LANMOR Consulting

Civil Engineers & Transport Planners

# 7 Elvetham Road

# Drainage Strategy

June 2021

211420/DS/JR/RS/01

LANMOR Consulting

Civil Engineers & Transport Planners

LANMOR Consulting Ltd,
Thorogood House, 34 Tolworth Close
Surbiton, Surrey, KT6 7EW

Tel: 0208 339 7899 Fax: 0208 339 7898
E-mail: info@lanmor.co.uk
Internet: www.lanmor.co.uk

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| | | | | |
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## APPENDICES

# 1 INTRODUCTION

## 1.1 Scope

1.1.1 Lanmor Consulting Ltd has been commissioned to prepare a Drainage Strategy report for the proposed development at 7 Elvetham Road, Fleet, GU51 4QL. This report has been prepared in support of development of the site and has been commissioned to advice on the feasibility of providing a solution for the foul and surface water drainage for the proposed development.

1.1.2 This report will consider the drainage regime for the site and sets out the drainage strategy for the proposed development including discharge rates and any requirements for attenuation.

1.1.3 The information within this report will be refined, modified, and updated as the detailed design is progressed. The scope of the works for this drainage strategy report is outlined below:

- Review available data in relation to on-site drainage and other drainage networks near the site
- Review of the ground conditions for the suitability of Sustainable Drainage Systems (SuDS)
- Consider the use of SuDS as an option for disposal of surface water runoff from the proposed development
- An assessment of the run-off likely to be generated.
- Undertake drainage assessments to establish attenuation requirements to deal with any increase in surface water runoff from the development.

# 2 SITE LOCATION AND DESCRIPTION

## 2.1 Location

2.1.1 The site is located within a residential area to the north of Fleet in the Hart district of Hampshire. The site is occupied by a large single dwelling, with associated parking areas and garage. Residential buildings can be found in all directions with the exception of railway tracks to the north of the site, running parallel with Elvetham Road. Drawing 1717/FE11A in Appendix A shows the existing block plan of the site.

2.1.2 Figure 2.1 below shows the location of the site.


**Figure 2.1 – Location Plan**

## 2.2 Existing Geology

2.2.1 The British Geological Survey indicates that the site sits upon a bedrock formation made up of Windlesham Formation, which consists of Sand, Silt and Clay. Sedimentary bedrock formed between 56 and 33.9 million years ago during the Palaeogene period.

2.2.2 There are no records of superficial deposits at the site.

## 2.3 Proposed Development

2.3.1 The proposed development will involve the demolition of the existing single dwelling to make way for a new block of residential flats, along with a new car parking area. Drawing 1717/FE12B in Appendix A shows the proposed layout of the site.

# 3 EXISTING DRAINAGE

## 3.1 Public Foul Drainage

3.1.1 As part of the investigation, Thames Water asset mapping was obtained. The records show that there is an existing foul sewer located to the north of the site beneath Elvetham Road. The sewer consists of a 200mm diameter pipe and flows from west to east.

## 3.2 Public Surface Water Drainage

3.2.1 According to the sewer records by Thames Water there is currently an existing Surface Water sewer located to the west of the site, approximately 15.0m away. The sewer consists of a 225mm Dia pipe. The asset mapping can be found in Appendix B of this report.

# 4 PROPOSED DRAINAGE REGIME

## 4.1 Proposed Foul Drainage

4.1.1 The proposed foul drainage will be collected and discharged to the existing Thames Water sewer via an existing connection. As part of the previous application (18_01743_FUL) a pre-planning enquiry was submitted to Thames Water in June 2018 and their response confirmed that there was sufficient capacity in the foul sewerage network.

## 4.2 Proposed Surface Water Drainage

4.2.1 Sustainable Drainage Systems (SuDS) were considered as part of this assessment for disposing of the surface water runoff from the development.

4.2.2 Since the proposed building has been designed with a flat roof, a green roof systems could potentially be used as part of the drainage regime.

4.2.3 Rainwater harvesting was also considered to reuse surface water runoff within the dwellings. These systems require a separate network of pipework, tanks and pumps to store the rainwater and distribute it through the units. Rainwater harvesting is suitable for large scale developments where the uptake matches the runoff.

4.2.4 Also, if there were consecutive storms the harvesting tank would be full at the start of the storm and all the runoff would discharge via the overflow, so the downstream SuDS feature (soakaway/attenuation tank) would need to be sized ignoring the harvesting facility. Given the rainwater harvesting cannot be relied on to reduce the rate of runoff from the site and the additional cost for the necessary infrastructure to implement it, rainwater harvesting has therefore been discounted.

4.2.5 Next on the sustainable drainage hierarchy is the use of ground infiltration techniques such as soakaways and infiltration basins. BGS records indicate that the underlying bedrock consists of Windlesham Formation, which consists of Sand, Silt and Clay. These ground conditions can sometimes be unfavourable for infiltration techniques, however a ground investigation was undertaken by K F Geotechnical in April 2018. This investigation was in relation to a previous application (18_01743_FUL).

4.2.6 As part of the investigation, two soakaway (trail pits) tests were undertaken at the north and south of the site. The tests found successful results, and gave infiltration rates between $8.3x10^{-6}$ and $2.4x10^{-5}$ m/s and thus it is recommended that for the drainage strategy, a conservative infiltration rate of $8.3x10^{-6}$ m/s be used for a trench soakaway.

4.2.7 There are no known watercourses located within the immediate vicinity of the site, thus it is not possible to adopt this method of discharge. There is a surface water sewer in the vicinity of the site, however the use of infiltration for the discharge of surface water is more sustainable and has been used in this design.

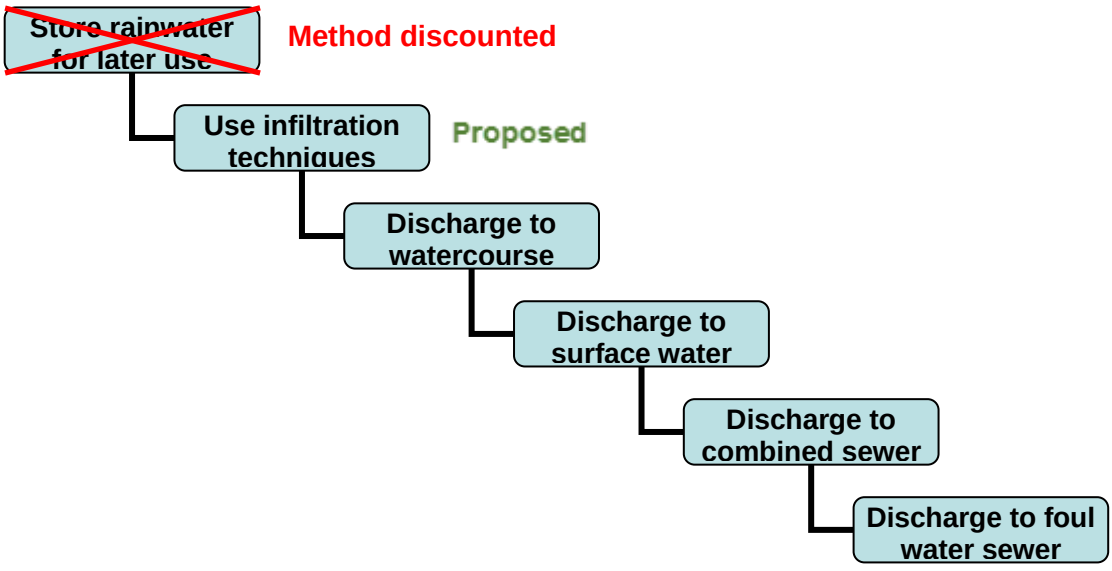



**Figure 4.1 – Sustainable Drainage Hierarchy**

4.2.8 Therefore, in accordance with the SuDS hierarchy, surface water runoff will discharge to the ground via the use of infiltration techniques. A green roof will also be implemented as part of the design.

4.2.9 As mentioned, based on the ground investigation results, a conservative infiltration rate of 8.3 x $10^{-6}$ m/s has been used to determine the size of the soakaway and the permeable paving structures.

4.2.10 The soakaway has been sized at 2.5m (w) x 12.0m (l) 1.5m (d) to achieve a max volume of 45.0$m^3$. For the detailed drainage design, the infiltration rate will need to be proved and if the rate differs from that of this strategy, the soakaway will be re-designed accordingly. Subject to testing for the detailed design, it may more appropriate to cascade the surface water run-off collected by the permeable to soakaway.

4.2.11 MicroDrainage was used to calculate the size of the soakaway and it has been designed to cater for all events up to and including a 1 in 100 year storm including 40% allowances for climate change. This confirms that no flooding will occur for the 1% AEP +CC event.

4.2.12 Permeable Paving will also be implemented as part of the strategy to aid in discharge of runoff from the access road and parking areas. The permeable paving areas will have a minimum subbase thickness of 300mm to provide storage for storms with a probability of 1 in 100 years +40% CC, the final thickness will be subject to detailed design once the finished car park levels are established.

4.2.13 An indicative drainage layout for the proposed development has been prepared and is included in Appendix C as drawing 211420/DS/01. MicroDrainage has been used to design the soakaway and permeable paving and a copy of these calculations are included in Appendix D.

## 5 SURFACE WATER / SUDS MAINTENANCE

5.1.1 Regularly inspection of the surface water drainage network for blockages and clearing unwanted debris / silt from the system should improve the performance of the surface water network and decrease the need for future repairs. In the event of blockages, high pressure water jets can be used to clear the gullies and pipes to ensure they are functioning correctly, this should be undertaken by certified trained professionals.

5.1.2 The level and frequency of maintenance required on site is dependent on the type of facility. The type of maintenance will fall into one of three categories "regular maintenance", "occasional maintenance" and "remedial maintenance".

5.1.3 Regular maintenance of the drainage and SuDS features will include, inspections, removal of litter / debris and sweeping of the surfaces. Occasional maintenance will include removal of sediment etc. and remedial maintenance may include structural repairs and infiltration reconditioning if required.

5.1.4 The drainage and SuDS elements after an initial inspection following construction should be inspected on a monthly basis for the first 12 months and after large storms, thereafter the following maintenance regime should be applied and adjusted if the 12-month monitoring process has identified any issues.

5.1.5 Following completion of the development a Management Company will be set up to maintain all the communal areas, including the drainage. It will be their responsibility to maintain the drainage network, including the SuDS elements.

5.1.6 For soakaways, the following maintenance is recommended.

| **Soakaway Maintenance Schedule** | | |
|---|---|---|
| | Required Action | Typical Frequency |

| | | |
|---|---|---|
| Regular maintenance | Inspect for sediment debris in pre-treatment components and floor of inspection tube / chamber and inside soakaway | Annually |
| | Cleaning of gutters and any filters on downpipes | Annually (or as required based on inspections) |
| | Trimming any roots that may be causing blockages | Annually (or as required) |
| Occasional maintenance | Remove sediment and debris from pre-treatment components and floor of inspection tube / chamber and inside soakaway | As required, based on inspections |
| Remedial Actions | Reconstruct soakaway and/or replace or clean void fill, if performance deteriorates or failure occurs | As required |
| | Replacement of clogged geotextile (will require reconstruction of soakaway) | As required |
| Monitoring | Inspect silt traps and note rate of sediment accumulation | Monthly in the first year and then annually |
| | Check soakaway to ensure emptying is occurring | Annually |

**Table 5.1 – Soakaway Maintenance Schedule**

5.1.7 For Permeable Paving Areas, the following maintenance is recommended:

| **Permeable Paving Maintenance Schedule** | | |
|---|---|---|
| | Required Action | Typical Frequency |
| Regular maintenance | Brushing and vacuuming (standard cosmetic sweep over whole surface) | Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations – pay |

| | | |
|---|---|---|
| | | particular attention to areas where water runs onto pervious surfaces from adjacent impermeable areas as this area is most likely to collect the most sediment. |
| Occasional maintenance | Stabilise and mow contributing and adjacent areas | As required |
| | Removal of weeds or management using glyphosate applied directly into the weeds by an applicator rather than spraying | As required- once per year on less frequently used pavements |
| Remedial Actions | Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50 mm of the level of the paving | As required |
| | Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and replace lost jointing material | As required |
| | Rehabilitation of surface and upper substructure by remedial sweeping | Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging) |
| Monitoring | Inspect for evidence of poor operation and/or weed growth - if required, take remedial action. | Three-monthly, 48 hours after large storms in the first six months |
| | Inspect silt accumulation rates and establish appropriate brushing frequencies | Annually |
| | Monitor inspection chambers | Annually |

**Table 5.2 – Permeable Paving Maintenance Schedule**

5.1.8 The above information is only intended as guidance to standard maintenance practise for surface water drainage and SuDS features. The above measures should be reviewed regularly and modified to suit the site conditions.

# 6 SUMMARY AND CONCLUSION

6.1.1 Lanmor Consulting Ltd has been commissioned to prepare a Drainage Strategy report for the proposed development at 7 Elvetham Road, Fleet, GU51 4QL. The proposed development will involve the demolition of the existing single dwelling to make way for a new block of residential flats, along with a new car parking area.

6.1.2 This strategy has assessed the use of SuDS and where possible it has been incorporated into the strategy. A site investigation has been carried out which included two soakaway tests being undertaken, both of which came back with positive results. Therefore, for the disposal of surface water runoff the use of infiltration techniques can be implemented.

6.1.3 The proposed drainage will use a combination of a single soakaway and permeable paving for the disposal of surface water runoff. These have been designed to cater for all events up to and including a 1 in 100-year storm plus 40% climate change allowances, using a conservative infiltration rate of $8.3x10^{-6}$ m/s for the preliminary design.

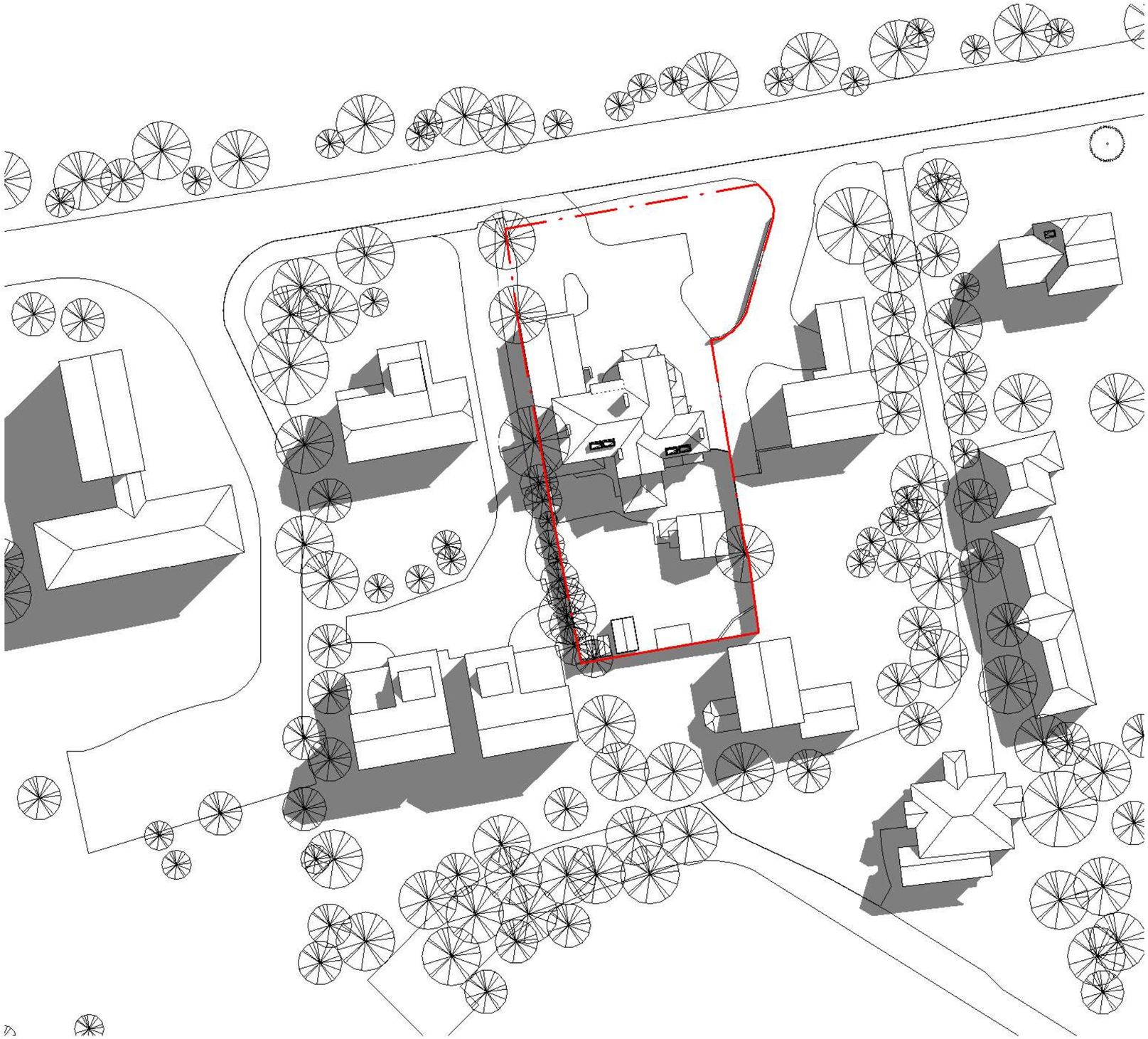
6.1.4 For the reasons outlined within this report, we see no reason to refuse planning permission on the grounds of there being insufficient capacity to discharge runoff from the development.

# APPENDIX A

Drawing 1717/FE11A – Existing Block Plan

Date Issue/Revisions

NORTH



0 5 10 20 m

Scale at A3 (1:500)

Form
Architecture and Planning

Form Architecture and Planning
Walton on Thames, Surrey. KT12 4RZ
Tel 01932 213248

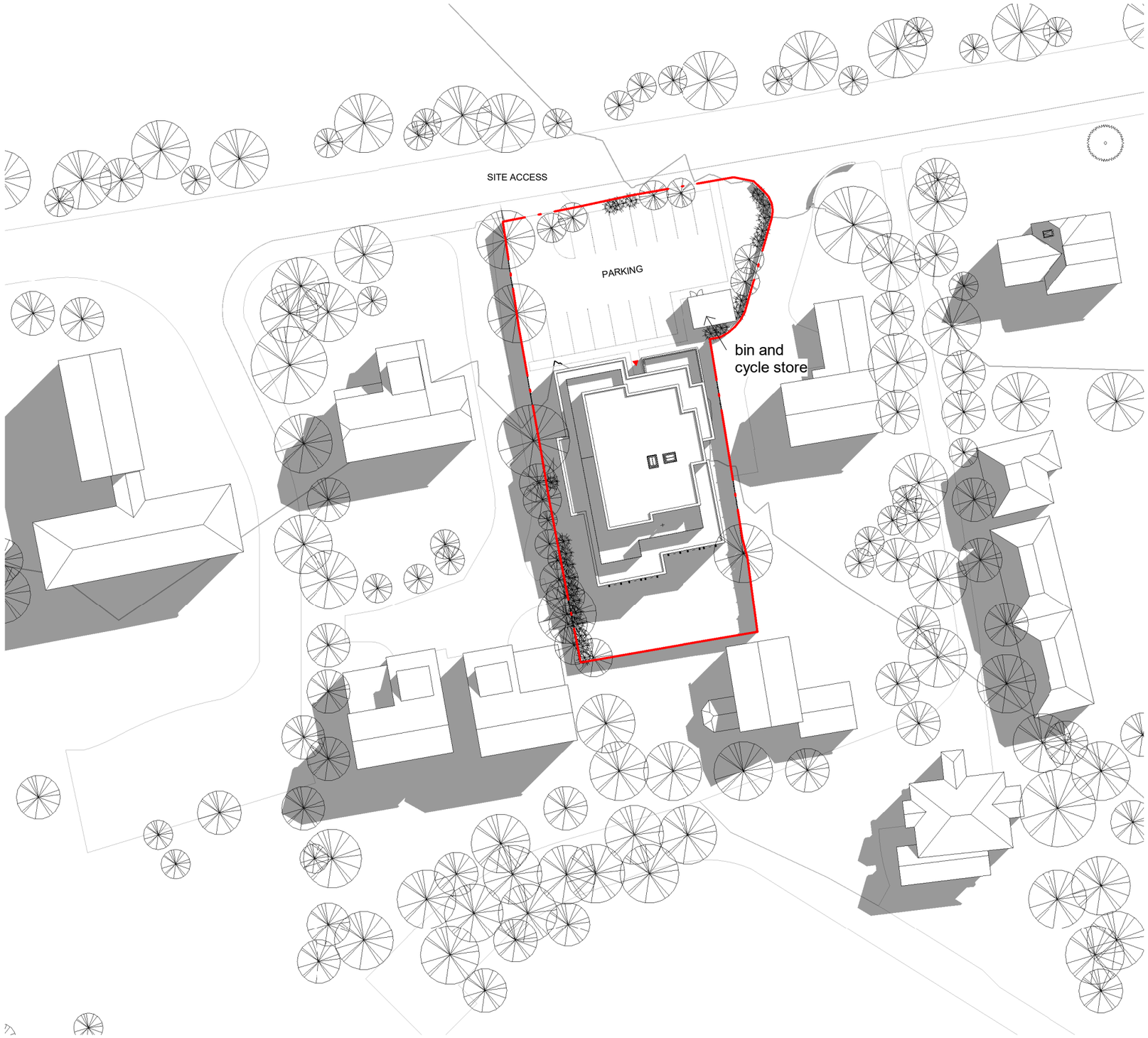
Architecture
Planning
interiors
Landscape

EXISTING BLOCK PLAN 1-500

PMPS2 Ltd | 7 Elvetham Road Fleet | 1717 | FE11A | 1 : 500

29/10/2020 15:51:49

Drawing 1717/FE12B – Proposed Block Plan






Date Issue/Revisions

NORTH

0 5 10 20 m

Scale at A3 (1:500)

Form
Architecture and Planning

Form Architecture and Planning
Walton on Thames, Surrey. KT12 4RZ
Tel 01932 213248

Architecture
Planning
interiors
Landscape

PROPOSED BLOCK PLAN 1-500

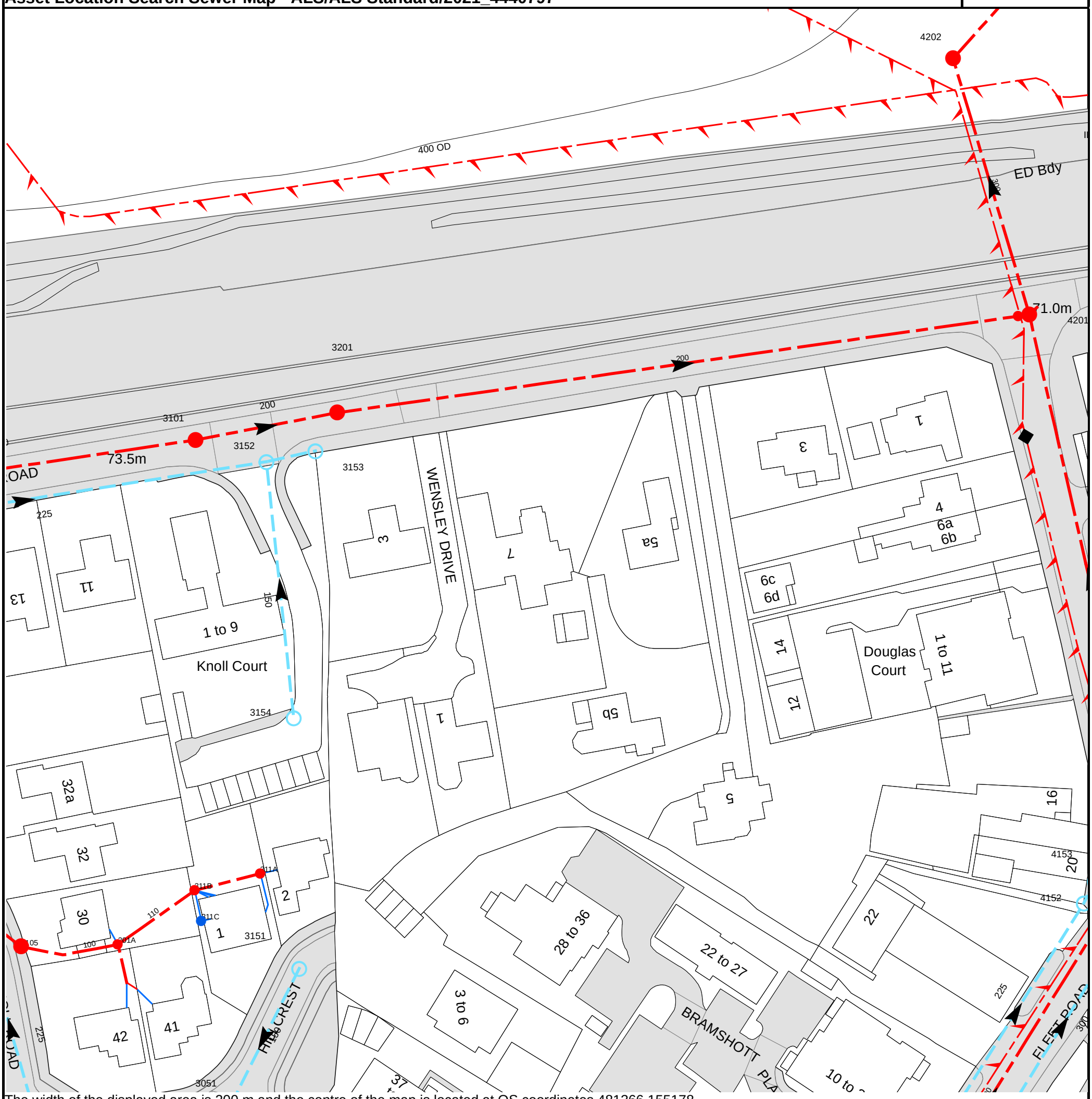
PMPS2 Ltd | 7 Elvetham Road Fleet | 1717 | FE12B | 1 : 500

12/03/2021 13:54:54

# APPENDIX B

Thames Water Records

**Asset Location Search Sewer Map - ALS/ALS Standard/2021_4440797**




The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 481366,155178

**The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.**

Based on the Ordnance Survey Map with the Sanction of the controller of H.M. Stationery Office, License no. 100019345 Crown Copyright Reserved.

NB. Levels quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates that no survey information is available

| Manhole Reference | Manhole Cover Level | Manhole Invert Level |
|---|---|---|
| 3101 | 73.46 | 71.36 |
| 3152 | 73.06 | 71.69 |
| 3154 | 74.68 | 73.37 |
| 3153 | 73.06 | 71.66 |
| 3201 | 72.94 | 71.04 |
| 4202 | n/a | n/a |
| 4201 | 71.17 | 67.47 |
| 4152 | 70.03 | 69.18 |
| 4153 | 70.06 | 69.25 |
| 3151 | 75.4 | 74.83 |
| 2105 | 75.85 | n/a |
| 201A | n/a | n/a |
| 311C | n/a | n/a |
| 311B | n/a | n/a |
| 311A | n/a | n/a |

**The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.**

# APPENDIX C

Drawing 211420/DS/01 – Proposed Drainage Layout

Existing connection to Thames Water sewer to be re-used, subject to S106 application

200mm Ø 1:38 Fall

TW 3201
CL: 72.94
IL: 71.04

Cellular Soakaway
CL: 72.60
Infil. Rate: 8.3x10^-6 m/s
Size: 2.5m x 12.0m x 1.5m
Volume: 45m³

2
FE40g

IC
CL: 72.56
IL: 71.56

landscaped amenity area

2
Porous Paving
Infil. Rate: 8.3x10^-6 m/s
Cap. Depth: 0.3m

TW 3153
CL: 73.06
IL: 71.66

IL:71.30

IC
CL: 72.94
IL: 72.08

5.00m Soakaway Exclusion Zone

IC
CL: 72.93
IL: 71.89

Proposed foul drainage to flow to existing network on site

Proposed foul drainage to flow to existing network on site

bin
cycle

IL:72.15

bin and cycle store

IL:71.52

IL:71.42

5.00m

IL:72.00

IL:71.52

All SVP locations to be confirmed by Architects

IL:72.24

IL:72.07

Existing drainage shown with red cross is to be removed and disposed of.

2
FE50B

Green roof

FFL: 73.20m
TBC by Architect

IL:71.65

IL:72.14

IL:72.38

2
FE50B

All RWP locations to be confirmed by Architects

IL:72.20

IL:71.69

IL:71.76

IL:72.26

RE

1
FE50B

RE

5.00m

amenity area

1
FE51

5.00m

5.00m

5.00m

Elvetham Road
Fleet

Drainage Strategy
Site Plan

| SCALE | DRAWN BY | PRJ No. | DWG No. |
|---|---|---|---|
| 1:250 | JR | 211420 | 211420/DS/01 |

LANMOR Consulting
Civil Engineers & Transport Planning

Thorogood House, 34 Tolworth Close, Surbiton, Surrey, KT6 7EW
Telephone: 0208 339 7899 Fax: 0208 339 7898
E-mail: info@lanmor.co.uk
www.lanmor.co.uk

# APPENDIX D

Soakaway Calculations

## Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 1339 minutes.

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|
| 15 min Summer | 70.367 | 0.467 | 0.1 | 13.3 | O K |
| 30 min Summer | 70.512 | 0.612 | 0.1 | 17.4 | O K |
| 60 min Summer | 70.661 | 0.761 | 0.2 | 21.7 | O K |
| 120 min Summer | 70.809 | 0.909 | 0.2 | 25.9 | O K |
| 180 min Summer | 70.889 | 0.989 | 0.2 | 28.2 | O K |
| 240 min Summer | 70.941 | 1.041 | 0.2 | 29.7 | O K |
| 360 min Summer | 71.000 | 1.100 | 0.3 | 31.3 | O K |
| 480 min Summer | 71.035 | 1.135 | 0.3 | 32.3 | O K |
| 600 min Summer | 71.054 | 1.154 | 0.3 | 32.9 | O K |
| 720 min Summer | 71.064 | 1.164 | 0.3 | 33.2 | O K |
| 960 min Summer | 71.070 | 1.170 | 0.3 | 33.3 | O K |
| 1440 min Summer | 71.074 | 1.174 | 0.3 | 33.5 | O K |
| 2160 min Summer | 71.066 | 1.166 | 0.3 | 33.2 | O K |
| 2880 min Summer | 71.046 | 1.146 | 0.3 | 32.7 | O K |
| 4320 min Summer | 70.993 | 1.093 | 0.3 | 31.2 | O K |
| 5760 min Summer | 70.936 | 1.036 | 0.2 | 29.5 | O K |
| 7200 min Summer | 70.882 | 0.982 | 0.2 | 28.0 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Time-Peak (mins) |
|---|---|---|---|
| 15 min Summer | 130.597 | 0.0 | 19 |
| 30 min Summer | 85.825 | 0.0 | 34 |
| 60 min Summer | 53.779 | 0.0 | 64 |
| 120 min Summer | 32.595 | 0.0 | 124 |
| 180 min Summer | 24.012 | 0.0 | 182 |
| 240 min Summer | 19.224 | 0.0 | 242 |
| 360 min Summer | 13.954 | 0.0 | 362 |
| 480 min Summer | 11.125 | 0.0 | 482 |
| 600 min Summer | 9.325 | 0.0 | 600 |
| 720 min Summer | 8.069 | 0.0 | 720 |
| 960 min Summer | 6.417 | 0.0 | 838 |
| 1440 min Summer | 4.640 | 0.0 | 1082 |
| 2160 min Summer | 3.350 | 0.0 | 1472 |
| 2880 min Summer | 2.656 | 0.0 | 1900 |
| 4320 min Summer | 1.912 | 0.0 | 2720 |
| 5760 min Summer | 1.513 | 0.0 | 3520 |
| 7200 min Summer | 1.261 | 0.0 | 4320 |

## Summary of Results for 100 year Return Period (+40%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|
| 8640 min Summer | 70.832 | 0.932 | 0.2 | 26.6 | O K |
| 10080 min Summer | 70.787 | 0.887 | 0.2 | 25.3 | O K |
| 15 min Winter | 70.367 | 0.467 | 0.1 | 13.3 | O K |
| 30 min Winter | 70.512 | 0.612 | 0.1 | 17.4 | O K |
| 60 min Winter | 70.661 | 0.761 | 0.2 | 21.7 | O K |
| 120 min Winter | 70.810 | 0.910 | 0.2 | 25.9 | O K |
| 180 min Winter | 70.891 | 0.991 | 0.2 | 28.2 | O K |
| 240 min Winter | 70.942 | 1.042 | 0.3 | 29.7 | O K |
| 360 min Winter | 71.002 | 1.102 | 0.3 | 31.4 | O K |
| 480 min Winter | 71.039 | 1.139 | 0.3 | 32.5 | O K |
| 600 min Winter | 71.060 | 1.160 | 0.3 | 33.1 | O K |
| 720 min Winter | 71.072 | 1.172 | 0.3 | 33.4 | O K |
| 960 min Winter | 71.079 | 1.179 | 0.3 | 33.6 | O K |
| 1440 min Winter | 71.074 | 1.174 | 0.3 | 33.5 | O K |
| 2160 min Winter | 71.053 | 1.153 | 0.3 | 32.9 | O K |
| 2880 min Winter | 71.019 | 1.119 | 0.3 | 31.9 | O K |
| 4320 min Winter | 70.941 | 1.041 | 0.2 | 29.7 | O K |
| 5760 min Winter | 70.865 | 0.965 | 0.2 | 27.5 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Time-Peak (mins) |
|---|---|---|---|
| 8640 min Summer | 1.086 | 0.0 | 5096 |
| 10080 min Summer | 0.957 | 0.0 | 5856 |
| 15 min Winter | 130.597 | 0.0 | 19 |
| 30 min Winter | 85.825 | 0.0 | 34 |
| 60 min Winter | 53.779 | 0.0 | 64 |
| 120 min Winter | 32.595 | 0.0 | 122 |
| 180 min Winter | 24.012 | 0.0 | 180 |
| 240 min Winter | 19.224 | 0.0 | 238 |
| 360 min Winter | 13.954 | 0.0 | 354 |
| 480 min Winter | 11.125 | 0.0 | 470 |
| 600 min Winter | 9.325 | 0.0 | 582 |
| 720 min Winter | 8.069 | 0.0 | 692 |
| 960 min Winter | 6.417 | 0.0 | 902 |
| 1440 min Winter | 4.640 | 0.0 | 1122 |
| 2160 min Winter | 3.350 | 0.0 | 1580 |
| 2880 min Winter | 2.656 | 0.0 | 2020 |
| 4320 min Winter | 1.912 | 0.0 | 2896 |
| 5760 min Winter | 1.513 | 0.0 | 3744 |

## Summary of Results for 100 year Return Period (+40%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|
| 7200 min Winter | 70.797 | 0.897 | 0.2 | 25.6 | O K |
| 8640 min Winter | 70.737 | 0.837 | 0.2 | 23.9 | O K |
| 10080 min Winter | 70.684 | 0.784 | 0.2 | 22.3 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Time-Peak (mins) |
|---|---|---|---|
| 7200 min Winter | 1.261 | 0.0 | 4544 |
| 8640 min Winter | 1.086 | 0.0 | 5360 |
| 10080 min Winter | 0.957 | 0.0 | 6152 |

## Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Winter Storms | Yes |
| Return Period (years) | 100 | Cv (Summer) | 1.000 |
| Region | England and Wales | Cv (Winter) | 1.000 |
| M5-60 (mm) | 19.000 | Shortest Storm (mins) | 15 |
| Ratio R | 0.400 | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +40 |

## Time Area Diagram

Total Area (ha) 0.041

| Time (mins) From: | To: | Area (ha) |
|---|---|---|
| 0 | 4 | 0.041 |

## Model Details

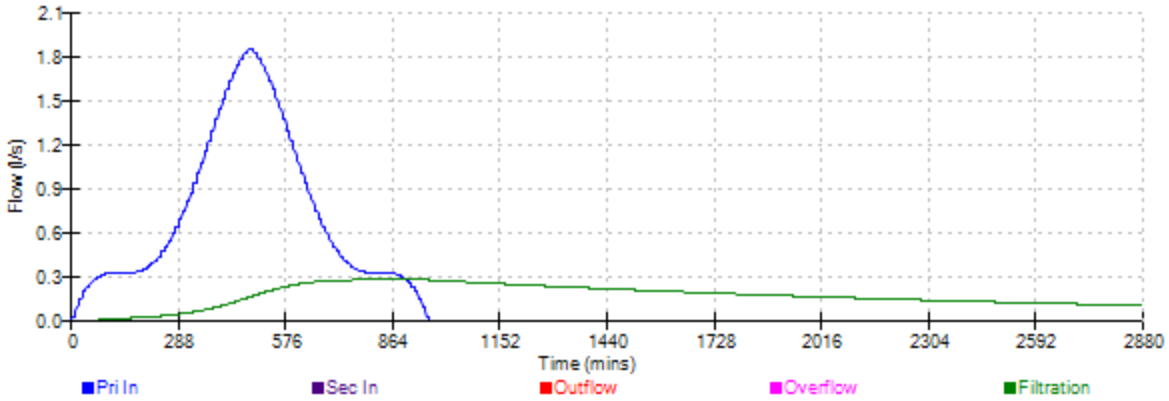
Storage is Online Cover Level (m) 72.600

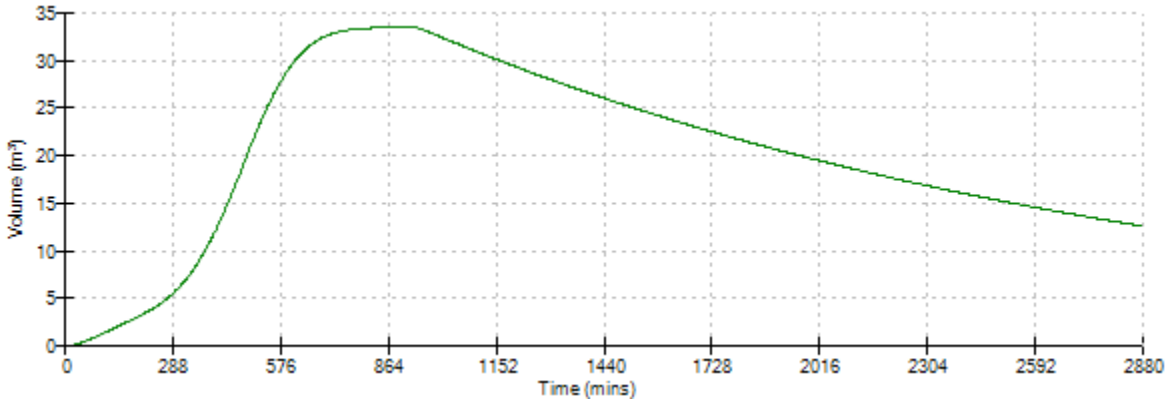
## Cellular Storage Structure

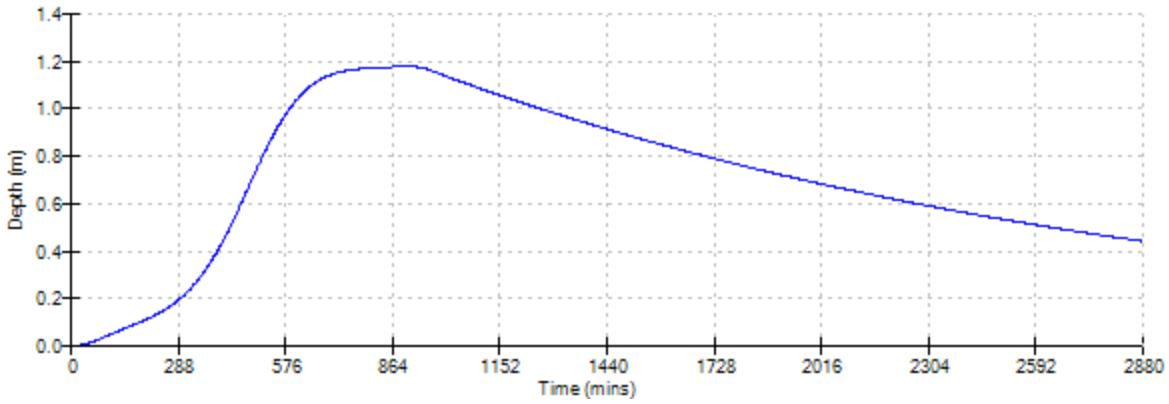
Invert Level (m) 69.900 Safety Factor 1.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.02980

| Depth (m) | Area (m²) | Inf. Area (m²) | Depth (m) | Area (m²) | Inf. Area (m²) |
|---|---|---|---|---|---|
| 0.000 | 30.0 | 30.0 | 1.501 | 0.0 | 73.5 |
| 1.500 | 30.0 | 73.5 | | | |

Event: 960 min Winter



Permeable Paving Calculations

## Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 99 minutes.

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|
| 15 min Summer | 72.328 | 0.178 | 0.9 | 6.0 | Flood Risk |
| 30 min Summer | 72.355 | 0.205 | 1.1 | 8.0 | Flood Risk |
| 60 min Summer | 72.373 | 0.223 | 1.2 | 9.4 | Flood Risk |
| 120 min Summer | 72.381 | 0.231 | 1.2 | 10.1 | Flood Risk |
| 180 min Summer | 72.382 | 0.232 | 1.2 | 10.1 | Flood Risk |
| 240 min Summer | 72.379 | 0.229 | 1.2 | 9.9 | Flood Risk |
| 360 min Summer | 72.372 | 0.222 | 1.2 | 9.3 | Flood Risk |
| 480 min Summer | 72.363 | 0.213 | 1.1 | 8.6 | Flood Risk |
| 600 min Summer | 72.355 | 0.205 | 1.1 | 7.9 | Flood Risk |
| 720 min Summer | 72.347 | 0.197 | 1.0 | 7.3 | Flood Risk |
| 960 min Summer | 72.332 | 0.182 | 1.0 | 6.3 | Flood Risk |
| 1440 min Summer | 72.309 | 0.159 | 0.8 | 4.8 | Flood Risk |
| 2160 min Summer | 72.283 | 0.133 | 0.7 | 3.3 | Flood Risk |
| 2880 min Summer | 72.264 | 0.114 | 0.6 | 2.5 | Flood Risk |
| 4320 min Summer | 72.239 | 0.089 | 0.5 | 1.5 | O K |
| 5760 min Summer | 72.223 | 0.073 | 0.4 | 1.0 | O K |
| 7200 min Summer | 72.212 | 0.062 | 0.3 | 0.7 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Time-Peak (mins) |
|---|---|---|---|
| 15 min Summer | 131.351 | 0.0 | 18 |
| 30 min Summer | 86.314 | 0.0 | 32 |
| 60 min Summer | 54.074 | 0.0 | 60 |
| 120 min Summer | 32.762 | 0.0 | 92 |
| 180 min Summer | 24.128 | 0.0 | 124 |
| 240 min Summer | 19.312 | 0.0 | 160 |
| 360 min Summer | 14.018 | 0.0 | 228 |
| 480 min Summer | 11.175 | 0.0 | 294 |
| 600 min Summer | 9.366 | 0.0 | 360 |
| 720 min Summer | 8.105 | 0.0 | 424 |
| 960 min Summer | 6.446 | 0.0 | 550 |
| 1440 min Summer | 4.660 | 0.0 | 794 |
| 2160 min Summer | 3.364 | 0.0 | 1148 |
| 2880 min Summer | 2.667 | 0.0 | 1504 |
| 4320 min Summer | 1.920 | 0.0 | 2208 |
| 5760 min Summer | 1.519 | 0.0 | 2944 |
| 7200 min Summer | 1.266 | 0.0 | 3672 |

## Summary of Results for 100 year Return Period (+40%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|
| 8640 min Summer | 72.204 | 0.054 | 0.3 | 0.5 | O K |
| 10080 min Summer | 72.199 | 0.049 | 0.2 | 0.4 | O K |
| 15 min Winter | 72.341 | 0.191 | 1.0 | 6.9 | Flood Risk |
| 30 min Winter | 72.370 | 0.220 | 1.2 | 9.2 | Flood Risk |
| 60 min Winter | 72.389 | 0.239 | 1.3 | 10.8 | Flood Risk |
| 120 min Winter | 72.397 | 0.247 | 1.3 | 11.5 | Flood Risk |
| 180 min Winter | 72.396 | 0.246 | 1.3 | 11.4 | Flood Risk |
| 240 min Winter | 72.392 | 0.242 | 1.3 | 11.0 | Flood Risk |
| 360 min Winter | 72.380 | 0.230 | 1.2 | 10.0 | Flood Risk |
| 480 min Winter | 72.368 | 0.218 | 1.1 | 9.0 | Flood Risk |
| 600 min Winter | 72.356 | 0.206 | 1.1 | 8.0 | Flood Risk |
| 720 min Winter | 72.345 | 0.195 | 1.0 | 7.2 | Flood Risk |
| 960 min Winter | 72.325 | 0.175 | 0.9 | 5.8 | Flood Risk |
| 1440 min Winter | 72.295 | 0.145 | 0.8 | 3.9 | Flood Risk |
| 2160 min Winter | 72.263 | 0.113 | 0.6 | 2.4 | Flood Risk |
| 2880 min Winter | 72.243 | 0.093 | 0.5 | 1.6 | O K |
| 4320 min Winter | 72.218 | 0.068 | 0.4 | 0.9 | O K |
| 5760 min Winter | 72.204 | 0.054 | 0.3 | 0.6 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Time-Peak (mins) |
|---|---|---|---|
| 8640 min Summer | 1.090 | 0.0 | 4400 |
| 10080 min Summer | 0.961 | 0.0 | 5120 |
| 15 min Winter | 131.351 | 0.0 | 18 |
| 30 min Winter | 86.314 | 0.0 | 31 |
| 60 min Winter | 54.074 | 0.0 | 60 |
| 120 min Winter | 32.762 | 0.0 | 96 |
| 180 min Winter | 24.128 | 0.0 | 134 |
| 240 min Winter | 19.312 | 0.0 | 172 |
| 360 min Winter | 14.018 | 0.0 | 244 |
| 480 min Winter | 11.175 | 0.0 | 314 |
| 600 min Winter | 9.366 | 0.0 | 380 |
| 720 min Winter | 8.105 | 0.0 | 448 |
| 960 min Winter | 6.446 | 0.0 | 576 |
| 1440 min Winter | 4.660 | 0.0 | 822 |
| 2160 min Winter | 3.364 | 0.0 | 1172 |
| 2880 min Winter | 2.667 | 0.0 | 1528 |
| 4320 min Winter | 1.920 | 0.0 | 2244 |
| 5760 min Winter | 1.519 | 0.0 | 2936 |

## Summary of Results for 100 year Return Period (+40%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|
| 7200 min Winter | 72.198 | 0.048 | 0.2 | 0.4 | O K |
| 8640 min Winter | 72.194 | 0.044 | 0.2 | 0.4 | O K |
| 10080 min Winter | 72.191 | 0.041 | 0.2 | 0.3 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Time-Peak (mins) |
|---|---|---|---|
| 7200 min Winter | 1.266 | 0.0 | 3608 |
| 8640 min Winter | 1.090 | 0.0 | 4376 |
| 10080 min Winter | 0.961 | 0.0 | 5024 |

## Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Winter Storms | Yes |
| Return Period (years) | 100 | Cv (Summer) | 0.750 |
| Region | England and Wales | Cv (Winter) | 0.840 |
| M5-60 (mm) | 19.100 | Shortest Storm (mins) | 15 |
| Ratio R | 0.400 | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +40 |

## Time Area Diagram

Total Area (ha) 0.033

| Time (mins) From: | To: | Area (ha) |
|---|---|---|
| 0 | 4 | 0.033 |

## Model Details

Storage is Online Cover Level (m) 72.550

## Porous Car Park Structure

| | | | |
|---|---|---|---|
| Infiltration Coefficient Base (m/hr) | 0.02988 | Width (m) | 14.0 |
| Membrane Percolation (mm/hr) | 1000 | Length (m) | 23.0 |
| Max Percolation (l/s) | 89.4 | Slope (1:X) | 90.0 |
| Safety Factor | 2.0 | Depression Storage (mm) | 5 |
| Porosity | 0.30 | Evaporation (mm/day) | 3 |
| Invert Level (m) | 72.150 | Cap Volume Depth (m) | 0.300 |

## Event: 120 min Winter