 0.37 | Based on site specific ground investigation report |
| 100 year return growth curve for Dublin Rivers | 2.6 | |
| QBARrural | 143 2/3 | l/s |

**Qbar for for 2.7922 hectare site (Proposed Development):**

| | | |
|---|---|---|
| Area (sq km) | 0.027922 | |
| SAAR (mm) | 700 | Typical for Dublin |
| Soil value | 0.37 | Based on site specific ground investigation report |
| 100 year return growth curve for Dublin Rivers | 2.6 | |
| QBARrural | 8.0213234 | l/s |

# Appendix F – Initial Ground Investigations Report

GROUND INVESTIGATIONS IRELAND
Geotechnical & Environmental

Catherinestown House,
Hazelhatch Road,
Newcastle,
Co. Dublin.
D22 YD52

Tel: 01 601 5175 / 5176
Email: info@gii.ie
Web: www.gii.ie



# Ground Investigations Ireland

# Greenhills Road

# Lohan & Donnelly

# Ground Investigation Report

# February 2021

## 1.0 Preamble

On the instructions of Lohan & Donnelly Consulting Engineers, a site investigation was carried out by Ground Investigations Ireland Ltd. in January 2021 at the site of the proposed residential development on the Greenhills Road, Dublin 12.

## 2.0 Overview

### 2.1. Background

It is proposed to construct new residential development with associated services, access roads and car parking at the proposed site. The site was historically used as a gravel quarry, with a large retaining wall structure marking the southwestern boundary of the site. The site is currently occupied by several derelict industrial/commercial buildings and is situated near the Walkinstown Roundabout, on the southern side of Greenhills Road (R918), Dublin 12. The proposed construction is envisaged to consist of conventional foundations and pavement make up with some local excavations for services and plant.

### 2.2. Purpose and Scope

The purpose of the site investigation was to investigate subsurface conditions utilising a variety of investigative methods in accordance with the project specification. The scope of the work undertaken for this project included the following:

- Visit project site to observe existing conditions
- Carry out 14 No. Window Sample Boreholes to recover soil samples
- Carry out 10 No. Cable Percussion boreholes to a maximum depth of 4.50m BGL
- Installation of 3 No. Groundwater monitoring wells
- Geotechnical & Environmental Laboratory testing
- Report with recommendations

## 3.0 Subsurface Exploration

### 3.1. General

During the ground investigation a programme of intrusive investigation specified by the Consulting Engineer was undertaken to determine the sub surface conditions at the proposed site. Regular sampling and in-situ testing was undertaken in the exploratory holes to facilitate the geotechnical descriptions and to enable laboratory testing to be carried out on the soil samples recovered during excavation and drilling.
The procedures used in this site investigation are in accordance with Eurocode 7 Part 2: Ground Investigation and testing (ISEN 1997 – 2:2007) and B.S. 5930:2015.

### 3.2. Window Sampling

The window sampling was carried out at the locations shown in Figure 2 in Appendix 1 using a Tecopsa SPT Tec 10 percussion drilling rig. The window sampling consists of a 1m long steel tube with a cutting edge and an internal plastic liner which is mechanically driven into the ground utilising a 50kg weight falling a height of 500mm. Upon completion of the 1m sample, the tube is withdrawn and the plastic liner removed and sealed for logging and sub sampling by a Geotechnical Engineer/Engineering Geologist. The tube is replaced in the borehole and a subsequent 1m sample can be recovered. Occasionally outer casing or a reduced diameter tube is utilised to enable the window sample to progress in difficult drilling conditions. Geotechnical or environmental soil samples can be recovered from each of the liners following logging. The window sample records are provided in Appendix 2 of this Report.

### 3.3. Cable Percussion Boreholes

The Cable Percussion Boreholes were drilled using a Dando 2000 drilling rig with regular in-situ testing and sampling undertaken to facilitate the production of geotechnical logs and laboratory testing.
The standard method of boring in soil for site investigation is known as the Cable Percussion method. It consists of using a Shell in non cohesive soils and a clay cutter in cohesive soils, both operated on a wire cable. Very hard soils, boulders and other hard obstructions are broken up by chiselling and the fragments removed with the Shell. Where ground conditions made it necessary, the borehole was lined with 200mm diameter steel casing. While the use of the Cable Percussion method of boring gives the maximum data on soil conditions, some mixing of laminated soil is inevitable. For this reason, thin lenses of granular material may not be noticed. Disturbed samples were taken from the boring tools at suitable depths, so that there is a representative sample at the top of each change in stratum and thereafter at regular intervals down the borehole until the next stratum was encountered. The disturbed samples were then sealed and sent to the laboratory where they were visually examined to confirm the description of the relevant strata.
Standard Penetration Tests were carried out in the boreholes. The results of these tests, together with the depths at which the tests were taken are shown on the accompanying borehole records. The test consists of a thick wall sampler tube, 50mm external diameter, being driven into the soil by a monkey weighing 63.5kg and with a free drop of 760mm. For gravels and glacial till the driving shoe was replaced by a solid 60º cone. The Standard Penetration Test number referred to as the ‘N’ value is the number of blows required to drive the tube 300mm, after an initial penetration of 150mm. The number gives a guide to the consistency of the soil and can also be used to estimate the relative strength/density at the depth of the test and also to estimate the bearing capacity and compressibility of the soil. The cable percussion borehole logs are provided in Appendix 3 of this Report.

### 3.4. Surveying

The exploratory hole locations have been recorded using a Trimble R10 GNSS System which records the coordinates and elevation of the locations to ITM, as required by the project specification. In areas where the Trimble R10 GNSS System was unable to record the data due to building interference, observation

methods were used to estimate the exploratory hole location. The coordinates and elevations are provided on the exploratory hole logs in the appendices of this Report.



### 3.5. Laboratory Testing

Samples were selected from the exploratory holes for a range of geotechnical and environmental testing to assist in the classification of soils and to provide information for the proposed design.
Environmental & Chemical testing as required by the specification, including the Rilta Suite, pH and sulphate testing was carried out by Element Materials Technology Laboratory in the UK. The Rilta suite testing includes both Solid Waste and Leachate Waste Acceptance Criteria.
Geotechnical testing consisting of moisture content, Atterberg limits and, Particle Size Distribution (PSD), tests were carried out in NMTL's Geotechnical Laboratory in Carlow.
The results of the completed laboratory are included in Appendix 4 of this Report.

## 4.0 Ground Conditions

### 4.1. General

The ground conditions encountered during the investigation are summarised below with reference to insitu and laboratory test results. The full details of the strata encountered during the ground investigation are provided in the exploratory hole logs included in the appendices of this report.

The sequence of strata encountered were variable across the site but generally comprised;

- Surfacing
- Made Ground
- Cohesive Deposits
- Granular Deposits

**SURFACING:** Tarmacadam or Concrete surfacing was present in all exploratory holes and was present to a maximum depth of 0.30m BGL.

**MADE GROUND:** Made Ground and suspected Made Ground deposits were encountered beneath the surfacing and were present to a depth of between 0.40m and 2.40m BGL, with the full extent of these deposits not determined at BH02, BH02A, BH03, WS02, WS02A, WS02B, WS08, and WS08A. These deposits varied across the site but were generally were described as either a *brown clayey sandy subangular to subrounded fine to coarse Gravel* or a *greyish brown sandy gravelly Clay,* and contained *rare fragments of red brick.*

**COHESIVE DEPOSITS:** Cohesive deposits were encountered beneath the made ground and/or surfacing at BH03A, BH04, BH05, BH06, WS03, WS04, WS05, WS09, WS10, and WS11. These deposits were described typically as *dark brown/grey slightly sandy gravelly CLAY with occasional cobbles.* The

secondary sand and gravel constituents varied across the site and with depth, with granular lenses occasionally present in the glacial till matrix. These deposits had occasional, some or many cobble and boulder content were noted on the exploratory hole logs.



**GRANULAR DEPOSITS:** Granular deposits were encountered beneath the made ground and/or cohesive deposits at BH01, BH04, BH05, BH06, BH07, BH08, WS01, WS06, and WS07. These deposits were generally described as *grey/brown clayey subangular to subrounded fine to coarse GRAVEL with occasional cobbl*es and *brown clayey gravelly fine to coarse SAND*. The secondary sand/gravel and silt/clay constituents varied across the site and with depth while occasional, some or many cobble and boulder content also present where noted on the exploratory hole logs.
Based on the SPT N values the deposits are typically medium dense and become dense with depth.

### 4.2. Groundwater

Groundwater strikes are noted on the exploratory hole logs where they occurred and where possible drilling was suspended for twenty minutes to allow the subsequent rise in groundwater to be recorded. We would point out that these exploratory holes did not remain open for sufficiently long periods of time to establish the hydrogeological regime and groundwater levels would be expected to vary with the tide, time of year, rainfall, nearby construction and other factors. For this reason, standpipes were installed in BH04, BH06 and BH08 to allow the equilibrium groundwater level to be determined. The groundwater monitoring is included in Appendix 5 of this Report.

### 4.3. Laboratory Testing

#### 4.3.1. Geotechnical Laboratory Testing

Will be included in the final report.

#### 4.3.2. Chemical Laboratory Testing

Will be included in the final report.

#### 4.3.3. Environmental Laboratory Testing

A number of samples were analysed for a suite of parameters which allows for the assessment of the sampled material in terms of total pollutant content for classification of materials as *hazardous* or *non-hazardous*. The suite also allows for the assessment of the sampled material in terms of suitability for placement at licenced landfills (inert, stable non-reactive, hazardous etc.). The parameter list for the suite includes analysis of the solid samples for arsenic, barium, cadmium, chromium, copper, cyanide, lead, nickel, mercury, zinc, speciated aliphatic and aromatic petroleum hydrocarbons, pH, sulphate, sulphide, moisture content, soil organic matter and an asbestos screen.
The suite also includes those parameters specified in the EU Council Decision establishing criteria for the acceptance of waste at Landfills (Council Decision 2003/33/EC), which for the solid samples are total

organic carbon (TOC), speciated aliphatic and aromatic petroleum hydrocarbons, BTEX, phenol, polychlorinated biphenyls (PCB) and PAH.

As part of the suite a leachate is generated from the solid sample, which is analysed for antimony, arsenic, barium, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, selenium, zinc, chloride, fluoride, soluble sulphate, sulphide, phenols, dissolved organic carbon (DOC) and total dissolved solids (TDS).

While the laboratory report provides a comparison with the waste acceptance criteria limits it does not provide a waste classification of the material sampled nor does it comment on any potentially hazardous properties of the materials tested. The possibility for contamination, not revealed by the testing undertaken should be borne in mind particularly where Made Ground deposits are present or the previous site use or location indicate a risk of environmental variation. The environmental assessment report is included under the cover of a sperate report by Ground Investigations Ireland.

The results of the completed laboratory are included in Appendix 4 of this Report.

## 5.0 Recommendations & Conclusions



### 5.1. General

The recommendations given and opinions expressed in this report are based on the findings as detailed in the exploratory hole records. Where an opinion is expressed on the material between exploratory hole locations, this is for guidance only and no liability can be accepted for its accuracy. No responsibility can be accepted for conditions which have not been revealed by the exploratory holes. Limited information has been provided at the ground investigation stage and any designs based on the recommendations or conclusions should be completed in accordance with the current design codes, taking into account the variation and the specific details contained within the exploratory hole logs.

### 5.2. Foundations

The allowable bearing capacities are outlined in Table 1 below and are recommended for conventional strip or pad foundations to permit the foundation assessment. The possibility for variation in the depth of the made ground in the vicinity of these foundations should be considered and foundation inspections should be carried out. Any soft spots encountered at the proposed foundation depths should be excavated and replaced with lean mix concrete. Where granular deposits and cohesive deposits are encountered at foundation level, we would recommend that all the foundations of the unit in question be lowered to the same stratum to avoid differential settlement. Where shallow refusal is noted, rotary core drilling is recommended to confirm the type and condition of the stratum below the refusal depth.

**Table 1.**

| Allowable Bearing Capacities (ABC) – Borehole Locations | | | | | | | |
|---|---|---|---|---|---|---|---|
| Shallowest Practical Depth | | | | Depth to 250 kN/m$^2$ | | | |
| Probe No. | ABC kN/m2 | Depth m BGL | Comment | Probe No. | ABC kN/m2 | Depth m BGL | Comment |
| BH01 | 100 | 1.20 | Granular | BH01 | 250 | 2.00 | Granular |
| BH02 | - | - | Shallow Refusal | BH02 | - | - | |
| BH02A | - | - | Shallow Refusal | BH02A | - | - | |
| BH03 | - | - | Shallow Refusal | BH03 | - | - | |
| BH03A | 125 | 1.20 | Shallow Refusal | BH03A | - | - | |
| BH04 | 125 | 2.20 | Cohesive | BH04 | 250 | 3.00 | Granular |
| BH05 | 125 | 2.00 | Cohesive | BH05 | 250 | 3.00 | Granular |
| BH06 | 125 | 2.00 | Cohesive | BH06 | 250 | 3.00 | Granular |
| BH07 | 100 | 1.50 | Granular | BH07 | 250 | 2.00 | Granular |
| BH08 | 100 | 1.20 | Granular | BH08 | 250 | 3.00 | Cohesive |

A ground bearing floor slab is recommended to be based on the stiff cohesive deposits or medium dense granular deposits with an appropriate depth of compacted hardcore specified by the consulting engineer and in accordance with the limits and guidelines in SR21:2014+A1:2016 and/or NRA SRW CL808 Type E granular stone fill. Where the depth of Made Ground/Soft deposits exceeds 0.90m then suspended floor slabs should be considered.

Due to the high loading anticipated, piled foundations may be more economically advantageous for the proposed building. The type, size and depth of the pile foundations should be confirmed by a specialist piling contractor based on the loading from the proposed building. The floor slab is recommended be suspended and also supported on the building piles.



### 5.3. Excavations

Short term temporary excavations in the cohesive deposits will remain stable for a limited time only and will require to be appropriately battered or the sides supported if the excavation is below 1.25m BGL or is required to permit man entry.

Excavations in the Made Ground or soft Cohesive Deposits will require to be appropriately battered or the sides supported due to the low strength of these deposits.

Any excavations which penetrate the granular deposits will require to be appropriately battered or the sides supported and are likely to require dewatering due to the groundwater seepages noted in the exploratory hole logs in the Appendices of this Report.

Any waste material to be removed off site should be disposed of to a suitably licenced landfill.

The environmental testing completed during the ground investigation is reported under the cover of a separate GII Environmental Assessment Report.

The recommendations provided in this report should be verified in the design of the proposed buildings, using the full details of the loading conditions and taking into consideration the allowable tolerable settlements/movements that the building can accommodate. The founding strata should be inspected and verified by a suitably qualified engineer prior to construction of the building foundations.

# **APPENDIX 2** – Window Sample Records

# Ground Investigations Ireland Ltd
www.gii.ie

| Site | Number |
|---|---|
| Greenhills Road | WS01 |

| Excavation Method | Dimensions | Ground Level (mOD) | Client | Job Number |
|---|---|---|---|---|
| Drive-in Windowless Sampler | 85mm to 2.00m<br>65mm to 3.00m | 58.28 | Lohan and Donnelly | 10299-12-20 |
| | **Location** | **Dates** | **Project Contractor** | **Sheet** |
| | 710701.7 E 730493.4 N | 18/01/2021 | GII | 1/1 |



| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|---|---|---|---|---|---|---|---|---|
| | | | | 58.16 | (0.12)<br>0.12 | TARMACADAM | | |
| | | | | 58.08 | (0.08)<br>0.20 | MADE GROUND: Grey silty sandy subangular to subrounded fine to coarse Gravel | | |
| | | | | | (0.20) | MADE GROUND: Brown slightly clayey sandy subangular fine to coarse Gravel | | |
| 0.50 | ES01 | | | 57.88 | 0.40 | MADE GROUND: Brown slightly gravelly clayey fine to coarse Sand with rare fragments of red brick | | |
| | | | | | (0.40) | | | |
| | | | | 57.48 | 0.80 | Possible MADE GROUND: Brown slightly sandy slightly gravelly Clay with occasional cobbles | | |
| 1.50 | ES02 | | | | (1.60) | | | |
| | | | | 55.88 | 2.40 | Brown gravelly very clayey fine to coarse SAND. Gravel is subrounded fine to coarse | | |
| | | | | | (0.60) | | | |
| 2.80 | ES03 | | | 55.28 | 3.00 | Complete at 3.00m | | |

**Remarks**
Borehole backfilled upon completion

| Scale (approx) | Logged By |
|---|---|
| 1:25 | SG |

**Figure No.**
10299-12-20.WS01

# Ground Investigations Ireland Ltd
www.gii.ie

| Site | Number |
|---|---|
| Greenhills Road | WS02 |

| Excavation Method | Dimensions | Ground Level (mOD) | Client | Job Number |
|---|---|---|---|---|
| Drive-in Windowless Sampler | 85mm to 0.40m | 57.98 | Lohan and Donnelly | 10299-12-20 |
| | **Location** | **Dates** | **Project Contractor** | **Sheet** |
| | 710696.6 E 730528.8 N | 18/01/2021 | GII | 1/1 |



| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|---|---|---|---|---|---|---|---|---|
| | | | | 57.86 | (0.12) 0.12 | TARMACADAM | | |
| | | | | | (0.18) | TARMACADAM | | |
| | | | | 57.68 | 0.30 | | | |
| | | | | 57.58 | (0.10) 0.40 | MADE GROUND: Grey silty sandy Subangular fine to coarse Gravel | | |
| | | | | | | Complete at 0.40m | | |

**Remarks**
Unable to advance borehole due to possible boulder

| Scale (approx) | Logged By |
|---|---|
| 1:25 | SG |

**Figure No.**
10299-12-20.WS02

# Ground Investigations Ireland Ltd
www.gii.ie

| Site | Number |
|---|---|
| Greenhills Road | WS02A |

| Excavation Method | Dimensions | Ground Level (mOD) | Client | Job Number |
|---|---|---|---|---|
| Drive-in Windowless Sampler | 85mm to 0.40m | 57.94 | Lohan and Donnelly | 10299-12-20 |
| | **Location** | **Dates** | **Project Contractor** | **Sheet** |
| | 710700.6 E 730527.3 N | 18/01/2021 | GII | 1/1 |



| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|---|---|---|---|---|---|---|---|---|
| | | | | 57.82 | (0.12) 0.12 | TARMACADAM | | |
| | | | | | (0.18) | TARMACADAM | | |
| | | | | 57.64 | 0.30 | | | |
| | | | | 57.54 | (0.10) 0.40 | MADE GROUND: Grey silty sandy Subangular fine to coarse Gravel | | |
| | | | | | | Complete at 0.40m | | |

**Remarks**
Unable to advance borehole due to possible boulder

| Scale (approx) | Logged By |
|---|---|
| 1:25 | SG |

**Figure No.**
10299-12-20.WS02a

# Ground Investigations Ireland Ltd
www.gii.ie

| Site | Number |
|---|---|
| Greenhills Road | **WS02B** |

| Excavation Method | Dimensions | Ground Level (mOD) | Client | Job Number |
|---|---|---|---|---|
| Drive-in Windowless Sampler | 85mm to 0.40m | 57.98 | Lohan and Donnelly | 10299-12-20 |
| | **Location** | **Dates** | **Project Contractor** | **Sheet** |
| | 710691.4 E 730524.3 N | 20/01/2021 | GII | 1/1 |



| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|---|---|---|---|---|---|---|---|---|
| | | | | 57.86 | (0.12) 0.12 | TARMACADAM | | |
| | | | | | (0.18) | TARMACADAM | | |
| | | | | 57.68 | 0.30 | | | |
| | | | | 57.58 | (0.10) 0.40 | MADE GROUND: Grey silty sandy Subangular fine to coarse Gravel | | |
| | | | | | | Complete at 0.40m | | |

**Remarks**
Unable to advance borehole due to possible boulder

| Scale (approx) | Logged By |
|---|---|
| 1:25 | SG |

**Figure No.**
10299-12-20.WS02b

# Ground Investigations Ireland Ltd
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| Site | Number |
|---|---|
| Greenhills Road | WS03 |

| Excavation Method | Dimensions | Ground Level (mOD) | Client | Job Number |
|---|---|---|---|---|
| Drive-in Windowless Sampler | 85mm to 2.00m<br>65mm to 3.00m | | Lohan and Donnelly | 10299-12-20 |
| | **Location**<br>710717.6 E 730562.5 N | **Dates**<br>18/01/2021 | **Project Contractor**<br>GII | **Sheet**<br>1/1 |



| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|---|---|---|---|---|---|---|---|---|
| | | | | | (0.23) 0.23 | CONCRETE | | |
| | | | | | (0.47) 0.70 | Possible MADE GROUND: Brown very clayey very sandy subangular to subrounded fine to coarse Gravel | | |
| 0.50 | ES04 | | | | (0.50) 1.20 | Possible MADE GROUND: Dark brown slightly sandy slightly gravelly Clay | | |
| 1.50 | ES05 | | | | (1.30) 2.50 | Grey slightly sandy slightly gravelly SILT. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse<br>Moderate hydrocarbon odour | | |
| | | | | | (0.50) 3.00 | Brown clayey sandy subangular to subrounded fine to coarse GRAVEL | | |
| 3.00 | ES06 | | | | | Complete at 3.00m | | |

**Remarks**
Borehole backfilled upon completion

| Scale (approx) | Logged By |
|---|---|
| 1:25 | SG |

**Figure No.**
10299-12-20.WS03

# Ground Investigations Ireland Ltd
www.gii.ie

| | | | |
|---|---|---|---|
| **Site** Greenhills Road | | | **Number** WS04 |
| **Excavation Method** Drive-in Windowless Sampler | **Dimensions** 85mm to 2.00m<br>65mm to 3.00m | **Ground Level (mOD)** | **Client** Lohan and Donnelly |
| | **Location** 710707.6 E 730590.2 N | **Dates** 18/01/2021 | **Project Contractor** GII |
| | | | **Job Number** 10299-12-20 |
| | | | **Sheet** 1/1 |



| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|---|---|---|---|---|---|---|---|---|
| | | | | | (0.22) | CONCRETE | | |
| | | | | | 0.22 | Possible MADE GROUND: Brown clayey very sandy subangular fine to coarse Gravel with occassional cobbles | | |
| 0.30 | ES07 | | | | | Mild hydrocarbon odour | | |
| | | | | | (1.28) | | | |
| 1.30 | ES08 | | | | | | | |
| | | | | | 1.50 | Dark brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse | | |
| | | | | | (0.50) | | | |
| | | | | | 2.00 | Light brown slightly clayey very sandy subangular to subrounded fine to coarse GRAVEL | | |
| | | | | | (0.80) | | | |
| | | | | | 2.80 | Light brown slightly clayey very sandy subrounded fine to coarse GRAVEL | | |
| | | | | | (0.20) | | | |
| | | | | | 3.00 | Complete at 3.00m | | |

**Remarks**
Borehole backfilled upon completion

| Scale (approx) | Logged By |
|---|---|
| 1:25 | SG |

**Figure No.** 10299-12-20.WS04

# Ground Investigations Ireland Ltd
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| Site | Number |
|---|---|
| Greenhills Road | WS05 |

| Excavation Method | Dimensions | Ground Level (mOD) | Client | Job Number |
|---|---|---|---|---|
| Drive-in Windowless Sampler | 85mm to 2.00m<br>65mm to 2.80m | | Lohan and Donnelly | 10299-12-20 |
| | **Location** | **Dates** | **Project Contractor** | **Sheet** |
| | 710747.7 E 730588.6 N | 18/01/2021 | GII | 1/1 |



| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|---|---|---|---|---|---|---|---|---|
| | | | | | (0.22) 0.22 | CONCRETE | | |
| | | | | | (0.28) 0.50 | Possible MADE GROUND: Brown clayey sandy subangular fine to coarse Gravel | | |
| 1.50 | ES09 | | | | (1.50) | Possible MADE GROUND: Dark brown clayey very sandy subangular fine to coarse Gravel | | |
| 2.10 | ES10 | | | | 2.00 (0.40) 2.40 | Brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse | | |
| | | | | | (0.40) 2.80 | Black slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse | | |
| | | | | | | Complete at 2.80m | | |

**Remarks**
Refusal at 2.80m BGL
Borehole backfilled upon completion

| Scale (approx) | Logged By |
|---|---|
| 1:25 | SG |

**Figure No.**
10299-12-20.WS05

# Ground Investigations Ireland Ltd
www.gii.ie

| Site | Number |
|---|---|
| Greenhills Road | WS06 |

| Excavation Method | Dimensions | Ground Level (mOD) | Client | Job Number |
|---|---|---|---|---|
| Drive-in Windowless Sampler | 85mm to 2.00m | | Lohan and Donnelly | 10299-12-20 |
| | **Location** | **Dates** | **Project Contractor** | **Sheet** |
| | 710784.5 E 730591.2 N | 19/01/2021 | GII | 1/1 |



| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|---|---|---|---|---|---|---|---|---|
| | | | | | 0.05 | TARMACADAM | | |
| | | | | | (0.25) | MADE GROUND: Red clayey very sandy subangular to subrounded fine to coarse Gravel | | |
| | | | | | 0.30 | | | |
| | | | | | (0.15) | Possible MADE GROUND: Brown slightly sandy slightly gravelly Clay | | |
| | | | | | 0.45 | | | |
| | | | | | | Possible MADE GROUND: Brown clayey very gravelly fine to coarse Sand | | |
| | | | | | (0.55) | | | |
| 1.00 | ES12 | | | | 1.00 | Dark brown clayey very gravelly fine to coarse SAND. Gravel is aubangular to subrounded fine to coarse | | |
| | | | | | (1.00) | | | |
| 2.00 | ES13 | | | | 2.00 | Complete at 2.00m | | |

**Remarks**
Refusal at 2.00m BGL
Borehole backfilled upon completion

| Scale (approx) | Logged By |
|---|---|
| 1:25 | SG |

**Figure No.**
10299-12-20.WS06

# Ground Investigations Ireland Ltd
www.gii.ie

| Site | Number |
|---|---|
| Greenhills Road | WS07 |

| Excavation Method | Dimensions | Ground Level (mOD) | Client | Job Number |
|---|---|---|---|---|
| Drive-in Windowless Sampler | 85mm to 2.00m<br>65mm to 2.30m | | Lohan and Donnelly | 10299-12-20 |
| | **Location**<br>710772.3 E 730620.9 N | **Dates**<br>19/01/2021 | **Project Contractor**<br>GII | **Sheet**<br>1/1 |



| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|---|---|---|---|---|---|---|---|---|
| | | | | | (0.20) 0.20 | CONCRETE | | |
| 0.20-1.00 | ES11 | | | | (1.80) | Recovered as; MADE GROUND: Brown sandy gravelly Clay with rare fragments of red brick | | |
| | | | | | 2.00 (0.30) 2.30 | Recovered as; Dark brown clayey sandy subangular to subrounded fine to coarse GRAVEL | | |
| | | | | | | Complete at 2.30m | | |

**Remarks**
Refusal at 2.30
Borehole backfilled upon completion

| Scale (approx) | Logged By |
|---|---|
| 1:25 | SG |

**Figure No.**
10299-12-20.WS07

# Ground Investigations Ireland Ltd
www.gii.ie

| Site | Number |
|---|---|
| Greenhills Road | WS08 |

| Excavation Method | Dimensions | Ground Level (mOD) | Client | Job Number |
|---|---|---|---|---|
| Drive-in Windowless Sampler | 85mm to 1.00m | | Lohan and Donnelly | 10299-12-20 |
| | **Location** | **Dates** | **Project Contractor** | **Sheet** |
| | 710801.2 E 730635.6 N | 20/01/2021 | GII | 1/1 |



| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|---|---|---|---|---|---|---|---|---|
| | | | | | (0.18) 0.18 | CONCRETE | | |
| | | | | | (0.42) 0.60 | MADE GROUND: Brown slightly sandy slightly gravelly Clay with rare fragments of red brick | | |
| | | | | | (0.40) 1.00 | Possible MADE GROUND: Grey clayey sandy subangular to subrounded fine to coarse Gravel with occasional cobbles | | |
| | | | | | | Complete at 1.00m | | |

**Remarks**
Refusal at 1.00m BGL
Borehole backfilled upon completion

| Scale (approx) | Logged By |
|---|---|
| 1:25 | SG |

**Figure No.**
10299-12-20.WS08

# Ground Investigations Ireland Ltd
www.gii.ie

| Site | Number |
|---|---|
| Greenhills Road | WS08A |

| Excavation Method | Dimensions | Ground Level (mOD) | Client | Job Number |
|---|---|---|---|---|
| Drive-in Windowless Sampler | 85mm to 1.40m | | Lohan and Donnelly | 10299-12-20 |
| | **Location** | **Dates** | **Project Contractor** | **Sheet** |
| | 710806.2 E 730632.5 N | 20/01/2021 | GII | 1/1 |



| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|---|---|---|---|---|---|---|---|---|
| | | | | | (0.20) 0.20 | CONCRETE | | |
| | | | | | (0.55) 0.75 | MADE GROUND: Brown slightly sandy slightly gravelly Clay with rare fragments of red brick | | |
| 1.00 | ES21 | | | | (0.65) 1.40 | MADE GROUND: Grey clayey very sandy subrounded fine to coarse Gravel with rare fragments of red brick | | |
| | | | | | | Complete at 1.40m | | |

**Remarks**
Refusal at 1.40m BGL
Borehole backfilled upon completion

| Scale (approx) | Logged By |
|---|---|
| 1:25 | SG |

**Figure No.**
10299-12-20.WS08a

# Ground Investigations Ireland Ltd
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| Site | Number |
|---|---|
| Greenhills Road | WS09 |

| Excavation Method | Dimensions | Ground Level (mOD) | Client | Job Number |
|---|---|---|---|---|
| Drive-in Windowless Sampler | 85mm to 2.00m<br>65mm to 3.00m | | Lohan and Donnelly | 10299-12-20 |
| | **Location** | **Dates** | **Project Contractor** | **Sheet** |
| | 710829.4 E 730651.4 N | 19/01/2021 | GII | 1/1 |



| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|---|---|---|---|---|---|---|---|---|
| | | | | | (0.20)<br>0.20 | CONCRETE | | |
| | | | | | (0.55)<br>0.75 | Possible MADE GROUND: Brown slightly sandy gravelly Clay | | |
| | | | | | (0.25)<br>1.00 | Possible MADE GROUND: Greyish brown slightly clayey sandy subrounded fine to coarse Gravel | | |
| | | | | | (0.70)<br>1.70 | Possible MADE GROUND: Brown slightly sandy gravelly Clay | | |
| 1.70 | ES14 | | | | (0.50)<br>2.20 | Possible MADE GROUND: Dark brown clayey gravelly fine to coarse Sand | | |
| 2.50 | ES15 | | | | (0.50)<br>2.70 | Brown slightly gravelly very sandy SILT. Gravel is subrounded fine to coarse | | |
| | | | | | (0.30)<br>3.00 | Brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse | | |
| | | | | | | Complete at 3.00m | | |

**Remarks**
Borehole backfilled upon completion

| Scale (approx) | Logged By |
|---|---|
| 1:25 | SG |

**Figure No.**
10299-12-20.WS09

# Ground Investigations Ireland Ltd
www.gii.ie

| Site | Number |
|---|---|
| Greenhills Road | WS10 |

| Excavation Method | Dimensions | Ground Level (mOD) | Client | Job Number |
|---|---|---|---|---|
| Drive-in Windowless Sampler | 85mm to 2.00m<br>65mm to 2.60m | | Lohan and Donnelly | 10299-12-20 |
| | **Location**<br>710808 E 730604.9 N | **Dates**<br>19/01/2021 | **Project Contractor**<br>GII | **Sheet**<br>1/1 |



| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|---|---|---|---|---|---|---|---|---|
| | | | | | 0.05 | TARMACADAM | | |
| | | | | | (1.05) | MADE GROUND: Dark brown slightly sandy slightly gravelly Clay with rare fragments of red brick | | |
| 0.50 | ES16 | | | | 1.10 | Dark brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse | | |
| | | | | | (1.50) | | | |
| 2.00 | ES17 | | | | 2.60 | Complete at 2.60m | | |

**Remarks**
Refusal at 2.60m BGL
Borehole backfilled upon completion

| Scale (approx) | Logged By |
|---|---|
| 1:25 | SG |

**Figure No.**
10299-12-20.WS10

# Ground Investigations Ireland Ltd
www.gii.ie

| Site | Number |
|---|---|
| Greenhills Road | WS11 |

| Excavation Method | Dimensions | Ground Level (mOD) | Client | Job Number |
|---|---|---|---|---|
| Drive-in Windowless Sampler | 85mm to 2.00m<br>65mm to 2.80m | | Lohan and Donnelly | 10299-12-20 |
| | **Location** | **Dates** | **Project Contractor** | **Sheet** |
| | 710835.1 E 730616.7 N | 20/01/2021 | GII | 1/1 |



| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|---|---|---|---|---|---|---|---|---|
| | | | | | 0.05 | TARMACADAM | | |
| | | | | | (0.45) | MADE GROUND: Brown clayey sandy subangular to subrounded fine to coarse Gravel | | |
| | | | | | 0.50 | | | |
| | | | | | (0.30) | Possible MADE GROUND: Brown slightly sandy slightly gravelly Clay | | |
| 0.80 | ES18 | | | | 0.80 | | | |
| | | | | | (0.40) | Possible MADE GROUND: Brown gravelly very clayey fine to coarse Sand | | |
| | | | | | 1.20 | | | |
| | | | | | (0.10) | Brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular fine to coarse | | |
| | | | | | 1.30 | | | |
| 1.50 | ES19 | | | | (0.35) | Greyish brown slightly gravelly silty fine to coarse SAND. Gravel subrounded fine to medium | | |
| | | | | | 1.65 | | | |
| | | | | | (0.35) | Brown slightly gravelly silty sandy CLAY. Sand is fine to coarse. Gravel is subangular fine to medium | | |
| | | | | | 2.00 | | | |
| 2.50 | ES20 | | | | (0.80) | Brown slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse<br>Moderate hydrocarbon odour | | |
| | | | | | 2.80 | | | |
| | | | | | | Complete at 2.80m | | |

**Remarks**
Refusal at 2.80m BGL
Borehole backfilled upon completion

| Scale (approx) | Logged By |
|---|---|
| 1:25 | SG |

**Figure No.**
10299-12-20.WS11

# **APPENDIX 3** – Cable Percussion Borehole Records

# Ground Investigations Ireland Ltd
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| | | | |
|---|---|---|---|
| **Site** Greenhills Road | | | **Borehole Number** BH-01 |
| **Machine :** Dando 2000<br>**Method :** Cable Percussion | **Casing Diameter** 200mm cased to 4.50m | **Ground Level (mOD)** 58.84 | **Client** Lohan and Donnelly |
| | **Location** (dGPS) 710668.2 E 730490.5 N | **Dates** 20/01/2021-25/01/2021 | **Project Contractor** GII |
| | | | **Job Number** 10299-12-20 |
| | | | **Sheet** 1/1 |



| Depth (m) | Sample / Tests | Casing Depth (m) | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 58.74 | 0.10 | TARMACADAM | | |
| 0.10<br>0.20 | B01<br>ES01 | | | | 58.64<br>58.54 | 0.20<br>0.30 | MADE GROUND: Brown slightly silty slightly gravelly fine to coarse Sand | | |
| | | | | | | (0.50) | Drillers note: MADE GROUND: 804 fill | | |
| | | | | | 58.04 | 0.80 | Drillers Note: Brown clayey fine Sand | | |
| 1.00-1.21<br>1.00 | SPT(C) 50/60<br>B02 | | | 7,9/50 | | | Dense grey very sandy subangular to subrounded fine to coarse GRAVEL | | |
| | | | | | | (2.20) | | | |
| 2.00-2.45<br>2.00 | SPT(C) N=41<br>B03 | | | 7,7/9,10,10,12 | | | | | |
| 3.00-3.45<br>3.00 | SPT(C) N=49<br>B04 | | | 7,10/19,9,9,12 | 55.84 | 3.00 | Dense grey sandy subangular to subrounded fine to coarse GRAVEL with occasional subrounded cobbles and some bands of brown slightly sandy slightly gravelly Clay | | ▼1 |
| | | | | | | (1.00) | | | |
| 4.00-4.06<br>4.00 | SPT(C) 25*/20<br>50/40<br>B05 | | | 25/50 | 54.84 | 4.00 | Dense grey slightly sandy subangular fine to coarse GRAVEL with some subangular to subrounded cobbles | | |
| | | | | | | (0.50) | | | |
| | | | | Water strike(1) at 4.50m, rose to 3.00m in 20 mins. | 54.34 | 4.50 | Complete at 4.50m | | ▽1 |

**Remarks**
BH-01 terminated at 4.50m BGL due to obstruction.
Chiselling from 4.50m to 4.50m for 1 hour.

| Scale (approx) | Logged By |
|---|---|
| 1:50 | SG |

**Figure No.** 10299-12-20.BH-01

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| | | | |
|---|---|---|---|
| **Site** Greenhills Road | | | **Borehole Number** BH-02 |
| **Machine :** Dando 2000<br>**Method :** Cable Percussion | **Casing Diameter** 200mm cased to 0.70m | **Ground Level (mOD)** 58.02 | **Client** Lohan and Donnelly |
| | **Location** (dGPS) 710724.1 E 730510.2 N | **Dates** 25/01/2021 | **Project Contractor** GII |
| | | | **Job Number** 10299-12-20 |
| | | | **Sheet** 1/1 |



| Depth (m) | Sample / Tests | Casing Depth (m) | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 57.89 | (0.13) 0.13 | TARMACADAM | | |
| 0.50 | B01 | | | | | (0.57) | MADE GROUND: Brown slightly clayey very sandy subangular to subrounded fine to coarse GRAVEL with occasional subangular to subrounded cobbles | | |
| | | | | | 57.32 | 0.70 | Complete at 0.70m | | |

**Remarks**
BH-02 terminated at 0.70m BGL due to obstruction.
Offset location and re-drill BH-02a
Chiselling from 0.70m to 0.70m for 1 hour.

| Scale (approx) | Logged By |
|---|---|
| 1:50 | SG |

**Figure No.** 10299-12-20.BH-02

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| | | | |
|---|---|---|---|
| **Site** Greenhills Road | | | **Borehole Number** BH-02A |
| **Machine :** Dando 2000<br>**Method :** Cable Percussion | **Casing Diameter** 200mm cased to 0.80m | **Ground Level (mOD)** 58.00 | **Client** Lohan and Donnelly |
| | **Location** | **Dates** 28/01/2021 | **Project Contractor** GII |
| | | | **Job Number** 10299-12-20 |
| | | | **Sheet** 1/1 |



| Depth (m) | Sample / Tests | Casing Depth (m) | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|---|---|---|---|---|---|---|---|---|---|
| 0.00-0.50 | ES01 | | | | 57.90 | 0.10 | TARMACADAM | | |
| 0.50 | B01 | | | | | (0.70) | MADE GROUND: Light brown slightly sandy gravelly Clay with occasional subangular to suborunded cobbles | | |
| | | | | | 57.20 | 0.80 | Complete at 0.80m | | |

**Remarks**
BH-02A terminated at 1.20m BGL due to obstruction.
Chiselling from 0.80m to 0.80m for 1 hour.

| Scale (approx) | Logged By |
|---|---|
| 1:50 | PM |

**Figure No.** 10299-12-20.BH-02A

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| | | | |
|---|---|---|---|
| **Site** Greenhills Road | | | **Borehole Number** BH-03 |
| **Machine :** Dando 2000<br>**Method :** Cable Percussion | **Casing Diameter** 200mm cased to 1.80m | **Ground Level (mOD)** 56.81 | **Client** Lohan and Donnelly |
| | **Location** (dGPS) 710761.6 E 730546.6 N | **Dates** 25/01/2021 | **Project Contractor** GII |
| | | | **Job Number** 10299-12-20 |
| | | | **Sheet** 1/1 |



| Depth (m) | Sample / Tests | Casing Depth (m) | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 56.65 | (0.16) 0.16 | CONCRETE | | |
| 0.50 | B01 | | | | | (1.04) | MADE GROUND: Brown clayey gravelly fine to coarse Sand with occasional subangular to subrounded cobbles. Gravel is subangular to subrounded fine to coarse | | |
| 1.00-1.29<br>1.00<br>1.00 | SPT(C) 50/135<br>B02<br>ES01 | | | 1,2/19,31 | 55.61 | 1.20 | Drillers note: Pushing cobble in front of casing. No recovery | | |
| | | | | | | (0.60) | | | |
| | | | | | 55.01 | 1.80 | Complete at 1.80m | | |

**Remarks**
BH-03 terminated at 1.80m BGL due to obstruction.
Offset location and re-drill BH-03a
Chiselling from 1.20m to 1.80m for 1 hour.

| Scale (approx) | Logged By |
|---|---|
| 1:50 | SG |

**Figure No.** 10299-12-20.BH-03

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| | | | |
|---|---|---|---|
| **Site** Greenhills Road | | | **Borehole Number** BH-03A |
| **Machine :** Dando 2000<br>**Method :** Cable Percussion | **Casing Diameter** 200mm cased to 1.20m | **Ground Level (mOD)** | **Client** Lohan and Donnelly |
| | **Location** | **Dates** 28/01/2021 | **Project Contractor** GII |
| | | | **Job Number** 10299-12-20<br>**Sheet** 1/1 |



| Depth (m) | Sample / Tests | Casing Depth (m) | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|---|---|---|---|---|---|---|---|---|---|
| 0.00-1.20 | ES01 | | | | | 0.10 | TARMACADAM | | |
| 0.50<br>0.50 | B01<br>ES02 | | | | | (0.90) | Possible MADE GROUND: Light brown slightly sandy slightly gravelly silty CLAY with occasional subangular to suborunded cobbles. Gravel is subangular to subrounded fine to coarse | | |
| 1.00-1.45<br>1.00 | SPT(C) N=50<br>B02 | | | 6,7/14,22,14 | | 1.00<br>(0.20)<br>1.20 | Very stiff light brown slightly sandy slightly gravelly silty CLAY with occasional subangular to suborunded cobbles. Gravel is subangular to subrounded fine to coarse | | |
| | | | | | | | Complete at 1.20m | | |

**Remarks**
BH-03A terminated at 1.20m BGL due to obstruction.
Chiselling from 1.20m to 1.20m for 1 hour.

| Scale (approx) | Logged By |
|---|---|
| 1:50 | PM |

**Figure No.** 10299-12-20.BH-03A

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| | | | |
|---|---|---|---|
| **Site** Greenhills Road | | | **Borehole Number** BH-04 |
| **Machine :** Dando 2000<br>**Method :** Cable Percussion | **Casing Diameter** 200mm cased to 3.30m | **Ground Level (mOD)** 56.50 | **Client** Lohan and Donnelly |
| | **Location** 710728.4 E 730621.4 N | **Dates** 27/01/2021 | **Project Contractor** GII |
| | | | **Job Number** 10299-12-20 |
| | | | **Sheet** 1/1 |



| Depth (m) | Sample / Tests | Casing Depth (m) | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water | Instr |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.00-1.70 | ES01 | | | | 56.30 | (0.20) 0.20 | TARMACADAM | | | |
| 0.50 | B01 | | | | | | Soft to firm light brown slightly sandy gravelly CLAY with occasional subangular to subrounded cobbles. Gravel is subangular to subrounded fine to coarse | | | |
| 1.00-1.45<br>1.00 | SPT(C) N=8<br>B02 | | | 1,1/1,2,2,3 | | (1.50) | | | | |
| 1.70-3.00 | ES02 | | | | 54.80 | 1.70 | Medium dense dark brown slightly clayey slightly gravelly SAND. Gravel is subangular to subrounded fine to coarse | | | |
| 2.00-2.45<br>2.00 | SPT(C) N=32<br>B03 | | | 3,3/6,7,10,9 | | (0.50) | | | | |
| | | | | | 54.30 | 2.20 | Very stiff dark brown gravelly very sandy CLAY with occasional subangular to subrounded cobbles. Gravel is subangular to subrounded fine to coarse | | ▼1 | |
| | | | | | | (0.80) | | | | |
| 3.00-3.45<br>3.00<br>3.30 | SPT(C) N=50<br>B04<br>B05 | | | 17,9/19,31<br><br>Water strike(1) at 3.20m, rose to 2.50m in 20 mins. | 53.50 | 3.00 | Dense grey slightly clayey slightly sandy subangular to subrounded fine to coarse GRAVEL | | ▽1 | |
| | | | | | 53.20 | (0.30) 3.30 | Complete at 3.30m | | | |

**Remarks**
BH-04 terminated at 3.30m BGL due to obstruction.
50mm slotted standpipe installed from 3.80m to 1.00m BGL with pea gravel surrond, plain pipe installed from 1.00m to ground level with bentonite seal and flush cover
Chiselling from 3.30m to 3.30m for 1 hour.

| Scale (approx) | Logged By |
|---|---|
| 1:50 | PM |

**Figure No.** 10299-12-20.BH-04

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| | | | |
|---|---|---|---|
| **Site** Greenhills Road | | | **Borehole Number** BH-05 |
| **Machine :** Dando 2000<br>**Method :** Cable Percussion | **Casing Diameter** 200mm cased to 3.20m | **Ground Level (mOD)** 56.30 | **Client** Lohan and Donnelly |
| | **Location** 710790.6 E 730600.4 N | **Dates** 27/01/2021 | **Project Contractor** GII |
| | | | **Job Number** 10299-12-20<br>**Sheet** 1/1 |



| Depth (m) | Sample / Tests | Casing Depth (m) | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|---|---|---|---|---|---|---|---|---|---|
| 0.00-0.50 | ES01 | | | | 56.10 | (0.20) 0.20 | CONCRETE | | |
| | | | | | | (0.30) | POSSIBLE MADE GROUND: Dark brown slightly silty slightly sandy slightly gravelly Clay | | |
| 0.50 | B01 | | | | 55.80 | 0.50 | | | |
| 0.50-2.40 | ES02 | | | | | | Soft dark brown mottled grey slightly silty slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles. Gravel is subangular to subrounded fine to coarse | | |
| 1.00-1.45 | SPT(C) N=5 | | | 1,0/1,1,1,2 | | | | | |
| 1.00 | B02 | | | | | (1.50) | | | |
| 2.00-2.45 | SPT(C) N=17 | | | 1,2/3,4,4,6 | 54.30 | 2.00 | | | |
| 2.00 | B03 | | | | | (0.40) | Stiff dark brown mottled grey slightly silty slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles. Gravel is subangular to subrounded fine to coarse | | ▼1 |
| 2.40-3.00 | ES03 | | | | 53.90 | 2.40 | | | |
| | | | | | | (0.60) | Stiff dark grey mottled brown slightly sandy slightly gravelly silty CLAY. Gravel is subangular to subrounded fine to coarse | | |
| 3.00-3.40 | SPT(C) 50*/100 N=50 | | | 50/50 | 53.30 | 3.00 | | | |
| 3.00 | B04 | | | Water strike(1) at 3.20m, rose to 2.20m in 20 mins. | 53.10 | (0.20) 3.20 | Dense grey fine to coarse subangular to subrounded GRAVEL with occasional subangular to subrounded cobbles | | ▽1 |
| | | | | | | | Complete at 3.20m | | |

**Remarks**
BH-05 terminated at 3.20m BGL due to obstruction.
Chiselling from 3.00m to 3.20m for 1 hour.

| Scale (approx) | Logged By |
|---|---|
| 1:50 | PM |

**Figure No.** 10299-12-20.BH-05

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| Site | Borehole Number |
|---|---|
| Greenhills Road | BH-06 |

| Machine : Dando 2000<br>Method : Cable Percussion | Casing Diameter<br>200mm cased to 3.30m | Ground Level (mOD)<br>55.97 | Client<br>Lohan and Donnelly | Job Number<br>10299-12-20 |
|---|---|---|---|---|
| | Location<br>710836.6 E 730597.5 N | Dates<br>27/01/2021 | Project Contractor<br>GII | Sheet<br>1/1 |



| Depth (m) | Sample / Tests | Casing Depth (m) | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water | Instr |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.00-0.30 | ES01 | | | | 55.87 | 0.10 (0.20) | TARMACADAM | | | |
| 0.30-0.80 | ES02 | | | | 55.67 | 0.30 (0.50) | MADE GROUND: Dark brown slightly silty sandy fine to coarse subangular to subrounded Gravel | | | |
| 0.50 | B01 | | | | | | | | | |
| 0.80-3.00 | ES03 | | | | 55.17 | 0.80 (1.20) | POSSIBLE MADE GROUND: Greyish brown slightly silty slightly gravelly sandy Clay with occasional subangular to subrounded cobbles. (reworked) | | | |
| 1.00-1.45<br>1.00 | SPT(C) N=5<br>B02 | | | 1,0/1,1,1,2 | | | Soft dark brown slightly sandy slightly gravelly silty CLAY with occasional subangular to subrounded cobbles. Gravel is subangular to subrounded fine to coarse | | | |
| 2.00-2.45<br>2.00 | SPT(C) N=17<br>B03 | | | 1,2/3,4,4,6 | 53.97 | 2.00 (0.70) | Stiff dark brown slightly sandy slightly gravelly silty CLAY with occasional subangular to subrounded cobbles. Gravel is subangular to subrounded fine to coarse | | | |
| | | | | Water strike(1) at 2.70m, fell to 3.20m in 20 mins. | 53.27 | 2.70 (0.60) | Dense grey slightly sandy silty subangular to subrounded fine to coarse GRAVEL<br>Strong hydrocarbon odour odour noted at 3.30m BGL | | ▽1<br>▼1 | |
| 3.00<br>3.00-3.40 | B04<br>SPT(C) 50*/100 N=50 | | | 50/50 | 52.67 | 3.30 | Complete at 3.30m | | | |
| 3.00-3.30 | ES04 | | | | | | | | | |

**Remarks**
Strong hydrocarbon odour noted at 3.30m BGL.
BH-06 terminated at 3.30m BGL due to obstruction.
50mm slotted standpipe installed from 3.30m to 1.00m BGL with pea gravel surrond, plain pipe installed from 1.00m to ground level with bentonite seal and flush cover
Chiselling from 1.20m to 1.20m for 1 hour.

| Scale (approx) | Logged By |
|---|---|
| 1:50 | PM |

**Figure No.**
10299-12-20.BH-06

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| | | | |
|---|---|---|---|
| **Site** Greenhills Road | | | **Borehole Number** BH-07 |
| **Machine :** Dando 2000<br>**Method :** Cable Percussion | **Casing Diameter** 200mm cased to 3.10m | **Ground Level (mOD)** 55.57 | **Client** Lohan and Donnelly |
| | **Location** (dGPS) 710845.7 E 730676.7 N | **Dates** 26/01/2021 | **Project Contractor** GII |
| | | | **Job Number** 10299-12-20 |
| | | | **Sheet** 1/1 |



| Depth (m) | Sample / Tests | Casing Depth (m) | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 55.52 | 0.05 | TARMACADAM | | |
| 0.50 | B01 | | | | | (1.25) | Possible MADE GROUND: Brown gravelly very clayey fine to coarse Sand | | |
| 1.00-1.45<br>1.00<br>1.00 | SPT(C) N=15<br>B02<br>ES01 | | | 3,3/4,3,4,4 | 54.27 | 1.30 | Medium dense grey sandy subangular to subrounded fine to coarse GRAVEL | | |
| | | | | | | (0.70) | | | |
| 2.00-2.44<br>2.00 | SPT(C) 50/285<br>B03 | | | 6,9/10,12,14,14 | 53.57 | 2.00 | Dense grey sandy subangular to subrounded fine to coarse GRAVEL | | |
| | | | | | | (0.60) | | | |
| | | | | | 52.97 | 2.60 | Dense grey subangular to subrounded coarse GRAVEL with some to many subangular to subrounded cobbles | | |
| | | | | | | (0.50) | | | |
| 3.00-3.12<br>3.00 | SPT(C) 25*/100 50/20<br>B04 | | | 17,8/50 | 52.47 | 3.10 | Complete at 3.10m | | |

**Remarks**
BH-07 terminated at 3.10m BGL due to obstruction.
Chiselling from 3.10m to 3.10m for 1 hour.

| Scale (approx) | Logged By |
|---|---|
| 1:50 | SG |

**Figure No.** 10299-12-20.BH-07

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| | | | |
|---|---|---|---|
| **Site** Greenhills Road | | | **Borehole Number** BH-08 |
| **Machine :** Dando 2000<br>**Method :** Cable Percussion | **Casing Diameter** 200mm cased to 3.80m | **Ground Level (mOD)** 55.36 | **Client** Lohan and Donnelly |
| | **Location** (dGPS) 710867.4 E 730633.6 N | **Dates** 26/01/2021 | **Project Contractor** GII |
| | | | **Job Number** 10299-12-20 |
| | | | **Sheet** 1/1 |



| Depth (m) | Sample / Tests | Casing Depth (m) | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water | Instr |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 55.26 | 0.10 (0.20) | TARMACADAM | | | |
| | | | | | 55.06 | 0.30 | Drillers Note: MADE GROUND: Gravel | | | |
| 0.50 | B01 | | | | | (0.60) | MADE GROUND: Orangish brown slightly sandy slightly gravelly CLAY with organic odour | | | |
| | | | | | 54.46 | 0.90 | | | | |
| 1.00-1.45<br>1.00 | SPT(C) N=20<br>B02 | | | 2,2/3,5,6,6 | | (0.70) | Medium dense dark brown clayey gravelly fine to coarse SAND. Gravel is subangular to subrounded fine to coarse | | | |
| | | | | | 53.76 | 1.60 | | | | |
| | | | | | | (0.50) | Medium dense brown slightly gravelly very silty fine to coarse SAND. Gravel is subrounded fine to coarse | | | |
| 2.00-2.45<br>2.00<br>2.00 | SPT(C) N=14<br>B03<br>ES01 | | | 2,2/3,3,4,4 | 53.26 | 2.10 | | | | |
| | | | | | | (0.40) | Drillers note: Brown sandy gravelly Clay (stiff) | | | |
| | | | | | 52.86 | 2.50 (0.20) | | | | |
| | | | | | 52.66 | 2.70 | Drillers note: pushing cobble in front of casing. No recovery | | | |
| 3.00 | B04 | | | Water strike(1) at 3.00m, rose to 2.90m in 20 mins, sealed at 3.20m. | | (1.10) | Very stiff grey slightly sandy slightly gravelly CLAY. Gravely is subangular to subrounded fine to coarse | | ▼1 | |
| 3.00-3.29 | SPT(C) 50/135 | | | 6,9/17,33 | | | | | | |
| 3.80<br>3.80 | B05<br>ES02 | | | | 51.56 | 3.80 | Complete at 3.80m | | | |

**Remarks**
50mm slotted standpipe installed from 3.80m to 1.00m BGL with pea gravel surrond, plain pipe installed from 1.00m to ground level with bentonite seal and flush cover
BH-08 terminated at 3.80m BGL due to obstruction.
Chiselling from 3.80m to 3.80m for 1 hour.

| Scale (approx) | Logged By |
|---|---|
| 1:50 | SG |

**Figure No.** 10299-12-20.BH-08

# Appendix G – Infiltration Test Ground Investigations Report

GROUND INVESTIGATIONS IRELAND
Geotechnical & Environmental

Catherinestown House,
Hazelhatch Road,
Newcastle,
Co. Dublin.
D22 YD52

Tel: 01 601 5175 / 5176
Email: info@gii.ie
Web: www.gii.ie



# Ground Investigations Ireland

# Greenhills Road

# Lohan & Donnelly

# Ground Investigation Report

# September 2023

GROUND INVESTIGATIONS IRELAND
Geotechnical & Environmental

Catherinestown House,
Hazelhatch Road,
Newcastle,
Co. Dublin.
D22 YD52

Tel: 01 601 5175 / 5176
Email: info@gii.ie
Web: www.gii.ie



## *DOCUMENT CONTROL SHEET*

| | |
|---|---|
| Project Title | Soakaways Greenhills Road |
| Engineer | Lohan & Donnelly |
| Project No | 13058-08-23 |
| Document Title | Ground Investigation Report |

| Rev. | Status | Author(s) | Reviewed By | Approved By | Office of Origin | Issue Date |
|---|---|---|---|---|---|---|
| A | Final | B Sexton | C Finerty | B Sexton | Dublin | 19 September 2023 |

*Ground Investigations Ireland Ltd. present the results of the fieldworks and laboratory testing in accordance with the specification and related documents provided by or on behalf of the client The possibility of variation in the ground and/or groundwater conditions between or below exploratory locations or due to the investigation techniques employed must be taken into account when this report and the appendices inform designs or decisions where such variation may be considered relevant. Ground and/or groundwater conditions may vary due to seasonal, man-made or other activities not apparent during the fieldworks and no responsibility can be taken for such variation. The data presented and the recommendations included in this report and associated appendices are intended for the use of the client and the client's geotechnical representative only and any duty of care to others is excluded unless approved in writing.*

GROUND INVESTIGATIONS IRELAND
Geotechnical & Environmental

Catherinestown House,
Hazelhatch Road,
Newcastle,
Co. Dublin.
D22 YD52

Tel: 01 601 5175 / 5176
Email: info@gii.ie
Web: www.gii.ie



## CONTENTS



## APPENDICES

## 1.0 Preamble

On the instructions of Lohan & Donnelly Consulting Engineers, a site investigation was carried out by Ground Investigations Ireland Ltd., in August 2023 at the site of the proposed development in Greenhills Road, Dublin 12.

## 2.0 Overview

### 2.1. Background

It is proposed to construct a new development with associated services, access roads and car parking at the proposed site. The site was historically used as a gravel quarry, with a large retaining wall structure marking the southwestern boundary of the site. The site is currently occupied by several industrial/commercial buildings and is situated near the Walkinstown Roundabout, on the southern side of Greenhills Road (R918), Dublin 12.

### 2.2. Purpose and Scope

The purpose of the site investigation was to investigate subsurface conditions utilising a variety of investigative methods in accordance with the project specification. The scope of the work undertaken for this project included the following:

- Visit project site to observe existing conditions
- Carry out 3 No. Trial Pits to a maximum depth of 1.80m BGL
- Carry out 3 No. Soakaways to determine a soil infiltration value to BRE digest 365
- Report with recommendations

## 3.0 Subsurface Exploration

### 3.1. General

During the ground investigation a programme of intrusive investigation specified by the Consulting Engineer was undertaken to determine the sub surface conditions at the proposed site. Regular sampling and in-situ testing was undertaken in the exploratory holes to facilitate the geotechnical descriptions and to enable laboratory testing to be carried out on the soil samples recovered during excavation and drilling.
The procedures used in this site investigation are in accordance with Eurocode 7 Part 2: Ground Investigation and testing (ISEN 1997 – 2:2007) and B.S. 5930:2015.

### 3.2. Trial Pits

The trial pits were excavated using a JCB 3CX excavator at the locations shown in the exploratory hole location plan in Appendix 1. The locations were checked using a CAT scan to minimise the potential for encountering services during the excavation. The trial pits were sampled, logged and photographed by a Geotechnical Engineer/Engineering Geologist prior to backfilling with arisings. Notes were made of any

services, inclusions, pit stability, groundwater encountered and the characteristics of the strata encountered and are presented on the trial pit logs which are provided in Appendix 2 of this Report.



### 3.3. Soakaway Testing

The soakaway testing was carried out in selected trial pits at the locations shown in the exploratory hole location plan in Appendix 1. These pits were carefully excavated and filled with water to assess the infiltration characteristics of the proposed site. The pits were allowed to drain and the drop in water level was recorded over time as required by BRE Digest 365. The pits were logged prior to completing the soakaway test and were backfilled with arising's upon completion. The soakaway test results are provided in Appendix 3 of this Report.

## 4.0 Ground Conditions

### 4.1. General

The ground conditions encountered during the investigation are summarised below with reference to insitu and laboratory test results. The full details of the strata encountered during the ground investigation are provided in the exploratory hole logs included in the appendices of this report.

The sequence of strata encountered were relatively consistent across the site and generally comprised;

- Surfacing
- Fill
- Made Ground
- Cohesive Deposits
- Granular Deposits

**SURFACING:** Tarmacadam was encountered at all locations ad was present to a maximum depth of 0.10m BGL.

**FILL:** Fill material comprised of crushed rock was encountered beneath the tarmacadam to a maximum depth of 0.25m BGL.

**MADE GROUND:** Made Ground deposits were encountered beneath the fill material at all locations and was present to a depth of between 0.50m and 1.30m BGL. These deposits were described generally as *slightly sandy slightly gravelly Clay with rare fragments of red brick, metal, yellow brick, ceramic and concrete.*

**COHESIVE DEPOSITS:** Cohesive deposits were encountered beneath the Made Ground in two of the three locations and were described typically as *brown to dark brown slightly sandy gravelly CLAY*. The secondary sand and gravel constituents varied across the site and with depth, with granular lenses

occasionally present in the glacial till matrix. These deposits had some, occasional or frequent cobble and boulder content, where noted on the exploratory hole logs.



**GRANULAR DEPOSITS:** Granular deposits were encountered below the made ground deposits in SA02 and were described as *brown slightly gravelly clayey fine to medium SAND with low cobble content.* The secondary sand/gravel and silt/clay constituents varied across the site and with depth while occasional or frequent cobble and boulder content also present where noted on the exploratory hole logs.

## 5.0 Recommendations & Conclusions

### 5.1. General

The recommendations given and opinions expressed in this report are based on the findings as detailed in the exploratory hole records. Where an opinion is expressed on the material between exploratory hole locations, this is for guidance only and no liability can be accepted for its accuracy. No responsibility can be accepted for conditions which have not been revealed by the exploratory holes. Limited information has been provided at the ground investigation stage and any designs based on the recommendations or conclusions should be completed in accordance with the current design codes, taking into account the variation and the specific details contained within the exploratory hole logs.

### 5.2. Soakaway Design

Infiltration rates of f=1.042 x $10^{-5}$ m/s, 8.530 x $10^{-6}$ m/s and 2.422 x $10^{-5}$ m/s respectively were calculated for the soakaway locations SA01, SA02 and SA03 respectively.

The recommendations provided in this report should be verified in the design of the proposed buildings, using the full details of the loading conditions and taking into consideration the allowable tolerable settlements/movements that the building can accommodate. The founding strata should be inspected and verified by a suitably qualified engineer prior to construction of the building foundations.

# **APPENDIX 1** - Site Location Plan


Site Location

Indicative Site Boundary

Trial Pit & Soakaway

**Client:**

**Project Code:**
13058-08-23

**Project Title:**
Greenhills Road

**Drawing Title:**
Figure 1 Site Location and Layout

GROUND INVESTIGATIONS IRELAND
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Ground Investigations Ireland Ltd.
Catherinstown House,
Hazelhatch Road,
Newcastle, Co. Dublin
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0 10 20 30 40 50 m

| Drawn By: | Date: |
|---|---|
| BS | 08-09-2022 |

# **APPENDIX 2** – Trial Pit Records

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| | | | |
|---|---|---|---|
| **Site** Greenhills Soakaway | | | **Trial Pit Number** SA01 |
| **Machine :** JCB 3CX<br>**Method :** Trial Pit | **Dimensions** 2.30m x 0.80m x 1.70m (L x W x D) | **Ground Level (mOD)** | **Client** Lohan & Donnelly |
| | **Location** | **Dates** 31/08/2023 | **Engineer** |
| | | | **Job Number** 13058-08-23 |
| | | | **Sheet** 1/1 |



| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|---|---|---|---|---|---|---|---|---|
| | | | | | (0.10) 0.10 | MADE GROUND: TARMAC | | |
| | | | | | (0.15) 0.25 | MADE GROUND: Crushed Rock Fill | | |
| | | | | | (0.25) 0.50 | MADE GROUND: Brown slightly sandy slightly gravelly Clay with rare fragments of concrete | | |
| | | | | | (0.80) 1.30 | Firm brown slightly gravelly sandy CLAY with low cobble content | | |
| | | | | | (0.40) 1.70 | Firm to stiff dark brownish grey slightly gravelly sandy CLAY | | |
| | | | | | | Complete at 1.70m | | |

**Plan**

**Remarks**

No groundwater encountered
Trial pit stable
Trial pit complete at 1.70m BGL
Trial pit backfilled upon completion

| Scale (approx) | Logged By | Figure No. |
|---|---|---|
| 1:25 | SB | 13058-08-23.SA01 |

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| | | | |
|---|---|---|---|
| **Site** Greenhills Soakaway | | | **Trial Pit Number** SA02 |
| **Machine :** JCB 3CX<br>**Method :** Trial Pit | **Dimensions** 2.10m x 0.90m x 1.70m (L x W x D) | **Ground Level (mOD)** | **Client** Lohan & Donnelly |
| | **Location** | **Dates** 31/08/2023 | **Engineer** |
| | | | **Job Number** 13058-08-23 |
| | | | **Sheet** 1/1 |



| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|---|---|---|---|---|---|---|---|---|
| | | | | | 0.05 | MADE GROUND: TARMAC | | |
| | | | | | (0.15) | MADE GROUND: Crushed Rock Fill | | |
| | | | | | 0.20 | MADE GROUND: Brown slightly sandy slightly gravelly CLAY with medium cobble content and rare fragments of red brick, concrete and metal | | |
| | | | | | (1.00) | | | |
| | | | | | 1.20 | Firm brown slightly gravelly clayey fine to medium SAND with low cobble content | | |
| | | | | | (0.50) | | | |
| | | | | | 1.70 | Complete at 1.70m | | |

**Plan**

**Remarks**

No groundwater encountered
Trial pit stable
Trial pit complete at 1.70m BGL
Trial pit backfilled upon completion

| Scale (approx) | Logged By | Figure No. |
|---|---|---|
| 1:25 | SB | 13058-08-23.SA01 |

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| | | | |
|---|---|---|---|
| **Site** Greenhills Soakaway | | | **Trial Pit Number** SA03 |
| **Machine :** JCB 3CX<br>**Method :** Trial Pit | **Dimensions** 2.20m x 0.80m x 1.80m (L x W x D) | **Ground Level (mOD)** | **Client** Lohan & Donnelly |
| | | | **Job Number** 13058-08-23 |
| | **Location** | **Dates** 31/08/2023 | **Engineer** |
| | | | **Sheet** 1/1 |



| Depth (m) | Sample / Tests | Water Depth (m) | Field Records | Level (mOD) | Depth (m) (Thickness) | Description | Legend | Water |
|---|---|---|---|---|---|---|---|---|
| | | | | | (0.10) 0.10 | MADE GROUND: TARMAC | | |
| | | | | | 0.15 | MADE GROUND: Crushed Rock Fill | | |
| | | | | | (1.15) | MADE GROUND: Brown slightly sandy slightly gravelly CLAY with low cobble content and rare fragments of red brick, yellow brick and ceramic | | |
| | | | | | 1.30 | | | |
| | | | | | (0.50) | Firm brown slightly sandy gravelly CLAY with low cobble content | | |
| | | | | | 1.80 | Complete at 1.80m | | |

**Plan**

**Remarks**

No groundwater encountered
Trial pit stable
Trial pit complete at 1.80m BGL
Trial pit backfilled upon completion

| Scale (approx) | Logged By | Figure No. |
|---|---|---|
| 1:25 | SB | 13058-08-23.SA03 |

# Greenhills Soakaways – Soakaway Photographs

## SA01



## SA01

# Greenhills Soakaways – Soakaway Photographs

## SA01



## SA01

# Greenhills Soakaways – Soakaway Photographs

## SA02



## SA02

# Greenhills Soakaways – Soakaway Photographs

## SA02



## SA02

# Greenhills Soakaways – Soakaway Photographs

## SA03



## SA03

# Greenhills Soakaways – Soakaway Photographs



## SA03

## SA03

# **APPENDIX 3** – Soakaway Test Records

GROUND INVESTIGATIONS IRELAND
Geotechnical & Environmental

Catherinestown House,
Hazelhatch Road,
Newcastle,
Co. Dublin.
D22 YD52

Tel: 01 601 5175 / 5176
Email: info@gii.ie
Web: www.gii.ie

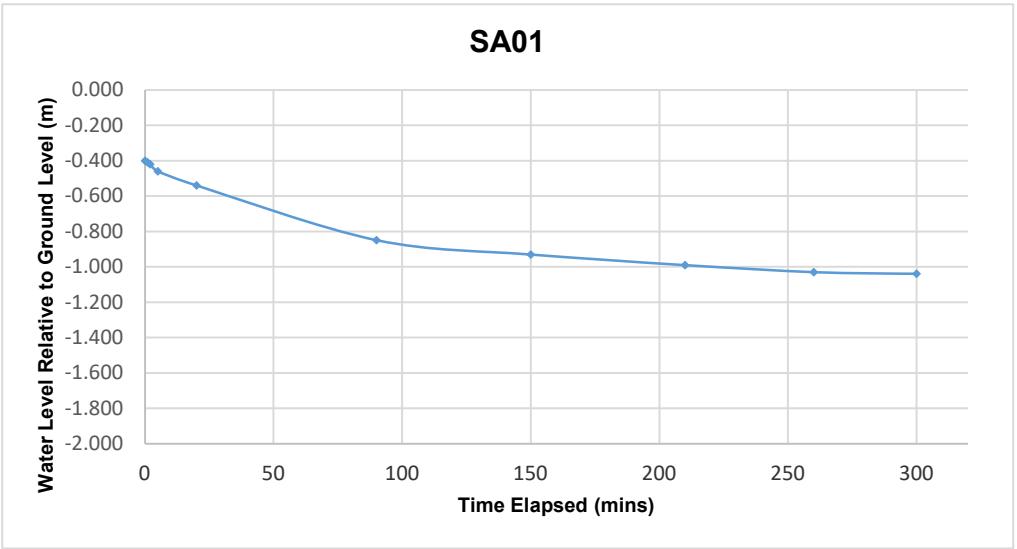


## SA01

**Soakaway Test to BRE Digest 365**
**Trial Pit Dimensions: 1.80m x 0.80m x 1.70m (L x W x D)**

| Date | Time | Water level (m bgl) |
|---|---|---|
| 31/08/2023 | 0 | -0.400 |
| 31/08/2023 | 1 | -0.410 |
| 31/08/2023 | 2 | -0.420 |
| 31/08/2023 | 5 | -0.460 |
| 31/08/2023 | 20 | -0.540 |
| 31/08/2023 | 90 | -0.850 |
| 31/08/2023 | 150 | -0.930 |
| 31/08/2023 | 210 | -0.990 |
| 31/08/2023 | 260 | -1.030 |
| 31/08/2023 | 300 | -1.040 |

| Start depth | Depth of Pit | | Diff | 75% full | 25%full |
|---|---|---|---|---|---|
| **0.40** | **1.700** | | **1.300** | **0.725** | **1.375** |
| Length of pit (m) | Width of pit (m) | | | 75-25Ht (m) | Vp75-25 (m3) |
| 1.800 | 0.800 | | | 0.650 | 0.94 |
| Tp75-25 (from graph) (s) | | **18628** | | 50% Eff Depth | ap50 (m2) |
| | | | | 0.650 | 4.82 |
| **f =** | **1.042E-05** | **m/s** | | | |



GROUND INVESTIGATIONS IRELAND
Geotechnical & Environmental

Catherinestown House,
Hazelhatch Road,
Newcastle,
Co. Dublin.
D22 YD52

Tel: 01 601 5175 / 5176
Email: info@gii.ie
Web: www.gii.ie

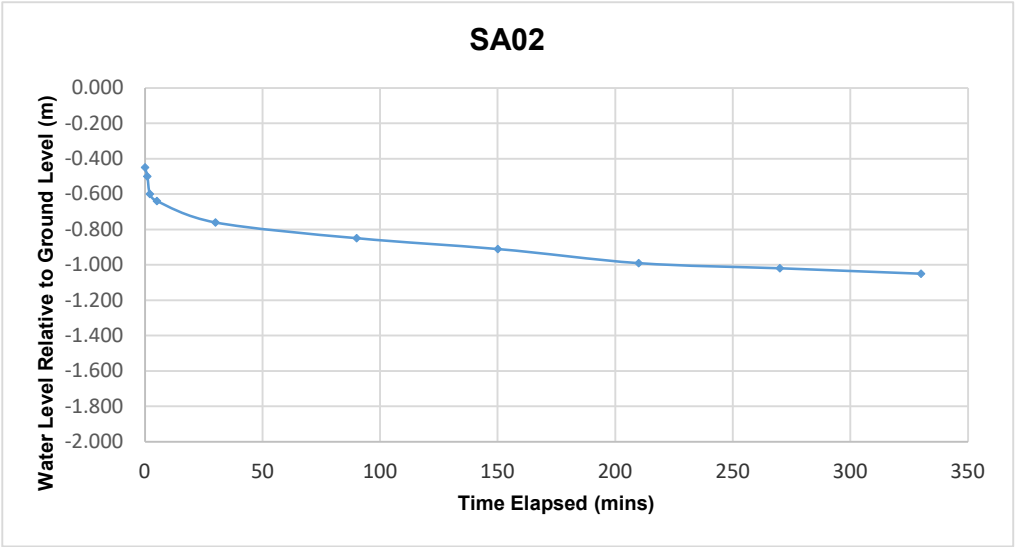


## SA02

**Soakaway Test to BRE Digest 365**
**Trial Pit Dimensions: 1.80m x 0.80m x 1.70m (L x W x D)**

| Date | Time | Water level (m bgl) |
|---|---|---|
| 31/08/2023 | 0 | -0.450 |
| 31/08/2023 | 1 | -0.500 |
| 31/08/2023 | 2 | -0.600 |
| 31/08/2023 | 5 | -0.640 |
| 31/08/2023 | 30 | -0.760 |
| 31/08/2023 | 90 | -0.850 |
| 31/08/2023 | 150 | -0.910 |
| 31/08/2023 | 210 | -0.990 |
| 31/08/2023 | 270 | -1.020 |
| 31/08/2023 | 330 | -1.050 |

| Start depth | Depth of Pit | | Diff | 75% full | 25%full |
|---|---|---|---|---|---|
| **0.45** | **1.700** | | **1.250** | **0.7625** | **1.3875** |
| Length of pit (m) | Width of pit (m) | | | 75-25Ht (m) | Vp75-25 (m3) |
| 1.700 | 0.900 | | | 0.625 | 0.96 |
| Tp75-25 (from graph) (s) | | **23453** | | 50% Eff Depth | ap50 (m2) |
| | | | | 0.625 | 4.78 |
| **f =** | **8.530E-06** | **m/s** | | | |



GROUND INVESTIGATIONS IRELAND
Geotechnical & Environmental

Catherinestown House,
Hazelhatch Road,
Newcastle,
Co. Dublin.
D22 YD52

Tel: 01 601 5175 / 5176
Email: info@gii.ie
Web: www.gii.ie



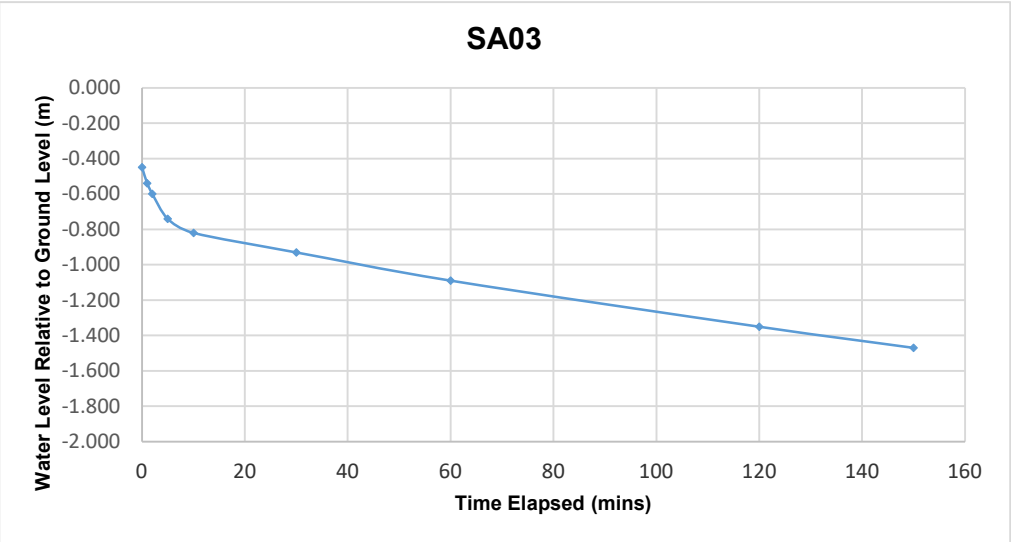
## SA03

**Soakaway Test to BRE Digest 365**
**Trial Pit Dimensions: 2.00m x 0.80m x 1.80m (L x W x D)**

| Date | Time | Water level (m bgl) |
|---|---|---|
| 31/08/2023 | 0 | -0.450 |
| 31/08/2023 | 1 | -0.540 |
| 31/08/2023 | 2 | -0.600 |
| 31/08/2023 | 5 | -0.740 |
| 31/08/2023 | 10 | -0.820 |
| 31/08/2023 | 30 | -0.930 |
| 31/08/2023 | 60 | -1.090 |
| 31/08/2023 | 120 | -1.350 |
| 31/08/2023 | 150 | -1.470 |

| Start depth | Depth of Pit | | Diff | 75% full | 25%full |
|---|---|---|---|---|---|
| **0.45** | **1.800** | | **1.350** | **0.7875** | **1.4625** |

| Length of pit (m) | Width of pit (m) | | 75-25Ht (m) | Vp75-25 (m3) |
|---|---|---|---|---|
| 1.700 | 0.900 | | 0.675 | 1.03 |
| Tp75-25 (from graph) (s) | | **8460** | 50% Eff Depth | ap50 (m2) |
| | | | 0.675 | 5.04 |
| **f =** | **2.422E-05** | **m/s** | | |

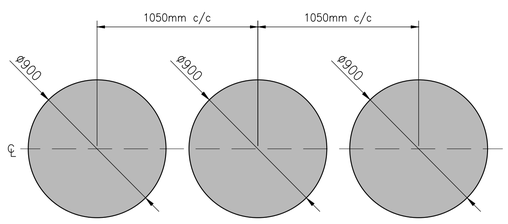


# Appendix H – Ayesa Geotechnical Design Report & Drawings

A1


LEGEND:
- WALL TYPE 01 (WT01)

PLAN 1:150 CONTIGUOUS PILE LAYOUT
SCALE 1:150




TYP 1:20 CONTIGUOUS PILE TYPICAL SET-OUT
SCALE 1:20

GENERAL NOTES

1. DO NOT SCALE FROM DRAWING – USE FIGURED DIMENSIONS ONLY.
2. PILE LOCATIONS SHOWN INDICATIVELY. SETTING OUT OF PILES BY OTHERS.
3. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.
4. ALL PILES ARE TO BE DESIGNED IN ACCORDANCE WITH I.S. EN 1997-1:2004 EUROCODE 7; GEOTECHNICAL DESIGN – GENERAL RULES AND THE IRISH NATIONAL ANNEX.
5. DESIGN LIFE OF PILES = 60 YEARS.
6. PILES TO BE INSTALLED TO SPECIFIED TOE LEVELS DETAILED ON SECTIONS.
7. PILE REINFORCEMENT TO BE PROVIDED AS PER SECTIONS AND DETAILS SHOWN.
8. REINFORCEMENT TO BE MINIMUM GRADE 500B.
9. MINIMUM COVER TO REINFORCEMENT 75mm UNLESS NOTED OTHERWISE.
10. DE-BONDING FOAM TO REINFORCEMENT OVER PROJECTION LENGTH IS RECOMMENDED FOR EASE OF PILE CROPPING.
11. DESIGN OF PILE CAPS/GROUND BEAMS BY OTHERS.
12. CONCRETE (DETAILED MIX DESIGN BY OTHERS):
    - MIN. CONCRETE GRADE = C30/37 TO BE CONFIRMED ACCEPTABLE BCME GROUP
    - MAX AGGREGATE SIZE = 20mm
    - MIN. EXPOSURE CLASS = XA2, XC2
15. ALL CONCRETE TO CONFORM TO IS EN 1536: 2010 AND SHOULD CONFORM TO A 60 YEAR DESIGN LIFE IN ACCORDANCE WITH IS EN 206: 2013.
16. CONCRETE TESTING REQUIREMENTS:
    - A MINIMUM OF 4 NO. CUBES SHALL BE MADE FROM EACH SAMPLE.
    - 1 NO. SAMPLE PER SHIFT; AND
    - FOR EVERY 50m$^3$ OF CONCRETE CAST DURING THE SAME SHIFT.
17. PILE DESIGN TO BE VALIDATED BY THE FOLLOWING TESTING REGIME:
    - ALL WORKING PILES TO BE INTEGRITY TESTED.
18. GROUND CONDITIONS BASED ON SITE INVESTIGATION INFORMATION. AYESA TO BE NOTIFIED IF CONDITIONS ENCOUNTERED DURING PILING WORKS DIFFER SUBSTANTIALLY FROM DESIGN GROUND PROFILE.

| Rev | Date | Description | By | Chk | App |
|---|---|---|---|---|---|
| 00 | 09/07/24 | FOR REVIEW | AI | SP | NP |

ayesa

CLIENT
LOHAN AND DONNELLY CONSULTING ENGINEERS

PROJECT
GREENHILLS ROAD

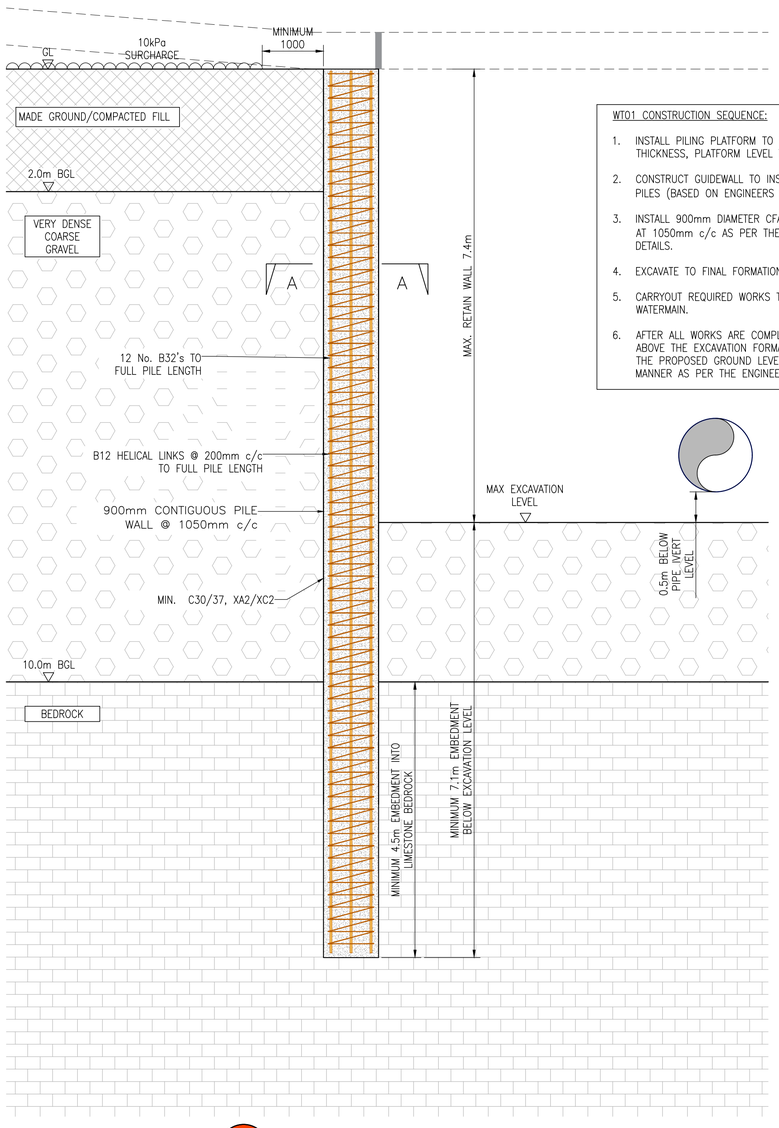
DRAWING TITLE
CONTIGUOUS PILE LAYOUT

| STATUS | SUITABILITY |
|---|---|
| FOR REVIEW | – |

| Date: 09/07/24 | Scale: AS NOTED | Drawn: AI | Chk: SP | App: NP |
|---|---|---|---|---|

| Project No: | Drg. No: | Rev: |
|---|---|---|
| B2156 | B2156-1000 | 00 |

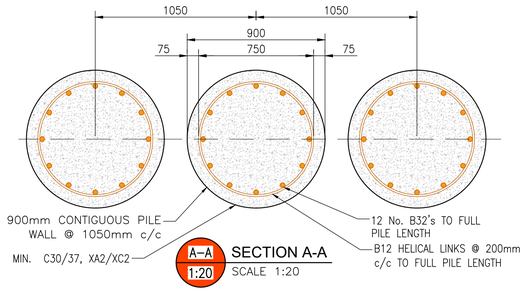
A1




WT01 CONSTRUCTION SEQUENCE:

1. INSTALL PILING PLATFORM TO REQUIRED THICKNESS, PLATFORM LEVEL TBC.
2. CONSTRUCT GUIDEWALL TO INSTALL CONTIGUOUS PILES (BASED ON ENGINEERS SET OUT).
3. INSTALL 900mm DIAMETER CFA CONTIGUOUS PILES AT 1050mm c/c AS PER THE DRAWING SECTION DETAILS.
4. EXCAVATE TO FINAL FORMATION LEVEL.
5. CARRYOUT REQUIRED WORKS TO EXISTING WATERMAIN.
6. AFTER ALL WORKS ARE COMPLETED, BACKFILL ABOVE THE EXCAVATION FORMATION LEVEL UP TO THE PROPOSED GROUND LEVEL IN A CONTROLLED MANNER AS PER THE ENGINEERS SPECIFICATION

WT01 1:50 WALL TYPE 01 SECTION (WT01)
SCALE 1:50




A-A 1:20 SECTION A-A
SCALE 1:20

RECEIVED: 15/05/2025

GENERAL NOTES

1. DO NOT SCALE FROM DRAWING – USE FIGURED DIMENSIONS ONLY.
2. PILE LOCATIONS SHOWN INDICATIVELY. SETTING OUT OF PILES BY OTHERS.
3. ALL DIMENSIONS IN MILLIMETRES UNLESS NOTED OTHERWISE.
4. ALL PILES ARE TO BE DESIGNED IN ACCORDANCE WITH I.S. EN 1997-1:2004 EUROCODE 7; GEOTECHNICAL DESIGN – GENERAL RULES AND THE IRISH NATIONAL ANNEX.
5. DESIGN LIFE OF PILES = 60 YEARS.
6. PILES TO BE INSTALLED TO SPECIFIED TOE LEVELS DETAILED ON SECTIONS.
7. PILE REINFORCEMENT TO BE PROVIDED AS PER SECTIONS AND DETAILS SHOWN.
8. REINFORCEMENT TO BE MINIMUM GRADE 500B.
9. MINIMUM COVER TO REINFORCEMENT 75mm UNLESS NOTED OTHERWISE.
10. DE-BONDING FOAM TO REINFORCEMENT OVER PROJECTION LENGTH IS RECOMMENDED FOR EASE OF PILE CROPPING.
11. DESIGN OF PILE CAPS/GROUND BEAMS BY OTHERS.
12. CONCRETE (DETAILED MIX DESIGN BY OTHERS):
    - MIN. CONCRETE GRADE = C30/37 TO BE CONFIRMED ACCEPTABLE BCME GROUP
    - MAX AGGREGATE SIZE = 20mm
    - MIN. EXPOSURE CLASS = XA2, XC2
15. ALL CONCRETE TO CONFORM TO IS EN 1536: 2010 AND SHOULD CONFORM TO A 60 YEAR DESIGN LIFE IN ACCORDANCE WITH IS EN 206: 2013.
16. CONCRETE TESTING REQUIREMENTS:
    - A MINIMUM OF 4 NO. CUBES SHALL BE MADE FROM EACH SAMPLE.
    - 1 NO. SAMPLE PER SHIFT; AND
    - FOR EVERY 50m$^3$ OF CONCRETE CAST DURING THE SAME SHIFT.
17. PILE DESIGN TO BE VALIDATED BY THE FOLLOWING TESTING REGIME:
    - ALL WORKING PILES TO BE INTEGRITY TESTED.
18. GROUND CONDITIONS BASED ON SITE INVESTIGATION INFORMATION. AYESA TO BE NOTIFIED IF CONDITIONS ENCOUNTERED DURING PILING WORKS DIFFER SUBSTANTIALLY FROM DESIGN GROUND PROFILE.

| Rev | Date | Description | By | Chk | App |
|---|---|---|---|---|---|
| 00 | 09/07/24 | FOR REVIEW | AI | SP | NP |

CLIENT
LOHAN AND DONNELLY CONSULTING ENGINEERS

PROJECT
GREENHILLS ROAD

DRAWING TITLE
CONTIGUOUS PILE WALL SECTIONS AND DETAILS

STATUS: FOR REVIEW
SUITABILITY: –

Date: 09/07/24 | Scale: AS NOTED | Drawn: AI | Chk: SP | App: NP

Project No: B2156 | Drg. No: B2156-1001 | Rev: 00

# Contiguous Pile Wall Geotechnical Design Report (GDR)

Greenhills Road

Report No. B2156-AYE-GEO-RP001

08 July 2024

Revision 01

Lohan & Donnelly Consulting Engineers

# Document Control



**Project**

Greenhills Road

**Client**

Lohan & Donnelly Consulting Engineers

**Document**

Contiguous Pile Wall Geotechnical Design Report (GDR)

**Report Number:**

B2156-AYE-GEO-RP001

**Document Checking:**

| Date | Rev | Details of Issue | Prepared by | Checked by | Approved by |
|---|---|---|---|---|---|
| 24 July 2024 | 00 | For Information | Subhasish Pasupalak | Keith Jennings | Nick Peters |
| 25 July 2004 | 01 | For Information | Subhasish Pasupalak | Keith Jennings | Nick Peters |
| | | | | | |

**Disclaimer: Please note that this report is based on specific information, instructions, and information from our Client and should not be relied upon by third parties.**

**www.ayesaeng.com**

**www.ayesa.com/en**

# Contents

# [1] Introduction



Ayesa have been requested to complete the design of a contiguous pile wall for the proposed development at Greenhills Rd, Greenhills, Dublin 12. The design has been completed on behalf of the LOHAN & DONNELLY Consulting Engineers (LDCE).

It has been proposed to install a 900mm diameter bored contiguous piles to act as a retention system for the proposed excavation. A contiguous pile wall is required to support the excavation works that may be required to access the existing 1200mm diameter watermain. It is understood that this retaining system is to be a permanent structure that at some point in the future may have a temporary function and Ayesa have progressed the design on this basis. It is proposed to install a 900mm diameter contiguous pile wall at 1,050mm centres. This report sets out the full details of the contiguous pile wall design package.

## [1.1] Design Standards & Codes of Practice

The geotechnical design of the piles will be completed in accordance with the following standards:

- I.S. EN 1997-1:2004 Eurocode 7: Geotechnical Design – General Rules
- I.S. EN 1536: 2010: Execution of Special Geotechnical Work – Bored Piles
- BS8004:2015 Code of Practice for Foundations

The recommendations of CIRIA C760 Guidance for Embedded Retaining Walls are also considered. The structural design and execution of the piles will be completed in accordance with the following design standards:

- I.S. EN 1992-1-1:2004 Eurocode 2: Design of Concrete Structures
- I.S. EN206: 2013 Concrete – Specification, performance, production and conformity
- Irish National Annex to each of the above

## [1.2] Design Deliverables

As per the requirement of IS EN 1997, the design assumptions, data, methods of calculation and results of the checking of safety and serviceability should be recorded in a Geotechnical Design Report (GDR) for all geotechnical designs, including small and relatively simple structures in straightforward ground conditions. This information contained within this report conforms to the IS EN 1997 requirements of a geotechnical design report (GDR).

As part of our agreed services, we will produce the following deliverables that will be issued to our client:

- Design Deliverables:
  - Geotechnical Design Report (GDR) for the design of the permanent works Contiguous piled wall.

- Drawing deliverables:
  - Foundation piles and Contiguous piled wall layout plan drawings and sections.

# [2] Site Details



## [2.1] Site Location & Description

The site is located along the R819 road Greenhills Rd, Dublin 12, Ireland. It is located immediate southwest to Walkinstown Roundabout on R819 road. The site location plan and aerial view is detailed in Figure 2.1 & Figure 2.2 below.


**Figure 2.1 Site location plan.**


**Figure 2.2 Aerial view (ref: Google maps).**

## [2.2] Proposed Development



A contiguous piled solution is proposed on both sides of an existing 1200mm ductile iron watermain. The inner-to-inner face of the wall is to be 14.0m allowing for 6.4m working space either side of the existing watermain. The purpose of the piled wall is to facilitate excavations to access the watermain where the cover level over the crown of the pipe exceeds 4.0m.

The overall pipe alignment is presented in Figure 2.3. The localised portion of the section having an overburden cover more than 4.0m up to maximum of 7.4m is presented in Figure 2.4. The piling method adopted is bored pilling, which is considered appropriate as the ground conditions are MADE GROUND underlain by Coarse GRAVEL and Bedrock.

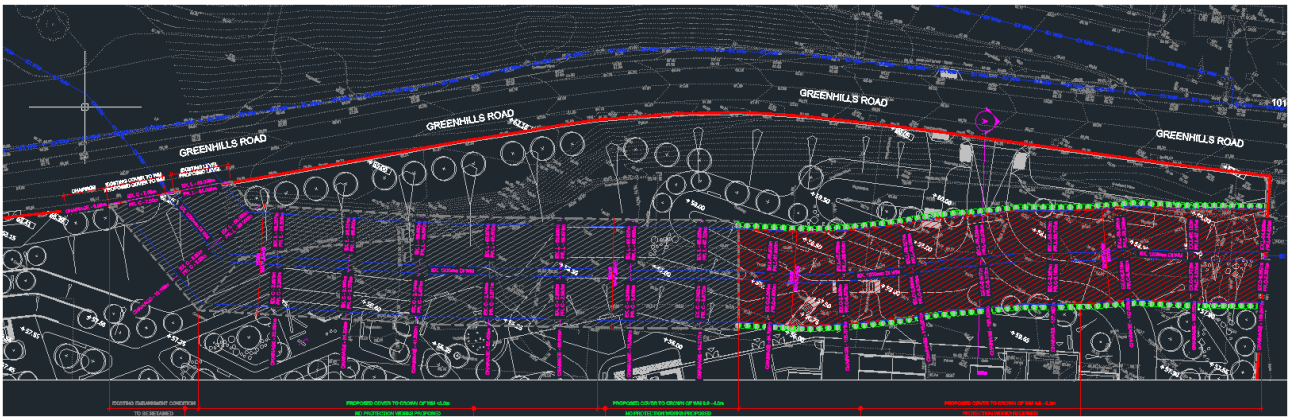



**Figure 2.3 Pipe alignment along the development area (ref. drg no. 20189-LDE-ZZ-ZZ-M2-C-0001 Wayleave)**

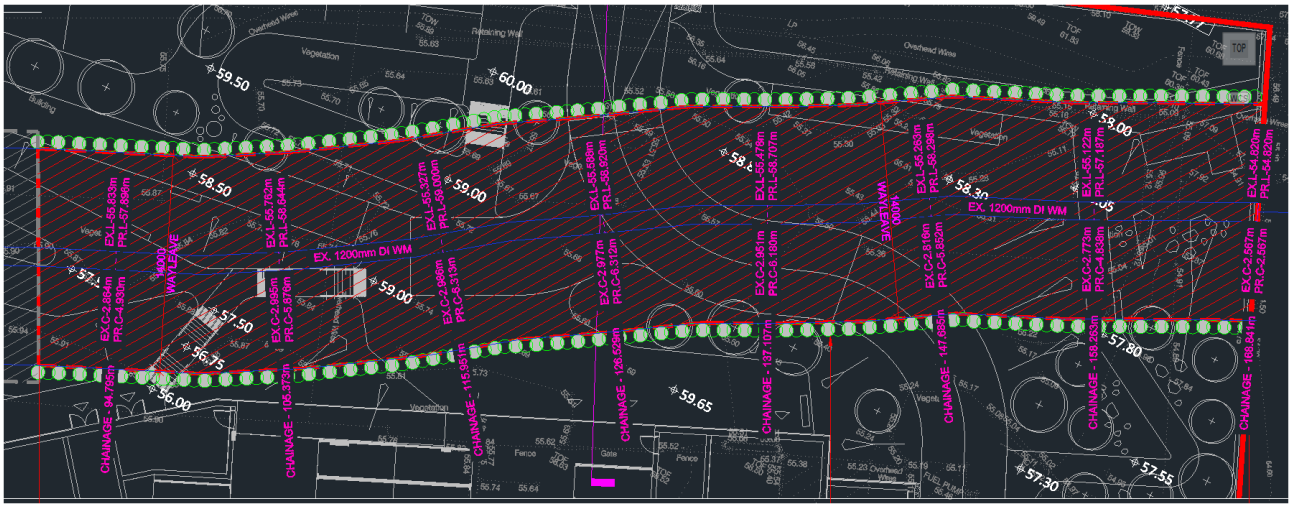



**Figure 2.4 Section showing the cover more than 4.0m**

# [3] Information Received



The following information has been received by Ayesa and forms the basis of the detailed design. Ayesa offers no guarantees or warranties for the completeness of the information provided.

## [3.1] Site Investigation Information

On the instructions of Lohan & Donnelly Consulting Engineers, Ground investigations Ireland (GII) completed a site investigation in Feb – Mar 2021. The details are as follows:

- Document Title: Ground Investigations Report Rev A
  - Project Title: Greenhills Road
  - Project Number: 10299-12-20
  - Engineer: Lohan & Donnelly Consulting Engineers
  - Issue Date: 09 March 2021

- Document Title: Environmental Assessment Report Rev A
  - Project Title: Greenhills Road
  - Project Number: 10299-12-20
  - Engineer: Lohan & Donnelly Consulting Engineers
  - Issue Date: 26 February 2021

- Document Title: Ground Investigations Report Rev 0
  - Project Title: Greenhills Road
  - Project Number: 10299-12-20
  - Engineer: Lohan & Donnelly Consulting Engineers
  - Issue Date: 17 February 2021

In addition to above the geotechnical investigation carried out adjacent to the current site available in GSI is also considered. The details of the reports were as below:

- GSI File name: 63174871
  - Site investigations at Walkinstown
  - CHADWICKS DUBLIN LIMITED

## [3.2] Engineer's Drawings

The following information has been provided by Lohan & Donnelly Consulting Engineers as part of the design package:

- Pipe alignment and sections
  - 20189-LDE-ZZ-ZZ-M2-C-0001 Wayleave
- Elevations:
  - MSL39720_EL_ITM_Rev0
- Topographical survey:
  - MSL39720_T_ITM_2d_Rev0
  - MSL39720_T_ITM_3d_Rev0

## [3.3] Pile Layout and Loadings

The Contiguous pile layout is detailed in drawing no. 20189-LDE-ZZ-ZZ-M2-C-0001 Wayleave. This is presented in Figure 2.4.



## [3.4] Piling Technique

Lohan & Donnelly Consulting Engineers have proposed to use an embedded pile wall solution to retain the ground and facilitate access to the existing watermain. From experience, depending on the piling contractor awarded the project, the piling techniques will consist of either of the following:

- Option 1 - Rotary Bored Piling:
    - This technique consists of using a temporary cased rotary bored technique in the overburden above the rock, once the rock is encountered, the rock socket is bored using down to the required depth using a coring bucket (Stage 1). Once the required pile toe level is reached, the reinforcement cage is lifted inside the casing down to the pile toe level (Stage 2). After which, the pile bore is concreted back up to ground level (Stage 3). As the concrete rises within the pile bore, the casing is gradually removed (Stage 4).

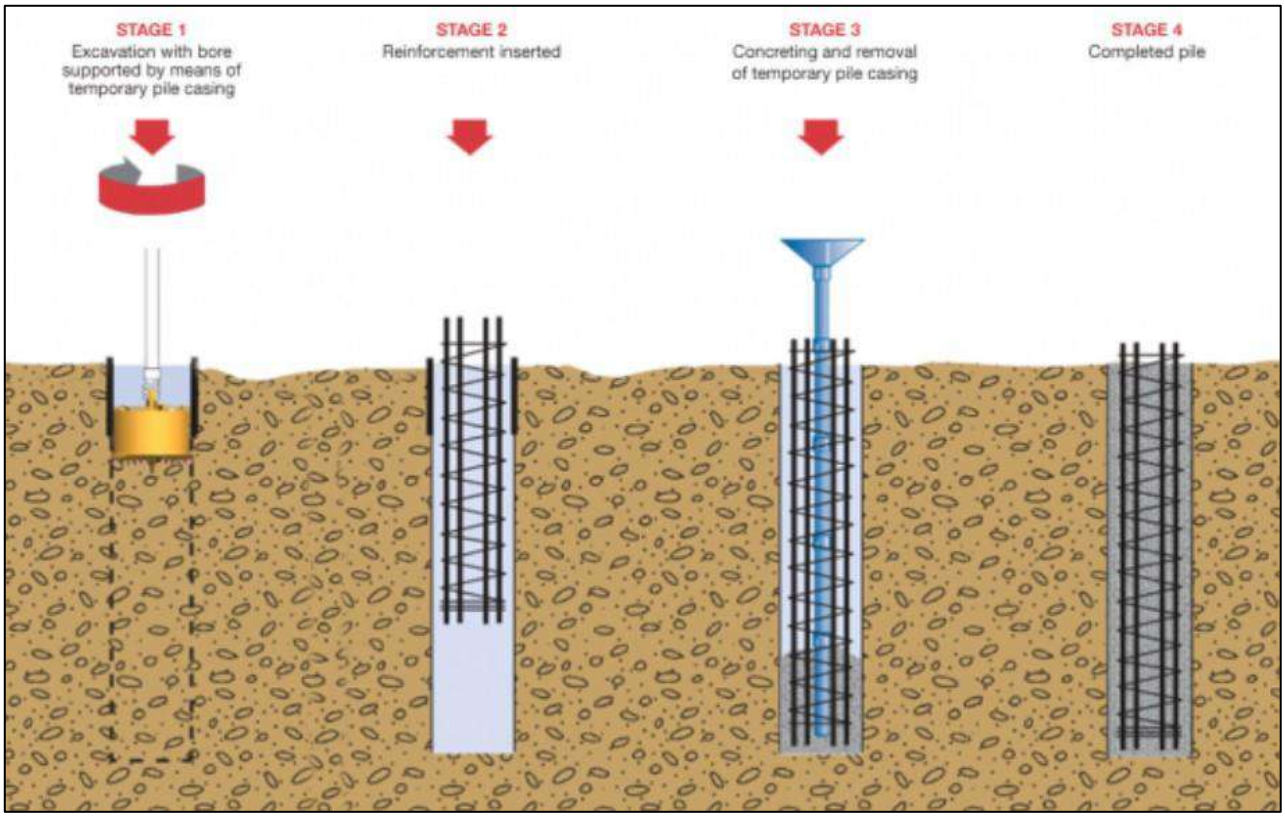



**Figure 3.0: Rotary bored piling technique**

- Option 2 - ODEX/CFA piling technique:
    - This solution uses a combination of 2 piling techniques, i.e. both ODEX and CFA.
    - Stage 1 consists of using an ODEX for the initial drilling. The term ODEX is an abbreviation for Overburden Drilling EXcentric. Odex piling is a drilling method

suitable for boring through boulders and rock strata, this is adopted where lengths of rock drilling are required as the CFA cannot pile large depths into the rock. The ODEX piling rig drills down through the overburden and the rock to the required pile toe level. After which the ODEX hammer is withdrawn and the pile bore is backfilled with the pulverised arisings up to the ground level.



- Once the pile is backfilled, the CFA auger the redrills down to the pile toe level, the CFA will not refuse within the rock socket length as the ODEX removed the rock. After the CFA auger reaches the required toe level (Stage 2), the CFA auger is withdrawn in a controlled manner and the pile bore is concrete from the bottom up to the top (Stage 3).
- While the concrete is still in a wet state within the concreted pile bore, the steel reinforcement cage is then lifted vertically and plunged down into the pile bore to the required depth.

- Potential for ground vibrations:
  - From experience, both piling techniques (Option 1 and Option 2 outlined above) have been used in dense urban environments directly adjacent to sensitive structures with tight movement and vibration limits (hospitals and listed structures).
  - Provided best practice is adopted durign construction, the vibrations induced on the existing watermain will be monitored to ensure they are within acceptable limits, additionally, the 6.4m clearance from the pile to the watermain is beneficial in allowing the peak vibrations to dissipate prior to reaching the watermain.
  - The design herein adopts the rotary bored approach; however the ODEX/CFA can be adopted in lieu of the rotary option without any change in design approach required.

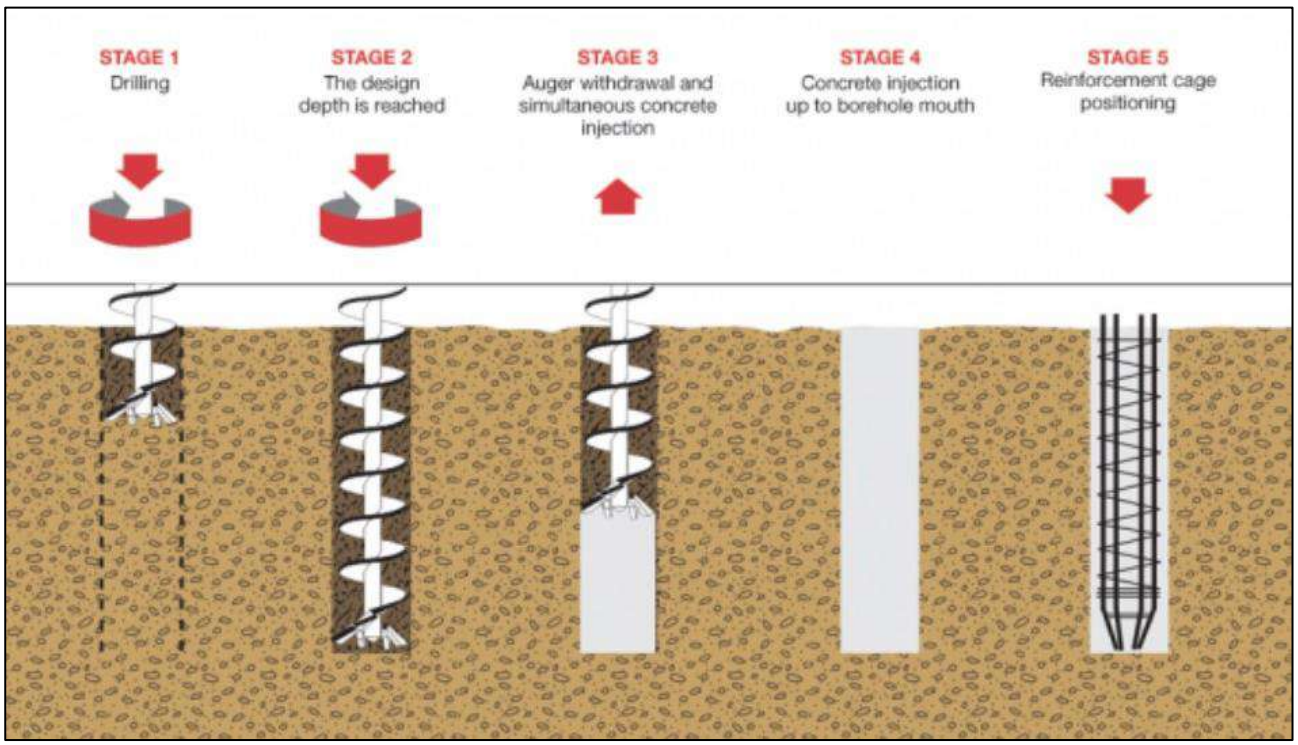



**Figure 3.1: ODEX/CFA piling technique.**

## [3.5] Design Life

The pile design life of the pile wall is assumed to be 60 years.

# [4] Ground Conditions



## [4.1] Site Investigation Information

A site-specific investigation was undertaken by GII in February to March 2021. The scope of the fieldworks consisted of the following:

- Carry out 14 No. Window Sample Boreholes to recover soil samples
- Carry out 10 No. Cable Percussion boreholes to a maximum depth of 4.50m BGL
- Installation of 3 No. Groundwater monitoring wells
- Geotechnical & Environmental Laboratory testing

The layout of the exploratory holes at the site is presented in Figure 4.1 below.


**Figure 4.1 Site investigation layout (ref. GII)**

From the site investigations completed to date, the ground conditions can generally be described as:

- **MADEGROUND**: The FILL or MADE GROUND encountered on the site from the Greenhills Road to the development site. Being the Greenhills Road at higher elevation the fill materials thickness varies from the road to the development site. The thickness varies from 0.5m to 2m.

- **Very Stiff Silty CLAY & Very Dense Coarse GRAVEL:** Underlying the FILL is a stratum of Very Stiff Silty CLAY & Very Dense Coarse GRAVEL which had been penetrated to the depth investigated.
- **Bedrock:** With reference to the GSI reports available, the investigation encountered refusals at a depth of 9.5 to 10m BGL.



Based on the relative thicknesses of the strata encountered in the boreholes, a design ground profile has been prepared and outlined in Table 4-1.

**Table 4-1 Design Ground Profile**

| Strata | Depth below Ground Level (m BGL) | Thickness (m) |
|---|---|---|
| Made Ground | 0.0 | ~2 |
| Very Stiff Silty CLAY & Very Dense Coarse GRAVEL | 2 | ~8.0 |
| Bedrock | 10 | --- |

## [4.2] Soil Parameters

In-situ SPT testing has been carried out in the boreholes completed by GII. The SPT 'N' values have been plotted against depth to aid in determining suitable soil parameters for the design of the pile wall. The SPT 'N' Plot is shown in Figure 4.2 below.

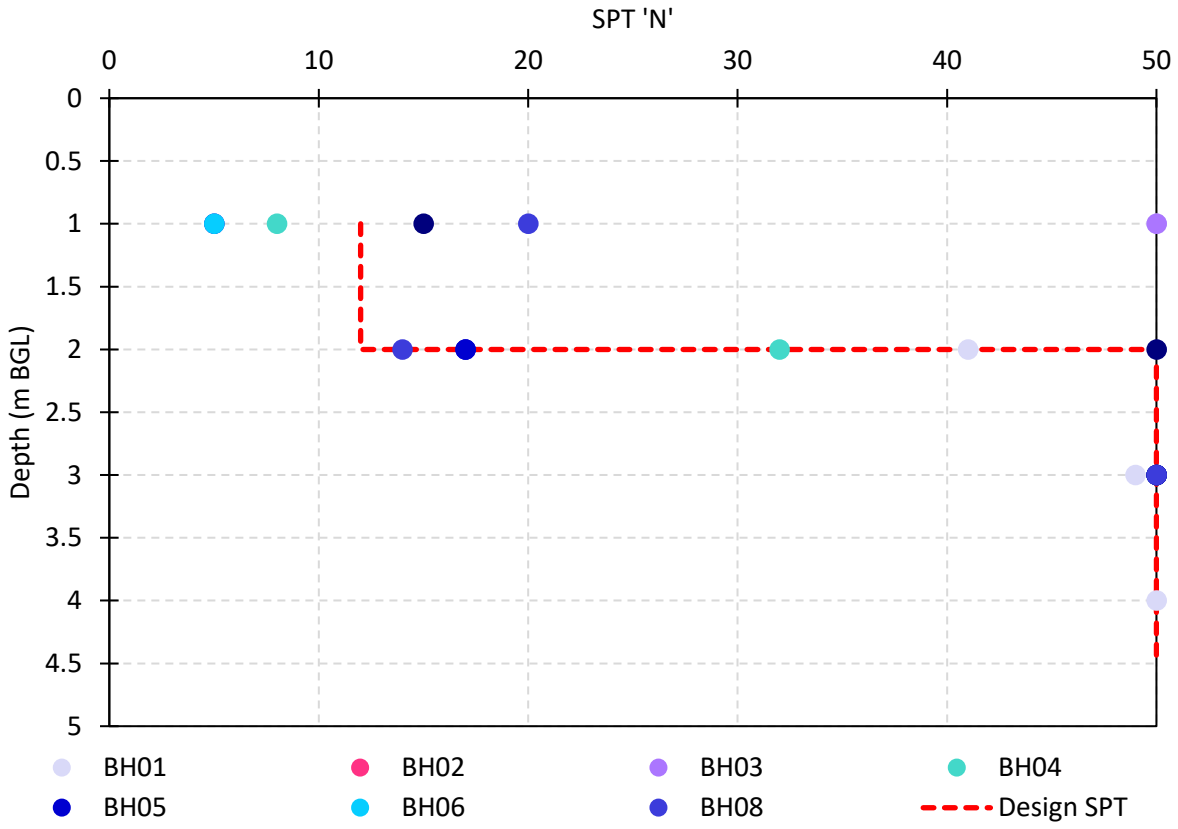



**Figure 4.2 SPT 'N' Profile**

The SPT ‘N’ plot shall be used to determine various soil parameters based upon published correlations and relationships for the underlying ground conditions. These correlations are summarised below.



- The undrained shear strength of the cohesive material can be calculated based on the Stroud correlation, $C_U$ = 5N.
- The internal angle of friction of the granular materials can be calculated after the relationship published by Peck with Figure 4.3 below detailing Pecks relationship between SPT ‘N’ values and the angle of shearing resistance.
- The soil stiffness can also be approximated using relationships as set out in CIRIA C580. The soil stiffness modulus is based on 600 x $C_U$ for the undrained boulder clay material and 66% of this value for the drained case. While for the granular soils the following relationship is taken, E’ = 2000N.

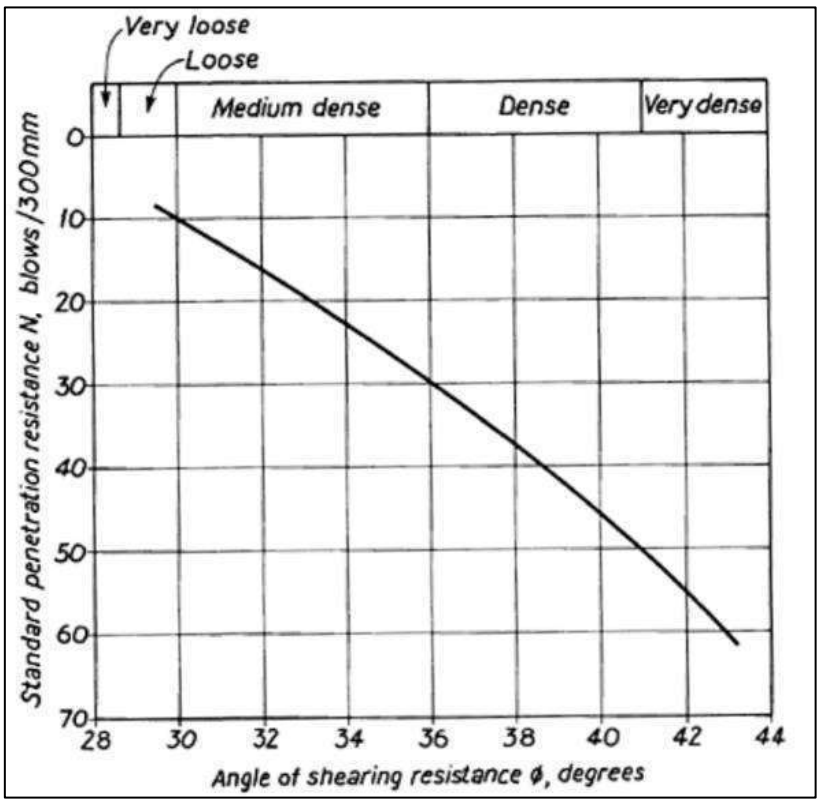



**Figure 4.3 Peck’s Relationship between SPT ‘N’ Angle of Shearing Resistance**

## [4.3] Design Parameters

It is noted that the Contiguous pile wall shall be installed from the existing ground level. The soil parameters taken for design purposes have been detailed in Table 4-2 below. These parameters are characteristic soil parameters as referenced in Eurocode 7.

**Table 4-2 Geotechnical Parameters**



| Strata | SPT 'N' | $\phi$ (°) | $\gamma$ (kg/m$^3$) | $c_u$/c' (kPa) | E' (kPa) | $E_u$ (kPa) |
|---|---|---|---|---|---|---|
| MADEGROUND or Compacted Fill (Drained) | 12 | 30 | 19 | - | 24,000 | - |
| Coarse GRAVEL (Drained) | 50 | 32 | 20 | - | 100,000 | - |
| Bedrock | - | 40 | 24 | - | 500,000 | - |

Within the analysis of the contiguous pile wall, some additional parameters will be required. These have been summarised in Table 4-3 below for completeness.

**Table 4-3 Additional Ground Parameters**

| Strata | $K_0$ | $K_r$ | δ/ϕ' | $c_w$/c |
|---|---|---|---|---|
| MADEGROUND (Drained) | 0.5 | 0.25 | 0.67 | - |
| Coarse GRAVEL (Drained) | 0.47 | 0.25 | 0.67 | - |
| Bedrock | 0.35 | 0.25 | 0.67 | - |

Where:

$K_0 = 1 – \sin \Phi'$ (for the Granular Soils)

$K_0 = 1$ (for Cohesive Soils – based on previous experience)

$K_r = \mu / 1 – \mu$ ($\mu$ = 0.2 for drained materials and 0.5 for undrained)

$\delta / \phi'$ (Ratio of wall/soil friction angle to shearing resistance angle = 0.67)

$c_w / c$ (Ratio of wall adhesion to soil cohesion, $c_w$ = Max $s_u/2$ or 50 kPa)

## [4.4] Groundwater

The boreholes conducted shows the groundwater table varying from 0.5 to 3.5m BGL. For design purposes, groundwater has been taken at 0.5m BGL for initial condition and post excavation 0.5m below the formation level. Due to the contiguous nature of the pile wall, the wall will not provide groundwater cut off. Hence, the analysis had been carried adopting the drained condition.

## [4.5] Soil and Groundwater Chemical Tests

The pH of the soil is found to be 7.73 to 8.7 and the sulphate content is < 0.010 g/l.

# [5] Geotechnical Design of Contiguous Pile Wall



## [5.1] Assumptions

The assumptions made in the design of the Contiguous pile wall have been outlined in this section. The proposed excavation sequence, the dig levels and the loading assumptions for the Contiguous pile wall have been outlined for wall section. Full details are set out below.

### [5.1.1] Pile Layout & Design Wall Sections

The proposed Contiguous pile wall layout has been detailed by Lohan & Donnelly Consulting Engineers on drawing 20189-LDE-ZZ-ZZ-M2-C-0001 Wayleave. The proposed piled layout consists of 900mm diameter piles installed at 1050mm centres in a Contiguous arrangement. The pile layout has been extracted and shown in the Figure 2.4. The wall sections have been summarized in Table 5-1 below.

**Table 5-1 Retaining wall details**

| Location | Retained Height * | Contiguous Wall Details | Surcharge Model ** |
|---|---|---|---|
| Boundary | 7.4m | 900mm Bored piles at 1050mm c/c. | Construction loading |

* The retained height has been calculated from 0.5m below the invert level of pipe to the ground level as provided in Drg No 20189-LDE-ZZ-ZZ-M2-C-0001 Wayleave.

** See Section [5.1.3].

### [5.1.2] Excavation Level

The existing ground level at the proposed basement location varies from approximately +63.00m OD to +55.00m OD. The proposed excavation level of the new basement is approximately +53.00m OD to +50.50m OD, equating to excavation depths of up to 7.4m BGL.

### [5.1.3] External Surcharge Loading

The general external surcharge loads have been allowed for a characteristic surcharge of 10kPa has been modelled 1.0m behind the wall at ground level to account for ‘the construction loading’.

### [5.1.4] Construction Sequence

The following construction sequence has been assumed in the design of the pile wall:

1. Install piling platform to required thickness, platform level TBC.
2. Construct guide wall to install contiguous piles (based on Engineer’s layout)
3. Install 900mm diameter CFA contiguous piles at 1050mm c/c as per the drawing section details.

4. Excavate to final formation level.
5. Carryout required works to existing watermain.
6. After all works are completed, backfill above the excavation formation level up to the proposed ground level in a controlled manner as per the Engineer's specification.



## [5.2] Design

### [5.2.1] Basis of Design

The design of the pile retaining wall has been carried out in accordance with the following standards:

- I.S. EN 1997-1:2004 Eurocode 7: Geotechnical design – Part 1;
- I.S. EN 1992-1-1:2004 Eurocode 2: Design of Concrete Structures;
- Irish National Annex to each Eurocode above; and
- CIRIA C760 (formally C580) Guidance on Embedded Retaining Wall Design.

In accordance with of I.S. EN 1997, calculations for Design Approach 1 Combination 1 and for Design Approach 1 Combination 2 have been completed. The combinations are as follows:

- DA1 Combination 1: A2 + M1 + R1; and
- DA1 Combination 2: A2 + (M1 or M2) + R4.

Where A, M and R relate to partial factors for applied loads, materials and resistances respectively. The partial factors are outlined in Appendix A.

A serviceability limit state (SLS) analysis has also been carried out to assess likely wall deflections. The following partial factors have been applied as outlined in Table 5-2.

**Table 5-2 EC7 Loading Combinations and Partial Factors**

| Parameter/Limit State | DA1-C1 | DA2-C2 | SLS |
|---|---|---|---|
| Angle of Friction (applied to tan ϕ') | 1.00 | 1.25 | 1.00 |
| Effective Cohesion | 1.00 | 1.25 | 1.00 |
| Undrained Shear Strength | 1.00 | 1.40 | 1.00 |
| Soil Stiffness | 1.00 | 1.00 | 1.00 |
| Reduction in Level of Resisting Ground* | Included | Included | Excluded |
| Factor on Effects of Surcharge (Variable) Actions | 1.11** | 1.30 | N/A |
| Factor on Effects of Soil and Water Actions | 1.35 | 1.00 | N/A |

**** CIRIA C760 recommends an allowance of 0.5m for unplanned excavation in the ultimate limit state (ULS) design.***

***** The partial factor on live loads for DA1 C1 is 1.5. For FREW analyses the partial factor on dead loads of 1.35 is applied to the effects of the actions, rather than the actions. As such to achieve a total partial factor of 1.5 on live loads, a factor of 1.11 is applied in FREW (which when combined with the 1.35 partial factor on the effects of actions give a total partial factor of 1.5; i.e. 1.35 x 1.11 = 1.5).***

### [5.2.2] Design Software



The Oasys software package FREW has been used to calculate the required minimum toe level, loads and expected displacements of the piled wall. FREW is used to model each construction stage individually and sequentially from the initial conditions, Contiguous wall installation, excavation and construction of permanent works. The soil parameters outlined above have been inputted into FREW. The construction sequence outlined above has been replicated in the FREW model.

### [5.2.3] Pile Flexural Stiffness

The stiffness of the pile wall is calculated, based on the recommendations provided within CIRIA C760, from the formula $K = 0.7 \times (EI/s)$ for the short-term stiffness per meter run of wall.

$E$ is the short-term young's modulus of concrete, taken as $30\times10^6$ kN/m$^2$ for the Contiguous piles. $I$ is the second moment of area of the piles and $s$ is the spacing of the piles. The factor of 0.7 accounts for shrinkage and cracking of the concrete over a short-term period.

The second moment of area of the piles has been taken as $I = (\pi \times d^4)/64$. Table 5-3 details the stiffness values per meter run taken in the design of the pile wall.

**Table 5-3 Contiguous Pile Wall Stiffness Values**

| Pile Type | Design short-term Stiffness EI (kN/m$^2$/m) |
|---|---|
| 900mm Contiguous Piles at 1050mm c/c. | 644,125 |

### [5.2.4] Wall Analysis

The results of the SLS and ULS analysis have been summarised in Table 5-4 and Table 5-5 below. The FREW SLS and ULS outputs are included in the Appendix B.

**Table 5-4 SLS Analysis Results**

| Wall Type | Serviceability Limit State (SLS) | | |
|---|---|---|---|
| | Max. Deflection (mm) * | Bending Moment (kNm/m) ** | Shear Force (kN/m) ** |
| 900mm Contiguous Piles at 1050mm c/c. | 60.0 | 737.5 | 216.8 |

***Note:*** *The maximum deflection shall be accepted by the engineer.*

**Table 5-5 ULS Analysis Results**

| Ultimate Limit State Combination 1 (DA1-C1) | | Ultimate Limit State Combination 2 (DA1-C2) | | Pile Toe Level (m OD) BPCOL = Below Pile Cut Off Level |
|---|---|---|---|---|
| Bending Moment (kNm/m) ** | Shear Force (kN/m) ** | Bending Moment (kNm/m) ** | Shear Force (kN/m) ** | |
| 1013.2 | 297.6 | 1198.2 | 432.7 | 14.5 m |

**The pile deflections quoted above are maximum predicted horizontal movements for the pile wall. The impact of wall deflections on services and nearby infrastructure is to be completed by others.*

***The bending moments and shear forces quoted above are maximum loads per metre run of wall. The full bending moment and shear force outputs are included in the appendices for information.*



## [5.3] Structural Design of Contiguous piles

### [5.3.1] Basis of Design

The structural design of the piles has been completed in accordance with the following standards:

- I.S. EN 1992-1-1:2004 Eurocode 2: Design of Concrete Structures;
- BS8004:2015 Code of Practice for Foundations; and
- *I.S.* EN 1536: 2010: Execution of Special Geotechnical Work – Bored Piles.

The following structural checks have been completed:

1. Minimum reinforcement
2. Bending moment capacity
3. Shear capacity
4. Anchorage length
5. Crack width assessment

### [5.3.2] Cover

In line with IS EN1536:1999 Section 7.6.4.2, the cover to all steel reinforcement shall be more than 75mm for bored and cast in place piles. A cover of 75mm is to be provided in this case.

### [5.3.3] Minimum Reinforcement Design

In accordance with I.S. EN1992-1-1:2004 Section 9.8.5(3) the minimum diameter for the longitudinal bars should not be less than 16mm. the minimum longitudinal reinforcement should then be calculated in accordance with Table 5-6.

**Table 5-6: Table 9.6N of EN1992-1-1:2004: Recommended minimum longitudinal reinforcement area in cast-in-place piles**

| Pile cross-section: $A_c$ | Minimum area of longitudinal reinforcement: $A_{S,bpmin}$ |
|---|---|
| $A_c \leq 0{,}5\ m^2$ | $A_S \geq 0{,}005 \cdot A_c$ |
| $0{,}5\ m^2 < A_c \leq 1{,}0\ m^2$ | $A_S \geq 25\ cm^2$ |
| $A_c > 1{,}0\ m^2$ | $A_S \geq 0{,}0025 \cdot A_c$ |

- For a 900mm diameter pile, the minimum reinforcement required is **2500 mm².**

### [5.3.4] Bending Moment Capacity Check

Oasys ADSEC has been used to determine the bending moment capacity of the pile sections with outputs included in the appendices of the report. Minimum C30/37 grade concrete is to be used. The

reinforcement has been designed for the maximum design bending moments taken from the FREW analysis above.



The main reinforcement cage design has been summarised in below with the minimum reinforcement required detailed for the maximum bending moments and shear forces generated in FREW.

**Table 5-7: Moment Capacity (Reinforcement Check for Maximum Bending Moments)**

| Pile Type | Max. Bending Moment (kN-m) | Main Reinforcement | As,bp (mm2) | Mu (kNm) | ULS Utilisation (%) |
|---|---|---|---|---|---|
| WT01 – 900mm dia pile | 1258.11 | 12 No. B32's | 9,651 | 1271 | 98.99 |

### [5.3.5] Shear Reinforcement

In accordance with I.S. EN 1536: 1999 section 7.6.4.2, the minimum cover to all reinforcement should not be less than 75mm. From section 9.8.5 (4) of I.S. EN1992-1-1: 2004, transverse reinforcement in piles should be detailed in accordance with I.S. EN 1536: 1999: Execution of special geotechnical work – piles.

The required shear link diameter and pitch have been calculated in accordance with I.S. EN1992-1-1:2004 and Feltham (2004). A summary of the shear reinforcement requirements is illustrated in Table 5-8.

**Table 5-8: Summary of Pile Reinforcement**

| Pile Type | Pile Dia. (mm) | Max. Shear Force (kN) | Concrete Grade | Shear Links |
|---|---|---|---|---|
| WT01 | 900 | 433 | C30/37 | B12 Helical links @ 200mm c/c |

### [5.3.6] Crack Width Check Basis

The maximum allowable crack width (for durability) is taken as <0.3mm in accordance with Table 7.1 of I.S. EN 1992-1-1:2005. In accordance with Table NC.4 of the Irish National Annex to I.S. EN 206:2013, for C30/37 grade concrete with exposure class XC2, the required crack width cover is equal to 35mm for a 50-year design life.

Oasys ADSEC has been used to analyse the pile sections under the serviceability loadings. Full outputs from ADSEC are included in Appendix D with a summary included in Table 5-9 below.

**Table 5-9: Crack Width Summary**

| Pile Type | Pile Diameter (mm) | SLS Tension (kN) | SLS Bending Moment (kN-m) | Main Reinforcement | Maximum Crack Width (mm) |
|---|---|---|---|---|---|
| WT01 | 900 | - | 737.5 | 12 No. B32's | <0.3mm |

### [5.3.7] Concrete Specification



Ayesa have assessed the concrete requirements for the foundation piles. From the results of the chemical tests it has been determined that a concrete classification XA2, and XC2 (wet, rarely dry) is required for the concrete piles.

In accordance with I.S. EN 206:2013, the minimum concrete requirements for the foundation piles are summarised as follows:

- 900mm Contiguous pile wall:
  - Minimum concrete grade = C30/37;
  - Maximum water/cement ratio = 0.50;
  - Minimum cement content = 340kg/$m^3$.

The use of GGBS in the concrete mix is acceptable, and the concrete supplier must ensure the mix design is in accordance with the Irish National Annex (2015) to I.S. EN 206:2013. Ayesa to review concrete mix design prior to the commencement of works on site.

# [6] Construction & Testing Details



## [6.1] Execution & Tolerances

The piles are to be installed in accordance with the practices outlined in I.S. EN 1536: 2010: Execution of Special Geotechnical Work – Bored Piles. The piles are to be installed within the tolerances outlined in Table B1.4 of ICE Specification for Piling and Embedded Retaining Walls (ICE SPERW).

## [6.2] Concrete Testing

All concrete used in the construction of the piles to conform to I.S. EN 1536: 2010 and should conform to a 60-year design life in accordance with I.S. EN 206: 2013.

Concrete cube testing is to be completed as per the ICE Specification for Piling and Embedded Retaining Walls (ICE SPERW).

A minimum of 4 No. cubes shall be made from each sample. The minimum samples are to be:

a) 1 No. sample per shift and;
b) For every 35 $m^3$ of concrete cast during the same shift.

The cubes shall be made, cured and tested in accordance with IS EN 12390. Acceptance criteria for compressive strength shall be in accordance with ICE SPERW 3rd Edition. Results of the concrete testing are to be provided to Ayesa for review.

## [6.3] Pile Testing Requirements for Foundation Piles

The proposed foundation pile load testing regime is to consist of the following:

- 100% of working piles to be integrity tested by sonic echo method

Piles are to be tested a minimum of 7 days after installation, or as agreed with the Engineer. Locations of piles tested are to be agreed upon with Engineer, Designer and Contractor. The pile load testing shall be carried out in accordance with ICE SPERW 3rd Edition. Results of the pile load testing are to be provided to Ayesa for review.

Concrete is to reach minimum compressive cube strength of 30MPa prior to testing – to be confirmed by cubes.

# [7] Summary



## [7.1] Design Summary

Ayesa have completed the design of the Contiguous pile retaining wall for the proposed development at Greenhills Road Dublin 12. The design has been completed on behalf of Lohan & Donnelly Consulting Engineers.

The contiguous pile wall is proposed to consist of 900mm Dia. installed at 1050mm centres. The excavation depth is a maximum 7.4m below ground level. The pile wall has been designed to serve as a temporary works element to facilitate the future inspection and repair the pipe by proving lateral soil support and later. As the timeline as to when the temporary works function will be required, a design life of 60-years has been adopted.

Ayesa have designed 1 type of contiguous pile wall. Refer to Ayesa drawing B2156 series drawings for the locations of each type of pile and sections of the pile types. The design is summarised in Table 7.1 below.

**Table 7-1 Design Summary**

| Pile Type | Pile Size | Main Reinforcement | Concrete Grade | Shear Reinforcement |
|---|---|---|---|---|
| WT01 | 900mm | 12 No. B32's full length | C30/37 XC2 | B12 helical at 200mm c/c |

The wall has been shown to be adequate to resist the imposed loads in accordance with IS EN 1997-1:2004 Eurocode 7: Geotechnical Design – Part 1: General Rules and with respect to the Irish National Annex to this document (INA-EC7). Guidance, where relevant, was sought by recourse to CIRIA c760 and *the ICE Specification of Embedded Retaining Walls* which are recognised by EC7 as non-conflicting, complementary information (NCCI).

Ayesa have included a Designers Risk Assessment (DRA) specific to the piling works in Appendix E. General risks and hazards (i.e. trips and slips, working with hand tools, wet concrete, lifting, plant movements etc.) are not included within this risk assessment and are taken to be accounted for under good practice by the contractor.

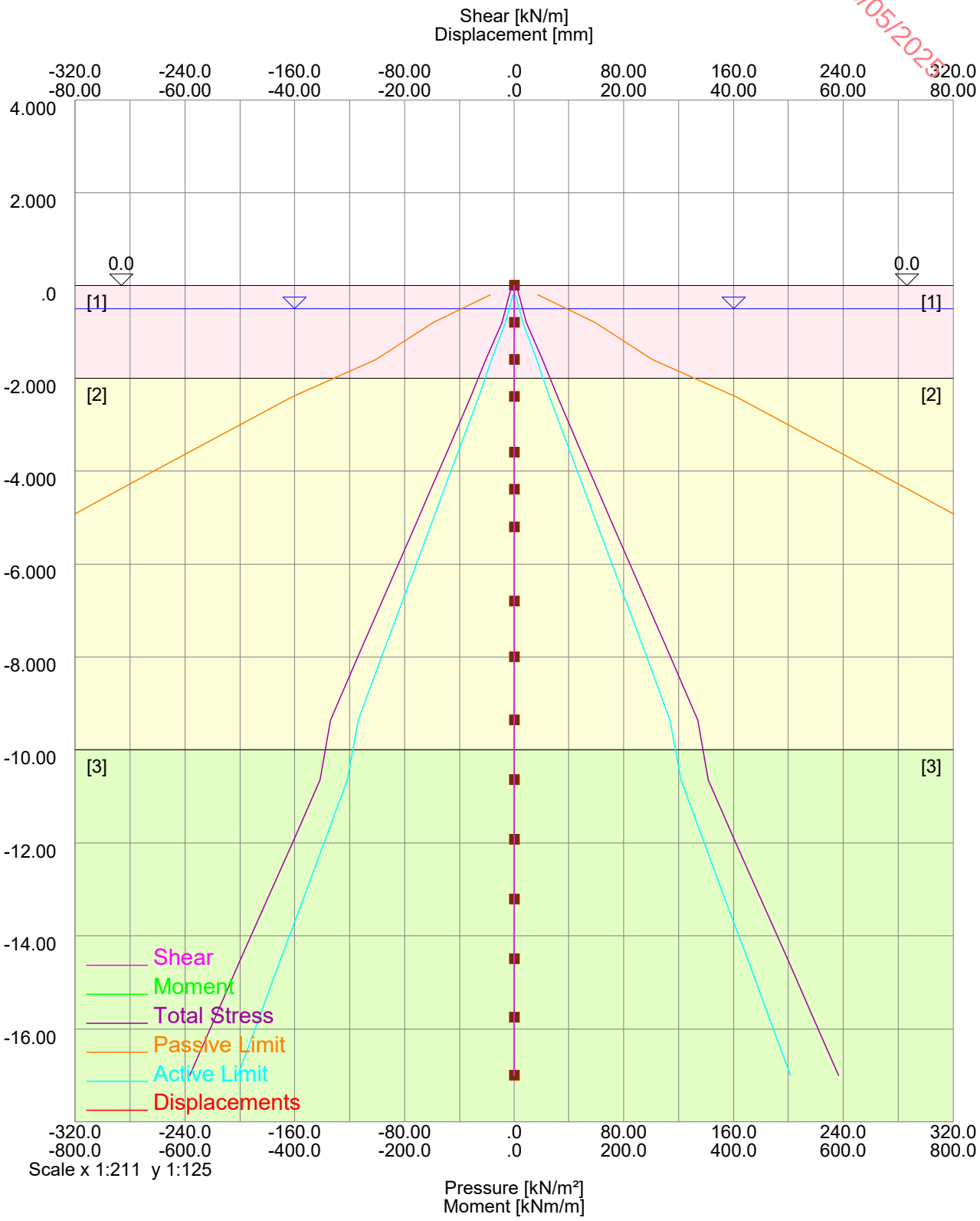
# Appendix A – FREW Outputs

Oasys

**Greenhills Road**
Contiguous pile wall design
900mm dia 1050mm C/C

| Job No. | Sheet No. | Rev. |
|---|---|---|
| B2156 | | |
| Drg. Ref. | | |
| Made by SP | Date 09-Jul-2024 | Checked / Date |





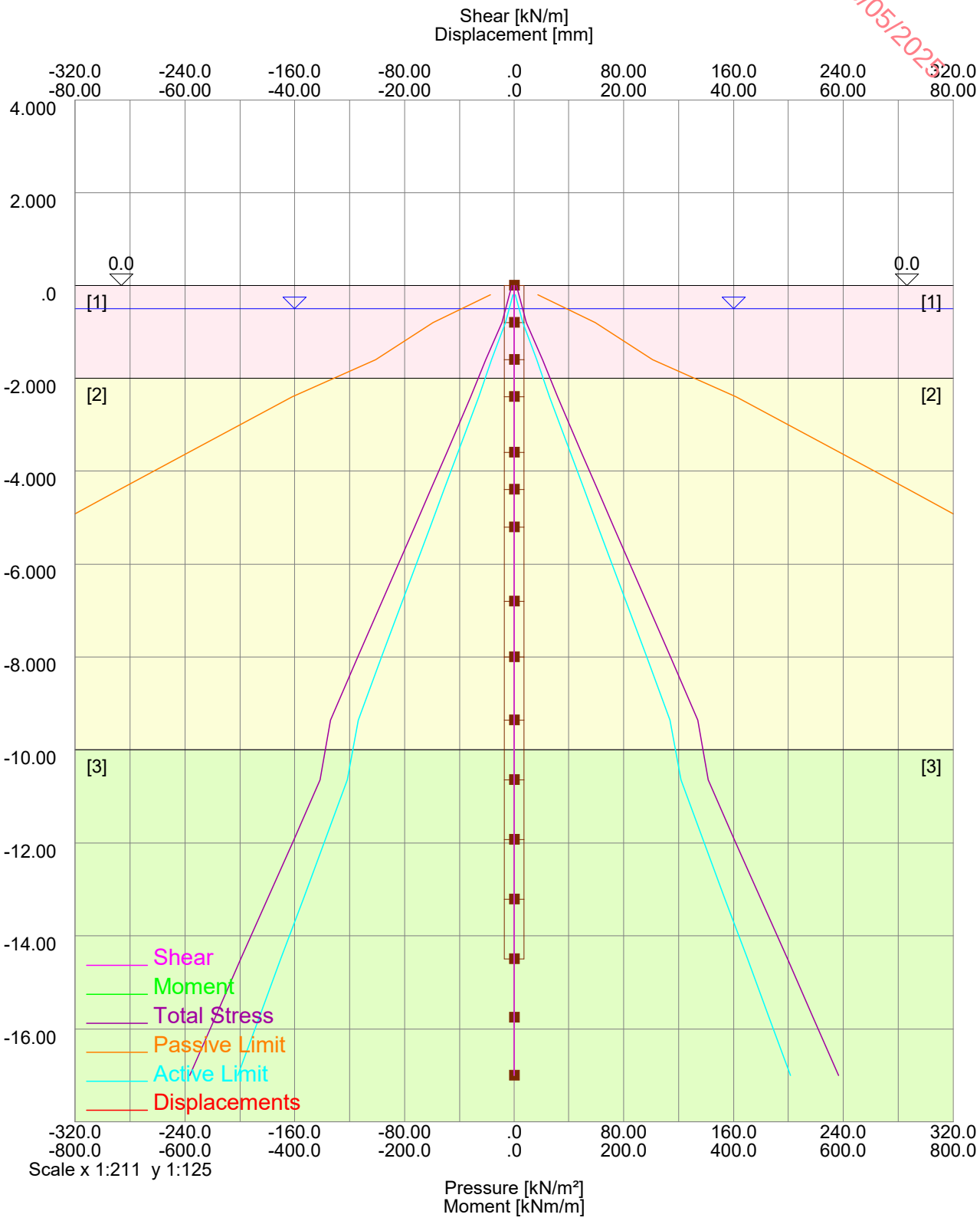

STAGE 0 : Initial condition
Results for factor set SLS

Oasys

**Greenhills Road**
Contiguous pile wall design
900mm dia 1050mm C/C

| Job No. | Sheet No. | Rev. |
|---|---|---|
| B2156 | | |
| Drg. Ref. | | |
| Made by SP | Date 09-Jul-2024 | Checked / Date |





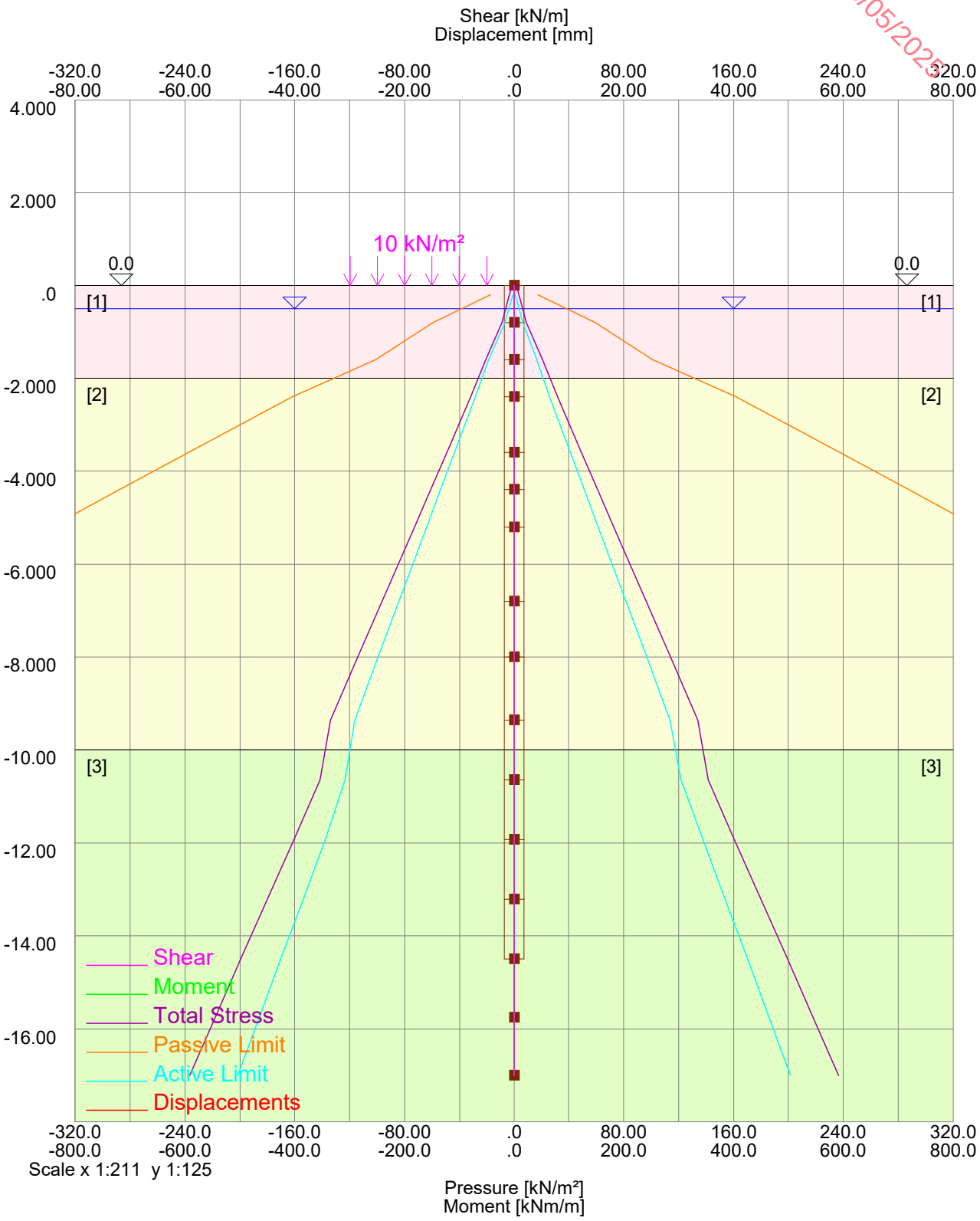

STAGE 1 : Wall installation
Results for factor set SLS

Oasys

**Greenhills Road**
Contiguous pile wall design
900mm dia 1050mm C/C

| Job No. | Sheet No. | Rev. |
|---|---|---|
| B2156 | | |
| Drg. Ref. | | |
| Made by SP | Date 09-Jul-2024 | Checked / Date |





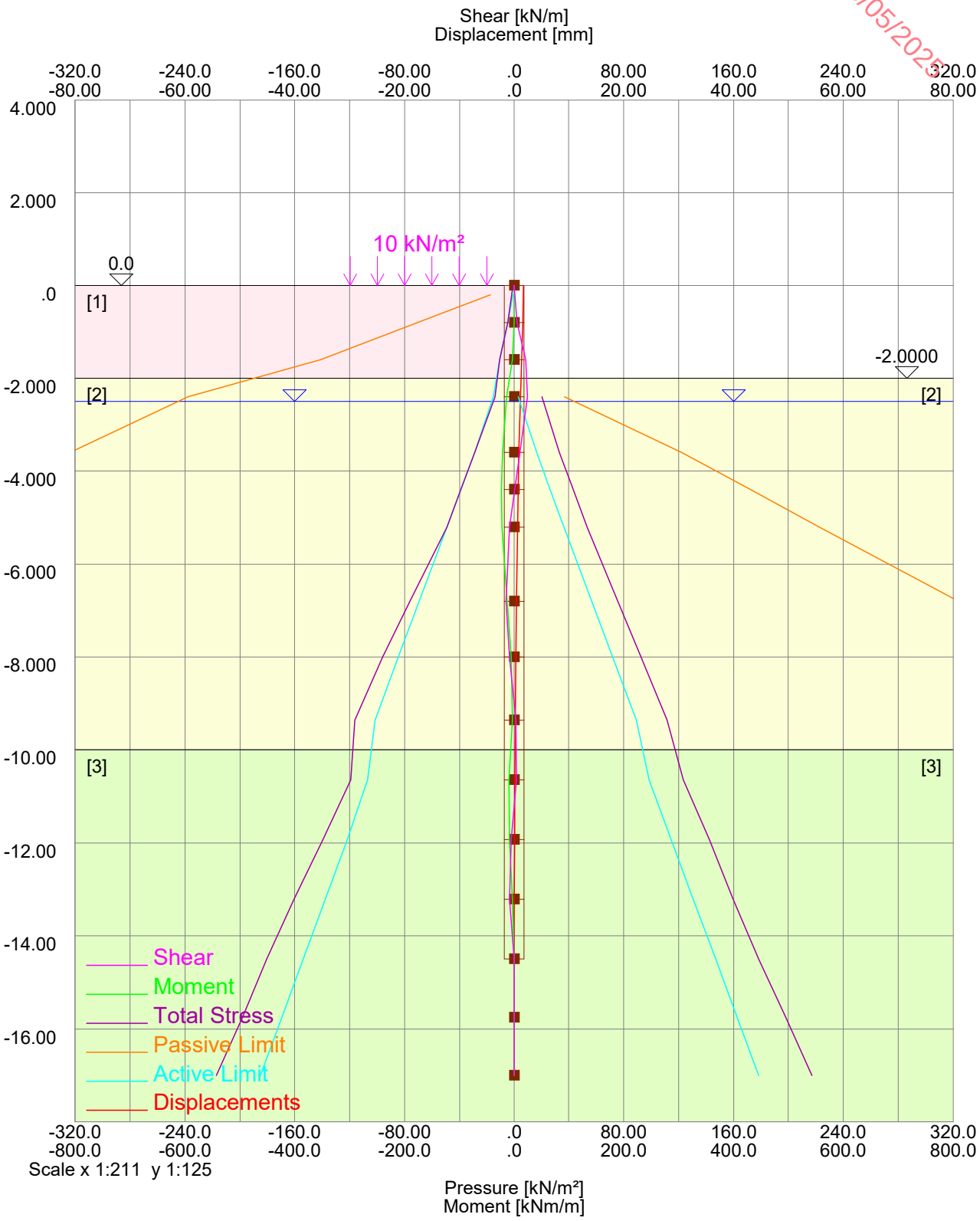

STAGE 2 : Surcharge
Results for factor set SLS

Oasys

**Greenhills Road**
Contiguous pile wall design
900mm dia 1050mm C/C

| Job No. | Sheet No. | Rev. |
|---|---|---|
| B2156 | | |
| Drg. Ref. | | |
| Made by SP | Date 09-Jul-2024 | Checked / Date |





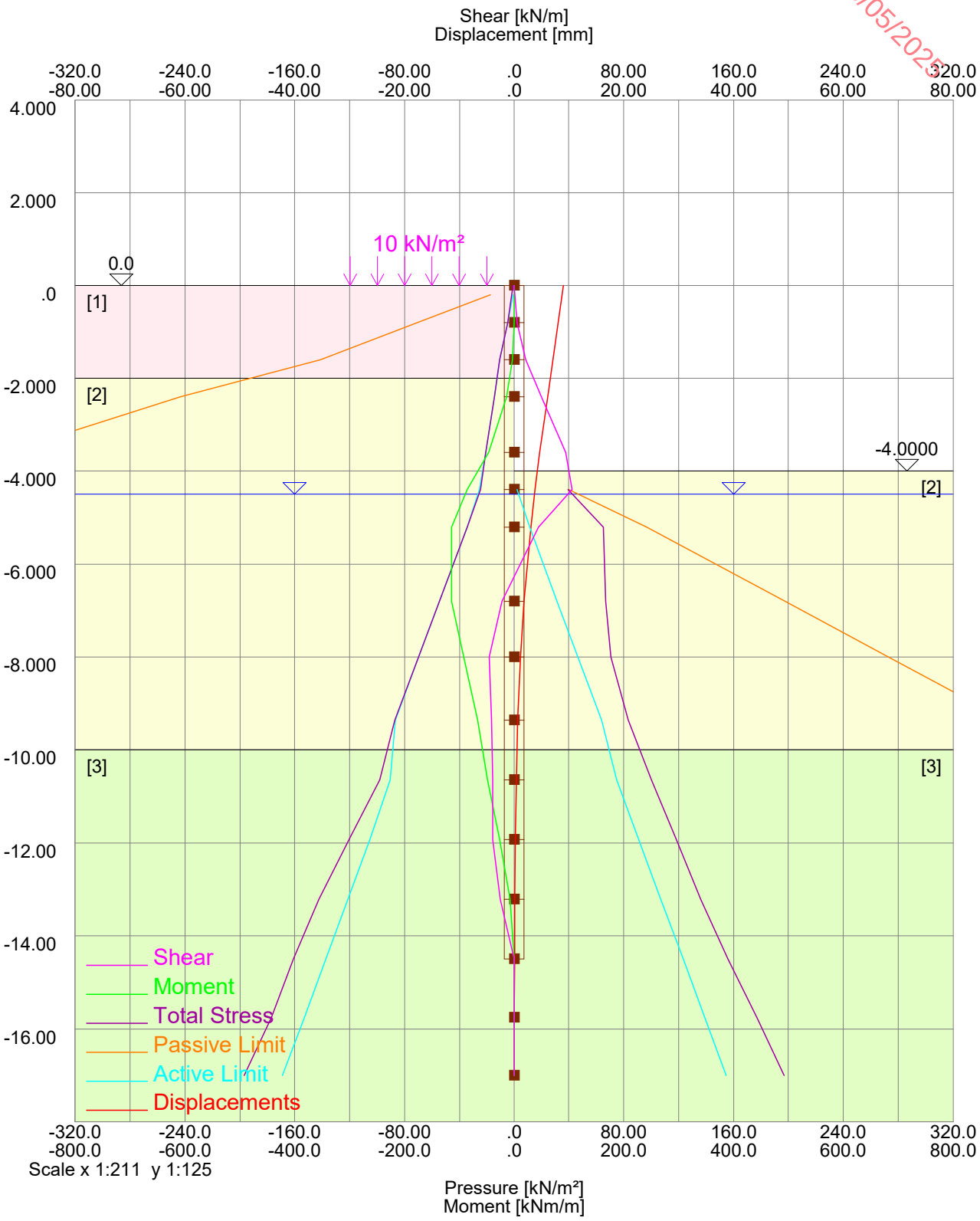

STAGE 3 : Excavation up to 2m
Results for factor set SLS

Oasys

**Greenhills Road**
Contiguous pile wall design
900mm dia 1050mm C/C

| Job No. | Sheet No. | Rev. |
|---|---|---|
| B2156 | | |
| Drg. Ref. | | |
| Made by SP | Date 09-Jul-2024 | Checked / Date |





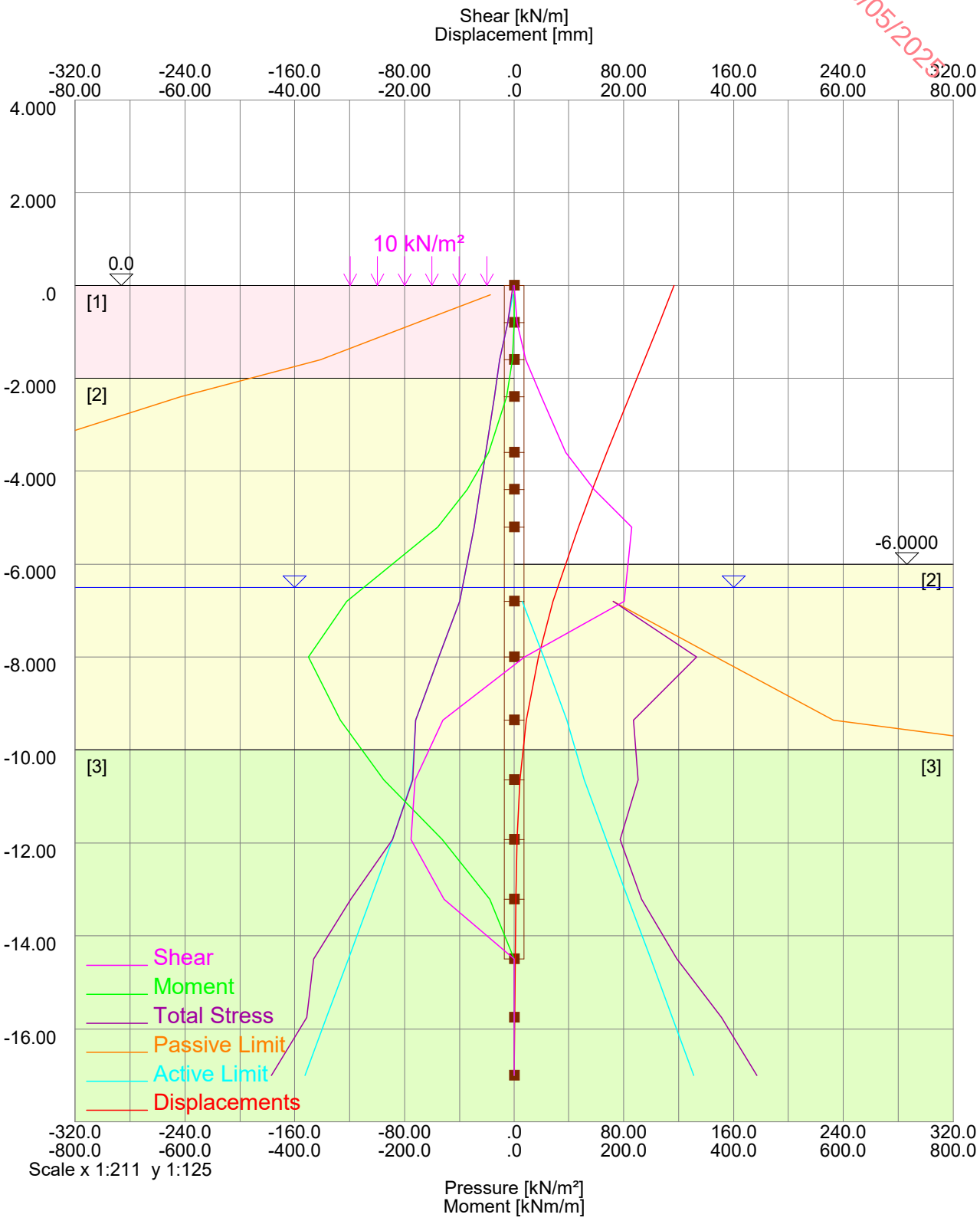

STAGE 4 : Excavation up to 4m
Results for factor set SLS

Oasys

**Greenhills Road**
Contiguous pile wall design
900mm dia 1050mm C/C

| Job No. | Sheet No. | Rev. |
|---|---|---|
| B2156 | | |
| Drg. Ref. | | |
| Made by SP | Date 09-Jul-2024 | Checked / Date |





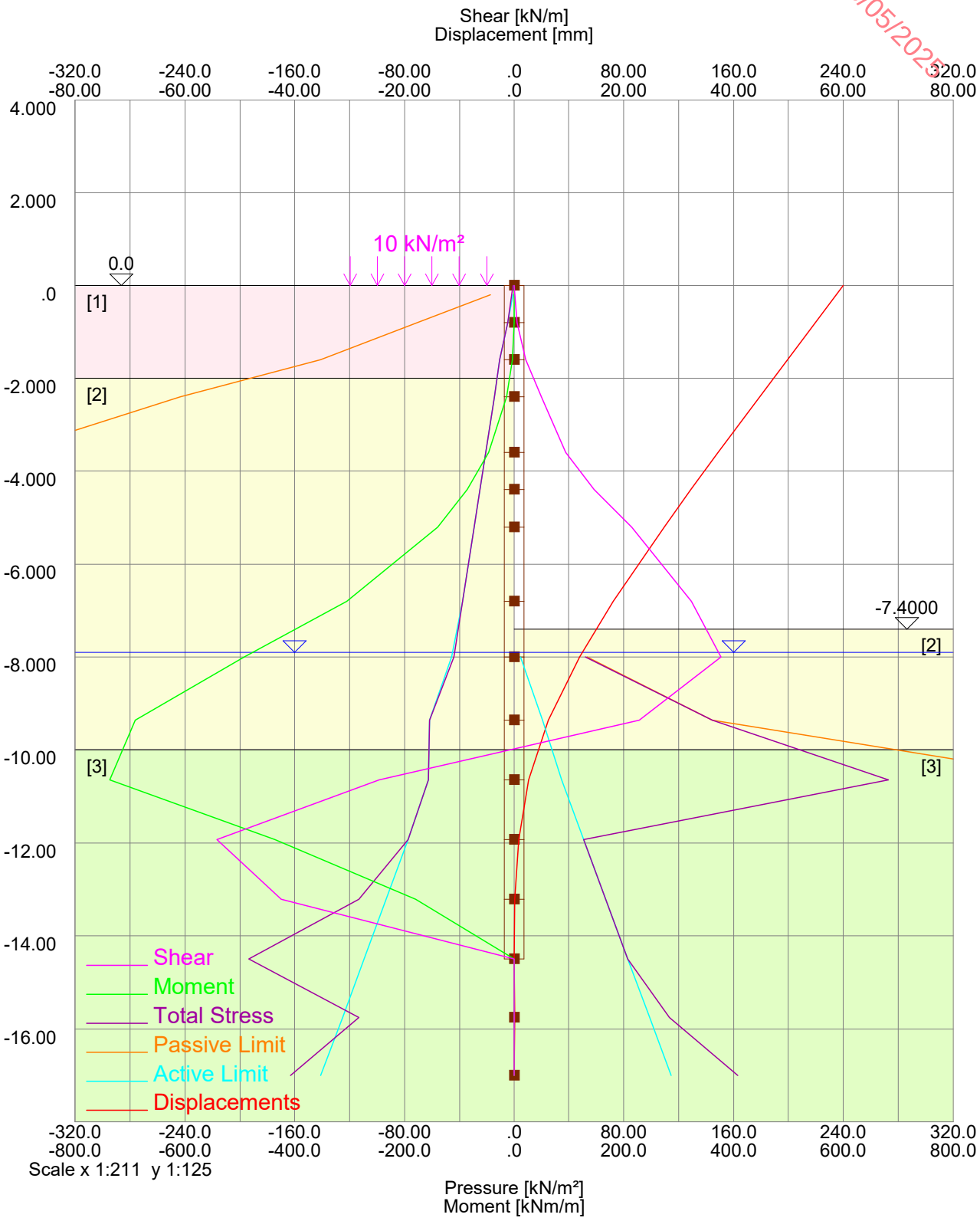

STAGE 5 : Excavation up to 6m
Results for factor set SLS

Oasys

**Greenhills Road**
Contiguous pile wall design
900mm dia 1050mm C/C

| Job No. | Sheet No. | Rev. |
|---|---|---|
| B2156 | | |
| Drg. Ref. | | |
| Made by SP | Date 09-Jul-2024 | Checked / Date |






STAGE 6 : Excavation up to 7.4m
Results for factor set SLS

## INITIAL DATA

### Soil properties

| No. | Description | Unit Wt [kN/m³] | K0 | Ka | Kp | Kac | Kpc | Kr | Earth pressure coefficients. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Madeground (D) | 19.00000 | 0.50000 | 0.28506 | 4.63887 | 1.06781 | 4.30761 | 0.25000 | *Calculated* |
| 2 | Coarse GRAVEL (D) | 20.00000 | 0.47008 | 0.26137 | 5.29118 | 1.02249 | 4.60051 | 0.25000 | *Calculated* |
| 3 | Bedrock | 24.00000 | 0.35721 | 0.18204 | 9.59504 | 0.85332 | 6.19517 | 0.25000 | *Calculated* |

| No. | c0 [kN/m²] | y0 [m] | Gradient of c [kN/m²/m] | E0 [kN/m²] | Gradient of E [kN/m²/m] | Drained/ Undrained |
|---|---|---|---|---|---|---|
| 1 | 0.00000 | 0.00000 | 0.00000 | 24000 | 0.0 | Drained |
| 2 | 0.00000 | 0.00000 | 0.00000 | 100000 | 0.0 | Drained |
| 3 | 0.00000 | 0.00000 | 0.00000 | 500000 | 0.0 | Drained |

### Parameters used to calculate Earth pressure coefficients

| No. | Phi [°] | Delta/Phi Ratio | Beta [°] | Cw/C Ratio |
|---|---|---|---|---|
| 1 | 30.00000 | 0.67000 | 0.00000 | 0.00000 |
| 2 | 32.00000 | 0.67000 | 0.00000 | 0.00000 |
| 3 | 40.00000 | 0.67000 | 0.00000 | 0.00000 |

### Partial factor sets

| Factor Set | Tan phi | Cohesion | Undrained cohesion | Young's modulus | Live (restoring) | Live (disturbing) | Dead (restoring) | Dead (disturbing) |
|---|---|---|---|---|---|---|---|---|
| SLS | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 1.00000 |
| DA1-1 | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 0.00000 | 1.11110 | 1.00000 | 1.00000 |
| DA1-2 | 1.25000 | 1.25000 | 1.40000 | 1.00000 | 0.00000 | 1.30000 | 1.00000 | 1.00000 |

### Surcharge properties

| No. | Stage In | Stage Out | Side | Level [m] | Pressure [kN/m²] | Factor Type | Partial Factor | Offset [m] | Width [m] | Ks |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | - | Left | 0.00000 | 10.00000 | Tan phi | 1.00000 | 1.00000 | 5.00000 | 0.00000 |

Note: Only the parameters in bold have been affected by Partial Factors.

### Surcharge Design properties

| No. | Stage In | Stage Out | Side | Level [m] | Pressure [kN/m²] | Offset [m] | Width [m] | Ks |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | - | Left | 0.00000 | 10.00000 | 1.00000 | 5.00000 | 0.00000 |

## STAGE 0 : INITIAL CONDITION

Ground level [m] LEFT: 0.00 RIGHT: 0.00 Soil zones changed

### Water data on LEFT side

| No. | Level [m] | Pressure [kN/m²] | Unit wt. [kN/m³] |
|---|---|---|---|
| 1 | -0.50000 | 0.00000 | 10.00000 |

### Water data on RIGHT side

| No. | Level [m] | Pressure [kN/m²] | Unit wt. [kN/m³] |
|---|---|---|---|
| 1 | -0.50000 | 0.00000 | 10.00000 |

### Analysis details

SAFE model with redistribution
and without friction at wall/soil interface

| | Left | Right |
|---|---|---|
| E profile Generated | | |
| Boundary distances [m] : | 50.00000 | 50.00000 |

### Convergence control parameters

Maximum number of iterations : 90000
Tolerance for displacement convergence [mm] : 0.01000
Tolerance for pressure convergence [kN/m²] : 0.10000

| | Left | Right |
|---|---|---|

Damping coefficient : 1.00000
Maximum incremental displacement [m] : 1.00000

## RESULTS FOR STAGE 0 : Initial condition (SLS)

### Summary Results

| | Node | Level [m] | Displacement [mm] | Moment [kNm/m] | Shear [kN/m] |
|---|---|---|---|---|---|
| Top wall node | 1 | 0.00000 | 0.0 | 0.0 | 0.0 |

## STAGE 1 : WALL INSTALLATION

Ground level [m] LEFT: 0.00 RIGHT: 0.00 Wall EI changed

## RESULTS FOR STAGE 1 : Wall installation (SLS)

### Summary Results

| | Node | Level [m] | Displacement [mm] | Moment [kNm/m] | Shear [kN/m] |
|---|---|---|---|---|---|
| Top wall node | 1 | 0.00000 | 0.0 | 0.0 | 0.0 |
| Wall toe | 14 | -14.50000 | 0.0 | 0.0 | 0.0 |

## STAGE 2 : SURCHARGE

## RESULTS FOR STAGE 2 : Surcharge (SLS)

### Surcharge, strut or wall load changes

Surcharge no. 1 applied at this stage

### Summary Results

| | Node | Level [m] | Displacement [mm] | Moment [kNm/m] | Shear [kN/m] |
|---|---|---|---|---|---|
| Top wall node | 1 | 0.00000 | 0.0 | 0.0 | 0.0 |
| Wall toe | 14 | -14.50000 | 0.0 | 0.0 | 0.0 |

## STAGE 3 : EXCAVATION UP TO 2M

Ground level [m] LEFT: 0.00 RIGHT: -2.00 Soil zones changed

### Water data on LEFT side

| No. | Level [m] | Pressure [kN/m²] | Unit wt. [kN/m³] |
|---|---|---|---|
| 1 | -2.50000 | 0.00000 | 10.00000 |

### Water data on RIGHT side

| No. | Level [m] | Pressure [kN/m²] | Unit wt. [kN/m³] |
|---|---|---|---|
| 1 | -2.50000 | 0.00000 | 10.00000 |

## RESULTS FOR STAGE 3 : Excavation up to 2m (SLS)

### Summary Results

| | Node | Level [m] | Displacement [mm] | Moment [kNm/m] | Shear [kN/m] |
|---|---|---|---|---|---|
| Top wall node | 1 | 0.00000 | 1.7875 | 0.0 | 0.0 |
| Dig level (R) | 4 | -2.40000 | 1.2055 | -14.041 | 9.7558 |
| Max BM | 6 | -4.40000 | 0.79916 | -23.879 | 0.60881 |
| Wall toe | 14 | -14.50000 | 0.073461 | -19.217E-12 | 2.5429E-12 |

## STAGE 4 : EXCAVATION UP TO 4M

Ground level [m] LEFT: 0.00 RIGHT: -4.00 Soil zones changed

### Water data on LEFT side

| No. | Level [m] | Pressure [kN/m²] | Unit wt. [kN/m³] |
|---|---|---|---|
| 1 | -4.50000 | 0.00000 | 10.00000 |

| No. | Level [m] | Pressure [kN/m²] | Unit wt. [kN/m³] |
|---|---|---|---|

### Water data on RIGHT side

| No. | Level [m] | Pressure [kN/m²] | Unit wt. [kN/m³] |
|---|---|---|---|
| 1 | -4.50000 | 0.00000 | 10.00000 |

## RESULTS FOR STAGE 4 : Excavation up to 4m (SLS)

### Summary Results

| | Node | Level [m] | Displacement [mm] | Moment [kNm/m] | Shear [kN/m] |
|---|---|---|---|---|---|
| Top wall node | 1 | 0.00000 | 9.0081 | 0.0 | 0.0 |
| Dig level (R) | 6 | -4.40000 | 3.8728 | -85.549 | 42.466 |
| Max BM | 7 | -5.20000 | 3.0838 | -114.87 | 18.074 |
| Wall toe | 14 | -14.50000 | 0.15040 | -194.88E-12 | 23.028E-12 |

## STAGE 5 : EXCAVATION UP TO 6M

Ground level [m] LEFT: 0.00 RIGHT: -6.00 Soil zones changed

### Water data on LEFT side

| No. | Level [m] | Pressure [kN/m²] | Unit wt. [kN/m³] |
|---|---|---|---|
| 1 | -6.50000 | 0.00000 | 10.00000 |

### Water data on RIGHT side

| No. | Level [m] | Pressure [kN/m²] | Unit wt. [kN/m³] |
|---|---|---|---|
| 1 | -6.50000 | 0.00000 | 10.00000 |

## RESULTS FOR STAGE 5 : Excavation up to 6m (SLS)

### Summary Results

| | Node | Level [m] | Displacement [mm] | Moment [kNm/m] | Shear [kN/m] |
|---|---|---|---|---|---|
| Top wall node | 1 | 0.00000 | 29.232 | 0.0 | 0.0 |
| Max Shear | 7 | -5.20000 | 11.771 | -140.16 | 85.778 |
| Dig level (R) | 8 | -6.80000 | 7.1586 | -305.42 | 80.513 |
| Max BM | 9 | -8.00000 | 4.4400 | -374.70 | 7.7830 |
| Wall toe | 14 | -14.50000 | 0.21581 | -476.14E-12 | 62.719E-12 |

## STAGE 6 : EXCAVATION UP TO 7.4M

Ground level [m] LEFT: 0.00 RIGHT: -7.40 Soil zones changed

### Water data on LEFT side

| No. | Level [m] | Pressure [kN/m²] | Unit wt. [kN/m³] |
|---|---|---|---|
| 1 | -7.90000 | 0.00000 | 10.00000 |

### Water data on RIGHT side

| No. | Level [m] | Pressure [kN/m²] | Unit wt. [kN/m³] |
|---|---|---|---|
| 1 | -7.90000 | 0.00000 | 10.00000 |

## RESULTS FOR STAGE 6 : Excavation up to 7.4m (SLS)

### Summary Results

| | Node | Level [m] | Displacement [mm] | Moment [kNm/m] | Shear [kN/m] |
|---|---|---|---|---|---|
| Top wall node | 1 | 0.00000 | 59.981 | 0.0 | 0.0 |
| Dig level (R) | 9 | -8.00000 | 11.953 | -492.50 | 150.95 |
| Max BM | 11 | -10.64286 | 2.7378 | -737.53 | -98.736 |
| Max Shear | 12 | -11.92857 | 0.89867 | -436.75 | -216.85 |
| Wall toe | 14 | -14.50000 | -0.0056157 | -576.81E-12 | 108.80E-12 |

### Results Envelope

| Node | Level [m] | Displacements [mm] Min | Displacements [mm] Max | Moments [kNm/m] Min | Moments [kNm/m] Max | Shears [kN/m] Min | Shears [kN/m] Max |
|---|---|---|---|---|---|---|---|
| 1 | 0.00000 | 0.00000 | 59.98135 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| 2 | -0.80000 | 0.00000 | 54.91911 | -0.34520 | 0.00000 | 0.00000 | 2.32853 |

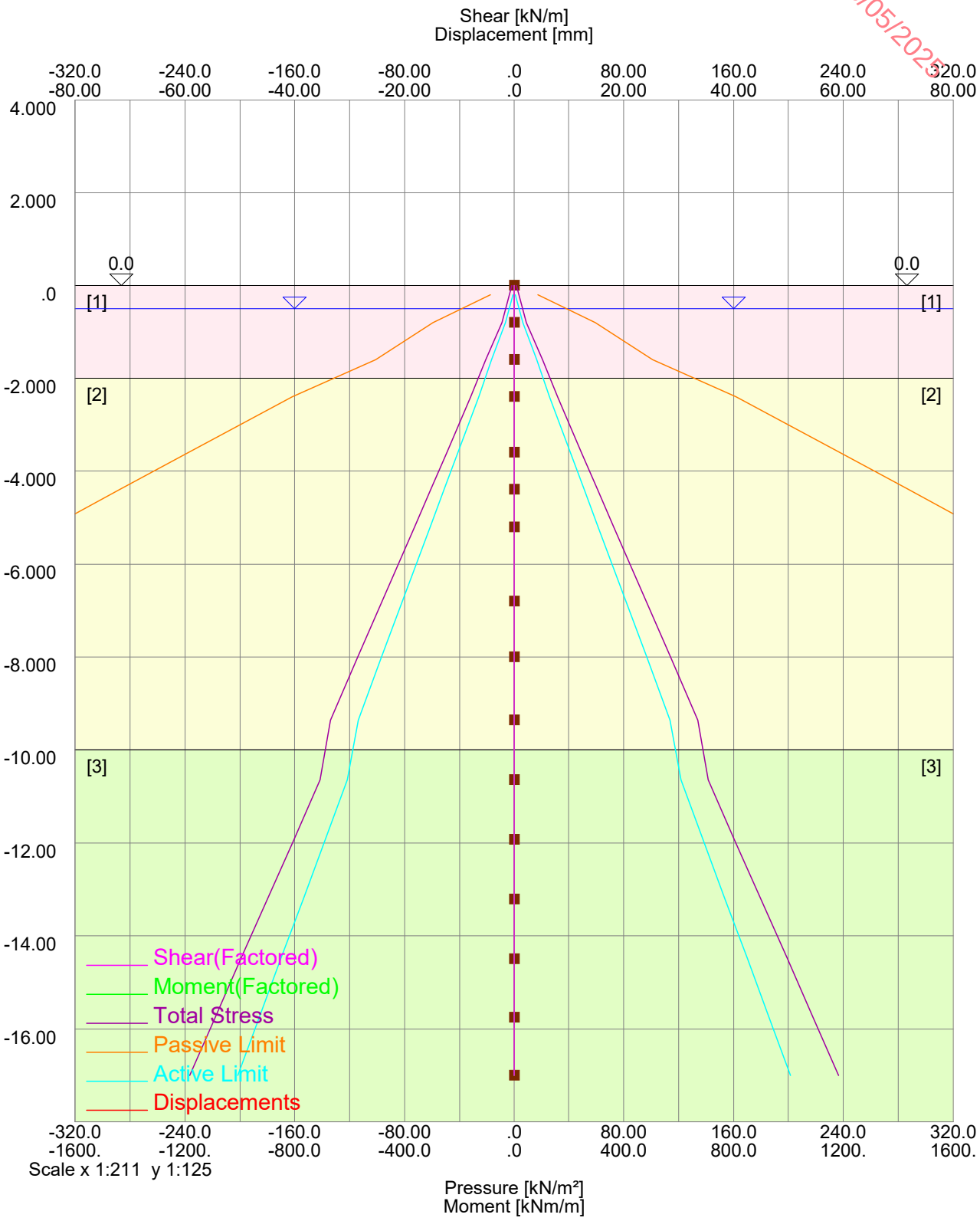
| Node | Level [m] | Displacements [mm] Min | Displacements [mm] Max | Moments [kNm/m] Min | Moments [kNm/m] Max | Shears [kN/m] Min | Shears [kN/m] Max |
|---|---|---|---|---|---|---|---|
| 3 | -1.60000 | 0.00000 | 49.85771 | -3.72565 | 0.00000 | 0.00000 | 8.55992 |
| 4 | -2.40000 | 0.00000 | 44.80115 | -14.04108 | 0.00000 | 0.00000 | 20.15105 |
| 5 | -3.60000 | 0.00000 | 37.25213 | -46.93389 | 0.00000 | 0.00000 | 37.85483 |
| 6 | -4.40000 | 0.00000 | 32.27596 | -85.55148 | 0.00000 | 0.00000 | 58.26991 |
| 7 | -5.20000 | 0.00000 | 27.38744 | -140.16573 | 0.00000 | -3.77814 | 85.77847 |
| 8 | -6.80000 | 0.00000 | 18.11958 | -305.42166 | 0.00000 | -9.08571 | 129.59118 |
| 9 | -8.00000 | 0.00000 | 11.95289 | -492.49853 | 0.00000 | -18.24679 | 150.95114 |
| 10 | -9.35714 | 0.00000 | 6.32099 | -690.64794 | 0.00000 | -52.05355 | 91.23600 |
| 11 | -10.64286 | 0.00000 | 2.73779 | -737.53425 | 0.00000 | -98.73631 | 2.07863 |
| 12 | -11.92857 | 0.00000 | 0.89867 | -436.75459 | 0.00000 | -216.85417 | 0.00000 |
| 13 | -13.21429 | 0.00000 | 0.31962 | -179.90933 | 0.00000 | -169.84903 | 0.00000 |
| ***14*** | ***-14.50000*** | ***-0.00562*** | ***0.21581*** | ***-0.00000*** | ***0.00000*** | ***0.00000*** | ***0.00000*** |
| 15 | -15.75000 | 0.00000 | 0.15632 | -0.00000 | 0.00000 | 0.00000 | 0.00000 |
| 16 | -17.00000 | 0.00000 | 0.00000 | -0.00000 | 0.00000 | 0.00000 | 0.00000 |

Oasys

**Greenhills Road**
Contiguous pile wall design
900mm dia 1050mm C/C

| Job No. | Sheet No. | Rev. |
|---|---|---|
| B2156 | | |
| Drg. Ref. | | |
| Made by SP | Date 09-Jul-2024 | Checked / Date |





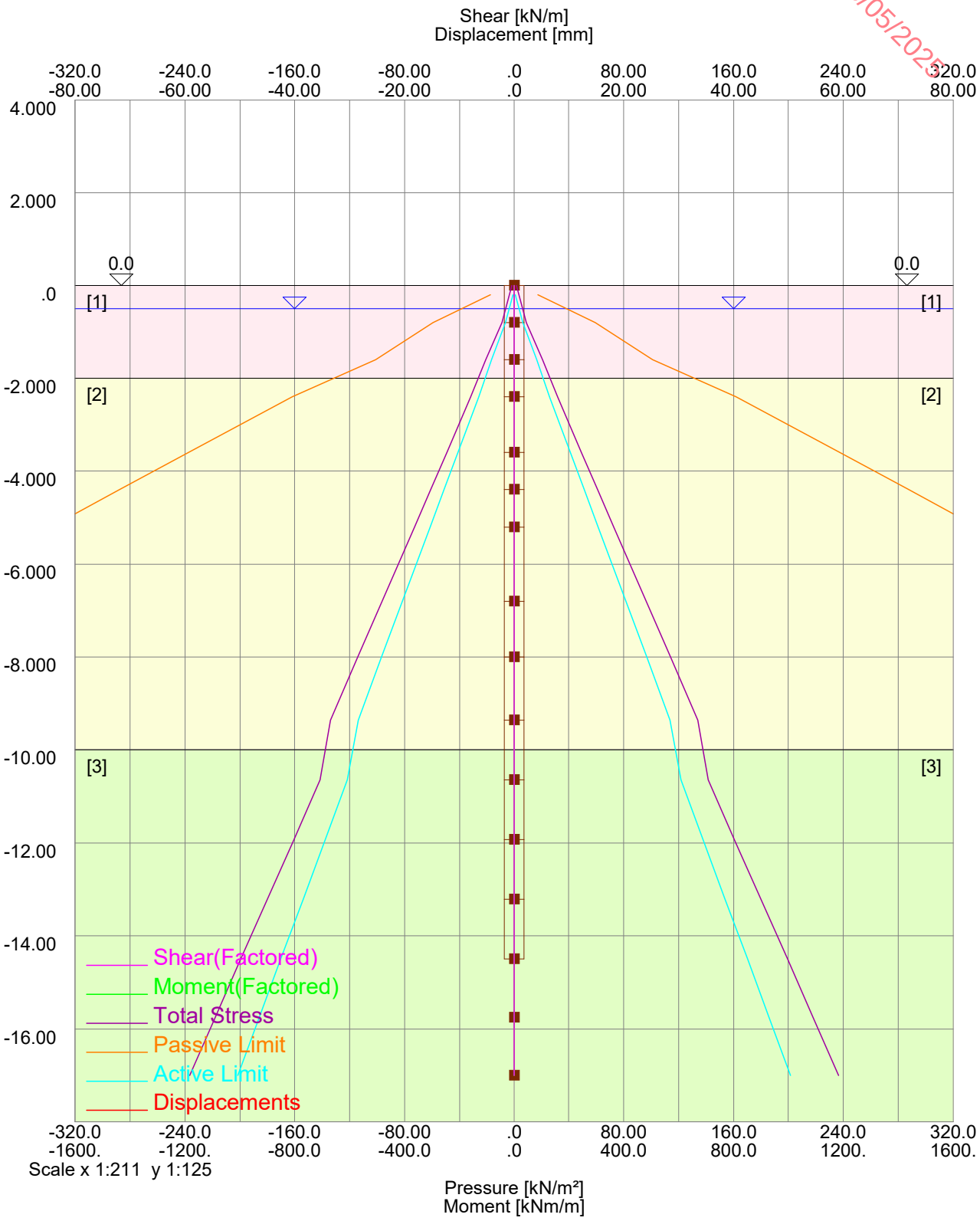

STAGE 0 : Initial condition
Results for factor set Eurocode 7 (UK - BS EN 1997-1:2011) DA1-1

Oasys

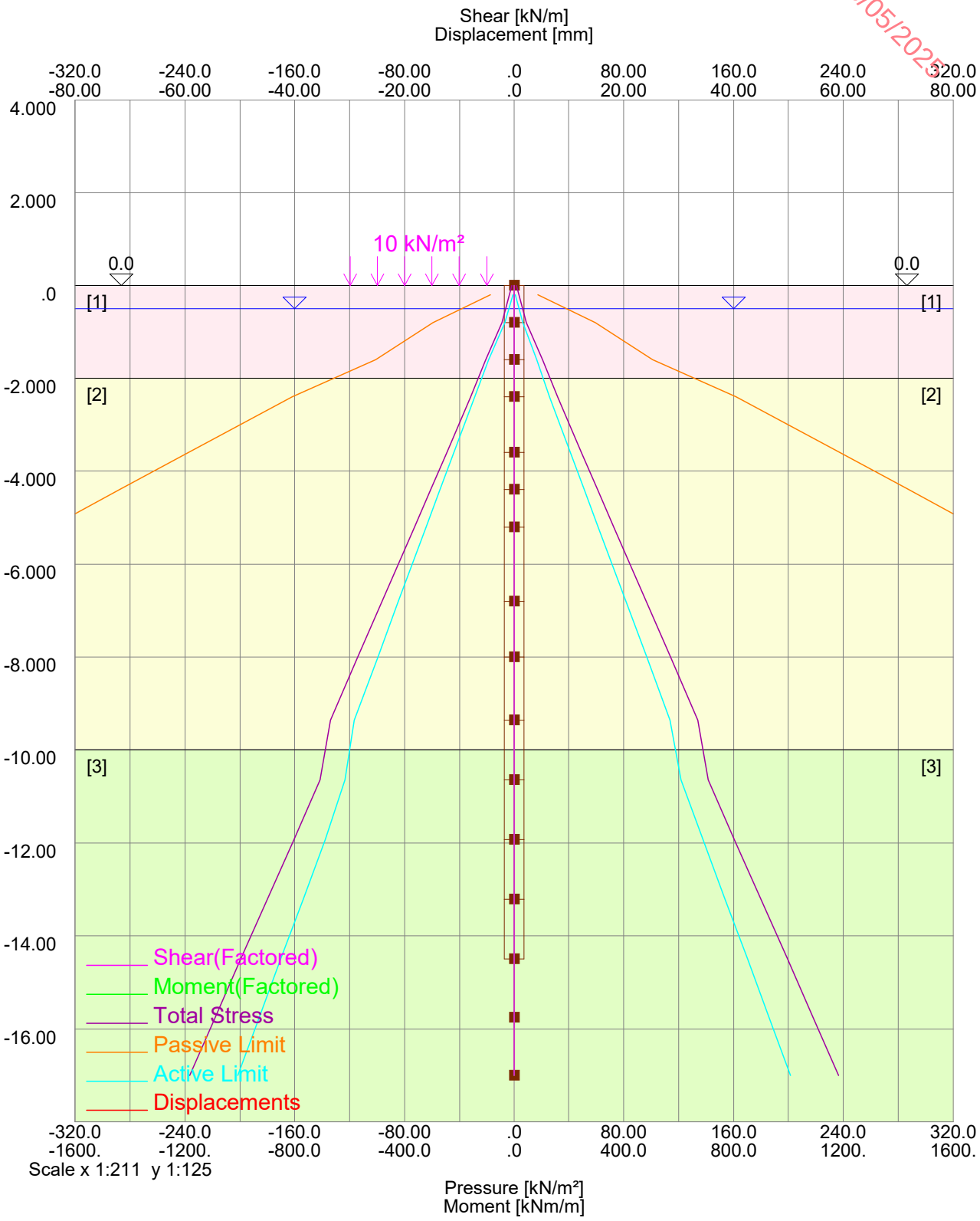
**Greenhills Road**
Contiguous pile wall design
900mm dia 1050mm C/C

| Job No. | Sheet No. | Rev. |
|---|---|---|
| B2156 | | |
| Drg. Ref. | | |
| Made by SP | Date 09-Jul-2024 | Checked / Date |






STAGE 1 : Wall installation
Results for factor set Eurocode 7 (UK - BS EN 1997-1:2011) DA1-1



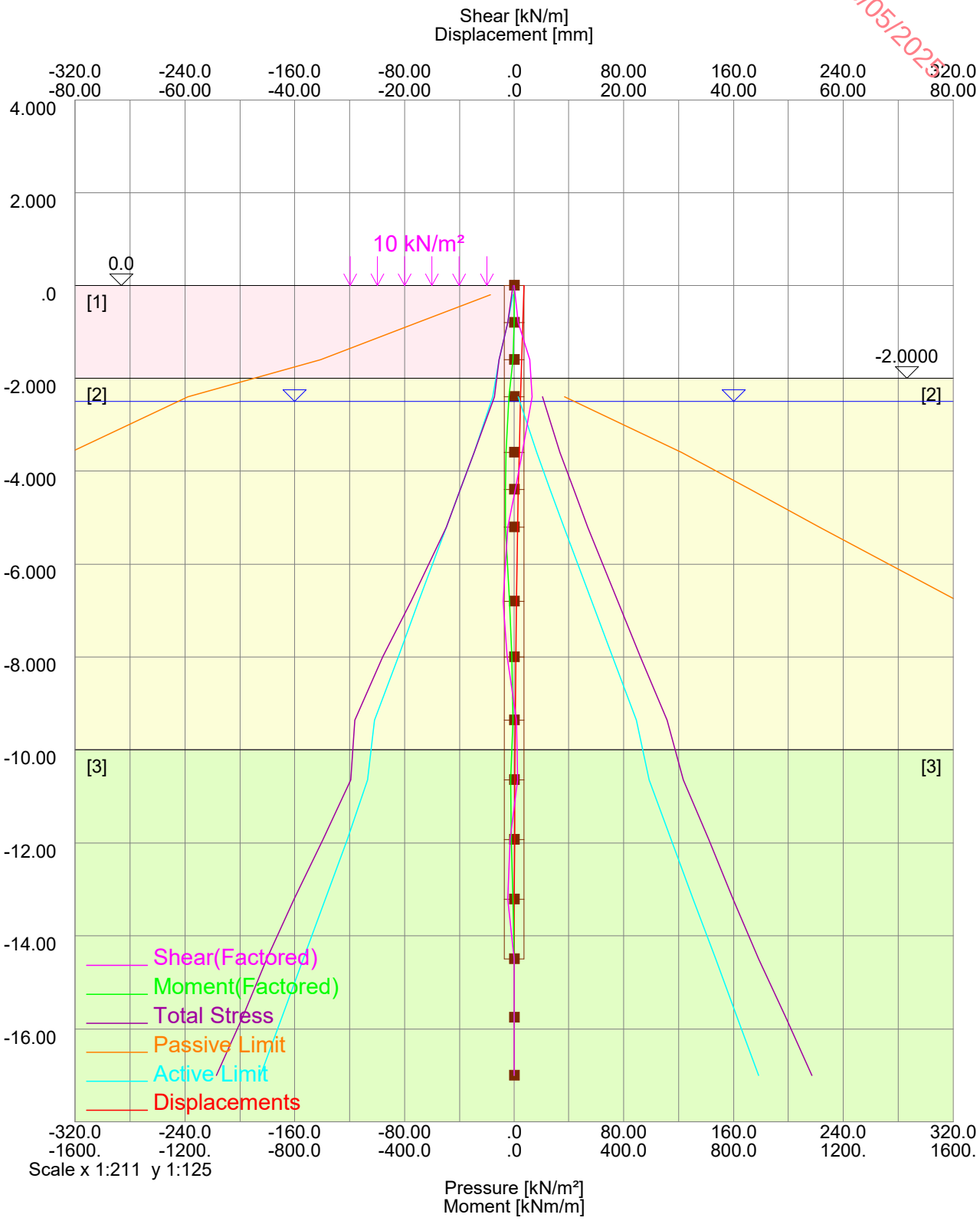

STAGE 2 : Surcharge
Results for factor set Eurocode 7 (UK - BS EN 1997-1:2011) DA1-1

Oasys

**Greenhills Road**
Contiguous pile wall design
900mm dia 1050mm C/C

| Job No. | Sheet No. | Rev. |
|---|---|---|
| B2156 | | |
| Drg. Ref. | | |
| Made by SP | Date 09-Jul-2024 | Checked / Date |





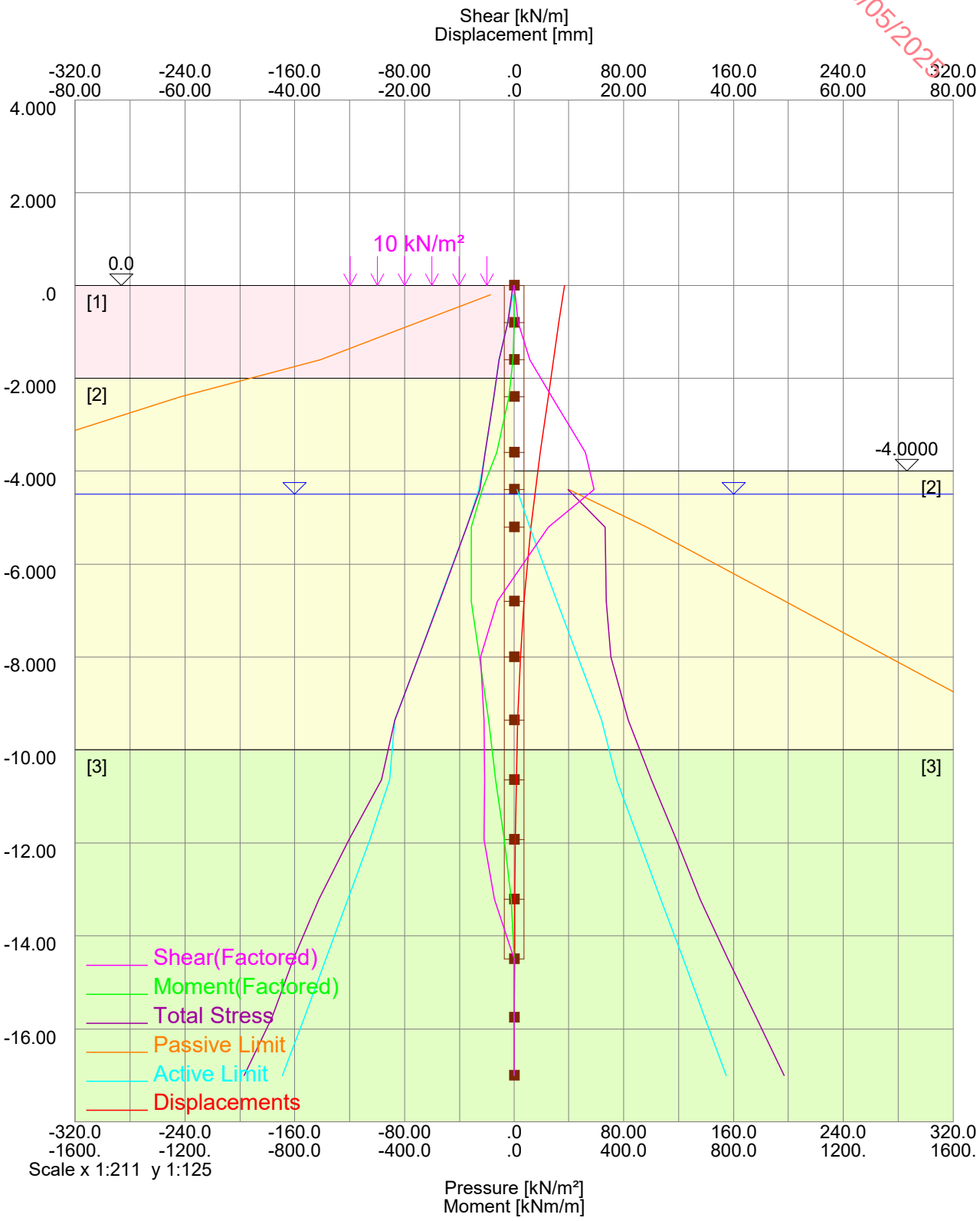

STAGE 3 : Excavation up to 2m
Results for factor set Eurocode 7 (UK - BS EN 1997-1:2011) DA1-1

Oasys

**Greenhills Road**
Contiguous pile wall design
900mm dia 1050mm C/C

| Job No. | Sheet No. | Rev. |
|---|---|---|
| B2156 | | |
| Drg. Ref. | | |
| Made by SP | Date 09-Jul-2024 | Checked / Date |





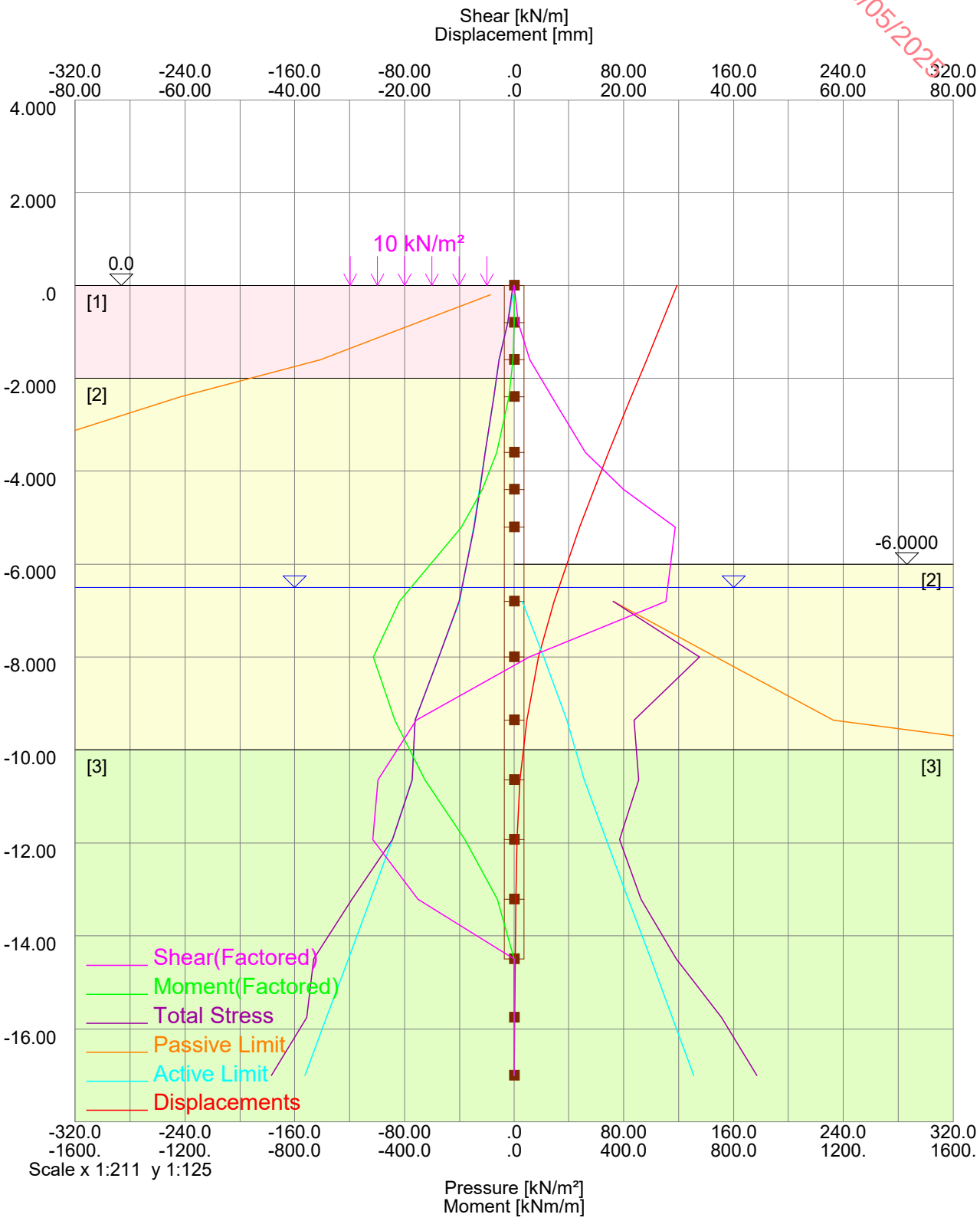

STAGE 4 : Excavation up to 4m
Results for factor set Eurocode 7 (UK - BS EN 1997-1:2011) DA1-1

Oasys

**Greenhills Road**
Contiguous pile wall design
900mm dia 1050mm C/C

| Job No. | Sheet No. | Rev. |
|---|---|---|
| B2156 | | |
| Drg. Ref. | | |
| Made by SP | Date 09-Jul-2024 | Checked / Date |





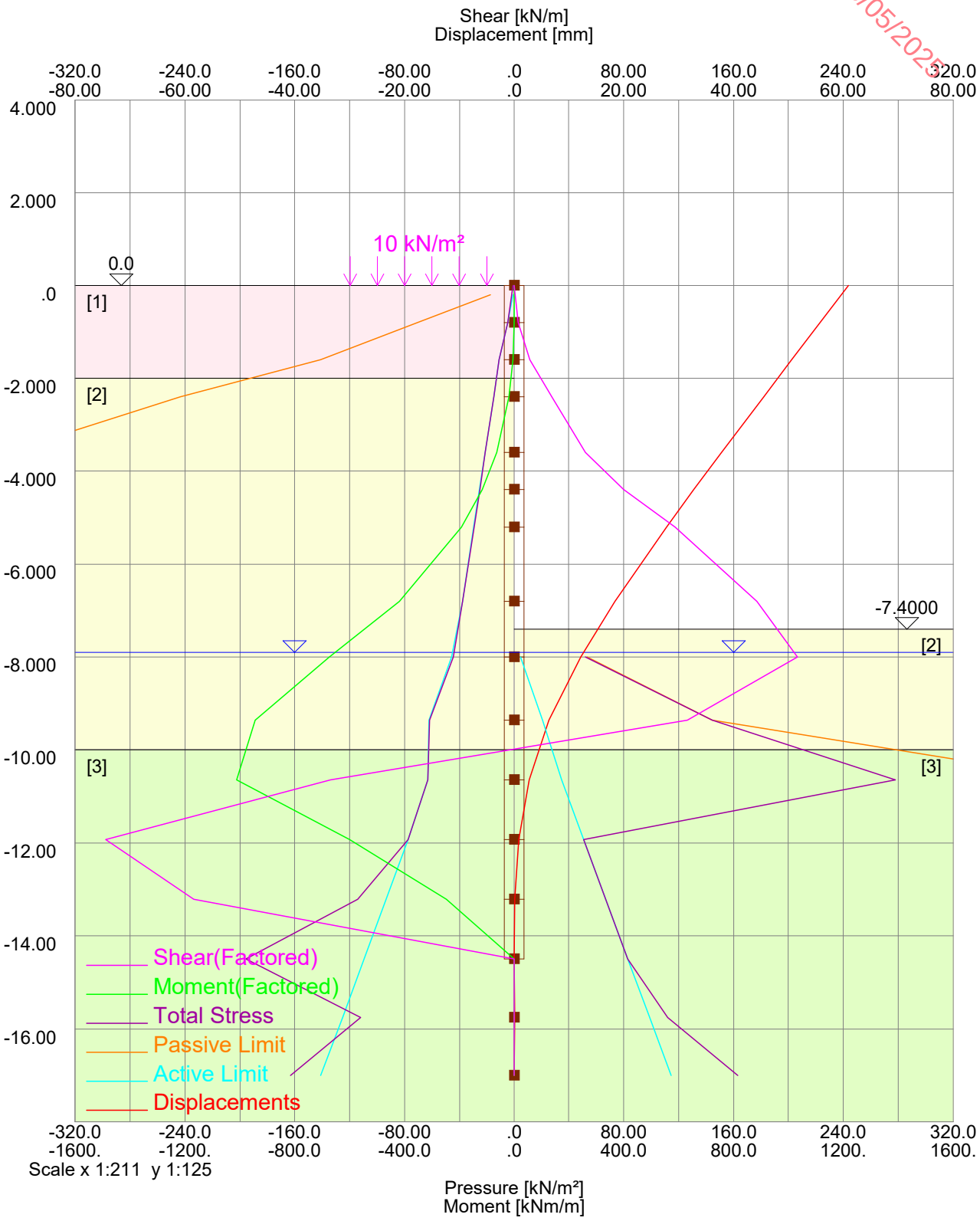

STAGE 5 : Excavation up to 6m
Results for factor set Eurocode 7 (UK - BS EN 1997-1:2011) DA1-1

Oasys

**Greenhills Road**
Contiguous pile wall design
900mm dia 1050mm C/C

| Job No. | Sheet No. | Rev. |
|---|---|---|
| B2156 | | |
| Drg. Ref. | | |
| Made by SP | Date 09-Jul-2024 | Checked / Date |






STAGE 6 : Excavation up to 7.4m
Results for factor set Eurocode 7 (UK - BS EN 1997-1:2011) DA1-1

## INITIAL DATA

### Soil properties

| No. | Description | Unit Wt [kN/m³] | K0 | Ka | Kp | Kac | Kpc | Kr | Earth pressure coefficients. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Madeground (D) | 19.00000 | 0.50000 | 0.28506 | 4.63887 | 1.06781 | 4.30761 | 0.25000 | *Calculated* |
| 2 | Coarse GRAVEL (D) | 20.00000 | 0.47008 | 0.26137 | 5.29118 | 1.02249 | 4.60051 | 0.25000 | *Calculated* |
| 3 | Bedrock | 24.00000 | 0.35721 | 0.18204 | 9.59504 | 0.85332 | 6.19517 | 0.25000 | *Calculated* |

| No. | c0 [kN/m²] | y0 [m] | Gradient of c [kN/m²/m] | E0 [kN/m²] | Gradient of E [kN/m²/m] | Drained/ Undrained |
|---|---|---|---|---|---|---|
| 1 | 0.00000 | 0.00000 | 0.00000 | 24000 | 0.0 | Drained |
| 2 | 0.00000 | 0.00000 | 0.00000 | 100000 | 0.0 | Drained |
| 3 | 0.00000 | 0.00000 | 0.00000 | 500000 | 0.0 | Drained |

### Parameters used to calculate Earth pressure coefficients

| No. | Phi [°] | Delta/Phi Ratio | Beta [°] | Cw/C Ratio |
|---|---|---|---|---|
| 1 | 30.00000 | 0.67000 | 0.00000 | 0.00000 |
| 2 | 32.00000 | 0.67000 | 0.00000 | 0.00000 |
| 3 | 40.00000 | 0.67000 | 0.00000 | 0.00000 |

### Partial factor sets

| Factor Set | Tan phi | Cohesion | Undrained cohesion | Young's modulus | Live (restoring) | Live (disturbing) | Dead (restoring) | Dead (disturbing) |
|---|---|---|---|---|---|---|---|---|
| SLS | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 1.00000 |
| DA1-1 | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 0.00000 | 1.11110 | 1.00000 | 1.00000 |
| DA1-2 | 1.25000 | 1.25000 | 1.40000 | 1.00000 | 0.00000 | 1.30000 | 1.00000 | 1.00000 |

### Soil Strength Partial Factors

| Name of Partial Factors: | tan Phi' | c' | Cu | E |
|---|---|---|---|---|
| DA1-1 | 1.00000 | 1.00000 | 1.00000 | 1.00000 |

Note: Only the parameters in bold have been affected by Partial Factors, No geometry or other factors have been changed.

### Design Soil properties after applying Partial Factors

| No. | Unit Wt [kN/m3] | K0 | Ka | Kp | Kac | Kpc | Kr | Earth pressure coefficients. |
|---|---|---|---|---|---|---|---|---|
| 1 | 19.00000 | 0.50000 | **0.28506** | **4.63887** | **1.06781** | **4.30761** | 0.25000 | Calculated |
| 2 | 20.00000 | 0.47008 | **0.26137** | **5.29118** | **1.02249** | **4.60051** | 0.25000 | Calculated |
| 3 | 24.00000 | 0.35721 | **0.18204** | **9.59504** | **0.85332** | **6.19517** | 0.25000 | Calculated |

| No. | c0 [kN/m2] | y0 [m] | Gradient of c [kN/m2/m] | E0 [kN/m2] | Gradient of E [kN/m2/m] | Drained/ Undrained |
|---|---|---|---|---|---|---|
| 1 | **0.00000** | 0.00000 | **0.00000** | **24000** | **0.00000** | Drained |
| 2 | **0.00000** | 0.00000 | **0.00000** | **100000** | **0.00000** | Drained |
| 3 | **0.00000** | 0.00000 | **0.00000** | **500000** | **0.00000** | Drained |

### Parameters used to calculate design Earth pressure coefficients

| No. | Phi [°] | Delta/Phi Ratio | Beta [°] | Cw/C Ratio |
|---|---|---|---|---|
| 1 | **30.00000** | 0.67000 | 0.00000 | 0.00000 |
| 2 | **32.00000** | 0.67000 | 0.00000 | 0.00000 |
| 3 | **40.00000** | 0.67000 | 0.00000 | 0.00000 |

### Surcharge properties

| No. | Stage In | Stage Out | Side | Level [m] | Pressure [kN/m²] | Factor Type | Partial Factor | Offset [m] | Width [m] | Ks |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | - | Left | 0.00000 | 10.00000 | Tan phi | 1.00000 | 1.00000 | 5.00000 | 0.00000 |

Note: Only the parameters in bold have been affected by Partial Factors.

### Surcharge Design properties

| No. | Stage In | Stage Out | Side | Level [m] | Pressure [kN/m²] | Offset [m] | Width [m] | Ks |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | - | Left | 0.00000 | 11.11100 | 1.00000 | 5.00000 | 0.00000 |

## STAGE 0 : INITIAL CONDITION

Ground level [m] LEFT: 0.00 RIGHT: 0.00 Soil zones changed

### Water data on LEFT side

| No. | Level [m] | Pressure [kN/m²] | Unit wt. [kN/m³] |
|---|---|---|---|
| 1 | -0.50000 | 0.00000 | 10.00000 |

### Water data on RIGHT side

| No. | Level [m] | Pressure [kN/m²] | Unit wt. [kN/m³] |
|---|---|---|---|
| 1 | -0.50000 | 0.00000 | 10.00000 |

### Analysis details

SAFE model with redistribution
and without friction at wall/soil interface

| | Left | Right |
|---|---|---|
| E profile Generated | | |
| Boundary distances [m] : | 50.00000 | 50.00000 |

### Convergence control parameters

Maximum number of iterations : 90000
Tolerance for displacement convergence [mm] : 0.01000
Tolerance for pressure convergence [kN/m²] : 0.10000
Damping coefficient : 1.00000
Maximum incremental displacement [m] : 1.00000

## RESULTS FOR STAGE 0 : Initial condition (DA1-1)

### Summary Results

| | Node | Level [m] | Displacement [mm] | Moment [kNm/m] | Shear [kN/m] |
|---|---|---|---|---|---|
| Top wall node | 1 | 0.00000 | 0.0 | 0.0 | 0.0 |

## STAGE 1 : WALL INSTALLATION

Ground level [m] LEFT: 0.00 RIGHT: 0.00 Wall EI changed

## RESULTS FOR STAGE 1 : Wall installation (DA1-1)

### Summary Results

| | Node | Level [m] | Displacement [mm] | Moment [kNm/m] | Shear [kN/m] |
|---|---|---|---|---|---|
| Top wall node | 1 | 0.00000 | 0.0 | 0.0 | 0.0 |
| Wall toe | 14 | -14.50000 | 0.0 | 0.0 | 0.0 |

## STAGE 2 : SURCHARGE

## RESULTS FOR STAGE 2 : Surcharge (DA1-1)

### Surcharge, strut or wall load changes

Surcharge no. 1 applied at this stage

### Summary Results

| | Node | Level [m] | Displacement [mm] | Moment [kNm/m] | Shear [kN/m] |
|---|---|---|---|---|---|
| Top wall node | 1 | 0.00000 | 0.0 | 0.0 | 0.0 |
| Wall toe | 14 | -14.50000 | 0.0 | 0.0 | 0.0 |

## STAGE 3 : EXCAVATION UP TO 2M

Ground level [m] LEFT: 0.00 RIGHT: -2.00 Soil zones changed

### Water data on LEFT side

| No. | Level [m] | Pressure [kN/m²] | Unit wt. [kN/m³] |
|---|---|---|---|
| 1 | -2.50000 | 0.00000 | 10.00000 |

### Water data on RIGHT side

| No. | Level [m] | Pressure [kN/m²] | Unit wt. [kN/m³] |
|---|---|---|---|
| 1 | -2.50000 | 0.00000 | 10.00000 |

## RESULTS FOR STAGE 3 : Excavation up to 2m (DA1-1)

### Summary Results

| | Node | Level [m] | Displacement [mm] | Moment [kNm/m] | Shear [kN/m] |
|---|---|---|---|---|---|
| Top wall node | 1 | 0.00000 | 1.8402 | 0.0 | 0.0 |
| Dig level (R) | 4 | -2.40000 | 1.2388 | -19.250 | 13.407 |
| Max BM | 6 | -4.40000 | 0.81758 | -32.866 | 1.0512 |
| Wall toe | 14 | -14.50000 | 0.073431 | -26.566E-12 | 3.5459E-12 |

## STAGE 4 : EXCAVATION UP TO 4M

Ground level [m] LEFT: 0.00 RIGHT: -4.00 Soil zones changed

### Water data on LEFT side

| No. | Level [m] | Pressure [kN/m²] | Unit wt. [kN/m³] |
|---|---|---|---|
| 1 | -4.50000 | 0.00000 | 10.00000 |

### Water data on RIGHT side

| No. | Level [m] | Pressure [kN/m²] | Unit wt. [kN/m³] |
|---|---|---|---|
| 1 | -4.50000 | 0.00000 | 10.00000 |

## RESULTS FOR STAGE 4 : Excavation up to 4m (DA1-1)

### Summary Results

| | Node | Level [m] | Displacement [mm] | Moment [kNm/m] | Shear [kN/m] |
|---|---|---|---|---|---|
| Top wall node | 1 | 0.00000 | 9.2056 | 0.0 | 0.0 |
| Dig level (R) | 6 | -4.40000 | 3.9587 | -117.52 | 58.592 |
| Max BM | 7 | -5.20000 | 3.1519 | -158.25 | 25.065 |
| Wall toe | 14 | -14.50000 | 0.15029 | -269.15E-12 | 31.864E-12 |

## STAGE 5 : EXCAVATION UP TO 6M

Ground level [m] LEFT: 0.00 RIGHT: -6.00 Soil zones changed

### Water data on LEFT side

| No. | Level [m] | Pressure [kN/m²] | Unit wt. [kN/m³] |
|---|---|---|---|
| 1 | -6.50000 | 0.00000 | 10.00000 |

### Water data on RIGHT side

| No. | Level [m] | Pressure [kN/m²] | Unit wt. [kN/m³] |
|---|---|---|---|
| 1 | -6.50000 | 0.00000 | 10.00000 |

## RESULTS FOR STAGE 5 : Excavation up to 6m (DA1-1)

### Summary Results

| | Node | Level [m] | Displacement [mm] | Moment [kNm/m] | Shear [kN/m] |
|---|---|---|---|---|---|
| Top wall node | 1 | 0.00000 | 29.746 | 0.0 | 0.0 |
| Max Shear | 7 | -5.20000 | 11.980 | -192.34 | 117.44 |
| Dig level (R) | 8 | -6.80000 | 7.2873 | -418.44 | 110.84 |
| Max BM | 9 | -8.00000 | 4.5193 | -514.87 | 11.221 |
| Wall toe | 14 | -14.50000 | 0.21543 | -659.11E-12 | 86.733E-12 |

## STAGE 6 : EXCAVATION UP TO 7.4M

| Node | Level [m] | Displacement [mm] | Moment [kNm/m] | Shear [kN/m] |
|---|---|---|---|---|

Ground level [m] LEFT: 0.00 RIGHT: -7.40 Soil zones changed

### Water data on LEFT side

| No. | Level [m] | Pressure [kN/m²] | Unit wt. [kN/m³] |
|---|---|---|---|
| 1 | -7.90000 | 0.00000 | 10.00000 |

### Water data on RIGHT side

| No. | Level [m] | Pressure [kN/m²] | Unit wt. [kN/m³] |
|---|---|---|---|
| 1 | -7.90000 | 0.00000 | 10.00000 |

## RESULTS FOR STAGE 6 : Excavation up to 7.4m (DA1-1)

### Summary Results

| | Node | Level [m] | Displacement [mm] | Moment [kNm/m] | Shear [kN/m] |
|---|---|---|---|---|---|
| Top wall node | 1 | 0.00000 | 60.936 | 0.0 | 0.0 |
| Dig level (R) | 9 | -8.00000 | 12.143 | -673.94 | 206.47 |
| Max BM | 11 | -10.64286 | 2.7724 | -1013.2 | -134.01 |
| Max Shear | 12 | -11.92857 | 0.90055 | -600.84 | -297.63 |
| Wall toe | 14 | -14.50000 | -0.016695 | -799.32E-12 | 150.11E-12 |

### Results Envelope

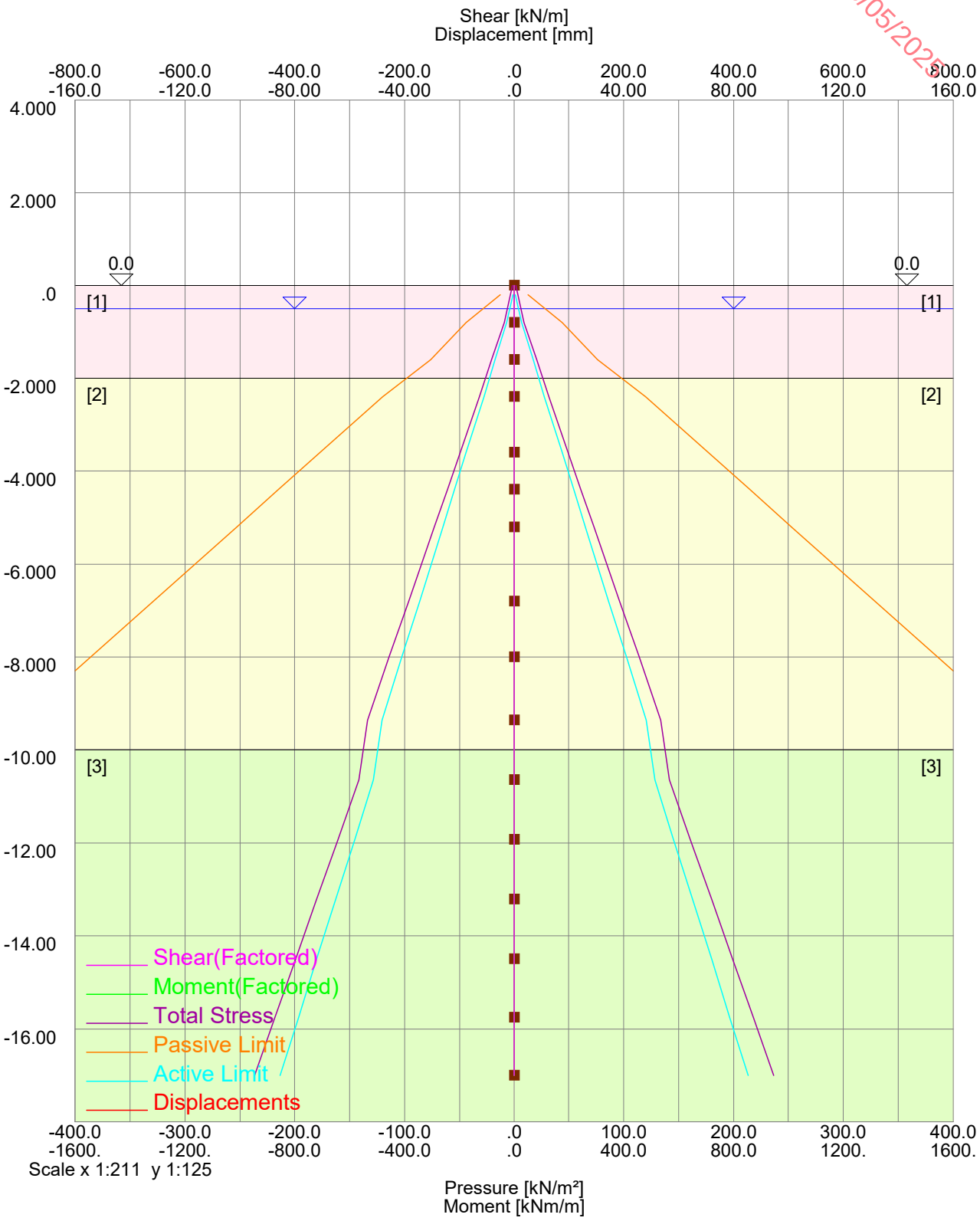
| Node | Level [m] | Displacements [mm] Min | Displacements [mm] Max | Moments [kNm/m] Min | Moments [kNm/m] Max | Shears [kN/m] Min | Shears [kN/m] Max |
|---|---|---|---|---|---|---|---|
| 1 | 0.00000 | 0.00000 | 60.93590 | 0.00000 | 0.00000 | 0.00000 | 0.00000 |
| 2 | -0.80000 | 0.00000 | 55.79310 | -0.46629 | 0.00000 | 0.00000 | 3.16947 |
| 3 | -1.60000 | 0.00000 | 50.65114 | -5.07114 | 0.00000 | 0.00000 | 11.73960 |
| 4 | -2.40000 | 0.00000 | 45.51408 | -19.24965 | 0.00000 | 0.00000 | 27.71322 |
| 5 | -3.60000 | 0.00000 | 37.84490 | -64.49764 | 0.00000 | 0.00000 | 52.01103 |
| 6 | -4.40000 | 0.00000 | 32.78961 | -117.51878 | 0.00000 | 0.00000 | 79.91822 |
| 7 | -5.20000 | 0.00000 | 27.82348 | -192.36461 | 0.00000 | -4.68362 | 117.44458 |
| 8 | -6.80000 | 0.00000 | 18.40855 | -418.47138 | 0.00000 | -12.51314 | 177.10480 |
| 9 | -8.00000 | 0.00000 | 12.14314 | -673.94281 | 0.00000 | -24.90097 | 206.46634 |
| 10 | -9.35714 | 0.00000 | 6.41819 | -945.42525 | 0.00000 | -71.51268 | 126.36117 |
| 11 | -10.64286 | 0.00000 | 2.77240 | -1013.16006 | 0.00000 | -134.00534 | 2.59871 |
| 12 | -11.92857 | 0.00000 | 0.90055 | -600.84019 | 0.00000 | -297.62769 | 0.00000 |
| 13 | -13.21429 | 0.00000 | 0.32090 | -247.83180 | 0.00000 | -233.66009 | 0.00000 |
| ***14*** | ***-14.50000*** | ***-0.01670*** | ***0.21543*** | ***-0.00000*** | ***0.00000*** | ***0.00000*** | ***0.00000*** |
| 15 | -15.75000 | 0.00000 | 0.15560 | -0.00000 | 0.00000 | 0.00000 | 0.00000 |
| 16 | -17.00000 | 0.00000 | 0.00000 | -0.00000 | 0.00000 | 0.00000 | 0.00000 |

Oasys

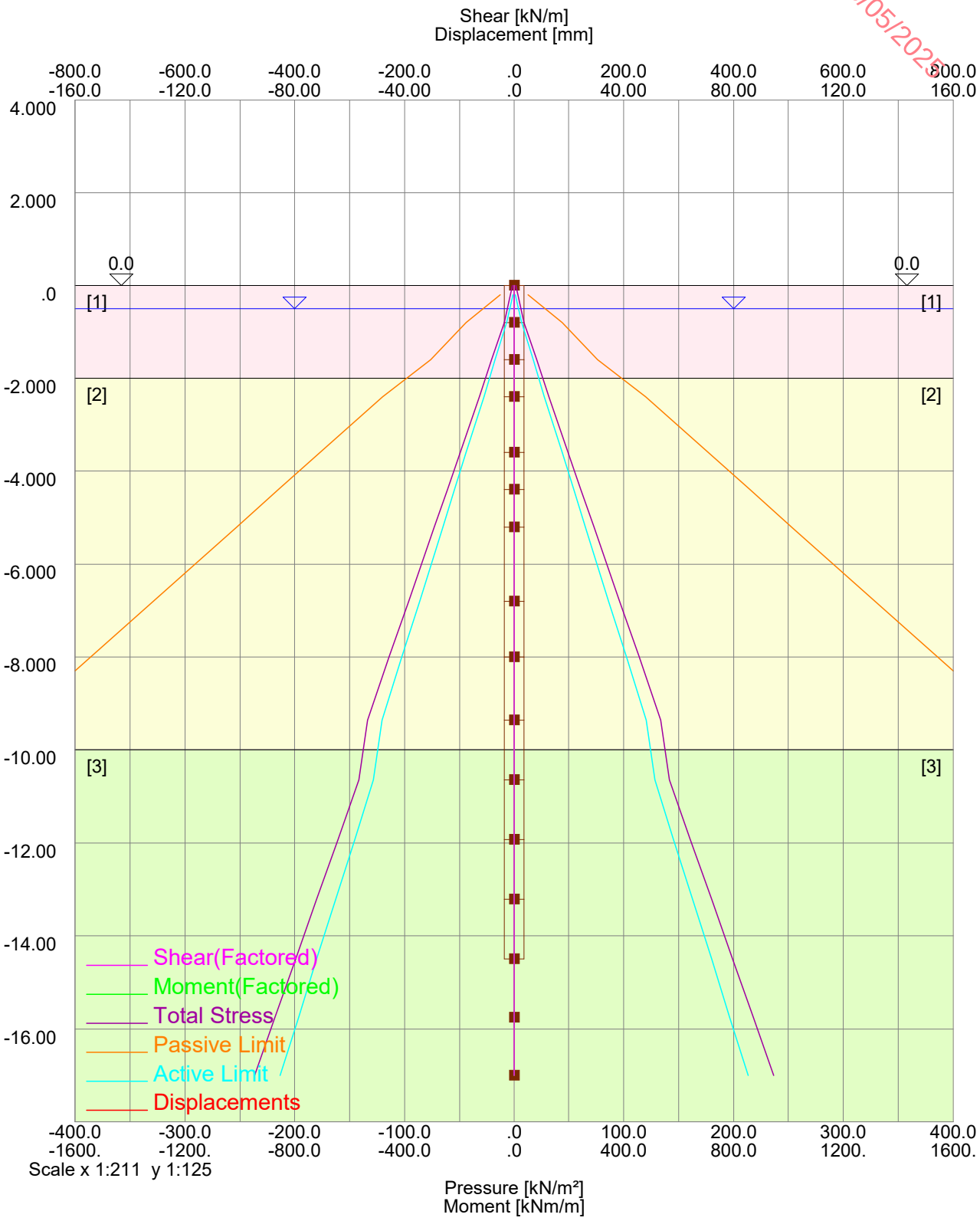
**Greenhills Road**
Contiguous pile wall design
900mm dia 1050mm C/C

| Job No. | Sheet No. | Rev. |
|---|---|---|
| B2156 | | |
| Drg. Ref. | | |
| Made by SP | Date 09-Jul-2024 | Checked / Date |






STAGE 0 : Initial condition
Results for factor set Eurocode 7 (UK - BS EN 1997-1:2011) DA1-2



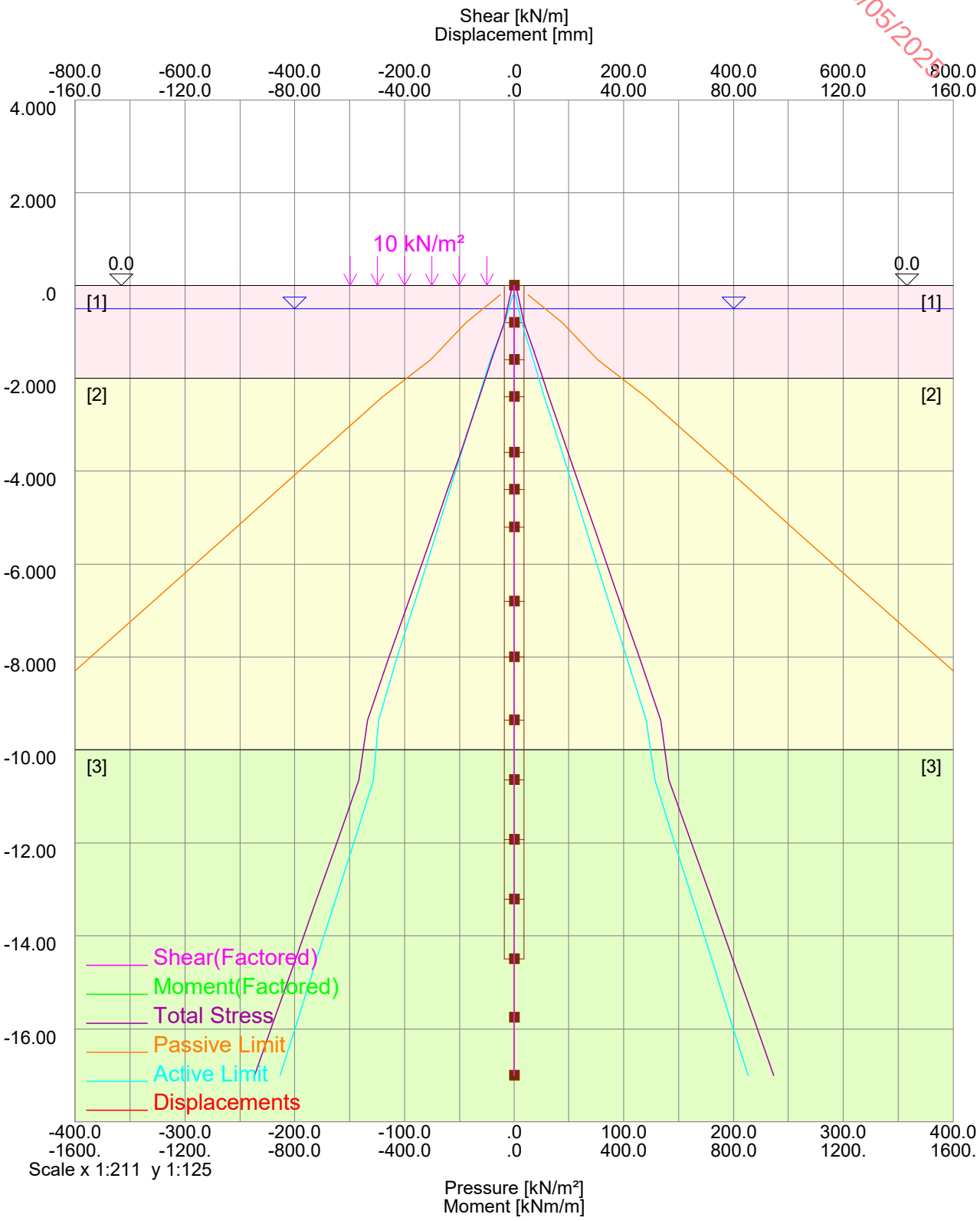

STAGE 1 : Wall installation
Results for factor set Eurocode 7 (UK - BS EN 1997-1:2011) DA1-2

Oasys

**Greenhills Road**
Contiguous pile wall design
900mm dia 1050mm C/C

| Job No. | Sheet No. | Rev. |
|---|---|---|
| B2156 | | |
| Drg. Ref. | | |
| Made by SP | Date 09-Jul-2024 | Checked / Date |





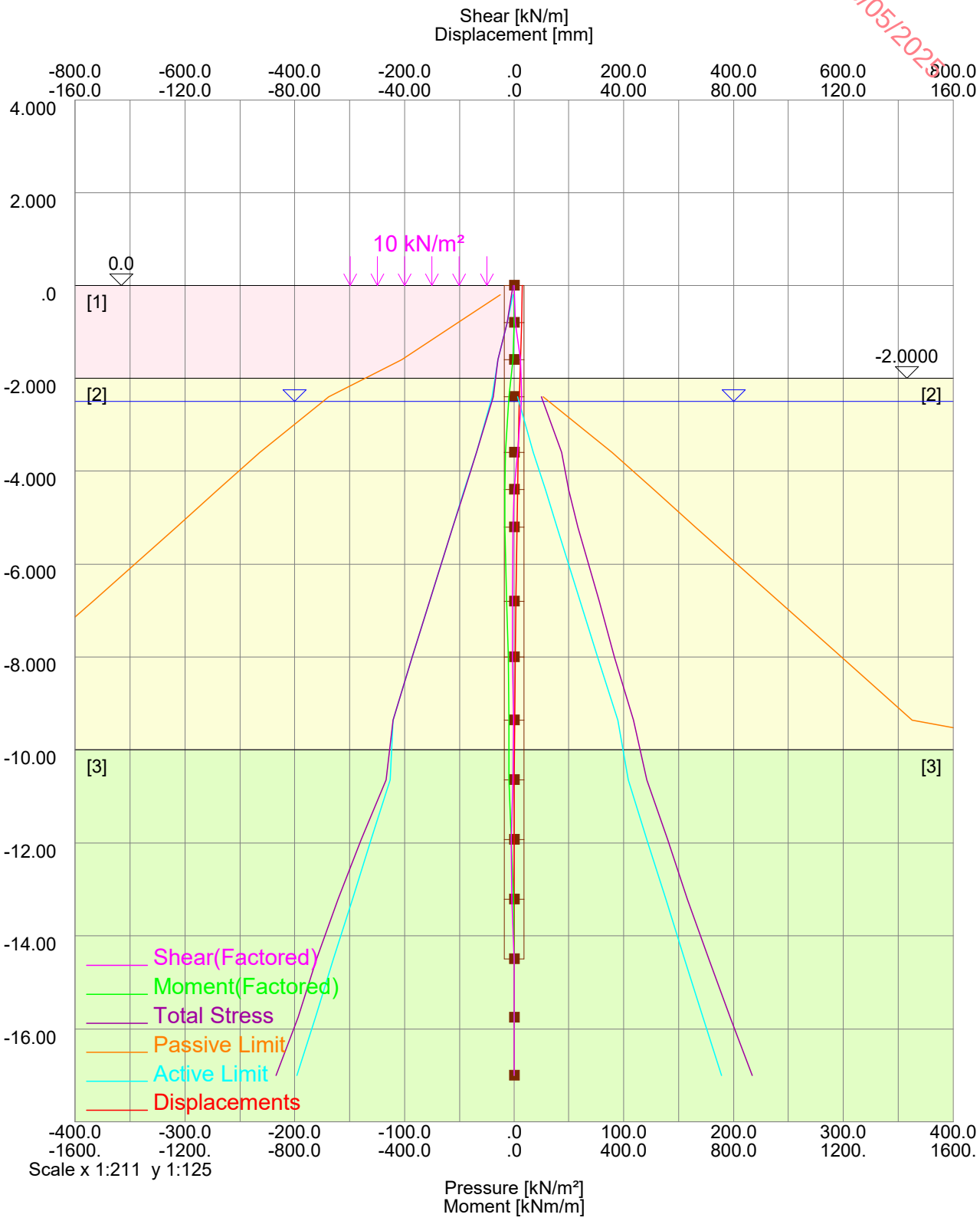

STAGE 2 : Surcharge
Results for factor set Eurocode 7 (UK - BS EN 1997-1:2011) DA1-2

Oasys

**Greenhills Road**
Contiguous pile wall design
900mm dia 1050mm C/C

| Job No. | Sheet No. | Rev. |
|---|---|---|
| B2156 | | |
| Drg. Ref. | | |
| Made by SP | Date 09-Jul-2024 | Checked / Date |





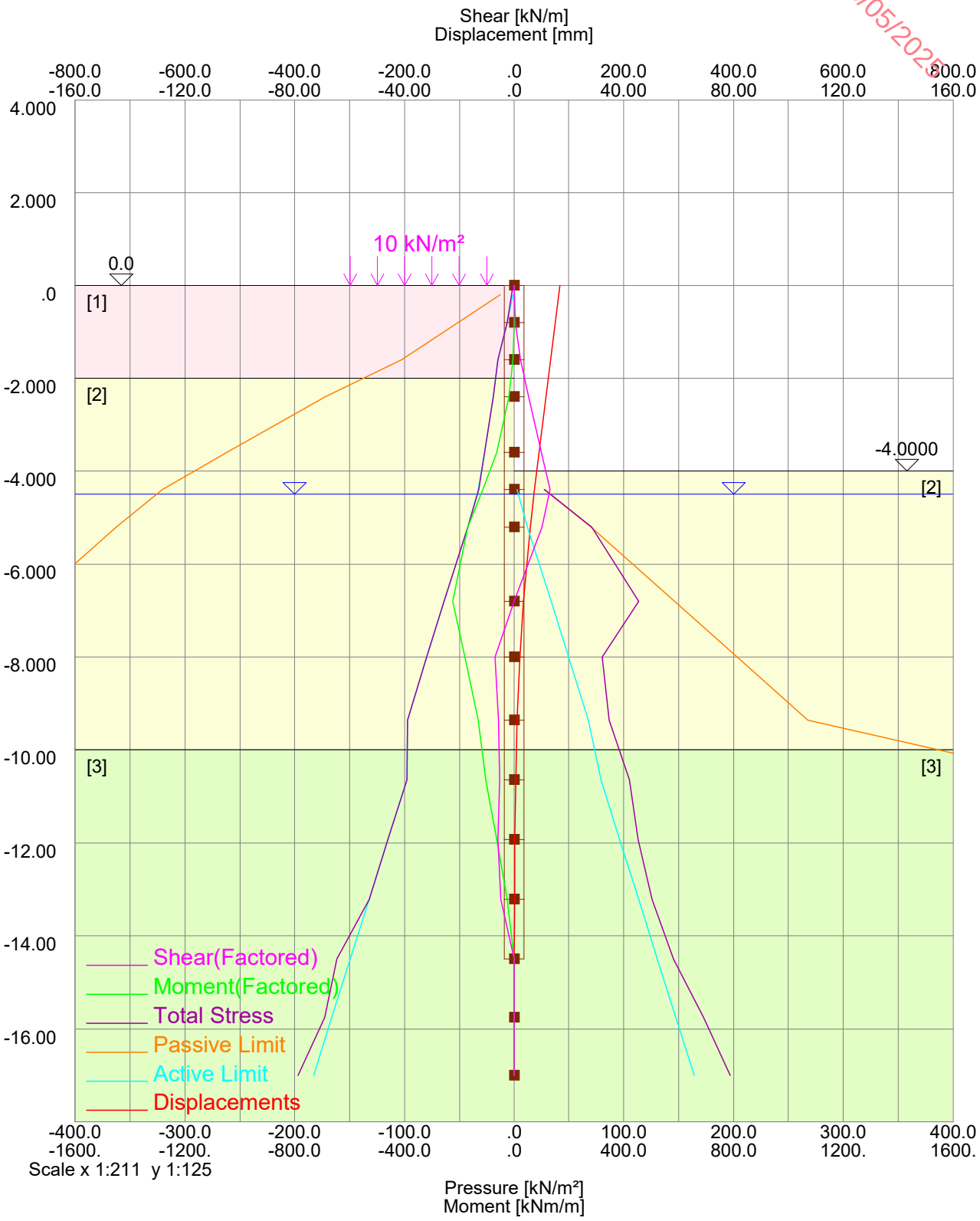

STAGE 3 : Excavation up to 2m
Results for factor set Eurocode 7 (UK - BS EN 1997-1:2011) DA1-2

Oasys

**Greenhills Road**
Contiguous pile wall design
900mm dia 1050mm C/C

| Job No. | Sheet No. | Rev. |
|---|---|---|
| B2156 | | |
| Drg. Ref. | | |
| Made by SP | Date 09-Jul-2024 | Checked / Date |





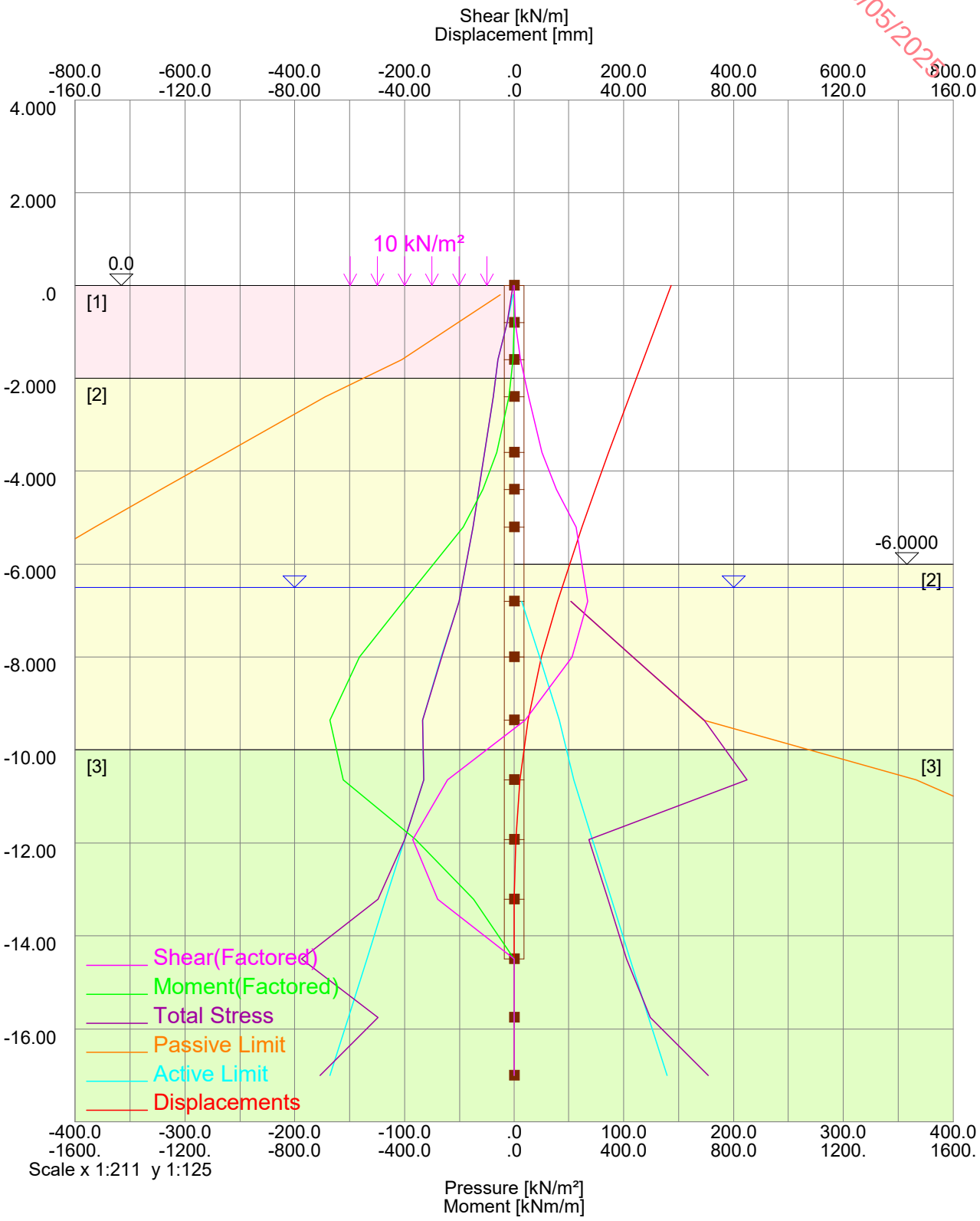

STAGE 4 : Excavation up to 4m
Results for factor set Eurocode 7 (UK - BS EN 1997-1:2011) DA1-2

Oasys

**Greenhills Road**
Contiguous pile wall design
900mm dia 1050mm C/C

| Job No. | Sheet No. | Rev. |
|---|---|---|
| B2156 | | |
| Drg. Ref. | | |
| Made by SP | Date 09-Jul-2024 | Checked Date |





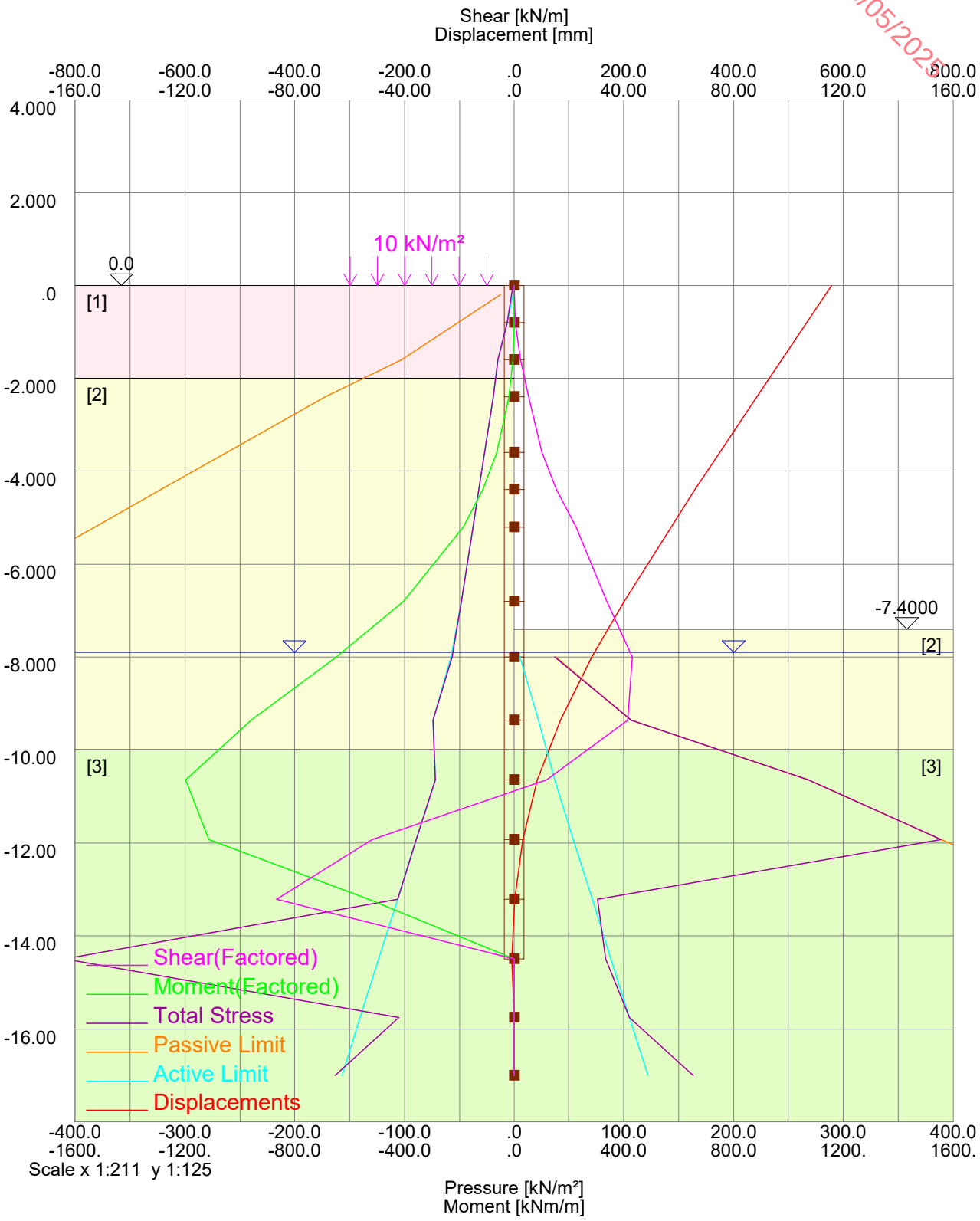

STAGE 5 : Excavation up to 6m
Results for factor set Eurocode 7 (UK - BS EN 1997-1:2011) DA1-2

Oasys

**Greenhills Road**
Contiguous pile wall design
900mm dia 1050mm C/C

| Job No. | Sheet No. | Rev. |
|---|---|---|
| B2156 | | |
| Drg. Ref. | | |
| Made by SP | Date 09-Jul-2024 | Checked / Date |






STAGE 6 : Excavation up to 7.4m
Results for factor set Eurocode 7 (UK - BS EN 1997-1:2011) DA1-2

## INITIAL DATA

### Soil properties

| No. | Description | Unit Wt [kN/m³] | K0 | Ka | Kp | Kac | Kpc | Kr | Earth pressure coefficients. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Madeground (D) | 19.00000 | 0.50000 | 0.28506 | 4.63887 | 1.06781 | 4.30761 | 0.25000 | *Calculated* |
| 2 | Coarse GRAVEL (D) | 20.00000 | 0.47008 | 0.26137 | 5.29118 | 1.02249 | 4.60051 | 0.25000 | *Calculated* |
| 3 | Bedrock | 24.00000 | 0.35721 | 0.18204 | 9.59504 | 0.85332 | 6.19517 | 0.25000 | *Calculated* |

| No. | c0 [kN/m²] | y0 [m] | Gradient of c [kN/m²/m] | E0 [kN/m²] | Gradient of E [kN/m²/m] | Drained/ Undrained |
|---|---|---|---|---|---|---|
| 1 | 0.00000 | 0.00000 | 0.00000 | 24000 | 0.0 | Drained |
| 2 | 0.00000 | 0.00000 | 0.00000 | 100000 | 0.0 | Drained |
| 3 | 0.00000 | 0.00000 | 0.00000 | 500000 | 0.0 | Drained |

### Parameters used to calculate Earth pressure coefficients

| No. | Phi [°] | Delta/Phi Ratio | Beta [°] | Cw/C Ratio |
|---|---|---|---|---|
| 1 | 30.00000 | 0.67000 | 0.00000 | 0.00000 |
| 2 | 32.00000 | 0.67000 | 0.00000 | 0.00000 |
| 3 | 40.00000 | 0.67000 | 0.00000 | 0.00000 |

### Partial factor sets

| Factor Set | Tan phi | Cohesion | Undrained cohesion | Young's modulus | Live (restoring) | Live (disturbing) | Dead (restoring) | Dead (disturbing) |
|---|---|---|---|---|---|---|---|---|
| SLS | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 1.00000 |
| DA1-1 | 1.00000 | 1.00000 | 1.00000 | 1.00000 | 0.00000 | 1.11110 | 1.00000 | 1.00000 |
| DA1-2 | 1.25000 | 1.25000 | 1.40000 | 1.00000 | 0.00000 | 1.30000 | 1.00000 | 1.00000 |

### Soil Strength Partial Factors

| Name of Partial Factors: | tan Phi' | c' | Cu | E |
|---|---|---|---|---|
| DA1-2 | 1.25000 | 1.25000 | 1.40000 | 1.00000 |

Note: Only the parameters in bold have been affected by Partial Factors, No geometry or other factors have been changed.

### Design Soil properties after applying Partial Factors

| No. | Unit Wt [kN/m³] | K0 | Ka | Kp | Kac | Kpc | Kr | Earth pressure coefficients. |
|---|---|---|---|---|---|---|---|---|
| 1 | 19.00000 | 0.50000 | **0.35564** | **3.37500** | **1.19271** | **3.67423** | 0.25000 | Calculated |
| 2 | 20.00000 | 0.47008 | **0.33011** | **3.74641** | **1.14910** | **3.87113** | 0.25000 | Calculated |
| 3 | 24.00000 | 0.35721 | **0.24071** | **6.01820** | **0.98124** | **4.90641** | 0.25000 | Calculated |

| No. | c0 [kN/m²] | y0 [m] | Gradient of c [kN/m²/m] | E0 [kN/m²] | Gradient of E [kN/m²/m] | Drained/ Undrained |
|---|---|---|---|---|---|---|
| 1 | **0.00000** | 0.00000 | **0.00000** | **24000** | **0.00000** | Drained |
| 2 | **0.00000** | 0.00000 | **0.00000** | **100000** | **0.00000** | Drained |
| 3 | **0.00000** | 0.00000 | **0.00000** | **500000** | **0.00000** | Drained |

### Parameters used to calculate design Earth pressure coefficients

| No. | Phi [°] | Delta/Phi Ratio | Beta [°] | Cw/C Ratio |
|---|---|---|---|---|
| 1 | **24.79128** | 0.67000 | 0.00000 | 0.00000 |
| 2 | **26.56026** | 0.67000 | 0.00000 | 0.00000 |
| 3 | **33.87266** | 0.67000 | 0.00000 | 0.00000 |

### Surcharge properties

| No. | Stage In | Stage Out | Side | Level [m] | Pressure [kN/m²] | Factor Type | Partial Factor | Offset [m] | Width [m] | Ks |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | - | Left | 0.00000 | 10.00000 | Tan phi | 1.00000 | 1.00000 | 5.00000 | 0.00000 |

Note: Only the parameters in bold have been affected by Partial Factors.

### Surcharge Design properties

| No. | Stage In | Stage Out | Side | Level [m] | Pressure [kN/m²] | Offset [m] | Width [m] | Ks |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | - | Left | 0.00000 | 13.00000 | 1.00000 | 5.00000 | 0.00000 |

## STAGE 0 : INITIAL CONDITION

Ground level [m] LEFT: 0.00 RIGHT: 0.00 Soil zones changed

### Water data on LEFT side

| No. | Level [m] | Pressure [kN/m²] | Unit wt. [kN/m³] |
|---|---|---|---|
| 1 | -0.50000 | 0.00000 | 10.00000 |

### Water data on RIGHT side

| No. | Level [m] | Pressure [kN/m²] | Unit wt. [kN/m³] |
|---|---|---|---|
| 1 | -0.50000 | 0.00000 | 10.00000 |

### Analysis details

SAFE model with redistribution
and without friction at wall/soil interface

| | Left | Right |
|---|---|---|
| E profile Generated | | |
| Boundary distances [m] : | 50.00000 | 50.00000 |

### Convergence control parameters

Maximum number of iterations : 90000
Tolerance for displacement convergence [mm] : 0.01000
Tolerance for pressure convergence [kN/m²] : 0.10000
Damping coefficient : 1.00000
Maximum incremental displacement [m] : 1.00000

## RESULTS FOR STAGE 0 : Initial condition (DA1-2)

### Summary Results

| | Node | Level [m] | Displacement [mm] | Moment [kNm/m] | Shear [kN/m] |
|---|---|---|---|---|---|
| Top wall node | 1 | 0.00000 | 0.0 | 0.0 | 0.0 |

## STAGE 1 : WALL INSTALLATION

Ground level [m] LEFT: 0.00 RIGHT: 0.00 Wall EI changed

## RESULTS FOR STAGE 1 : Wall installation (DA1-2)

### Summary Results

| | Node | Level [m] | Displacement [mm] | Moment [kNm/m] | Shear [kN/m] |
|---|---|---|---|---|---|
| Top wall node | 1 | 0.00000 | 0.0 | 0.0 | 0.0 |
| Wall toe | 14 | -14.50000 | 0.0 | 0.0 | 0.0 |

## STAGE 2 : SURCHARGE

## RESULTS FOR STAGE 2 : Surcharge (DA1-2)

### Surcharge, strut or wall load changes

Surcharge no. 1 applied at this stage

### Summary Results

| | Node | Level [m] | Displacement [mm] | Moment [kNm/m] | Shear [kN/m] |
|---|---|---|---|---|---|
| Top wall node | 1 | 0.00000 | 0.014985 | 0.0 | 0.0 |
| Max Shear | 4 | -2.40000 | 0.0077217 | 0.010276 | 0.33148 |
| Max BM | 5 | -3.60000 | 0.0041734 | -0.61818 | 0.23324 |
| Wall toe | 14 | -14.50000 | -2.9918E-6 | 0.0 | 0.0 |

## STAGE 3 : EXCAVATION UP TO 2M

Ground level [m] LEFT: 0.00 RIGHT: -2.00 Soil zones changed

| Node | Level [m] | Displacement [mm] | Moment [kNm/m] | Shear [kN/m] |
|---|---|---|---|---|

### Water data on LEFT side

| No. | Level [m] | Pressure [kN/m²] | Unit wt. [kN/m³] |
|---|---|---|---|
| 1 | -2.50000 | 0.00000 | 10.00000 |

### Water data on RIGHT side

| No. | Level [m] | Pressure [kN/m²] | Unit wt. [kN/m³] |
|---|---|---|---|
| 1 | -2.50000 | 0.00000 | 10.00000 |

## RESULTS FOR STAGE 3 : Excavation up to 2m (DA1-2)

### Summary Results

| | Node | Level [m] | Displacement [mm] | Moment [kNm/m] | Shear [kN/m] |
|---|---|---|---|---|---|
| Top wall node | 1 | 0.00000 | 3.1107 | 0.0 | 0.0 |
| Dig level (R) | 4 | -2.40000 | 2.0868 | -19.114 | 14.474 |
| Max BM | 6 | -4.40000 | 1.3450 | -34.693 | 0.66196 |
| Wall toe | 14 | -14.50000 | 0.071788 | -32.745E-12 | 4.2965E-12 |

## STAGE 4 : EXCAVATION UP TO 4M

Ground level [m] LEFT: 0.00 RIGHT: -4.00 Soil zones changed

### Water data on LEFT side

| No. | Level [m] | Pressure [kN/m²] | Unit wt. [kN/m³] |
|---|---|---|---|
| 1 | -4.50000 | 0.00000 | 10.00000 |

### Water data on RIGHT side

| No. | Level [m] | Pressure [kN/m²] | Unit wt. [kN/m³] |
|---|---|---|---|
| 1 | -4.50000 | 0.00000 | 10.00000 |

## RESULTS FOR STAGE 4 : Excavation up to 4m (DA1-2)

### Summary Results

| | Node | Level [m] | Displacement [mm] | Moment [kNm/m] | Shear [kN/m] |
|---|---|---|---|---|---|
| Top wall node | 1 | 0.00000 | 16.783 | 0.0 | 0.0 |
| Dig level (R) | 6 | -4.40000 | 7.5029 | -114.94 | 66.123 |
| Max BM | 8 | -6.80000 | 3.5557 | -223.87 | -0.65709 |
| Wall toe | 14 | -14.50000 | 0.13920 | -388.84E-12 | 45.511E-12 |

## STAGE 5 : EXCAVATION UP TO 6M

Ground level [m] LEFT: 0.00 RIGHT: -6.00 Soil zones changed

### Water data on LEFT side

| No. | Level [m] | Pressure [kN/m²] | Unit wt. [kN/m³] |
|---|---|---|---|
| 1 | -6.50000 | 0.00000 | 10.00000 |

### Water data on RIGHT side

| No. | Level [m] | Pressure [kN/m²] | Unit wt. [kN/m³] |
|---|---|---|---|
| 1 | -6.50000 | 0.00000 | 10.00000 |

## RESULTS FOR STAGE 5 : Excavation up to 6m (DA1-2)

### Summary Results

| | Node | Level [m] | Displacement [mm] | Moment [kNm/m] | Shear [kN/m] |
|---|---|---|---|---|---|
| Top wall node | 1 | 0.00000 | 57.308 | 0.0 | 0.0 |
| Dig level (R) | 8 | -6.80000 | 15.850 | -404.61 | 134.71 |
| Max BM | 10 | -9.35714 | 5.1544 | -672.86 | 20.469 |
| Max Shear | 12 | -11.92857 | 0.65555 | -359.60 | -184.78 |
| Wall toe | 14 | -14.50000 | -0.037938 | -998.61E-12 | 130.79E-12 |