# PROPOSED SURFACE & FOUL WATER DRAINAGE STRATEGY

# UPON

# 6 PLOT RESIDENTIAL DEVELOPMENT

# LAND OFF WINDMILL LANE, GOSBERTON RISEGATE

# SPALDING, LINCOLNSHIRE, PE11 4ES

## PROJECT NO: SW23-334

## DOCUMENT REF: SW23-334-REP-01




## FOR R K WILSON BUILDERS (GR) LTD.


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## Contents

1 Introduction ..... 4
2 Site Information ..... 4
2.2 Geology ..... 5
2.2.1 Underlying Strata ..... 5
2.2.2 Infiltration testing ..... 6
2.3 Drainage ..... 6
2.3.1 Foul Water ..... 6
2.3.2 Surface Water ..... 6
2.4 Topography ..... 6
3 Proposed Development ..... 6
4 Flood Risk ..... 6
5 Surface Water Drainage Strategy ..... 7
5.1 SuDS Considerations ..... 7
5.1.1 Hierarchy ..... 7
5.1.1.1 Infiltration ..... 7
5.1.1.2 Watercourse ..... 7
5.1.1.3 Surface Water Sewer ..... 7
5.1.1.4 Combined Sewer ..... 8
5.1.1.5 Source Control ..... 8
5.2 Proposals ..... 8
5.2.1 Existing Greenfield Run-off Rate ..... 8
5.2.2 Proposed Flow Control Rate ..... 8
5.2.3 Drainage Proposals ..... 9
5.3 Consultation ..... 9
5.4 Hydraulic Modelling ..... 10
5.5 Flood Exceedance ..... 10
5.6 Management/Maintenance Strategy ..... 11
5.6.1 Management Company ..... 11
5.6.2 Plot Owners ..... 12
6 Foul Water Drainage Strategy ..... 12
6.1 Proposals ..... 12
6.2 Management/Maintenance Strategy ..... 12
6.2.1 Management Company ..... 12
6.2.2 Plot Owners ..... 13


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7 Conclusion ..... 13
Appendix A – Ground Engineering Ltd GI Extracts ..... 14
Appendix B – AWS Map (No assets) ..... 28
Appendix C – Architects Site Plan (Rev B)..... 31
Appendix D – Drainage Strategy Arrangement Drawings ..... 33
Appendix E – Proposed Surface Water Drainage Calculations..... 36

| Revision | Date | Description | | |
|---|---|---|---|---|
| - | March 2024 | First Issue | Prepared | M. R. Barlow |
| | | | Approved | A.Wilson CEng MIStructE |


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## 1 Introduction

Under the instruction of R K Wilson Builders (GR) Ltd., the following drainage strategy report has been prepared for a proposed residential development of 6 dwellings at land off Windmill Lane, Gosberton Risegate.

The object of this report is to clarify the design philosophy followed when preparing the proposed surface & foul water drainage arrangements for the site and to outline the proposed solution in sufficient detail for all relevant parties to be able to comment. This assessment also demonstrates that the proposals are within the guidance contained with the National Planning Policy Framework (NPPF).

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## 2 Site Information

### 2.1 Location & Description

The site is approximately 0.371 hectares in size and is located East of Windmill Lane, Gosberton Risegate, Spalding, Lincolnshire, PE11 4ES, with National Grid reference TF 221303.




*Figure 1: Site Location*


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## 2.2 Geology

### 2.2.1 Underlying Strata

Desktop study of the area has been undertaken using the British Geological Society (BGS) Maps.

The maps indicate the site to be underlain by a bedrock geology of Mudstone, with superficial tidal flat deposits of Clay and Silt.

This information is based upon publicly available records.

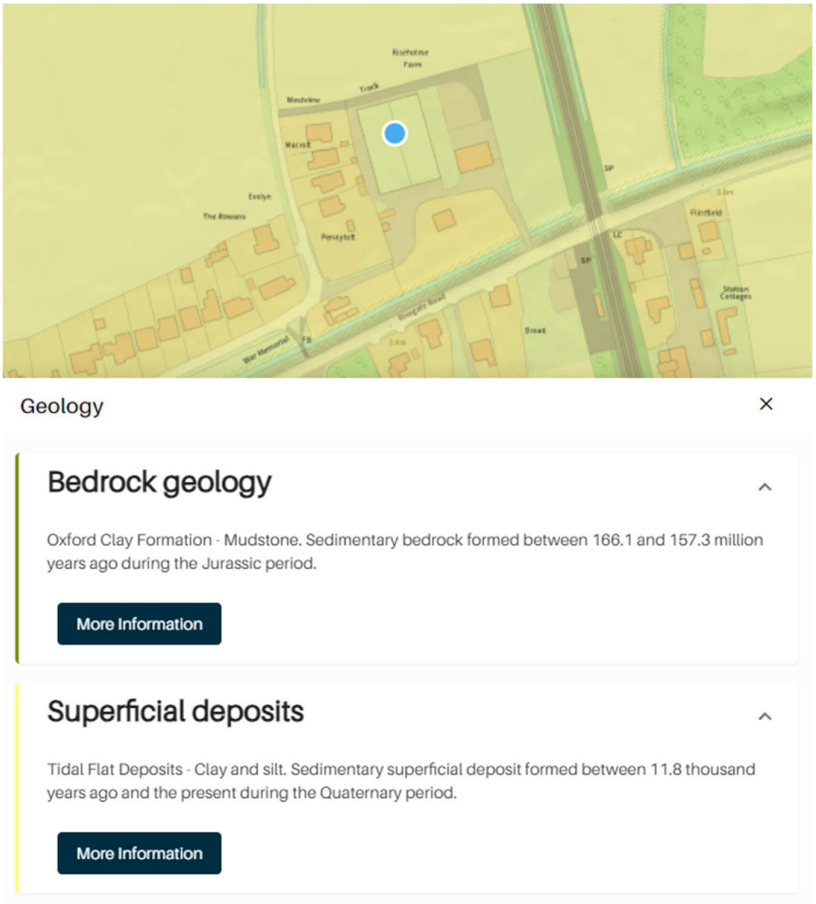



*Figure 2: British Geological Society Maps*

A ground investigation was undertaken by Ground Engineering Limited in December of 2023, in which 8 Trial Pits were excavated. Their report of the ground conditions in these trial pits generally conforms with the findings from the BGS maps, with tidal flat deposits below a layer of top soil. Ground water was found to be approximately 1.6m below ground level across all the deep trial pits. Extracts from Ground Engineering Limited's Ground Investigation report can be found within Appendix A.


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### 2.2.2 Infiltration testing

During the ground investigation by Ground Engineering Limited conducted in December of 2023, 2 no. soakaway tests were undertaken in TP04 & TP08. A worst case rate of 1.21 x 10-6 m/s was calculated, which is a relatively poor drainage rate in accordance with BS8004: 1986, Section Six, Figure 6. Extracts on the infiltration rates from Ground Engineering Limited's Ground investigation can be found within Appendix A.

## 2.3 Drainage

### 2.3.1 Foul Water

There are no Anglian Water foul water assets in the area. The Anglian Water asset map can be found in Appendix B.

### 2.3.2 Surface Water

The site falls within Welland & Deeping Internal Drainage Boards' (WDIDB) District. The nearest WDIDB maintained drain is the 'Risegate EAU', approximately 35m to the South.

## 2.4 Topography

The topography is relatively flat with site levels varying from approximately 3.450m to 3.000m.

# 3 Proposed Development

This strategy is based upon Robert Doughty Consultancy architectural site layout drawing 1443-4_SK_SP03 Rev B

The proposed development consists of 6 dwellings, together with a central private access road, which connects to Windmill Lane.

The proposed site plan can be found in Appendix C.

# 4 Flood Risk

A site specific flood risk assessment has been prepared by RM Associates, report reference 'FLOOD RISK ASSESSMENT November 2023 Version 1'. This has highlighted that the site lies in both flood zone 2 and 3.

The Flood risk assessment has identified that floor levels are to be a minimum of 300mm above existing ground level.


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# 5 Surface Water Drainage Strategy

The proposed surface water drainage strategy arrangement is shown on drawings SW23-334-001 & 002, included within Appendix D.

## 5.1 SuDS Considerations

### 5.1.1 Hierarchy

The NPPF guidance advises that surface water discharge from proposed developments should aim to be as high up the following hierarchy as reasonably possible:

1. Into the ground (infiltration) – via soakaways or other infiltration device,
2. To a surface water body – i.e. a watercourse / Internal Drainage Board,
3. To a surface water sewer, highway drain, or another drainage system,
4. To a combined sewer.

#### 5.1.1.1 Infiltration

Following the infiltration tests performed by Ground Engineering Limited, the results demonstrated that there is some infiltration potential.

Soakaways are unfeasible, due to the infiltration rate meaning soakaways would have to be overly large, and due to the water level on site being only 1.6m below ground level, the bottom of the crates would likely be too close to the water level once sufficient cover over the crates is allowed.

However, it may be possible to meet some of the NPPF criteria for infiltrating some surface water, by having permeable driveways. The depth of these are shallow, therefore there is adequate distance below the sub-base for this water to infiltrate before reaching ground water level. This ensures that approximately 30% of hard surface area's are drained via the highest level of the SuDS hierarchy.

#### 5.1.1.2 Watercourse

A viable surface water outfall route can be achieved, using the WDIDB maintained watercourse, 'Risegate EAU', to the South of the site.

It is therefore proposed that surface water is collected from the shared access road and dwelling roofs to be collected in an attenuation tank, and pumped to the existing watercourse. This meets the second highest level of the SuDS hierarchy.

#### 5.1.1.3 Surface Water Sewer

Surface water discharge from site via this method is not required as higher levels of the SuDS hierarchy are achieved.


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#### 5.1.1.4 Combined Sewer

Surface water discharge from site via this method is not required as higher levels of the SuDS hierarchy are achieved.

#### 5.1.1.5 Source Control

Permeable surfaces are to be used for the private driveways and shared driveways, not subject to frequent heavy good vehicle loading. These will be permeable tarmac or gravel and therefore improve the water quality prior to infiltrating to the ground.

### 5.2 Proposals

#### 5.2.1 Existing Greenfield Run-off Rate

The development site is predominantly grass land with little information of any existing flow rates from the demolished buildings. Therefore, where possible the discharge rate from site should be restricted to the sites QBar. The site area is only 0.371 hectares, therefore as demonstrated by the following QBar calculations existing run off totals 0.52 litres per second.

| Greenfield runoff rates | Default | Edited |
|---|---|---|
| $Q_{BAR}$ (l/s): | 0.52 | 0.52 |
| 1 in 1 year (l/s): | 0.45 | 0.45 |
| 1 in 30 years (l/s): | 1.27 | 1.27 |
| 1 in 100 year (l/s): | 1.85 | 1.85 |
| 1 in 200 years (l/s): | 2.19 | 2.19 |

*Figure 3: Existing QBar Calculation Rate*

#### 5.2.2 Proposed Flow Control Rate

A flow control chamber incorporating a Pump will be introduced into the downstream elements of the proposed drainage system to restrict flows offsite.

It will not be possible to restrict flows off site to the QBar rate established above, as the likelihood of blockage would be high and therefore increase flood risk.


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It is therefore proposed to restrict flows off site to a maximum of 5 litres per second, which is generally deemed a practical minimum.

### 5.2.3 Drainage Proposals

The proposed surface water drainage strategy arrangement is shown on drawing SW23-334-001 & 002, included within Appendix D.

The surfacing areas are summarised on the drainage strategy arrangement drawing and within the table below:

| Name | Description | Area ($m^2$) | Discharge Method/Location |
|---|---|---|---|
| A | Proposed Shared Access Road | 445 | Outfalling to WDIDB Watercourse |
| B | Proposed Dwelling Roofs | 810 | Outfalling to WDIDB Watercourse |
| C | Proposed Shared Driveway | 210 | Infiltrating to ground (At source) |
| D | Proposed Private Driveways | 350 | Infiltrating to ground (At source) |

*Figure 4: Surface Water Area Summary*

The proposed Shared Access Road denoted as area A, is to have an impermeable surface. Surface water run-off is to be collected via gullies which will discharge to the drainage system. Permeable surfacing has been considered, however this was deemed inappropriate for this area due to the frequent use by goods/delivery vehicles, which also turn in this area.

The proposed Dwelling Roof's denoted as Area B, will be drained via rainwater pipes and underground pipe networks local to each plot, prior to discharging to the drainage system below the shared access road.

The proposed Shared Driveway denoted as area C, is to infiltrate to ground (At source).

The proposed Private Driveway denoted as area D, is to infiltrate to ground (At source).

The whole impermeable catchment, areas A & B will be conveyed underground to a geocellular attenuation tank for storage to the North of the site, and will be discharged off site through the flow control chamber at a restriction of 5 litres / second. A section of gravity pipe will be incorporated to break the pump flow discharging into the watercourse.

### 5.3 Consultation

The relevant Land Drainage consents for surface water discharge and alteration to a watercourse will be applied for at the detailed design stage.


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## 5.4 Hydraulic Modelling

The system serving the shared access road and dwelling roofs has been modelled using Causeway Flow+ and the calculation inputs and outputs are included within our calculation package SW23-334-CAL-C-01, contained withing Appendix E.

These calculations demonstrate that the run-off will be safely conveyed and attenuated during storms up to and including the 1 in 100 year storm even plus climate change allowance.

The calculations show the system has very limited surcharging during the 1:2 year event. There is no flooding during the 1:30 & 1:100+CC year events.

The system has been modelled using both FSR and FEH rainfall data.

The shared and private driveways are to have a voided sub-base as described above. The depth of the sub-base is to be designed hydraulically to accommodate the 1:100+CC event, in accordance with Interpave document 'Design and Construction of Concrete Block Permeable Pavements'. The below extract shows a minimum depth of 140mm is required based upon an infiltration rate worse than recorded on site and the rainfall parameters:

Infiltration rate = 1 x $10^{-6}$m/s

| | | 1 in 10 | 1 in 30 | 1 in 100 | 1 in 100 + 20% | 1 in 100 + 30% |
|---|---|---|---|---|---|---|
| M5-60 | r | 10 | 3.33 | 1 | 0.5 | 0.25 |
| 20 | 0.4 | 50 | 70 | 95 | 125 | 140 |
| | 0.3 | 50 | 70 | 100 | 130 | 145 |
| | 0.2 | 50 | 70 | 105 | 140 | 160 |
| 17 | 0.4 | 50 | 50 | 75 | 100 | 110 |
| | 0.3 | 50 | 50 | 75 | 100 | 115 |
| | 0.2 | 50 | 50 | 80 | 110 | 125 |
| 14 | 0.4 | | | | | |
| | 0.3 | 50 | 50 | 60 | 80 | 85 |
| | 0.2 | 50 | 50 | 55 | 75 | 90 |

*Figure 5: Interpave Design Guidance Extract*

## 5.5 Flood Exceedance

Proposed site levels have been designed to generally mimic the existing topography where possible, and any overland flows are diverted towards the north of the site away from the dwellings. Drawing SW23-334-001 included, within Appendix D demonstrates the existing & proposed flood exceedance routes.

Proposed site levels have been sympathetic to existing levels, particularly at boundaries. Therefore, no additional flood risk management precautions are required local to the site boundaries.


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## 5.6 Management/Maintenance Strategy

The proposed system contains various assets which are all required to be in reasonable working order for the systems to function as a whole and operate as anticipated within the design models. These assets should generally be maintained in accordance with The SuDS Manual C753 or manufacturer guidance.

The scope/nature of inspection and maintenance is such that various facilities and structures are inspected and maintained at yearly intervals, as well as after or during use and/or heavy storms, in order that they continue to perform effectively.

On completion of the below, ensure the drainage system is running freely and cleanly. If not, repeat maintenance activities. Written records should be kept of all maintenance work carried out.

The proposed surface water drainage system is to be maintained and owned by several different parties.

### 5.6.1 Management Company

A Management Company will be formed and be responsible for the following assets:

- Shared access road
- Shared Driveway
- Road gullies
- Underground pipe network and chambers (within their land ownership)
- Geocellular attenuation system (To the North of the Site)
- Pump Chamber
- Headwall

**Operation and maintenance requirements for attenuation storage tanks**

| Maintenance schedule | Required action | Typical frequency |
|---|---|---|
| Regular maintenance | Inspect and identify any areas that are not operating correctly. If required, take remedial action | Monthly for 3 months, then annually |
| | Remove debris from the catchment surface (where it may cause risks to performance) | Monthly |
| | For systems where rainfall infiltrates into the tank from above, check surface of filter for blockage by sediment, algae or other matter; remove and replace surface infiltration medium as necessary. | Annually |
| | Remove sediment from pre-treatment structures and/ or internal forebays | Annually, or as required |
| Remedial actions | Repair/rehabilitate inlets, outlet, overflows and vents | As required |
| Monitoring | Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed | Annually |
| | Survey inside of tank for sediment build-up and remove if necessary | Every 5 years or as required |

*Figure 6: Attenuation Tanks Maintenance Requirements (The SuDS Manual C753)*

The pump will be maintained under a management/service agreement with the pump manufacturer to the Management Company.


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### 5.6.2 Plot Owners

The prospective plot owners will be responsible for the following assets:

- permeable driveway construction
- Gutters, downpipes and other building rainwater goods
- Buried pipe networks and chambers local to plot

## 6 Foul Water Drainage Strategy

The proposed foul water drainage strategy arrangement is shown on drawing SW23-334-001, included within Appendix D.

### 6.1 Proposals

The proposed dwellings will have their own private buried pipe foul water network local to the building. These will discharge to a shared foul network, which is to connect to a combined treatment plant to the North of the site. This treated foul will then be pumped to the South of the site to the surface water system, where connection is to be made by gravity to the WDIDB 'Risegate EAU'. This discharge is subject to their formal consent.

The proposed treatment plant is to meet the Environment Agency's generally binding rules.

### 6.2 Management/Maintenance Strategy

The proposed system contains various assets which are all require to be in reasonable working order for the system to function as a whole and operate as anticipated.

The maintenance schedule for the foul water system, should as a minimum consist of annual inspections and 5 yearly rodding/jetting should no issue be encountered.

The proposed foul water drainage system is to be maintained and owned by several different parties.

### 6.2.1 Management Company

A Management Company will be responsible for the following assets:

- Underground pipes (beneath the shared driveway and access road)
- Manhole chambers (within their land ownership)
- Foul water treatment plant and pump

The treatment plant and pump will be maintained under a management/service agreement with the manufacturer(s) to the Management Company.


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### 6.2.2 Plot Owners

The prospective plot owners will be responsible for the following assets:

- Building soil and waste goods
- Underground pipes local to plot
- Inspection chambers local to plot

## 7 Conclusion

In summary:

- Site investigations have been undertaken by Ground Engineering Ltd. to assess the ground conditions.
- Existing site features, topography, drainage assets, etc. have been evaluated.
- Flood Risk Assessment reviewed in accordance with the proposals.
- SuDS hierarchy has been explored;
- Infiltration is to be used where possible for permeable surfaces,
- The second level of the SUDS hierarchy is to be used to get the surface water off site to the Welland and Deeping IDB drain to the South of the site.
- Various source control features have been reviewed
- Greenfield run-off rate reviewed and discharge rates specified.
- Hydraulic modelling undertaken for storms ranging from 1:2 – 1:100+CC utilising both FEH and FSR data.
- Proposed flood exceedance routes have been at the forefront of design, and mimic the existing development scenario.
- Foul water discharge possible through the use of pump and treatment tank, to combine with the surface system, prior to discharge to the WDIDB watercourse.
- Management and maintenance responsibilities explored for both the surface and foul water systems.

As illustrated by our design proposals on drawings SW23-334-001,002 and the information outlined within this report, it is demonstrable that a viable and robust surface & foul water scheme that complies with the requirements of National Planning Guidance can be provided for the proposed residential development.

Under the proposals outlined within the report, all the drainage features will be either, the responsibility of a Management Company or under private house holder ownership and as such have suitable management and on-going maintenance.


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Appendix A – Ground Engineering Ltd GI Extracts


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## GROUND CONDITIONS

The ground conditions have been plotted as a soil profile in Figure 1. The ground conditions comprised a surface layer of made ground/topsoil to between 0.25m and 0.80m depth. The made ground was underlain by superficial Tidal Flat Deposits, which were encountered to at least the base of the deepest trial pit at 2.50m depth. Groundwater seepages were locally recorded at 1.60m and 1.65m depth during the investigation, which was generally following by pit sidewall collapse.

### Made Ground/Topsoil

Topsoil and made ground was encountered to between 0.25m (TP2, TP4 & TP5) and 0.80m (TP3) depth, with the deeper fill associated with old land drains at 0.60m in TP8 and 0.80m depth in TP3. The topsoil generally comprised dark brown, silty fine sand. The made ground generally comprised brown, dark brown and grey, slightly clayey, slightly gravelly, silty sand fill, and locally soft, slightly sandy, slightly gravelly, silty clay fill (TP7). The gravel fraction comprised angular and sub-angular, flint, ironstone, clay pipe, ash and brick fragments.

### Tidal Flat Deposits

Beneath the surface made ground/topsoil at between 0.25m and 0.80m depth, generally medium dense, brown, light grey and orange brown, locally slightly clayey, sandy silt/silty sand, with occasional shell fragments and dark grey lenses (TP2), was encountered. A layer of firm, brown, orange brown and light grey, slightly sandy, silty clay was encountered in TP5 at 0.70m to 1.25m depth. The sand fraction was fine grained. These soils were considered to represent the anticipated superficial Tidal Flat Deposits, which were encountered to at least the base of the trial pits, and to at least 2.50m depth.

**Groundwater**

Groundwater seepages were recorded during excavation at 1.60m (TP2, TP3, TP5, TP7 & TP8), and water was recorded on completion of TP4 at 1.65m depth. No groundwater was recorded during excavation of the shallow trial pits TP1 and TP6 to 1.05m and 1.10m depth. Due to pit sides collapse it was generally not possible to record groundwater levels on completion.

**Observations**

Roots were observed in all of the exploratory holes and to a maximum depth of 1.50m in TP3.

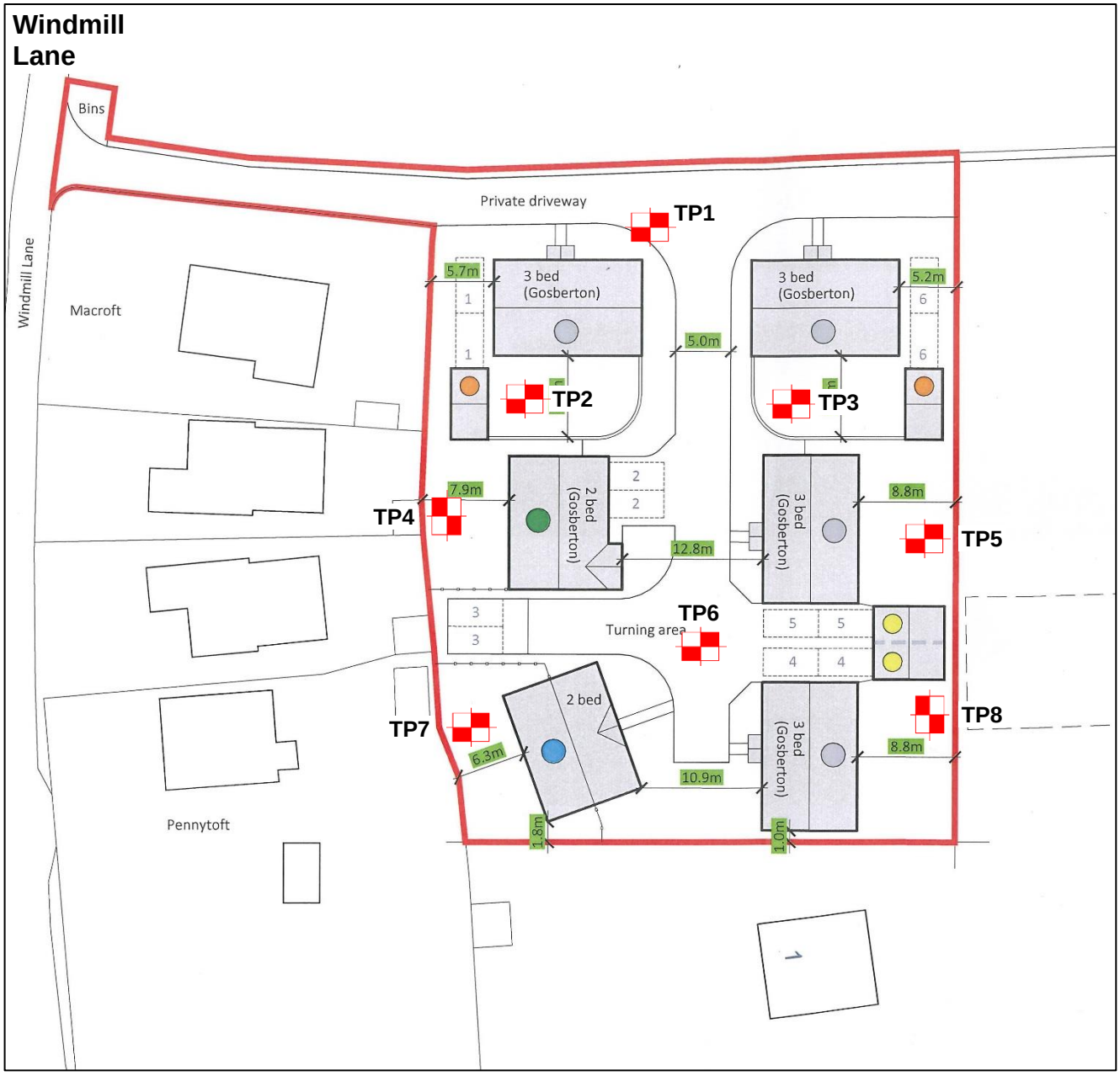
The shallow trial pit sides were stable, however there was sidewall collapse in trial pits below 1.60m depth associated with groundwater seepages.

**Evidence of Contamination**

The made ground encountered during this investigation was not noted to have olfactory or visual evidence of fuel contamination. The made ground contained occasional fragments of clay pipe, ash and brick. No asbestos containing materials were noted in the soils during this investigation, or during testing.

# Exploratory Hole Location Plan

Based on plan provided by the client. © Crown Copyright. Licence number AL100005523




**Key**

Trial pit

**Not to Scale**

**Project:** Riseholme Farm, Windmill Lane, Gosberton Risegate, Lincolnshire

**Client:** R. K. Wilson Builders Limited

GROUND ENGINEERING LIMITED
Peterborough Tel : 01733 566566

**Project No.** C16066

**GROUND ENGINEERING LIMITED**
Tel: 01733-566566
www.groundengineering.co.uk

Site: RISEHOLME FARM, WINDMILL LANE, GOSBERTON RISEGATE

TRIAL PIT
TP1

Date: 03/11/23

Pit Size: 1.80m L x 0.35m W x 1.05m D.

Ground Level:

| Samples and in-situ Tests | | | (Date) Water | Description of Strata | Legend | Depth m | O.D. Level m |
|---|---|---|---|---|---|---|---|
| Depth m | Type | Result | | | | | |
| 0.10 | D1 | | | MADE GROUND - Dark grey and dark brown, slightly gravelly, silty SAND. Sand is fine grained. Gravel is fine and medium grained, flint, ash, glass and brick fragments. | | | |
| 0.10 | ES1 | | | | | 0.40 | |
| 0.50-0.70 | B1 | | | Dark brown and brown, silty SAND. Sand is fine grained. | | | |
| 0.60 | D2 | | | (TIDAL FLAT DEPOSIT) | | 0.70 | |
| 0.70-1.00 | MP1 | 80 | | Medium dense, brown and grey, silty SAND. Sand is fine grained. | | | |
| 1.00 | D3 | | | (TIDAL FLAT DEPOSIT) | | | |
| 1.00-1.20 | MP2 | 100 | | | | 1.05 | |
| | | | | Pit completed at 1.05m depth | | | |

KEY
- D - Disturbed Sample
- B - Bulk Sample
- U - Undisturbed Sample
- R - Root Sample
- W - Water Sample
- ES - Environmental Sample
- ▽ Water Strike
- ▼ Water Rise
- ▼c Level on completion
- MP - Mackintosh Probe
- P( ) - Hand Penetrometer Cohesion ( ) kPa
- V - Vane Shear Test Cohesion ( ) kPa

REMARKS
1. Roots observed to at least 1.05m depth
2. Pit dry
3. Pit sides stable

Project No 16066

Scale 1:25

Page 1/1

GROUND ENGINEERING LIMITED
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Site: RISEHOLME FARM, WINDMILL LANE, GOSBERTON RISEGATE

TRIAL PIT TP2

Date: 03/11/23

Pit Size: 1.70m L x 0.35m W x 2.50m D.

Ground Level:

| Samples and in-situ Tests | | | (Date) Water | Description of Strata | Legend | Depth m | O.D. Level m |
|---|---|---|---|---|---|---|---|
| Depth m | Type | Result | | | | | |
| | | | | TOPSOIL - Dark brown, silty SAND. Sand is fine grained. | | 0.25 | |
| 0.20 | D1 | | | | | | |
| 0.20 | ES1 | | | Medium dense, brown and orange brown, slightly clayey, sandy SILT. Sand is fine grained. | | | |
| 0.50-0.70 | B1 | | | | | | |
| 0.60 | D2 | | | | | | |
| 0.60 | ES2 | | | (TIDAL FLAT DEPOSIT) | | | |
| 0.90-1.05 | MP1 | 100 | | | | 1.10 | |
| 1.20 | D3 | | | Medium dense, brown and light grey, silty SAND. Sand is fine grained. | | | |
| | | | | (TIDAL FLAT DEPOSIT) | | | |
| 1.60 | D4 | | ▽1 | | | | |
| 1.60-1.90 | MP2 | 80 | | | | 1.70 | |
| 1.80 | D5 | | | Medium dense, brown and light grey, silty SAND with occasional shell fragments. | | | |
| | | | | ...With occasional dark grey lenses below 2.30m depth | | | |
| | | | | (TIDAL FLAT DEPOSIT) | | 2.50 | |
| | | | | Pit completed at 2.50m depth | | | |

KEY
- D - Disturbed Sample
- B - Bulk Sample
- U - Undisturbed Sample
- R - Root Sample
- W - Water Sample
- ES - Environmental Sample
- ▽ Water Strike
- ▼ Water Rise
- ▼c Level on completion
- MP - Mackintosh Probe
- P( ) - Hand Penetrometer Cohesion ( ) kPa
- V - Vane Shear Test Cohesion ( ) kPa

REMARKS
1. Roots observed to 1.15m depth
2. Groundwater seepage at 1.60m depth
3. Pit sides unstable below 1.50m depth

Project No 16066

Scale 1:25

Page 1/1

**GROUND ENGINEERING LIMITED**

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Site: RISEHOLME FARM, WINDMILL LANE, GOSBERTON RISEGATE

TRIAL PIT
TP3

Date: 03/11/23

Pit Size: 1.80m L x 0.35m W x 2.30m D.

Ground Level:

| Samples and in-situ Tests | | | (Date) Water | Description of Strata | Legend | Depth m | O.D. Level m |
|---|---|---|---|---|---|---|---|
| Depth m | Type | Result | | | | | |
| 0.20 | D1 | | | TOPSOIL - Dark brown, silty SAND. Sand is fine grained. | | | |
| 0.20 | ES1 | | | | | 0.30 | |
| 0.50-0.70 | B1 | | | MADE GROUND - Light brown and dark brown, slightly gravelly, silty SAND. Sand is fine grained. Gravel is angular clay pipe fragments. | | | |
| 0.50 | D2 | | | | | | |
| 0.50 | ES2 | | | | | | |
| 0.70-1.00 | MP1 | 100 | | | | 0.80 | |
| 1.00 | D3 | | | Medium dense, brown and light grey, silty SAND. Sand is fine grained. | | | |
| 1.50 | D4 | | | | | | |
| 1.60-1.90 | MP2 | 36 | 1 ▽ | ...Becoming loose below 1.60m depth | | | |
| | | | | (TIDAL FLAT DEPOSIT) | | 1.80 | |
| 1.90-2.10 | MP3 | 50 | | Medium dense, brown and grey, silty SAND. | | | |
| 2.00 | D5 | | | (TIDAL FLAT DEPOSIT) | | | |
| | | | | | | 2.30 | |
| | | | | Pit completed at 2.30m depth | | | |

KEY

- D - Disturbed Sample
- B - Bulk Sample
- U - Undisturbed Sample
- R - Root Sample
- W - Water Sample
- ES - Environmental Sample
- ▽ Water Strike
- ▼ Water Rise
- ▼c Level on completion
- MP - Mackintosh Probe
- P( ) - Hand Penetrometer Cohesion ( ) kPa
- V - Vane Shear Test Cohesion ( ) kPa

REMARKS

1. Land drain at 0.80m depth
2. Roots observed to 1.50m depth
3. Groundwater seepage at 1.60m depth
4. Pit sides collapsed below 0.40m depth

| Project No | |
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| 16066 | |
| Scale | Page |
| 1:25 | 1/1 |

**GROUND ENGINEERING LIMITED**

Tel: 01733-566566
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Site: RISEHOLME FARM, WINDMILL LANE, GOSBERTON RISEGATE

TRIAL PIT
TP4

Date: 03/11/23

Pit Size: 1.70m L x 0.65m W x 1.70m D.

Ground Level:

| Samples and in-situ Tests | | | (Date) Water | Description of Strata | Legend | Depth m | O.D. Level m |
|---|---|---|---|---|---|---|---|
| Depth m | Type | Result | | | | | |
| | | | | MADE GROUND - Dark brown, slightly gravelly, silty SAND. Sand is fine grained. Gravel is angular and sub-angular flint and brick fragments. | | | |
| 0.20 | D1 | | | | | 0.25 | |
| 0.20 | ES1 | | | Medium dense, brown and orange brown, slightly sandy SILT. Sand is fine grained. | | | |
| 0.40-0.60 | B1 | | | | | | |
| 0.40 | D2 | | | | | | |
| 0.40 | ES2 | | | | | | |
| 0.60-0.90 | MP1 | 100 | | | | | |
| | | | | (TIDAL FLAT DEPOSIT) | | | |
| 0.70 | D3 | | | | | 0.85 | |
| | | | | Medium dense, light grey, slightly silty, clayey SAND with occasional shell fragments. Sand is fine grained. (TIDAL FLAT DEPOSIT) | | 0.90 | |
| 1.00 | D4 | | | Medium dense, brown, light brown and orange brown, silty SAND. Sand is fine grained. | | | |
| | | | | (TIDAL FLAT DEPOSIT) | | | |
| | | | ▼c | | | 1.70 | |
| 1.70 | D5 | | | | | | |
| 1.70-2.00 | MP2 | 60 | | Pit completed at 1.70m depth | | | |
| 2.00-2.25 | MP3 | 100 | | | | | |

KEY
- D - Disturbed Sample
- B - Bulk Sample
- U - Undisturbed Sample
- R - Root Sample
- W - Water Sample
- ES - Environmental Sample
- ▽ Water Strike
- ▼ Water Rise
- ▼c Level on completion
- MP - Mackintosh Probe
- P( ) - Hand Penetrometer Cohesion ( ) kPa
- V - Vane Shear Test Cohesion ( ) kPa

REMARKS
1. Roots observed to 0.90m depth
2. Water stood at 1.65m on completion
3. Pit sides stable
4. Soakaway test undertaken at 1.70m depth

| Project No | |
|---|---|
| 16066 | |
| Scale | Page |
| 1:25 | 1/1 |

# SOAKAWAY TEST RESULTS

## BRE DIGEST 365 - SOIL INFILTRATION RATE

Project: Riseholme Farm, Windmill Lane, Gosberton Risegate
Client: R.K. Wilson Builders Limited

Project No: C16066
Sheet No: 1/1

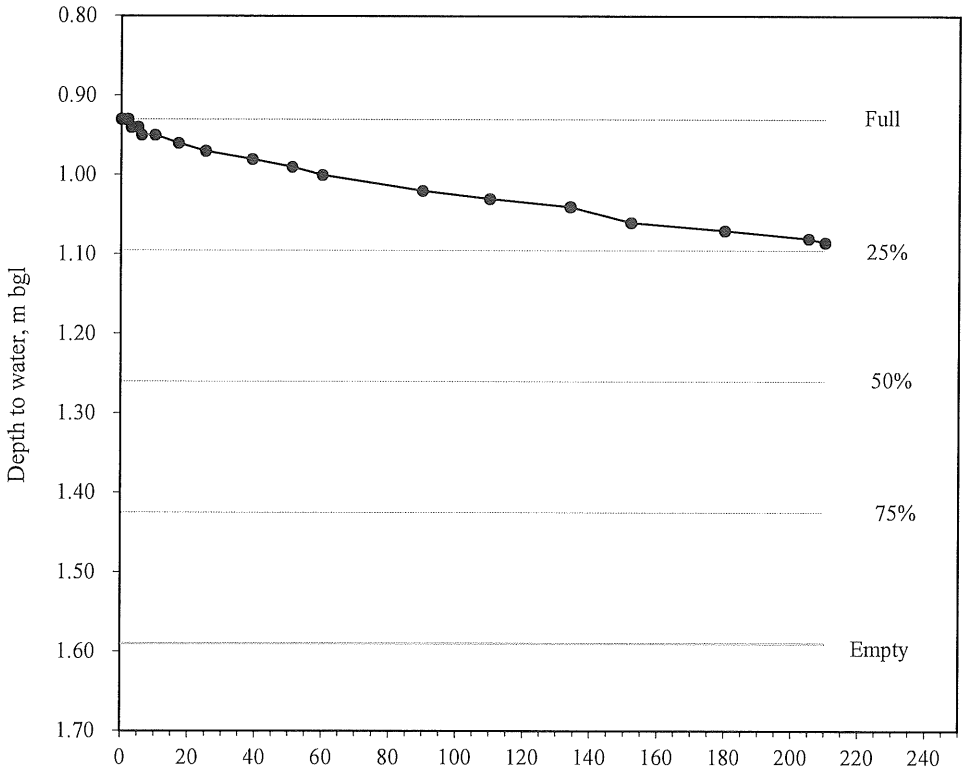
Trial Pit: TP4 FIRST FILLING
Depth: 1.70
Length: 1.70
Width: 0.65

Description of Stratum under test: Brown and light brown, silty fine SAND

Depth to water prior to test: 1.59
(below ground level)

| Elapsed Time min | Depth to Water m |
|---|---|
| 0 | 0.93 |
| 1 | 0.93 |
| 2 | 0.93 |
| 3 | 0.94 |
| 5 | 0.94 |
| 6 | 0.95 |
| 10 | 0.95 |
| 17 | 0.96 |
| 25 | 0.97 |
| 39 | 0.98 |
| 51 | 0.99 |
| 60 | 1.00 |
| 90 | 1.02 |
| 110 | 1.03 |
| 134 | 1.04 |
| 152 | 1.06 |
| 180 | 1.07 |
| 205 | 1.08 |
| 210 | 1.085 |

DEPTH TO WATER vs ELAPSED TIME




All dimensions given in metres

**f = (V75-V25)/A50(T75-T25)**

V75-V25 = 0.365
A50 = 2.656
T75-T25 = 1750 (extrapolated)

Extrapolated Soil Infiltration Rate **f = 1.31E-06 m/s**

**GROUND ENGINEERING LIMITED, Peterborough**

**GROUND ENGINEERING LIMITED**

Tel: 01733-566566
www.groundengineering.co.uk

Site: RISEHOLME FARM, WINDMILL LANE, GOSBERTON RISEGATE

TRIAL PIT
TP5

Date: 03/11/23

Pit Size: 1.50m L x 0.35m W x 2.30m D.

Ground Level:

| Samples and in-situ Tests | | | (Date) Water | Description of Strata | Legend | Depth m | O.D. Level m |
|---|---|---|---|---|---|---|---|
| Depth m | Type | Result | | | | | |
| | | | | TOPSOIL - Dark brown, silty SAND. Sand is fine grained. | | | |
| 0.20 | D1 | | | | | 0.25 | |
| 0.20 | ES1 | | | Brown and light brown, silty SAND with rare shell fragments. Sand is fine grained. | | | |
| 0.40 | D2 | | | | | | |
| 0.40 | ES2 | | | | | | |
| 0.50-0.60 | B1 | | | (TIDAL FLAT DEPOSIT) | | | |
| | | | | | | 0.70 | |
| 0.80 | D3 | | | Firm, brown, orange brown and light grey, slightly sandy, silty CLAY. | | | |
| 1.00 | V1 | (43) | | (TIDAL FLAT DEPOSIT) | | | |
| | | | | | | 1.25 | |
| 1.30 | D4 | | | Medium dense, light brown and light grey, slightly clayey, silty SAND with lenses of silt. Sand is fine grained. | | | |
| | | | 1 ▽ | | | | |
| 1.70 | D5 | | | (TIDAL FLAT DEPSOIT) | | | |
| 1.70-2.00 | MP1 | 70 | | | | | |
| 2.00-2.30 | MP2 | 100 | | | | 2.00 | |
| | | | | Medium dense, brown, orange brown and light grey, sandy SILT. Sand is fine grained. | | | |
| 2.20 | D6 | | | (TIDAL FLAT DEPOSIT) | | | |
| | | | | | | 2.30 | |
| | | | | Pit completed at 2.30m depth | | | |

KEY

- D - Disturbed Sample
- B - Bulk Sample
- U - Undisturbed Sample
- R - Root Sample
- W - Water Sample
- ES - Environmental Sample
- ▽ Water Strike
- ▼ Water Rise
- ▼c Level on completion
- MP - Mackintosh Probe
- P( ) - Hand Penetrometer Cohesion ( ) kPa
- V - Vane Shear Test Cohesion ( ) kPa

REMARKS

1. Roots observed to 1.50m depth
2. Groundwater seepage at 1.60m depth
3. Pit dry on completion
4. Pit sides collapsed below 0.45m depth

| Project No | |
|---|---|
| 16066 | |
| Scale | Page |
| 1:25 | 1/1 |

GROUND ENGINEERING LIMITED
Tel: 01733-566566
www.groundengineering.co.uk

Site: RISEHOLME FARM, WINDMILL LANE, GOSBERTON RISEGATE

TRIAL PIT TP6

Date: 03/11/23

Pit Size: 1.70m L x 0.35m W x 1.10m D.

Ground Level:

| Samples and in-situ Tests | | | (Date) Water | Description of Strata | Legend | Depth m | O.D. Level m |
|---|---|---|---|---|---|---|---|
| Depth m | Type | Result | | | | | |
| 0.20 | D1 | | | MADE GROUND - Dark brown and brown, clayey, silty, gravelly SAND. Gravel is angular flint, ironstone, brick and glass fragments. | | | |
| 0.20 | ES1 | | | | | 0.30 | |
| 0.50-0.70 | B1 | | | Brown, light brown and orange brown, slightly clayey, silty SAND. Sand is fine grained. | | | |
| 0.50 | D2 | | | | | | |
| 0.50 | ES2 | | | | | | |
| 0.70-0.86 | MP1 | 100 | | (TIDAL FLAT DEPOSIT) | | | |
| 0.80 | D3 | | | | | 0.90 | |
| | | | | Light brown and orange brown, silty SAND. Sand is fine grained. (TIDAL FLAT DEPOSIT) | | | |
| 1.10 | D4 | | | | | 1.10 | |
| | | | | Pit completed at 1.10m depth | | | |

KEY
- D - Disturbed Sample
- B - Bulk Sample
- U - Undisturbed Sample
- R - Root Sample
- W - Water Sample
- ES - Environmental Sample
- ▽ Water Strike
- ▼ Water Rise
- ▼c Level on completion
- MP - Mackintosh Probe
- P( ) - Hand Penetrometer Cohesion ( ) kPa
- V - Vane Shear Test Cohesion ( ) kPa

REMARKS
1. Roots observed to 0.90m depth
2. Pit dry
3. Pit sides stable

Project No 16066

Scale 1:25

Page 1/1

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Site: RISEHOLME FARM, WINDMILL LANE, GOSBERTON RISEGATE

TRIAL PIT
TP7

Date: 03/11/23

Pit Size: 1.80m L x 0.35m W x 2.00m D.

Ground Level:

| Samples and in-situ Tests | | | (Date) Water | Description of Strata | Legend | Depth m | O.D. Level m |
|---|---|---|---|---|---|---|---|
| Depth m | Type | Result | | | | | |
| 0.20 | D1 | | | MADE GROUND - Soft, dark brown, slightly sandy, slightly gravelly, silty CLAY. Gravel is angular flint. | | | |
| 0.20 | ES1 | | | | | 0.30 | |
| 0.40 | D2 | | | Brown and dark brown, slightly clayey, silty SAND. Sand is fine grained. (TIDAL FLAT DEPOSIT) | | | |
| 0.40 | ES2 | | | | | 0.50 | |
| 0.60-0.70 | B1 | | | Medium dense, brown, orange brown and light grey, sandy SILT. Sand is fine grained. | | | |
| 0.80 | D3 | | | | | | |
| 0.80-1.10 | MP1 | 100 | | (TIDAL FLAT DEPOSIT) | | | |
| | | | | | | 1.20 | |
| 1.40 | D4 | | ▽1 | Brown, light brown and orange brown, silty SAND. Sand is fine grained. | | | |
| | | | | (TIDAL FLAT DEPOSIT) | | | |
| 2.00 | D5 | | | | | 2.00 | |
| | | | | Pit completed at 2.00m depth | | | |

KEY

- D - Disturbed Sample
- B - Bulk Sample
- U - Undisturbed Sample
- R - Root Sample
- W - Water Sample
- ES - Environmental Sample
- ▽ Water Strike
- ▼ Water Rise
- ▼c Level on completion
- MP - Mackintosh Probe
- P( ) - Hand Penetrometer Cohesion ( ) kPa
- V - Vane Shear Test Cohesion ( ) kPa

REMARKS

1. Roots observed to 1.20m depth
2. Groundwater seepage at 1.60m depth
3. Pit sides collapsed below 1.30m depth

| Project No | |
|---|---|
| 16066 | |
| Scale | Page |
| 1:25 | 1/1 |

**GROUND ENGINEERING LIMITED**

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Site: RISEHOLME FARM, WINDMILL LANE, GOSBERTON RISEGATE

TRIAL PIT
TP8

Date: 03/11/23

Pit Size: 1.80m L x 0.65m W x 2.10m D.

Ground Level:

| Samples and in-situ Tests | | | (Date) Water | Description of Strata | Legend | Depth m | O.D. Level m |
|---|---|---|---|---|---|---|---|
| Depth m | Type | Result | | | | | |
| 0.20 | D1 | | | MADE GROUND - Dark brown, slightly clayey, slightly gravelly, silty SAND. Gravel is angular flint and brick fragments. | | 0.25 | |
| 0.20 | ES1 | | | MADE GROUND - Light brown and dark brown, slightly gravelly, silty SAND. Sand is fine grained. Gravel is angular flint, ash and brick fragments. | | 0.65 | |
| 0.40 | D2 | | | | | | |
| 0.40 | ES2 | | | | | | |
| 0.65-0.80 | B1 | | | | | | |
| 0.70 | D3 | | | Medium dense, light brown and orange brown, very silty SAND. Sand is fine grained. | | | |
| 0.80-1.10 | MP1 | 100 | | (TIDAL FLAT DEPOSIT) | | 1.15 | |
| 1.30 | D4 | | | Brown, orange brown and light grey, silty SAND. Sand is fine grained. | | | |
| 1.60 | D5 | | 1 ▽ | (TIDAL FLAT DEPOSIT) | | | |
| 2.00 | D6 | | | | | 2.10 | |
| | | | | Pit completed at 2.10m depth | | | |

KEY

- D - Disturbed Sample
- B - Bulk Sample
- U - Undisturbed Sample
- R - Root Sample
- W - Water Sample
- ES - Environmental Sample
- ▽ Water Strike
- ▼ Water Rise
- ▼c Level on completion
- MP - Mackintosh Probe
- P( ) - Hand Penetrometer Cohesion ( ) kPa
- V - Vane Shear Test Cohesion ( ) kPa

REMARKS

1. Land drain at 0.60m depth
2. Roots observed to 1.05m depth
3. Groundwater seepage at 1.60m depth
4. Pit dry on completion
5. Pit sides collapsed below 1.20m depth
6. Soakaway test undertaken at 2.10m depth

| Project No | |
|---|---|
| 16066 | |
| Scale | Page |
| 1:25 | 1/1 |

# SOAKAWAY TEST RESULTS

## BRE DIGEST 365 - SOIL INFILTRATION RATE

Project: Riseholme Farm, Windmill Lane, Gosberton Risegate
Client: R.K. Wilson Builders Limited

Project No: C16066
Sheet No: 1/1

Trial Pit: TP8 FIRST FILLING
Depth: 2.10
Length: 1.80
Width: 0.65

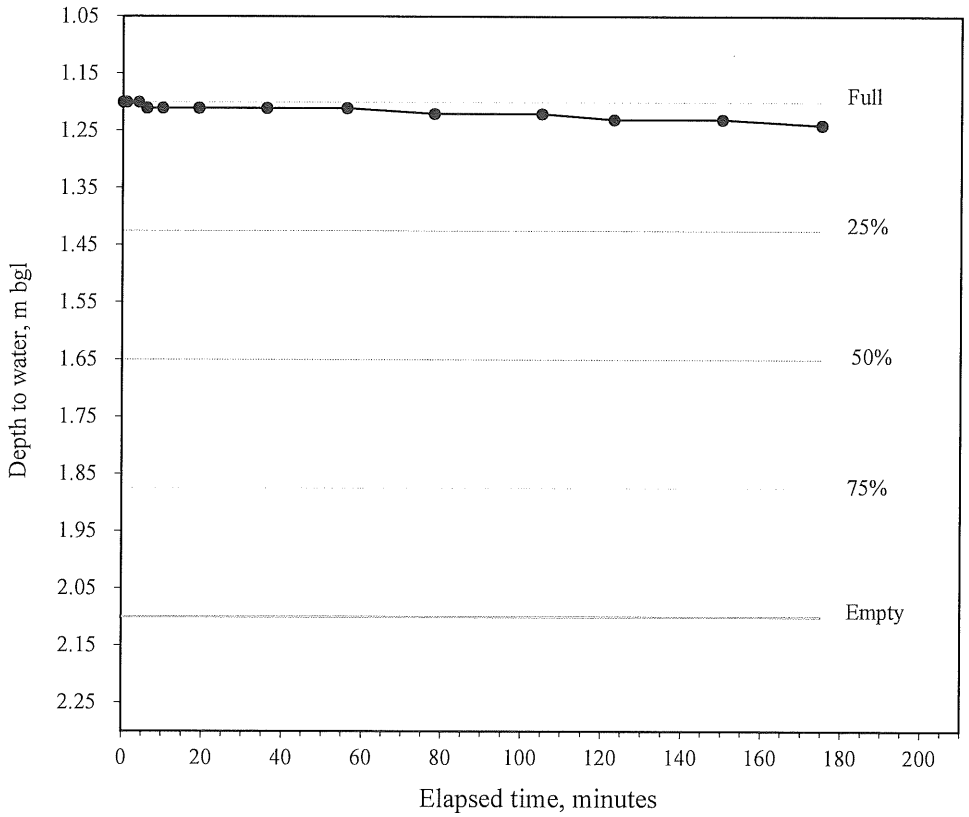
Description of Stratum under test: Brown and light grey, slightly silty, fine SAND

Depth to water prior to test: Dry
(below ground level)

| Elapsed Time min | Depth to Water m |
|---|---|
| 0 | 1.20 |
| 1 | 1.20 |
| 4 | 1.20 |
| 6 | 1.21 |
| 10 | 1.21 |
| 19 | 1.21 |
| 36 | 1.21 |
| 56 | 1.21 |
| 78 | 1.22 |
| 105 | 1.22 |
| 123 | 1.23 |
| 150 | 1.23 |
| 175 | 1.24 |

All dimensions given in metres

DEPTH TO WATER vs ELAPSED TIME




**f = (V75-V25)/A50(T75-T25)**

V75-V25 = 0.527
A50 = 3.375
T75-T25 = 2155 (extrapolated)

Extrapolated Soil Infiltration Rate **f = 1.21E-06 m/s**

Appendix B – AWS Map (No assets)


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(c) Crown copyright and database rights 2023 Ordnance Survey 100022432 | Date: 09/11/23 | Scale: 1:1250 | Map Centre: 522096,330326 | Data updated: 31/10/23 | Our Ref: 1317512 - 1 | Wastewater Plan A3

This plan is provided by Anglian Water pursuant its obligations under the Water Industry Act 1991 sections 198 or 199. It must be used in conjunction with any search results attached. The information on this plan is based on data currently recorded but position must be regarded as approximate. Service pipes, private sewers and drains are generally not shown. Users of this map are strongly advised to commission their own survey of the area shown on the plan before carrying out any works. The actual position of all apparatus MUST be established by trial holes. No liability whatsoever, including liability for negligence, is accepted by Anglian Water for any error or inaccuracy or omission, including the failure to accurately record, or record at all, the location of any water main, discharge pipe, sewer or disposal main or any item of apparatus. This information is valid for the date printed. This plan is produced by Anglian Water Services Limited (c) Crown copyright and database rights 2023 Ordnance Survey 100022432.This map is to be used for the purposes of viewing the location of Anglian Water plant only. Any other uses of the map data or further copies is not permitted. This notice is not intended to exclude or restrict liability for death or personal injury resulting from negligence.

- Foul Sewer
- Surface Sewer
- Combined Sewer
- Final Effluent
- Rising Main*
- Private Sewer*
- Decommissioned Sewer*
- Outfall*
- Inlet*
- Manhole*
- Sewage Treatment Works
- Public Pumping Station
- Decommissioned Pumping Station

*(Colour denotes effluent type)

civils@shieldswilson.co.uk

SW23-334

love every drop anglianwater

| Manhole Reference | Liquid Type | Cover Level | Invert Level | Depth to Invert |
|---|---|---|---|---|

| Manhole Reference | Liquid Type | Cover Level | Invert Level | Depth to Invert |
|---|---|---|---|---|

| Manhole Reference | Liquid Type | Cover Level | Invert Level | Depth to Invert |
|---|---|---|---|---|

Appendix C – Architects Site Plan (Rev B)


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## Boundary treatments

Brick wall with timber fence (overall height 1.8m)

1.8m high close boarded fence

1.2m high post & rail fence

**Notes**

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**Dimensions**
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**CDM 2015**
This drawing is for illustrative purposes and/or obtaining the relevant planning permission only. It should not be used for construction and accordingly, risk identification under the Construction (Design & Management) Regulations 2015 has not been undertaken.

N

0 5 10 15 20 25m

| Rev | Description | Date |
|---|---|---|
| B | Garage added to plot 3. Drainage easement included within red line | 14.03.24 |
| A | Adjacent development revised | 20.02.24 |

rdc
Robert Doughty Consultancy

32 High Street, Helpringham
Sleaford, Lincolnshire, NG34 0RA

Tel: 01529 421646
Email: admin@rdc-landplan.co.uk
Web: www.rdc-landplan.co.uk

**Client**
R K Wilson Builders Ltd

**Project**
Land off Windmill Lane
Gosberton Risegate

**Drawing**
Proposed Site Plan

| Scale @ A3 | Date |
|---|---|
| 1: 500 | 01/02/24 |
| **Drawn By** | **Checked By** |
| WW | . |

| Job Number | Status | Purpose of Issue |
|---|---|---|
| 1443-4 | SK | Discussion |

**Drawing No.** 1443-4_SK_SP03 **Rev** B

Appendix D – Drainage Strategy Arrangement Drawings


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**DRAWING TO BE READ IN CONJUNCTION WITH THE DRAINAGE STRATEGY REPORT SW23-334-REP-01**

NOMINAL DEPRESSION TO BE FORMED TO NORTHERN EDGE OF ROAD TO ATTENUATE SW RUN-OFF IN EXCESS OF 1:100 + CC EVENT

PROPOSED UNDERGROUND SURFACE WATER ATTENUATION TANK
266 NO. POLYSTORM CRATES O.S.A
52.34m³ STORAGE VOLUME
TANK DIMENSIONS 2m WIDE x 37m LONG x 0.8m DEEP
WITH 1 NO. STEP IN CRATES FOR PERFORATED PIPE RUN
FORMATION LEVEL: 1.350

| Point | Easting | Northing | Elevation |
|---|---|---|---|
| J1 | 522083.544 | 330355.836 | 3.407 |
| J2 | 522099.647 | 330360.478 | 3.417 |
| J3 | 522116.237 | 330365.398 | 3.393 |

NEW SW03
450ø PPIC
CL: 3.150
IL: 1.325

NEW SW04
FLOW CONTROL CHAMBER
WITH INTEGRAL PUMP
MAX FLOW RATE: 5.00L/s
CL: 3.250
IL: 1.220 (INCOMING)

NEW FW02
1200ø PCC
CL: 3.520
IL: 2.050

NEW FW03
1200ø PCC
CL: 3.520
IL: 1.880

NEW SW01
1200ø PCC
CL: 3.410
IL: 1.675

NEW FW01
1200ø PCC
CL: 3.410
IL: 2.525

NEW SW02
1200ø PCC
CL: 3.335
IL: 1.365

PROPOSED FOUL WATER TREATMENT PLANT AND PUMPING STATION MIN. 10m FROM ANY STRUCTURE

HATCHED AREA DENOTES 10m EXCLUSION ZONE

MIN. FFL TO BE 300mm ABOVE EXISTING GROUND LEVEL IN ACCORDANCE WITH RM ASSOCIATES FRA V1 DATED NOVEMBER 2023

PLOT 1 FFL 3.550
PLOT 2 FFL 3.625
PLOT 3 FFL 3.700
PLOT 4 FFL 3.700
PLOT 5 FFL 3.625
PLOT 6 FFL 3.550

3m WIDE EASEMENT

NEW SW05
SURFACE WATER MANHOLE CHAMBER
TO CONNECT BY GRAVITY
TO W&D IDB MAINTAINED DRAIN
CL: 3.400
IL: 2.350

ASSUMED LINE OF FENCE

NOMINAL BOUNDARY RETAINING MAY B REQUIRED TO SOUTH OF SITE, MAX 300mm

WORKS WITHIN 9m of A MAINTAINED WATERCOURSE SUBJECT TO WDIDB CONSENT UNDER BYELAW 10

TREATED FOUL WATER DISCHARGE TO WATERCOURSE SUBJECT TO WDIDB CONSENT UNDER BYELAW 3

SURFACE WATER DISCHARGE TO WATERCOURSE SUBJECT TO WDIDB CONSENT UNDER BYELAW 3

HW01 NEW
PCC HEADWALL
DISCHARGING INTO WELLAND & DEEPING
IDB MAINTAINED WATERCOURSE

WATER LEVEL AT TIME OF SURVEY = 1.545 AOD

IDB MAINTAINED WATERCOURSE

## KEY:

- PROPOSED FOUL WATER SEWER – MANAGEMENT CO.
- PROPOSED FOUL WATER CHAMBER – MANAGEMENT CO.
- PROPOSED PUMPED TREATED FOUL WATER SEWER – MANAGEMENT CO.
- PROPOSED FOUL DRAIN – PRIVATE
- PROPOSED SURFACE WATER SEWER – MANAGEMENT CO.
- PROPOSED SURFACE WATER CHAMBER – MANAGEMENT CO.
- PROPOSED SURFACE WATER GULLY & LATERAL – MANAGEMENT CO.
- PROPOSED PUMPED SURFACE WATER SEWER – MANAGEMENT CO.
- PROPOSED UNDERGROUND ATTENUATION TANK – MAN. CO.
- PROPOSED SURFACE WATER DRAIN – PRIVATE
- 3.67 EXISTING SITE LEVEL
- 3.000 PROPOSED SITE LEVEL
- 1:150 FALL PROPOSED SURFACE FALL
- DENOTES PROPOSED FLOOD EXCEEDANCE ROUTE
- DENOTES EXISTING FLOOD EXCEEDANCE ROUTE
- AREA A – PROPOSED SHARED ACCESS ROAD – IMPERMEABLE = 445m²
- AREA B – PROPOSED DWELLING ROOF'S – IMPERMEABLE = 810m²

TOTAL IMPERMEABLE AREA TO WDIDB WATERCOURSE VIA DRAINAGE SYSTEM = 1,255m²

- AREA C – PROPOSED SHARED DRIVEWAY – PERMEABLE = 210m²
- AREA D – PROPOSED PRIVATE DRIVEWAYS – PERMEABLE = 350m²

TOTAL PERMEABLE AREA TO INFILTRATE TO GROUND (AT SOURCE) = 560m²

**PLEASE REFER TO ARCHITECTS DRAWINGS FOR CONFIRMATION OF ALL WALL/SETTING OUT DIMENSIONS PRIOR TO COMMENCING OF WORKS**

**THIS DRAWING MUST BE READ IN CONJUNCTION WITH ALL RELEVANT DRAWINGS & STRUCTURAL CALCULATIONS**

N

0 2 4 6 8 12 16 20m
1:200

| REV. | DESCRIPTION | DRN. | APP. | DATE |
|---|---|---|---|---|
| – | PRELIMINARY – FOR INFORMATION | MRB | APW | 26.03.24 |

SHIELDS WILSON
e: info@shieldswilson.co.uk t: 01775 729252
STRUCTURAL AND CIVIL ENGINEERING

STATUS: FOR INFORMATION

CLIENT: R K WILSON BUILDERS (GR) LTD.

PROJECT: PROPOSED RESIDENTIAL DEVELOPMENT
LAND OFF WINDMILL LANE, GOSBERTON RISEGATE,
SPALDING, LINCOLNSHIRE, PE11 4ES

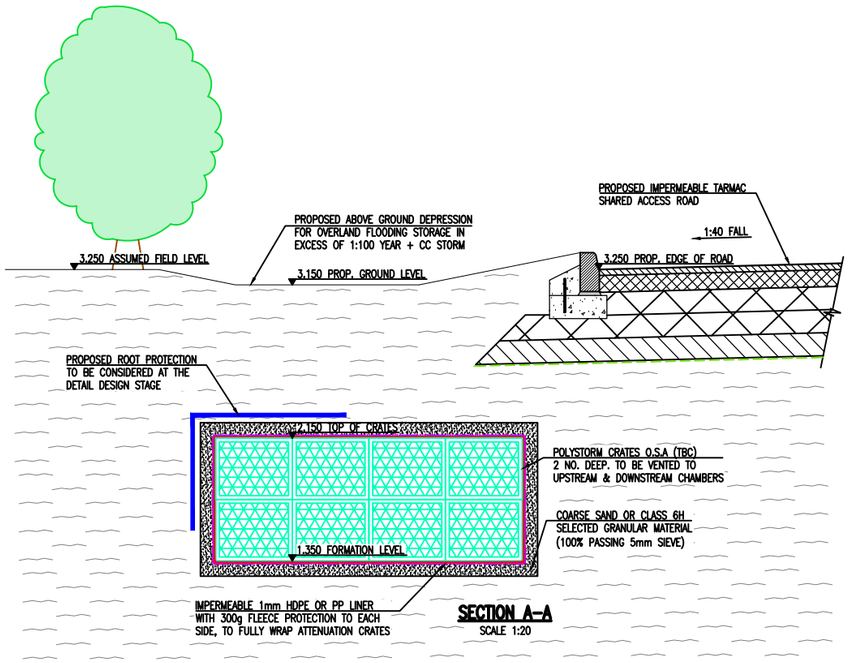
TITLE: PROPOSED DRAINAGE STRATEGY ARRANGEMENT

| DATE | MAR. '24 | SCALE @A1 | DRAWING NO. | REV. |
|---|---|---|---|---|
| DRAWN | MRB | 1:200 | SW23-334-001 | – |

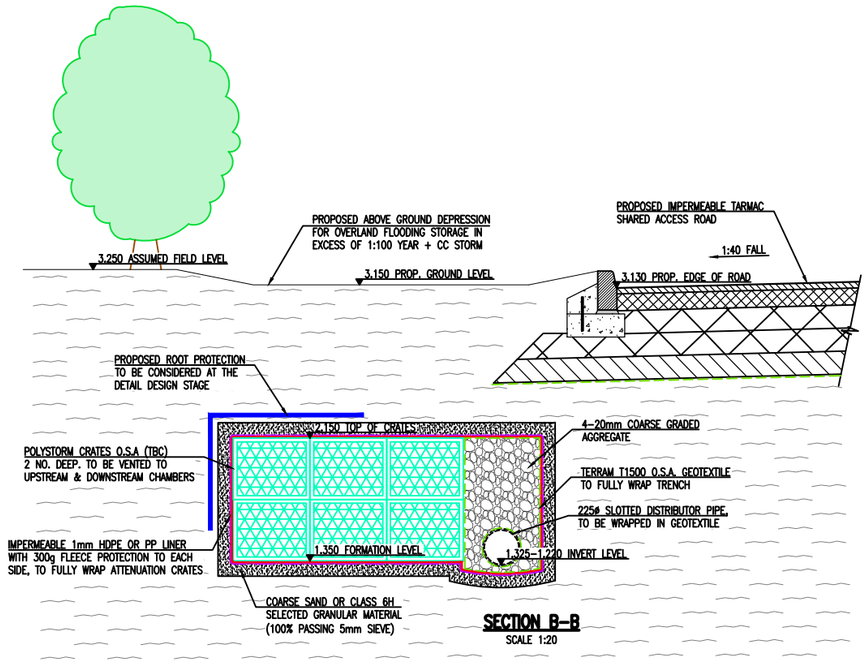
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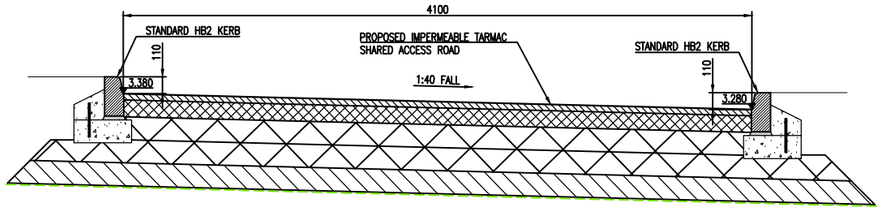
THIS DRAWING MUST BE READ IN CONJUNCTION WITH ALL RELEVANT DRAWINGS & STRUCTURAL CALCULATIONS



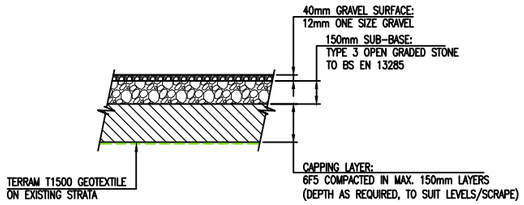

**SECTION A–A**
SCALE 1:20



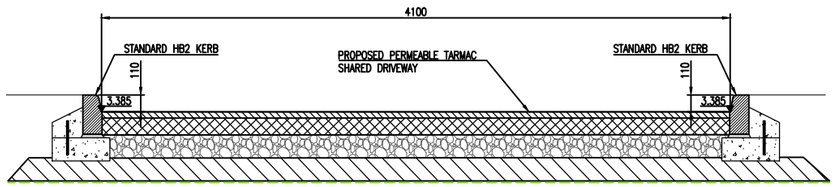

**SECTION B–B**
SCALE 1:20




**SECTION C–C**
SCALE 1:20




**GRAVEL DRIVEWAY DETAIL**
SCALE 1:20




**SECTION D–D**
SCALE 1:20

0 0.2 0.4 0.6 0.8 1.2 1.6 2m
1:20

| REV. | DESCRIPTION | DRN. | APP. | DATE |
|---|---|---|---|---|
| – | PRELIMINARY – FOR INFORMATON | MRB | APW | 26.03.24 |

SHIELDS WILSON
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STRUCTURAL AND CIVIL ENGINEERING

STATUS: FOR INFORMATION

CLIENT: R K WILSON BUILDERS (GR) LTD.

PROJECT: PROPOSED RESIDENTIAL DEVELOPMENT
LAND OFF WINDMILL LANE, GOSBERTON RISEGATE, SPALDING, LINCOLNSHIRE, PE11 4ES

TITLE: PROPOSED DRAINAGE STRATEGY SECTIONS & DETAILS

| DATE | MAR. '24 | SCALE @A1 | DRAWING NO. | REV. |
|---|---|---|---|---|
| DRAWN | MRB | 1:20 | SW23–334–002 | – |

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Appendix E – Proposed Surface Water Drainage Calculations


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# PROPOSED SURFACE WATER DRAINAGE CALCULATIONS

# UPON

# 6 PLOT RESIDENTIAL DEVELOPMENT

# LAND OFF WINDMILL LANE, GOSBERTON RISEGATE

# SPALDING, LINCOLNSHIRE, PE11 4ES

## PROJECT NO: SW23-334

## DOCUMENT REF: SW23-334-CAL-C-01




## FOR R K WILSON BUILDERS (GR) LTD.


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## Contents

Greenfield Run-off Calculations ..... 3
Modelled Network Layout Graphic ..... 5
Network Details ..... 6
FEH Rainfall Data Hydraulic Model Output ..... 10
FEH Data 1:100 + CC Year Maximum Water Level Graphic..... 16
FSR Rainfall Data Hydraulic Model Output ..... 17
FSR Data 1:100 Year + CC Maximum Water Level Graphic..... 23

| Revision | Date | Description | | |
|---|---|---|---|---|
| - | March 2024 | First Issue | Prepared | M. R. Barlow |
| | | | Approved | A.Wilson CEng MIStructE |


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# Greenfield Run-off Calculations


© Shields Wilson Limited.

# Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

| | |
|---|---|
| Calculated by: | Max Barlow |
| Site name: | SW23-334 |
| Site location: | Gosberton Risegate |

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

## Site Details

| | |
|---|---|
| Latitude: | 52.85624° N |
| Longitude: | 0.18827° W |
| Reference: | 2929734258 |
| Date: | Mar 26 2024 08:45 |

## Runoff estimation approach

IH124

## Site characteristics

Total site area (ha): 0.371

## Methodology

| | |
|---|---|
| $Q_{BAR}$ estimation method: | Calculate from SPR and SAAR |
| SPR estimation method: | Calculate from SOIL type |

## Soil characteristics

| | Default | Edited |
|---|---|---|
| SOIL type: | 2 | 2 |
| HOST class: | N/A | N/A |
| SPR/SPRHOST: | 0.3 | 0.3 |

## Hydrological characteristics

| | Default | Edited |
|---|---|---|
| SAAR (mm): | 559 | 559 |
| Hydrological region: | 5 | 5 |
| Growth curve factor 1 year: | 0.87 | 0.87 |
| Growth curve factor 30 years: | 2.45 | 2.45 |
| Growth curve factor 100 years: | 3.56 | 3.56 |
| Growth curve factor 200 years: | 4.21 | 4.21 |

## Notes

### (1) Is $Q_{BAR}$ < 2.0 l/s/ha?

When $Q_{BAR}$ is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

### (2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

### (3) Is SPR/SPRHOST ≤ 0.3?

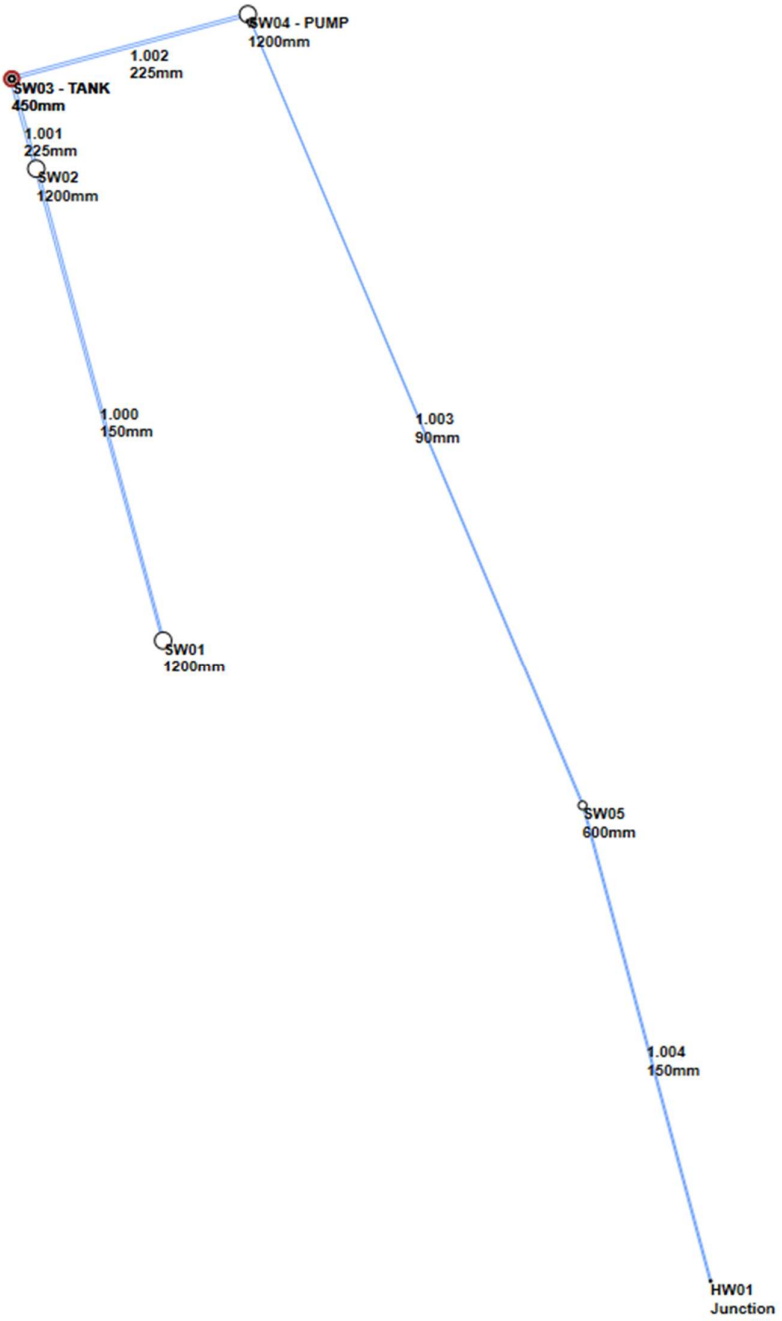
Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

## Greenfield runoff rates

| | Default | Edited |
|---|---|---|
| $Q_{BAR}$ (l/s): | 0.52 | 0.52 |
| 1 in 1 year (l/s): | 0.45 | 0.45 |
| 1 in 30 years (l/s): | 1.27 | 1.27 |
| 1 in 100 year (l/s): | 1.85 | 1.85 |
| 1 in 200 years (l/s): | 2.19 | 2.19 |

This report was produced using the greenfield runoff tool developed by HR Wallingford and available at www.uksuds.com. The use of this tool is subject to the UK SuDS terms and conditions and licence agreement , which can both be found at www.uksuds.com/terms-and-conditions.htm. The outputs from this tool are estimates of greenfield runoff rates. The use of these results is the responsibility of the users of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, CEH, Hydrosolutions or any other organisation for the use of this data in the design or operational characteristics of any drainage scheme.

## Modelled Network Layout Graphic





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Network Details


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## Design Settings

| | | | |
|---|---|---|---|
| Rainfall Methodology | FEH-13 | Minimum Velocity (m/s) | 1.00 |
| Return Period (years) | 100 | Connection Type | Level Soffits |
| Additional Flow (%) | 0 | Minimum Backdrop Height (m) | 0.200 |
| CV | 0.750 | Preferred Cover Depth (m) | 1.200 |
| Time of Entry (mins) | 5.00 | Include Intermediate Ground | ✓ |
| Maximum Time of Concentration (mins) | 30.00 | Enforce best practice design rules | x |
| Maximum Rainfall (mm/hr) | 50.0 | | |

## Nodes

| Name | Area (ha) | T of E (mins) | Cover Level (m) | Diameter (mm) | Easting (m) | Northing (m) | Depth (m) |
|---|---|---|---|---|---|---|---|
| SW01 | 0.042 | 5.00 | 3.410 | 1200 | 522113.085 | 330326.818 | 1.735 |
| SW02 | 0.046 | 5.00 | 3.335 | 1200 | 522104.148 | 330360.144 | 1.970 |
| SW03 - TANK | 0.019 | 5.00 | 3.150 | 450 | 522102.424 | 330366.491 | 1.825 |
| SW04 - PUMP | 0.019 | 5.00 | 3.250 | 1200 | 522119.058 | 330371.055 | 2.330 |
| SW05 | | | 3.400 | 600 | 522142.633 | 330315.088 | 1.050 |
| HW01 | | | 3.200 | | 522151.656 | 330281.426 | 1.100 |

## Links

| Name | US Node | DS Node | Length (m) | ks (mm) / n | US IL (m) | DS IL (m) | Fall (m) | Slope (1:X) | Dia (mm) | T of C (mins) | Rain (mm/hr) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.000 | SW01 | SW02 | 34.504 | 0.600 | 1.675 | 1.440 | 0.235 | 146.8 | 150 | 5.70 | 50.0 |
| 1.001 | SW02 | SW03 - TANK | 6.577 | 0.600 | 1.365 | 1.325 | 0.040 | 164.4 | 225 | 5.80 | 50.0 |
| 1.002 | SW03 - TANK | SW04 - PUMP | 17.249 | 0.600 | 1.325 | 1.220 | 0.105 | 164.3 | 225 | 6.09 | 50.0 |
| 1.003 | SW04 - PUMP | SW05 | 67.250 | 0.600 | 0.920 | 2.410 | -1.490 | -45.1 | 90 | 7.21 | 50.0 |
| 1.004 | SW05 | HW01 | 34.850 | 0.600 | 2.350 | 2.100 | 0.250 | 139.4 | 150 | 7.89 | 50.0 |

| Name | Vel (m/s) | Cap (l/s) | Flow (l/s) | US Depth (m) | DS Depth (m) | Σ Area (ha) | Σ Add Inflow (l/s) | Pro Depth (mm) | Pro Velocity (m/s) |
|---|---|---|---|---|---|---|---|---|---|
| 1.000 | 0.827 | 14.6 | 5.6 | 1.585 | 1.745 | 0.042 | 0.0 | 65 | 0.775 |
| 1.001 | 1.017 | 40.4 | 11.8 | 1.745 | 1.600 | 0.087 | 0.0 | 83 | 0.884 |
| 1.002 | 1.017 | 40.4 | 14.5 | 1.600 | 1.805 | 0.107 | 0.0 | 93 | 0.933 |
| 1.003 | 1.000 | 6.4 | 17.1 | 2.240 | 0.900 | 0.126 | 0.0 | 90 | 0.000 |
| 1.004 | 0.849 | 15.0 | 17.1 | 0.900 | 0.950 | 0.126 | 0.0 | 150 | 0.865 |

## Pipeline Schedule

| Link | Length (m) | Slope (1:X) | Dia (mm) | Link Type | US CL (m) | US IL (m) | US Depth (m) | DS CL (m) | DS IL (m) | DS Depth (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.000 | 34.504 | 146.8 | 150 | Circular | 3.410 | 1.675 | 1.585 | 3.335 | 1.440 | 1.745 |
| 1.001 | 6.577 | 164.4 | 225 | Circular | 3.335 | 1.365 | 1.745 | 3.150 | 1.325 | 1.600 |
| 1.002 | 17.249 | 164.3 | 225 | Circular | 3.150 | 1.325 | 1.600 | 3.250 | 1.220 | 1.805 |
| 1.003 | 67.250 | -45.1 | 90 | Circular | 3.250 | 0.920 | 2.240 | 3.400 | 2.410 | 0.900 |

| Link | US Node | Dia (mm) | Node Type | MH Type | DS Node | Dia (mm) | Node Type | MH Type |
|---|---|---|---|---|---|---|---|---|
| 1.000 | SW01 | 1200 | Manhole | Adoptable | SW02 | 1200 | Manhole | Adoptable |
| 1.001 | SW02 | 1200 | Manhole | Adoptable | SW03 - TANK | 450 | Manhole | Adoptable |
| 1.002 | SW03 - TANK | 450 | Manhole | Adoptable | SW04 - PUMP | 1200 | Manhole | Adoptable |
| 1.003 | SW04 - PUMP | 1200 | Manhole | Adoptable | SW05 | 600 | Manhole | Adoptable |

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## Pipeline Schedule

| Link | Length (m) | Slope (1:X) | Dia (mm) | Link Type | US CL (m) | US IL (m) | US Depth (m) | DS CL (m) | DS IL (m) | DS Depth (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.004 | 34.850 | 139.4 | 150 | Circular | 3.400 | 2.350 | 0.900 | 3.200 | 2.100 | 0.950 |

| Link | US Node | Dia (mm) | Node Type | MH Type | DS Node | Dia (mm) | Node Type | MH Type |
|---|---|---|---|---|---|---|---|---|
| 1.004 | SW05 | 600 | Manhole | Adoptable | HW01 | | Junction | |

## Manhole Schedule

| Node | Easting (m) | Northing (m) | CL (m) | Depth (m) | Dia (mm) | Connections | Link | IL (m) | Dia (mm) |
|---|---|---|---|---|---|---|---|---|---|
| SW01 | 522113.085 | 330326.818 | 3.410 | 1.735 | 1200 |  | | | |
| | | | | | | 0 | 1.000 | 1.675 | 150 |
| SW02 | 522104.148 | 330360.144 | 3.335 | 1.970 | 1200 |  | 1.000 | 1.440 | 150 |
| | | | | | | 0 | 1.001 | 1.365 | 225 |
| SW03 - TANK | 522102.424 | 330366.491 | 3.150 | 1.825 | 450 |  | 1.001 | 1.325 | 225 |
| | | | | | | 0 | 1.002 | 1.325 | 225 |
| SW04 - PUMP | 522119.058 | 330371.055 | 3.250 | 2.330 | 1200 |  | 1.002 | 1.220 | 225 |
| | | | | | | 0 | 1.003 | 0.920 | 90 |
| SW05 | 522142.633 | 330315.088 | 3.400 | 1.050 | 600 |  | 1.003 | 2.410 | 90 |
| | | | | | | 0 | 1.004 | 2.350 | 150 |
| HW01 | 522151.656 | 330281.426 | 3.200 | 1.100 | |  | 1.004 | 2.100 | 150 |

## Node SW04 - PUMP Online Pump Control

| | | | | | |
|---|---|---|---|---|---|
| Flap Valve | x | Invert Level (m) | 0.920 | Switch on depth (m) | 0.300 |
| Downstream Link | 1.003 | Design Depth (m) | 2.230 | Switch off depth (m) | 0.100 |
| Replaces Downstream Link | ✓ | Design Flow (l/s) | 5.0 | | |

| Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) |
|---|---|---|---|
| 0.300 | 5.000 | 2.230 | 5.000 |

## Node SW03 - TANK Depth/Area Storage Structure

| | | | | | |
|---|---|---|---|---|---|
| Base Inf Coefficient (m/hr) | 0.00000 | Safety Factor | 2.0 | Invert Level (m) | 1.350 |
| Side Inf Coefficient (m/hr) | 0.00000 | Porosity | 0.95 | Time to half empty (mins) | |

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| Depth (m) | Area (m²) | Inf Area (m²) | Depth (m) | Area (m²) | Inf Area (m²) | Depth (m) | Area (m²) | Inf Area (m²) |
|---|---|---|---|---|---|---|---|---|
| 0.000 | 66.5 | 0.0 | 0.800 | 66.5 | 0.0 | 0.801 | 0.0 | 0.0 |

**Node SW03 - TANK Depth/Area Storage Structure**

| | | | | | |
|---|---|---|---|---|---|
| Base Inf Coefficient (m/hr) | 0.00000 | Safety Factor | 2.0 | Invert Level (m) | 1.350 |
| Side Inf Coefficient (m/hr) | 0.00000 | Porosity | 0.30 | Time to half empty (mins) | |

| Depth (m) | Area (m²) | Inf Area (m²) | Depth (m) | Area (m²) | Inf Area (m²) | Depth (m) | Area (m²) | Inf Area (m²) |
|---|---|---|---|---|---|---|---|---|
| 0.000 | 7.4 | 0.0 | 0.800 | 7.4 | 0.0 | 0.801 | 0.0 | 0.0 |

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FEH Rainfall Data Hydraulic Model Output


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## Simulation Settings

| | | | | | |
|---|---|---|---|---|---|
| Rainfall Methodology | FEH-13 | Analysis Speed | Normal | Additional Storage (m³/ha) | 0.0 |
| Summer CV | 0.750 | Skip Steady State | x | Check Discharge Rate(s) | x |
| Winter CV | 0.840 | Drain Down Time (mins) | 240 | Check Discharge Volume | x |

**Storm Durations**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 30 | 60 | 120 | 180 | 240 | 360 | 480 | 600 | 720 | 960 | 1440 |

| Return Period (years) | Climate Change (CC %) | Additional Area (A %) | Additional Flow (Q %) |
|---|---|---|---|
| 2 | 0 | 0 | 0 |
| 30 | 0 | 0 | 0 |
| 100 | 0 | 0 | 0 |
| 100 | 40 | 0 | 0 |

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**Results for 2 year Critical Storm Duration. Lowest mass balance: 99.36%**

| Node Event | US Node | Peak (mins) | Level (m) | Depth (m) | Inflow (l/s) | Node Vol (m³) | Flood (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 15 minute winter | SW01 | 11 | 1.741 | 0.066 | 6.0 | 0.0751 | 0.0000 | OK |
| 15 minute winter | SW02 | 11 | 1.452 | 0.087 | 12.1 | 0.0987 | 0.0000 | OK |
| 30 minute winter | SW03 - TANK | 24 | 1.413 | 0.088 | 11.6 | 4.1412 | 0.0000 | OK |
| 15 minute winter | SW04 - PUMP | 16 | 1.431 | 0.511 | 9.6 | 0.5775 | 0.0000 | SURCHARGED |
| 30 minute summer | SW05 | 18 | 2.410 | 0.060 | 5.0 | 0.0170 | 0.0000 | OK |
| 60 minute summer | HW01 | 33 | 2.159 | 0.059 | 5.0 | 0.0000 | 0.0000 | OK |

| Link Event (Upstream Depth) | US Node | Link | DS Node | Outflow (l/s) | Velocity (m/s) | Flow/Cap | Link Vol (m³) | Discharge Vol (m³) |
|---|---|---|---|---|---|---|---|---|
| 15 minute winter | SW01 | 1.000 | SW02 | 5.8 | 0.776 | 0.395 | 0.2564 | |
| 15 minute winter | SW02 | 1.001 | SW03 - TANK | 12.0 | 1.146 | 0.298 | 0.0791 | |
| 30 minute winter | SW03 - TANK | 1.002 | SW04 - PUMP | 9.4 | 0.650 | 0.232 | 0.4502 | |
| 15 minute winter | SW04 - PUMP | Pump | SW05 | 5.0 | | | | |
| 30 minute summer | SW05 | 1.004 | HW01 | 5.0 | 0.766 | 0.333 | 0.2275 | 9.4 |

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**Results for 30 year Critical Storm Duration. Lowest mass balance: 99.36%**

| Node Event | US Node | Peak (mins) | Level (m) | Depth (m) | Inflow (l/s) | Node Vol (m³) | Flood (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 15 minute winter | SW01 | 11 | 1.839 | 0.164 | 16.9 | 0.1859 | 0.0000 | SURCHARGED |
| 60 minute winter | SW02 | 52 | 1.669 | 0.304 | 18.1 | 0.3442 | 0.0000 | SURCHARGED |
| 60 minute winter | SW03 - TANK | 52 | 1.669 | 0.344 | 23.2 | 20.9401 | 0.0000 | SURCHARGED |
| 60 minute winter | SW04 - PUMP | 52 | 1.667 | 0.747 | 8.6 | 0.8453 | 0.0000 | SURCHARGED |
| 60 minute winter | SW05 | 21 | 2.410 | 0.060 | 5.0 | 0.0170 | 0.0000 | OK |
| 30 minute winter | HW01 | 12 | 2.159 | 0.059 | 5.0 | 0.0000 | 0.0000 | OK |

| Link Event (Upstream Depth) | US Node | Link | DS Node | Outflow (l/s) | Velocity (m/s) | Flow/Cap | Link Vol (m³) | Discharge Vol (m³) |
|---|---|---|---|---|---|---|---|---|
| 15 minute winter | SW01 | 1.000 | SW02 | 15.9 | 0.940 | 1.086 | 0.5635 | |
| 60 minute winter | SW02 | 1.001 | SW03 - TANK | 17.6 | 0.877 | 0.434 | 0.2616 | |
| 60 minute winter | SW03 - TANK | 1.002 | SW04 - PUMP | 6.5 | 0.654 | 0.161 | 0.6860 | |
| 60 minute winter | SW04 - PUMP | Pump | SW05 | 5.0 | | | | |
| 60 minute winter | SW05 | 1.004 | HW01 | 5.0 | 0.766 | 0.333 | 0.2275 | 38.1 |

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**Results for 100 year Critical Storm Duration. Lowest mass balance: 99.36%**

| Node Event | US Node | Peak (mins) | Level (m) | Depth (m) | Inflow (l/s) | Node Vol (m³) | Flood (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 15 minute winter | SW01 | 11 | 2.162 | 0.487 | 22.7 | 0.5513 | 0.0000 | SURCHARGED |
| 120 minute winter | SW02 | 96 | 1.854 | 0.489 | 15.8 | 0.5534 | 0.0000 | SURCHARGED |
| 120 minute winter | SW03 - TANK | 96 | 1.854 | 0.529 | 18.7 | 33.0675 | 0.0000 | SURCHARGED |
| 120 minute winter | SW04 - PUMP | 96 | 1.852 | 0.932 | 9.4 | 1.0546 | 0.0000 | SURCHARGED |
| 60 minute summer | SW05 | 20 | 2.410 | 0.060 | 5.0 | 0.0170 | 0.0000 | OK |
| 15 minute winter | HW01 | 7 | 2.159 | 0.059 | 5.0 | 0.0000 | 0.0000 | OK |

| Link Event (Upstream Depth) | US Node | Link | DS Node | Outflow (l/s) | Velocity (m/s) | Flow/Cap | Link Vol (m³) | Discharge Vol (m³) |
|---|---|---|---|---|---|---|---|---|
| 15 minute winter | SW01 | 1.000 | SW02 | 20.3 | 1.152 | 1.388 | 0.6074 | |
| 120 minute winter | SW02 | 1.001 | SW03 - TANK | 15.2 | 0.728 | 0.377 | 0.2616 | |
| 120 minute winter | SW03 - TANK | 1.002 | SW04 - PUMP | 6.7 | 0.654 | 0.166 | 0.6860 | |
| 120 minute winter | SW04 - PUMP | Pump | SW05 | 5.0 | | | | |
| 60 minute summer | SW05 | 1.004 | HW01 | 5.0 | 0.766 | 0.333 | 0.2275 | 46.6 |

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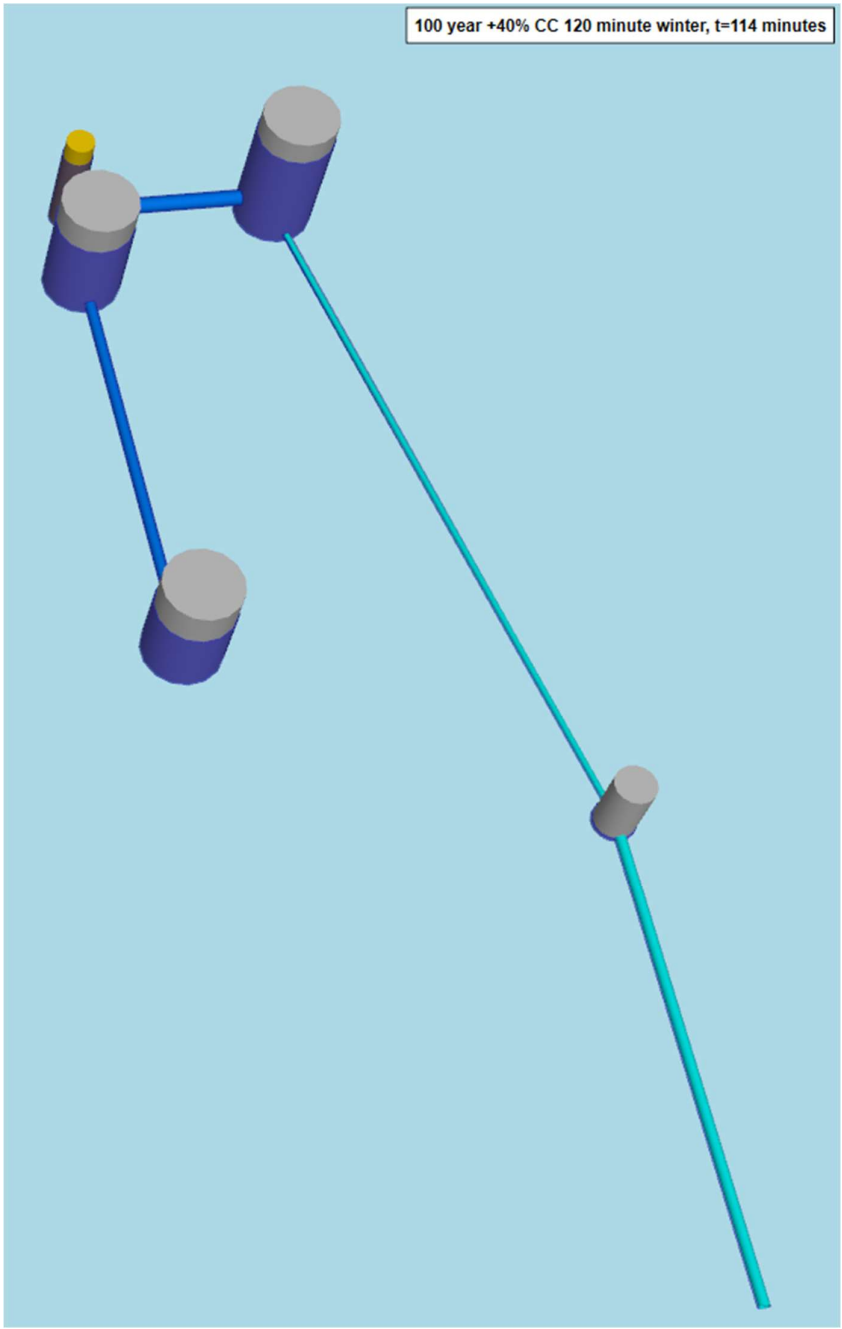
**Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 99.36%**

| Node Event | US Node | Peak (mins) | Level (m) | Depth (m) | Inflow (l/s) | Node Vol (m³) | Flood (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 120 minute winter | SW01 | 114 | 2.846 | 1.171 | 10.6 | 1.3247 | 0.0000 | SURCHARGED |
| 120 minute winter | SW02 | 114 | 2.843 | 1.478 | 21.8 | 1.6715 | 0.0000 | SURCHARGED |
| 120 minute winter | SW03 - TANK | 114 | 2.842 | 1.517 | 26.2 | 52.6227 | 0.0000 | SURCHARGED |
| 120 minute winter | SW04 - PUMP | 114 | 2.841 | 1.921 | 8.4 | 2.1726 | 0.0000 | SURCHARGED |
| 15 minute winter | SW05 | 6 | 2.410 | 0.060 | 5.0 | 0.0170 | 0.0000 | OK |
| 15 minute winter | HW01 | 6 | 2.159 | 0.059 | 5.0 | 0.0000 | 0.0000 | OK |

| Link Event (Upstream Depth) | US Node | Link | DS Node | Outflow (l/s) | Velocity (m/s) | Flow/Cap | Link Vol (m³) | Discharge Vol (m³) |
|---|---|---|---|---|---|---|---|---|
| 120 minute winter | SW01 | 1.000 | SW02 | 10.2 | 0.796 | 0.695 | 0.6074 | |
| 120 minute winter | SW02 | 1.001 | SW03 - TANK | 21.3 | 0.722 | 0.527 | 0.2616 | |
| 120 minute winter | SW03 - TANK | 1.002 | SW04 - PUMP | 5.9 | 0.662 | 0.145 | 0.6860 | |
| 120 minute winter | SW04 - PUMP | Pump | SW05 | 5.0 | | | | |
| 15 minute winter | SW05 | 1.004 | HW01 | 5.0 | 0.767 | 0.333 | 0.2275 | 44.1 |

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## FEH Data 1:100 + CC Year Maximum Water Level Graphic





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FSR Rainfall Data Hydraulic Model Output


© Shields Wilson Limited.

## Simulation Settings

| | | | |
|---|---|---|---|
| Rainfall Methodology | FSR | Analysis Speed | Normal |
| FSR Region | England and Wales | Skip Steady State | x |
| M5-60 (mm) | 20.000 | Drain Down Time (mins) | 240 |
| Ratio-R | 0.400 | Additional Storage (m³/ha) | 0.0 |
| Summer CV | 0.750 | Check Discharge Rate(s) | x |
| Winter CV | 0.840 | Check Discharge Volume | x |

**Storm Durations**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 30 | 60 | 120 | 180 | 240 | 360 | 480 | 600 | 720 | 960 | 1440 |

| Return Period (years) | Climate Change (CC %) | Additional Area (A %) | Additional Flow (Q %) |
|---|---|---|---|
| 2 | 0 | 0 | 0 |
| 30 | 0 | 0 | 0 |
| 100 | 0 | 0 | 0 |
| 100 | 40 | 0 | 0 |

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**Results for 2 year Critical Storm Duration. Lowest mass balance: 99.41%**

| Node Event | US Node | Peak (mins) | Level (m) | Depth (m) | Inflow (l/s) | Node Vol (m³) | Flood (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 15 minute winter | SW01 | 11 | 1.751 | 0.076 | 7.6 | 0.0863 | 0.0000 | OK |
| 15 minute winter | SW02 | 11 | 1.465 | 0.100 | 15.5 | 0.1130 | 0.0000 | OK |
| 30 minute winter | SW03 - TANK | 26 | 1.443 | 0.118 | 16.3 | 6.1455 | 0.0000 | OK |
| 30 minute winter | SW04 - PUMP | 26 | 1.466 | 0.546 | 10.1 | 0.6172 | 0.0000 | SURCHARGED |
| 60 minute summer | SW05 | 31 | 2.410 | 0.060 | 5.0 | 0.0170 | 0.0000 | OK |
| 60 minute winter | HW01 | 29 | 2.159 | 0.059 | 5.0 | 0.0000 | 0.0000 | OK |

| Link Event (Upstream Depth) | US Node | Link | DS Node | Outflow (l/s) | Velocity (m/s) | Flow/Cap | Link Vol (m³) | Discharge Vol (m³) |
|---|---|---|---|---|---|---|---|---|
| 15 minute winter | SW01 | 1.000 | SW02 | 7.3 | 0.824 | 0.501 | 0.3065 | |
| 15 minute winter | SW02 | 1.001 | SW03 - TANK | 15.3 | 1.212 | 0.379 | 0.1047 | |
| 30 minute winter | SW03 - TANK | 1.002 | SW04 - PUMP | 8.4 | 0.662 | 0.209 | 0.5251 | |
| 30 minute winter | SW04 - PUMP | Pump | SW05 | 5.0 | | | | |
| 60 minute summer | SW05 | 1.004 | HW01 | 5.0 | 0.766 | 0.333 | 0.2275 | 15.1 |

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**Results for 30 year Critical Storm Duration. Lowest mass balance: 99.41%**

| Node Event | US Node | Peak (mins) | Level (m) | Depth (m) | Inflow (l/s) | Node Vol (m³) | Flood (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 15 minute winter | SW01 | 11 | 1.797 | 0.122 | 14.4 | 0.1385 | 0.0000 | OK |
| 60 minute winter | SW02 | 49 | 1.599 | 0.234 | 15.5 | 0.2650 | 0.0000 | SURCHARGED |
| 60 minute winter | SW03 - TANK | 49 | 1.599 | 0.274 | 18.5 | 16.3515 | 0.0000 | SURCHARGED |
| 60 minute winter | SW04 - PUMP | 49 | 1.597 | 0.677 | 10.2 | 0.7662 | 0.0000 | SURCHARGED |
| 60 minute summer | SW05 | 26 | 2.410 | 0.060 | 5.0 | 0.0170 | 0.0000 | OK |
| 30 minute winter | HW01 | 13 | 2.159 | 0.059 | 5.0 | 0.0000 | 0.0000 | OK |

| Link Event (Upstream Depth) | US Node | Link | DS Node | Outflow (l/s) | Velocity (m/s) | Flow/Cap | Link Vol (m³) | Discharge Vol (m³) |
|---|---|---|---|---|---|---|---|---|
| 15 minute winter | SW01 | 1.000 | SW02 | 13.9 | 0.951 | 0.951 | 0.5031 | |
| 60 minute winter | SW02 | 1.001 | SW03 - TANK | 15.1 | 0.884 | 0.374 | 0.2616 | |
| 60 minute winter | SW03 - TANK | 1.002 | SW04 - PUMP | 7.2 | 0.662 | 0.178 | 0.6860 | |
| 60 minute winter | SW04 - PUMP | Pump | SW05 | 5.0 | | | | |
| 60 minute summer | SW05 | 1.004 | HW01 | 5.0 | 0.766 | 0.333 | 0.2275 | 29.0 |

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**Results for 100 year Critical Storm Duration. Lowest mass balance: 99.41%**

| Node Event | US Node | Peak (mins) | Level (m) | Depth (m) | Inflow (l/s) | Node Vol (m³) | Flood (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 15 minute winter | SW01 | 11 | 1.902 | 0.227 | 18.7 | 0.2571 | 0.0000 | SURCHARGED |
| 60 minute winter | SW02 | 57 | 1.728 | 0.363 | 20.3 | 0.4104 | 0.0000 | SURCHARGED |
| 60 minute winter | SW03 - TANK | 57 | 1.727 | 0.402 | 25.2 | 24.7762 | 0.0000 | SURCHARGED |
| 60 minute winter | SW04 - PUMP | 57 | 1.726 | 0.806 | 9.5 | 0.9115 | 0.0000 | SURCHARGED |
| 60 minute summer | SW05 | 23 | 2.410 | 0.060 | 5.0 | 0.0170 | 0.0000 | OK |
| 60 minute winter | HW01 | 20 | 2.159 | 0.059 | 5.0 | 0.0000 | 0.0000 | OK |

| Link Event (Upstream Depth) | US Node | Link | DS Node | Outflow (l/s) | Velocity (m/s) | Flow/Cap | Link Vol (m³) | Discharge Vol (m³) |
|---|---|---|---|---|---|---|---|---|
| 15 minute winter | SW01 | 1.000 | SW02 | 17.1 | 0.973 | 1.171 | 0.6074 | |
| 60 minute winter | SW02 | 1.001 | SW03 - TANK | 19.0 | 0.869 | 0.470 | 0.2616 | |
| 60 minute winter | SW03 - TANK | 1.002 | SW04 - PUMP | 6.6 | 0.660 | 0.162 | 0.6860 | |
| 60 minute winter | SW04 - PUMP | Pump | SW05 | 5.0 | | | | |
| 60 minute summer | SW05 | 1.004 | HW01 | 5.0 | 0.766 | 0.333 | 0.2275 | 38.1 |

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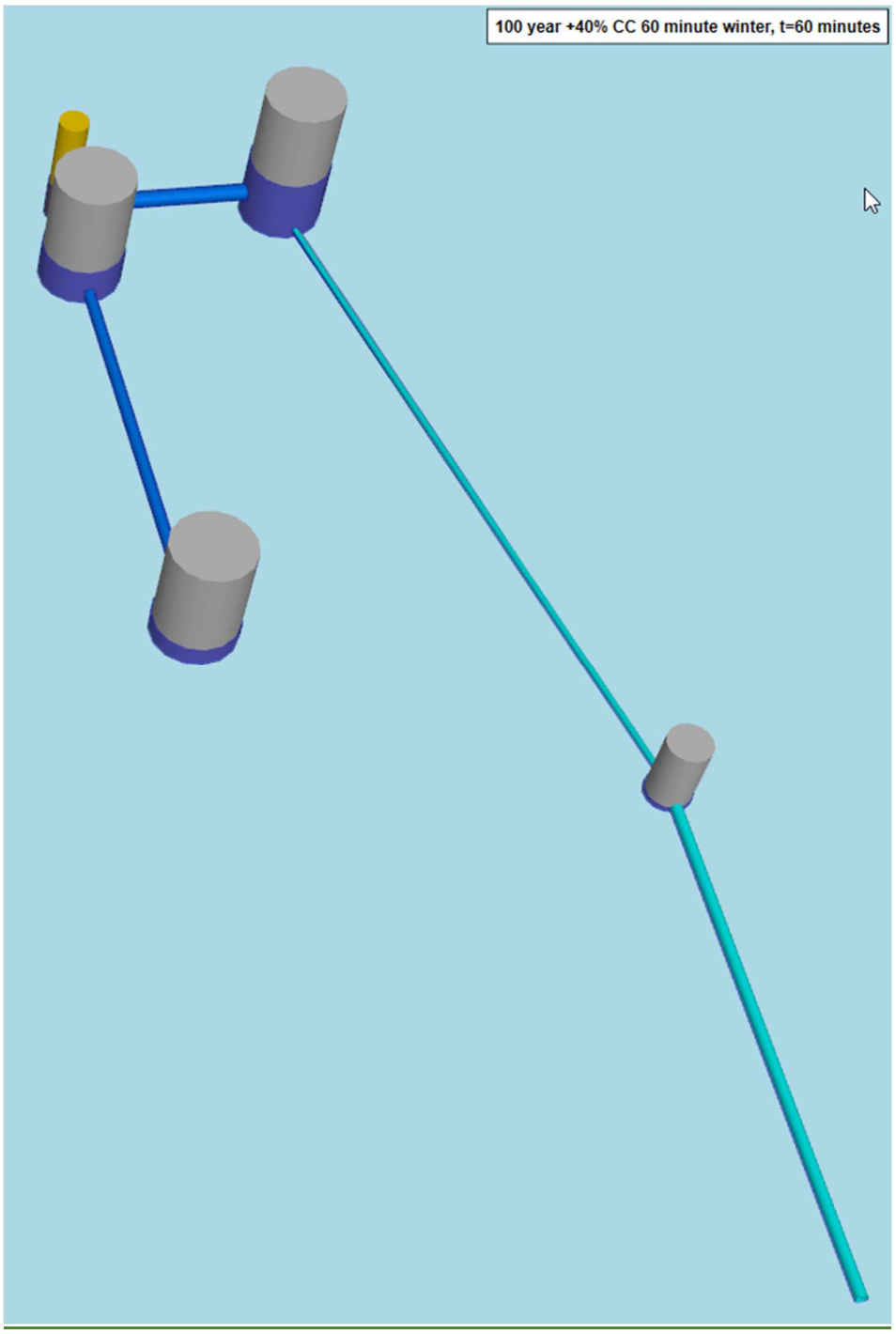
**Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 99.41%**

| Node Event | US Node | Peak (mins) | Level (m) | Depth (m) | Inflow (l/s) | Node Vol (m³) | Flood (m³) | Status |
|---|---|---|---|---|---|---|---|---|
| 15 minute winter | SW01 | 11 | 2.402 | 0.727 | 26.1 | 0.8219 | 0.0000 | SURCHARGED |
| 60 minute winter | SW02 | 59 | 1.962 | 0.597 | 27.3 | 0.6747 | 0.0000 | SURCHARGED |
| 60 minute winter | SW03 - TANK | 60 | 1.961 | 0.636 | 34.5 | 40.1074 | 0.0000 | SURCHARGED |
| 60 minute winter | SW04 - PUMP | 59 | 1.960 | 1.040 | 9.4 | 1.1758 | 0.0000 | SURCHARGED |
| 15 minute winter | SW05 | 6 | 2.410 | 0.060 | 5.0 | 0.0170 | 0.0000 | OK |
| 60 minute summer | HW01 | 18 | 2.159 | 0.059 | 5.0 | 0.0000 | 0.0000 | OK |

| Link Event (Upstream Depth) | US Node | Link | DS Node | Outflow (l/s) | Velocity (m/s) | Flow/Cap | Link Vol (m³) | Discharge Vol (m³) |
|---|---|---|---|---|---|---|---|---|
| 15 minute winter | SW01 | 1.000 | SW02 | 23.4 | 1.332 | 1.604 | 0.6074 | |
| 60 minute winter | SW02 | 1.001 | SW03 - TANK | 26.7 | 0.854 | 0.661 | 0.2616 | |
| 60 minute winter | SW03 - TANK | 1.002 | SW04 - PUMP | 6.2 | 0.668 | 0.154 | 0.6860 | |
| 60 minute winter | SW04 - PUMP | Pump | SW05 | 5.0 | | | | |
| 15 minute winter | SW05 | 1.004 | HW01 | 5.0 | 0.766 | 0.333 | 0.2275 | 36.3 |

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## FSR Data 1:100 Year + CC Maximum Water Level Graphic





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