Foul and Surface Water Management Strategy

Elite

Hornash Lane

Shadoxhurst

TN26 1HU

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CONTENTS

1. Background and Introduction

This Foul and Surface Water Management Strategy accompanies a planning application submitted to Ashford Borough Council. The planning application is for residential development at Elite, Hornash Lane, Shadoxhurst, TN26 1HU.

2. Development Location and Description

Development Location

The site is located to the south of Hornash Lane, Shadoxhurst, Figure 1. It is a brownfield site that used to be used for car sales and agriculture and covers 0.96ha.

Figure 1. Site location plan.

Development Proposals

An outline planning application is being made for the demolition of existing commercial and agricultural buildings and the construction of seven detached dwellings, Figure 2.

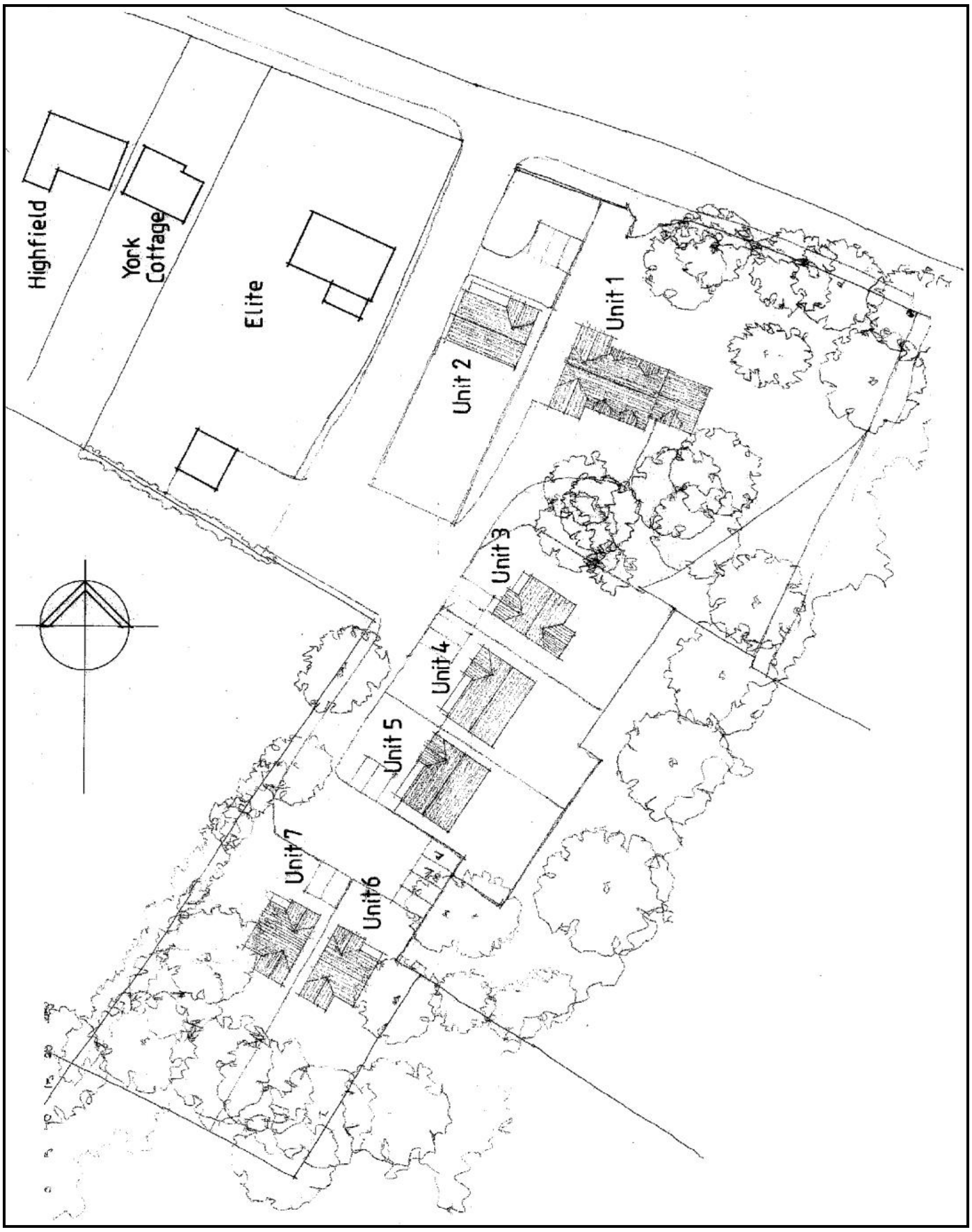


Figure 2. Proposed development.

3. Policy Background

The management of surface water across the development has to comply with the National Planning Policy Framework and local policy documents adopted by Ashford Borough Council.

The National Planning Policy Framework

The National Planning Policy Framework (NPPF) makes specific reference the need to avoid inappropriate development in areas at risk from flooding. In particular paragraph 99 of the NPPF compels Local Plans to:

"…take account of climate change over the longer term… When new development is brought forward in areas which are vulnerable, care should be taken to ensure that risks can be managed through suitable adaptation measures…"

Furthermore, paragraph 100 of the NPPF directs that:

"…inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere."

The management of surface water across the development has to comply with a number of local policy documents adopted by Ashford Borough Council.

Ashford Borough Council Core Strategy

Policy CS20 of the Core Strategy, adopted by Ashford in 2008, covers sustainable drainage.

POLICY CS20: Sustainable Drainage

All development should include appropriate sustainable drainage systems (SUDS) for the disposal of surface water, in order to avoid any increase in flood risk or adverse impact on water quality.

For greenfield developments in that part of the Ashford Growth Area that drains to the River Stour, SUDS features shall be required so as to achieve a reduction in the pre-development runoff rate. On all other sites in the Borough, including those in the south-western part of the Growth Area that drains to the River Beult, developments should aim to achieve a reduction from the existing runoff rate but must at least, result in no net additional increase in runoff rates.

SUDS features should normally be provided on-site. In the Ashford Growth Area if this cannot be achieved, then more strategic forms of SUDS may be appropriate. In such circumstances, developers will need to contribute towards the costs of provision via Section 106 Agreements or the strategic tariff. In all cases, applicants will need to demonstrate that acceptable management arrangements are funded and in place so that these areas are well maintained in future.

SUDS should be sensitively designed and located to promote improved bio-diversity, an enhanced landscape and good quality spaces that improve public amenities in the area.

Sustainable Drainage SPD

Ashford Borough Council adopted its Sustainable Drainage Supplementary Planning Document (SPD) in October 2010. The main purpose of the SPD is to provide guidance on the measures and opportunities available to planners and developers to integrate sustainable surface water management into their development. The document specifically provides guidance for those developments required to comply with Policy CS20.

The key objectives of the SPD are:

- *To ensure all new developments are designed to reduce the risk of flooding, and maximise environmental gain, such as: water quality, water resources, biodiversity, landscape and recreational open space.*
- *To ensure that all new developments are designed to mitigate and adapt to the effects of climate change.*
- *To provide guidance to developers on what will be expected to deliver the Core Strategy Policy CS20 standards, and the information that is required to be submitted with applications.*

The SPD sets out the runoff standards applied to different parts of the Borough. The standards applicable to brownfield sites outside identified growth areas are shown in Table 1.

Site	**Acceptable runoff rate**
Previously developed	'Best endeavours' to achieve 6 l/s/ha. Failing that, aim to achieve a reduction from the existing run-off rate for the site (where this can be established); As an absolute minimum, must not lead to a net increase in run-off rate above the existing rate for the site (where this can be established) or 10.26 l/s/ha (where the existing rate cannot be established).

Table 1. SPD runoff requirements.

The SPD identifies the most appropriate SuDS (Sustainable Urban Drainage Systems) for the Borough as:

- Green roofs
- Water butts
- Swales
- Wet ponds
- Detention basins

4. Site Characteristics

Topographical Survey - Contours have been generated from Lidar data, Figure 3. The site is relatively flat at a level of 44mAOD (Above Ordnance Datum). There is a slight fall from south to north from 44.5mAOD to 43.5mAOD, at an average gradient of approximately 1 in 150.

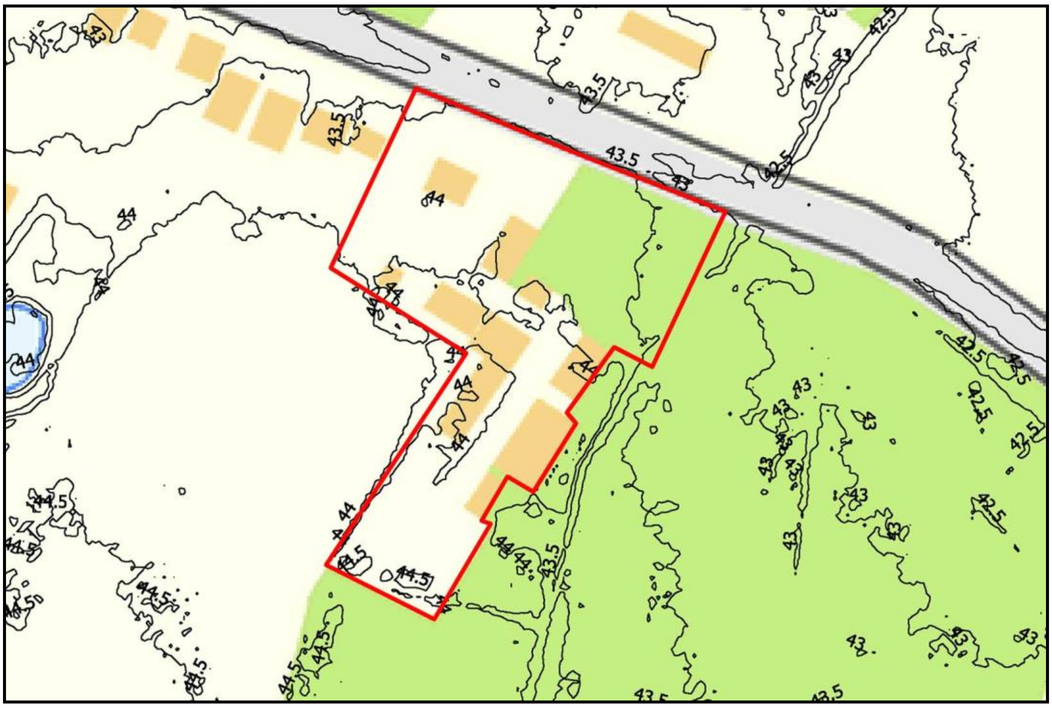


Figure 3. Local topography.

Geology and Soils - The bedrock geology consists of the Weald Clay Formation, mudstone. There are no superficial deposits recorded at the site. Soils are classified as slowly permeable seasonally wet loamy and clayey soils with impeded drainage, draining to a stream network.

Groundwater - The site lies outside any groundwater source protection zones. The bedrock is classed as unproductive strata and the site lies outside any defined groundwater vulnerability zones.

Records of boreholes sunk in the vicinity of the site indicate that groundwater level is at approximately 33mAOD, 11m below ground level at the site.

Infiltration Rates - Soakage testing has not been carried out at the site. The Weald Clay bedrock, soils characterised as having impeded drainage and the presence of ponds and watercourses indicate that infiltration rates are likely to be low and that a surface water drainage strategy based on a controlled discharge from the site is the most appropriate.

Existing Surface Water Drainage Patterns - The catchment characteristics for the site have been obtained from the Flood Estimation Handbook (FEH) Web Service. The site is part of a wider catchment that drains to the west to an existing stream network, Figure 4.

The FEH catchment descriptors are shown in Appendix A. These have been used for calculating the size of surface water drainage structures.

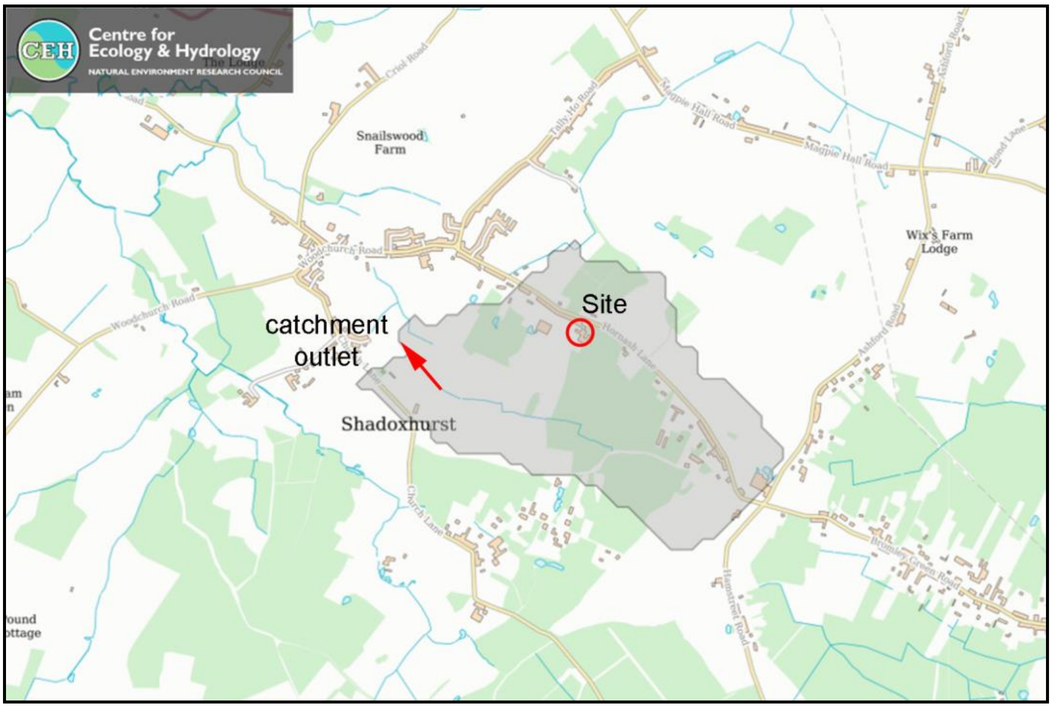


Figure 4. Local drainage catchment. (© Flood Estimation Handbook)

Whilst the catchment as a whole drains to the west the site initially drains to the north towards Hornash Lane, Figure 5. There is a shallow ditch running along the southern side of Hornash Lane, Figure 6.

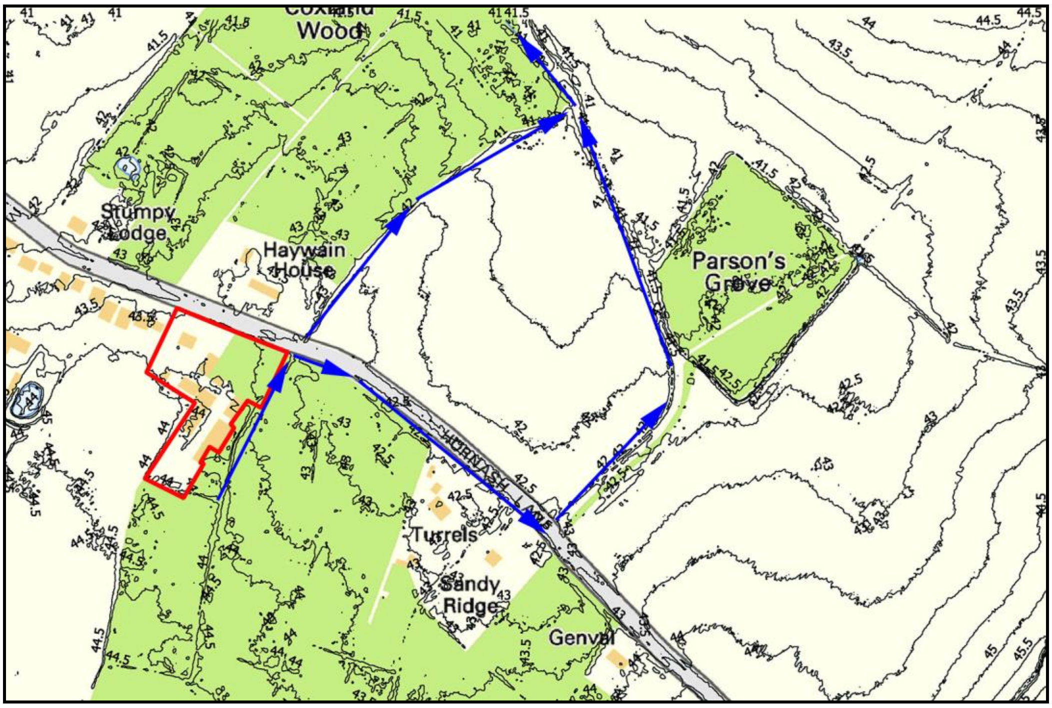


Figure 5. Local drainage paths.

Figure 6. Shallow ditch running along Hornash Lane.

The British Geological Survey hydrogeology map shows the site lies over rocks with essentially no groundwater.

Sewer Record - The site is not served by public sewers. The nearest public foul sewer is 480m to the west of the site, Figure 7.

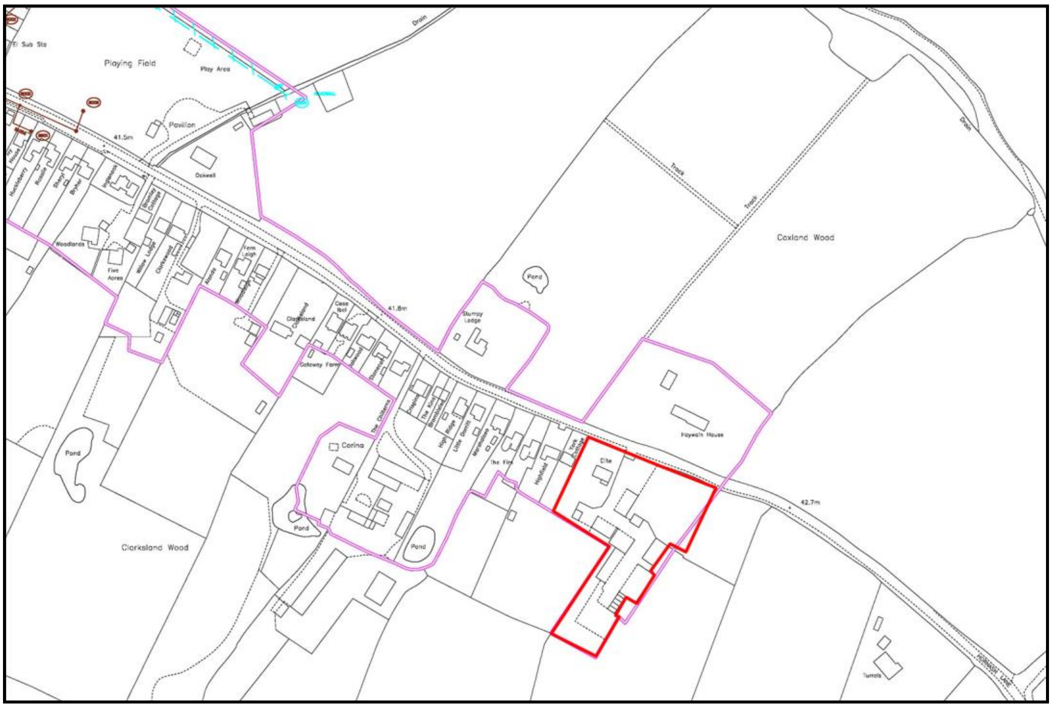


Figure 7. Sewer record. (© Southern Water)

Existing Site - The site is a brownfield site. 3,770m^2 of the existing site is covered with impermeable materials consisting of 1,530m^2 of roof and 2,240m^2 of paving, Figure 8.

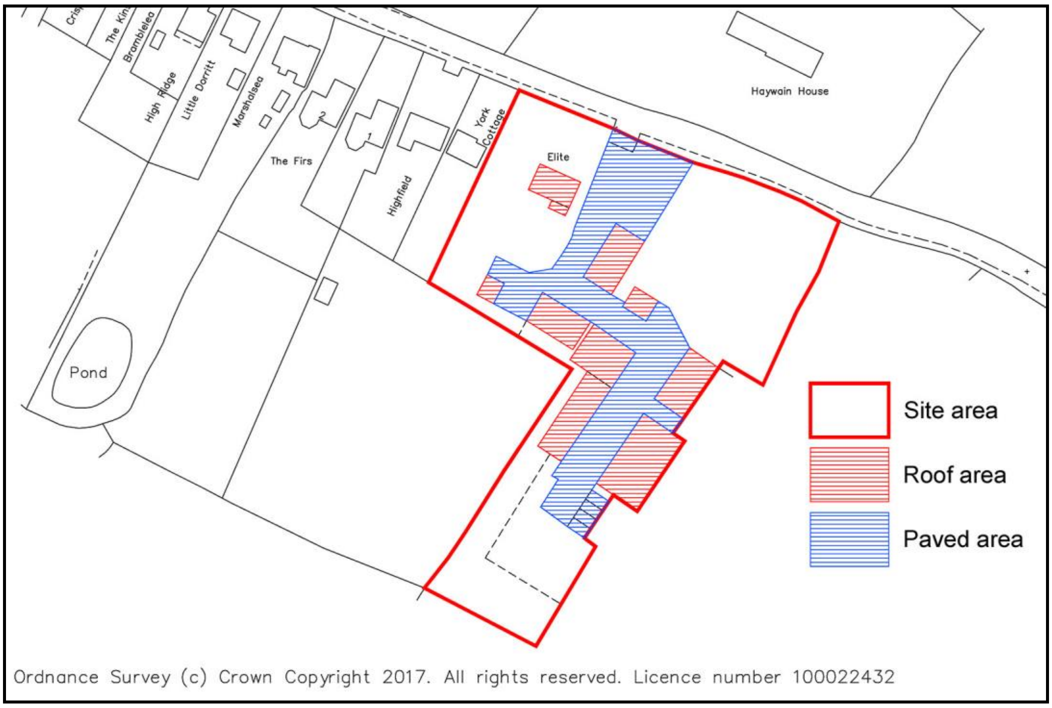


Figure 8. Existing impermeable areas.

The peak rate of runoff and volume of runoff for the critical storm duration for the pre-development site, is shown in Table 2.

Storm Return Period (years)	**Peak Runoff (Q l/s)**	**Volume of Runoff 360 minute duration storm (m^3)**
1	30	70
30	98	177
100	149	247
100 + 20%	179	296
100 + 40%	209	

Table 2. Peak rate of runoff and volume of runoff from the existing site.

Greenfield runoff - The peak greenfield runoff rate for the critical storm duration has been calculated using the IH124 method from the greenfield runoff rate estimation tool published online by HR Wallingford at uksuds.com, Table 3.

Return Period	Runoff Rate Q l/s	
	per ha.	Site (0.96 ha)
QBar	5.0	4.8
1	4.2	4.0
30	11.4	10.9
100	15.8	15.2

Table 3. Greenfield runoff rate for the site.

5. Flood Risk Assessment

Fluvial Flood Risk - The NPPF states that inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk. Local Plans should apply a sequential, risk-based approach to the location of development to avoid where possible flood risk to people and property and manage any residual risk, taking account of the impacts of climate change by applying the Sequential Test.

Flood zones are the starting point for the Sequential Test. These zones are a broad assessment of flood risk as given below.

Zone 1 Low Probability - land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).

Zone 2 Medium Probability - land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) or between 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% - 0.1%) in any year.

Zone 3a High Probability - land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.

Zone 3b The Functional Floodplain - land where water has to flow or be stored in times of flood, land which would flood with an annual probability of 1 in 20 (5%) of greater in any year or designed to flood in an extreme flood.

The site lies within flood zone 1, Figure 9 and therefore residential development is appropriate.

Figure 9. The Government's Flood Map for Planning.

Surface Water - The Government has published surface water flooding maps. These show that the majority of the site is at very low risk of surface water flooding with small areas at low to high risk, Figure 10. The definition of each category is given below:

Very Low (white) a chance of flooding of less than 1 in 1000 (0.1%)
Low (pale blue) a chance of flooding of between 1 in 1000 (0.1%) and 1 in 100 (1%)
Medium (mid blue) a chance of flooding of between 1 in 100 (1%) and 1 in 30 (3.3%)
High (dark blue) a chance of flooding of greater than 1 in 30 (3.3%)

The depth of water associated with the low, medium and high risk events is shown in Figures 11 to 13. The definition of each colour is given below:

Below 300mm (light blue)
300-900mm (medium blue)
Over 900mm (dark blue)

The surface water flood maps also give an indication of velocity and direction of flow, Figure 14. The definition of each colour is given below:

Over 0.25 m/s (dark blue)
Less than 0.25 m/s (light blue)

The arrows indicate the direction of flow.

Figure 10. Surface water flood map with the site edged red.

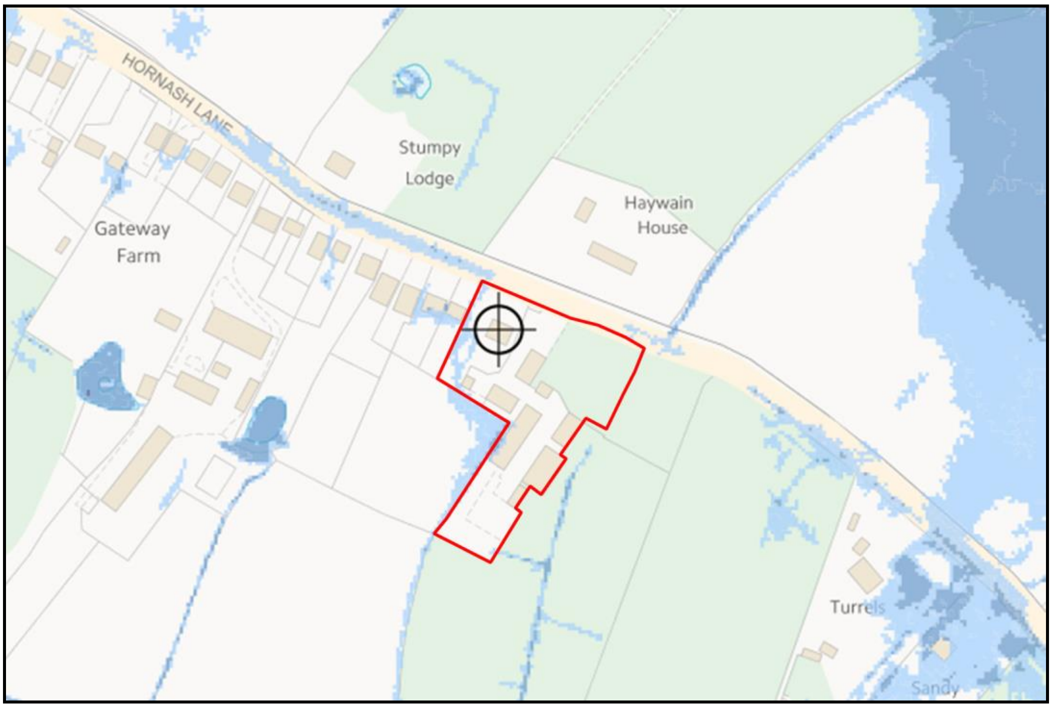


Figure 11. Surface water flood depth map for the low risk flood event with the site edged red.

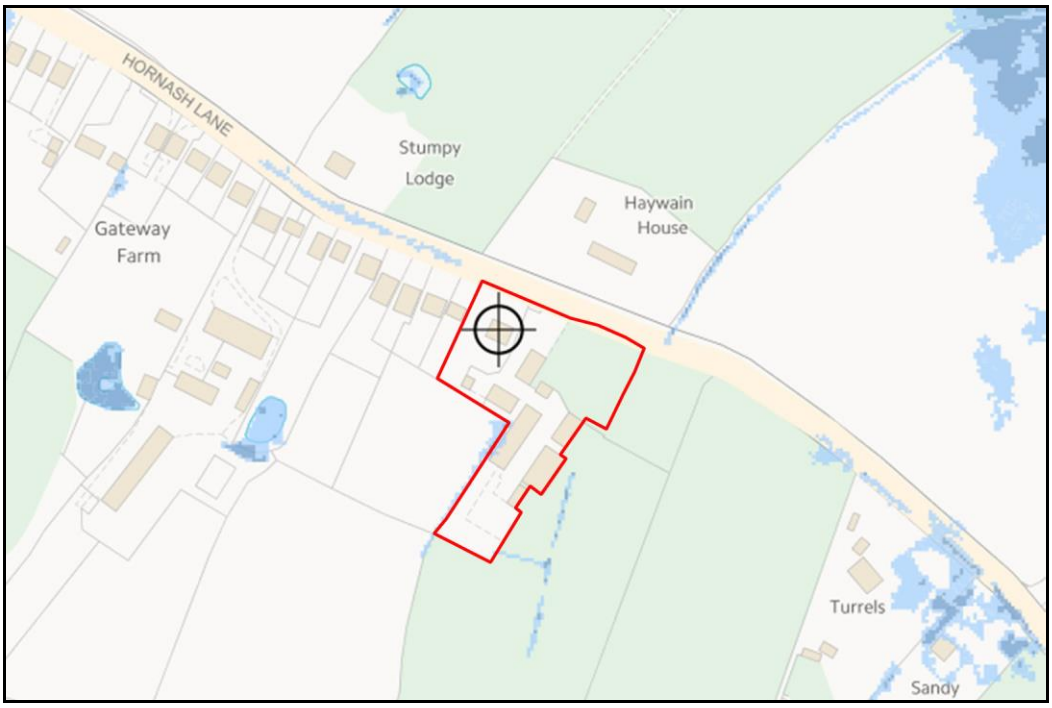


Figure 12. Surface water flood depth map for the medium risk flood event with the site edged red.

Figure 13. Surface water flood depth map for the high risk flood event with the site edged red.

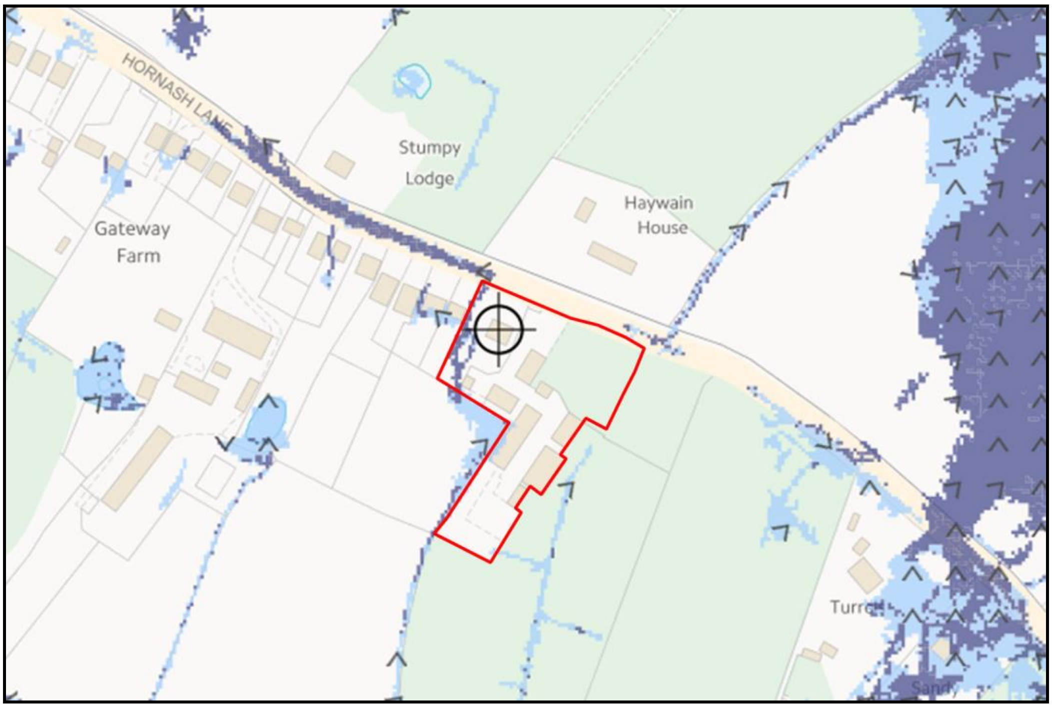


Figure 14. Surface water flood velocity map for the low risk flood event with the site edged red.

A small section of the site, along the western boundary, is at risk from surface water flooding to a depth of below 300mm. The illustrative layout places the proposed dwellings on the eastern boundary away from the area at risk of flooding. The development is considered to be at low risk from surface water flooding.

Groundwater - Water levels below the ground rise during wet winter months, and fall again in the summer as water flows out into rivers. In very wet winters, rising water levels may lead to the flooding of normally dry land, as well as reactivating flow in 'bournes' (streams that only flow for part of the year). Where land that is prone to groundwater flooding has been built on, the effect of a flood can be very costly, and because groundwater responds slowly compared with rivers, floods can last for weeks or months.

Borehole records indicate that ground water is approximately 11m below ground level at the site. Any groundwater flooding will emerge at lower levels and flow away from the site. The risk of groundwater flooding at the site is considered to be low.

Infrastructure - The SWMP identifies localised flooding incidents reported in Ashford Borough, Figure 15. There are no flooding incidents recorded at the site. There is a surface water flooding incident recorded east of the site on Hornash Lane. There are no public sewers or reservoirs in the vicinity of the site. The risk of infrastructure flooding at the site is considered to be low.

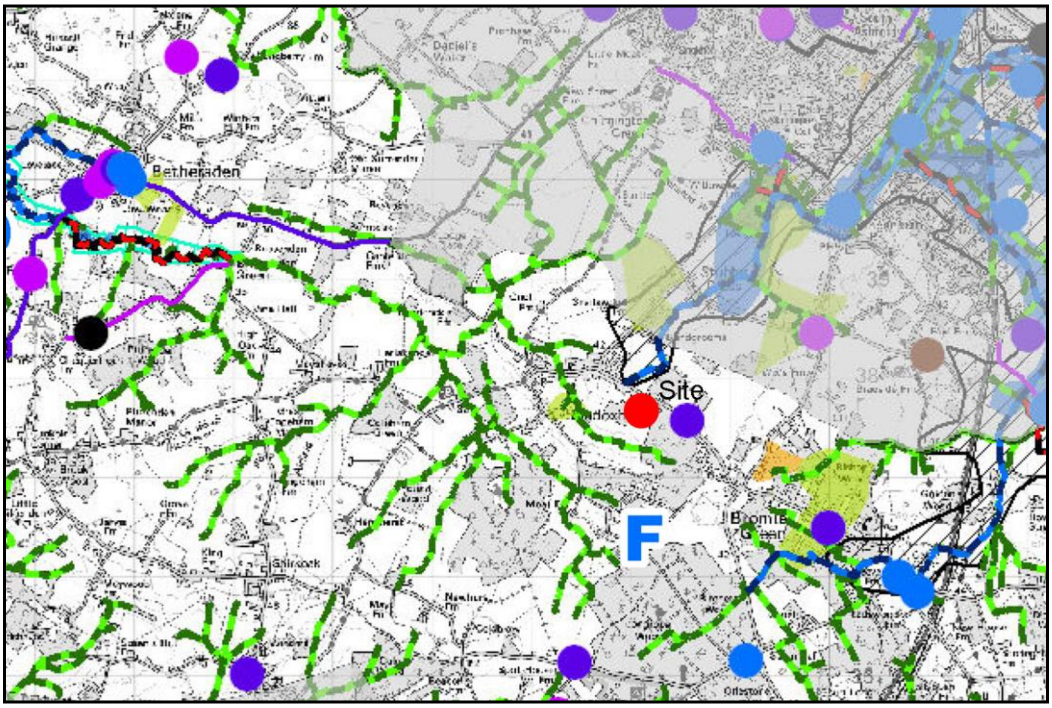


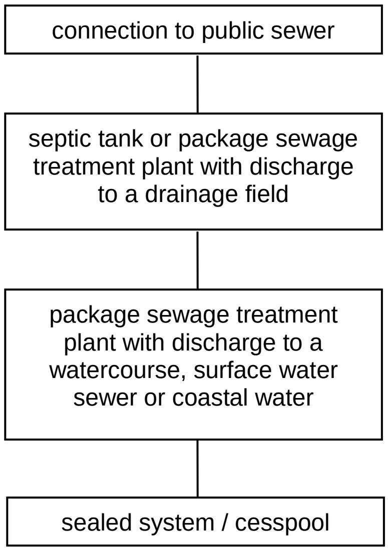
Figure 15. Historic flooding incidents. (© Kent County Council).

The site lies within flood zone 1 and is at low risk of flooding from all other sources.

6. Foul Water Management Strategy

Choosing the right sewage treatment and disposal method is essential for the protection of public health and the environment and ensures effective long term performance of the system. Sewage treatment and disposal can be provided by a sewerage undertaker or by a private treatment system.

There is therefore a hierarchy of methods for disposing of foul sewage.



Connection to Public Sewer

The nearest public sewer is 480m east of the site in Hornash Lane. It would be possible to requisition a public sewer connection for the site through s98 of the Water Industry Act 1991. The cost of providing the sewer would be payable by the developer.

The environmental permit for discharging up to 15m^3 a day of treated effluent into ground or up to 20m^3 a day to surface water states that:

Before you submit the application, you must explore the possibility of connecting to the foul sewer, and send us evidence that you have approached the sewerage undertaker, including their formal response regarding connection. You must also show the extra cost of connecting to a sewer compared to the treatment system you propose, and details of any physical obstacles for example roads, railways, rivers or canals.

We will only agree to the use of private treatment systems within sewered areas if you can demonstrate that:

- *the additional cost of connecting to the foul sewer would be unreasonable;*
- *connection is not practically feasible; or*
- *the proposed private treatment system can be shown to significantly benefit the environment.*

For discharges from domestic properties the cut-off distance for undertaking this work is 30m per dwelling. For a development of seven dwellings connection to the public sewer should be considered if the sewer is within 210m of the site boundary.

Under the environmental permitting rules connection to the public sewerage system does not need to be explored.

Septic Tank or Package Sewage Treatment Plant with Discharge to a Drainage Field

Infiltration rates are likely to be low due to the Weald Clay geology. Low infiltration rates may discount the use of a drainage field. Shallow percolation tests should be undertaken to verify this at detailed design stage, as discharge to ground is preferable to discharge to a watercourse.

Septic Tank or Package Sewage Treatment Plant with Discharge to a Watercourse

Discharge of treated effluent to a watercourse is likely to be the most appropriate solution to providing foul drainage.

The Planning Practice Guidance that accompanies the NPPF states:

Where a connection to a public sewage treatment plant is not feasible (in terms of cost and/or practicality) a package sewage treatment plant can be considered. This could either be adopted in due course by the sewerage company or owned and operated under a new appointment or variation. The package sewage treatment plant should offer treatment so that the final discharge from it meets the standards set by the Environment Agency.

A proposal for a package sewage treatment plant and infrastructure should set out clearly the responsibility and means of operation and management to ensure that the permit is not likely to be infringed in the life of the plant. There may also be effects on amenity and traffic to be considered because of the need for sludge to be removed by tankers.

Cesspool

If disposal of treated effluent to ground or a watercourse is not feasible, cesspools could be installed. Cesspools need to be sited at least 7m from any habitable parts of buildings and have a capacity of at least 18,000 litres below the level of the inlet for two users, increased by 6,800 litres for each additional user. Cesspools should be sited within 30m of a vehicle access to allow emptying. The layout is illustrative and would need to be amended to meet the requirements for installing cesspools. There is sufficient space on site to accommodate the proposed number of properties and associated cesspools, but this should only be considered as a last resort in terms of foul drainage provision.

Foul Sewage Flows

Individual package treatment plants are proposed for each of the proposed dwellings. The residents will be responsible for the management of their own plant.

The discharge would need to be pumped to an outlet to the shallow ditch running along the southern side of Hornash Lane. If a drainage field is not feasible a length of perforated pipe should be considered before discharging to the ditch.

The volume of effluent created by the development has been calculated using the British Water Code of Practice, Flows and Loads - 4, based on an assumed unit mix, and is shown in Table 4.

Effluent Volume Calculation **Carried out in accordance with British Water Code of Practice Flows and Loads - 4**			
Number of Properties		People/property	People (P)
3 bed	3	5	15
4 bed	3	6	18
5 bed	1	7	7
Total	7		40
Adjusted P	0.8		32
Effluent Volume	150	l/person/day	**4,800 litres**
BOD	60	g/person/day	**1,920 grams**
Ammonia	8	g/person/day	**256 grams**

Table 4. Effluent volume calculations.

An environmental permit is required for discharges to ground of greater than $2m^3$ per day or discharges to surface water of greater than $5m^3$ per day.

Part H of the Building Regulations details the requirements for sewage treatment. This includes advice on the design and siting of septic tanks/treatment plants. Septic tank/treatment plants should be sited 7m away from habitable parts of buildings. There is sufficient space on each plot to achieve this.

7. Climate Change

The global climate is constantly changing, but it is widely recognised that we are now entering a period of accelerating change. Climate change will result in an increase in sea levels, rainfall intensity and river flows.

The impact of climate change will be to reduce the standard of protection provided by current defences with time and increase the risk of flooding in undefended areas. The Planning Practice Guidance to the National Planning Policy Framework (NPPF) recommends using the following range of increases in peak rainfall intensity due to climate change to 2115 in any assessment:

Upper End	+40%
Central	+20%

The range is based on percentiles. The 50th percentile is the point at which half of the possible scenarios for peak rainfall intensity fall below it and half fall above it. The Central allowance is based on the 50th percentile whilst the Upper End is based on the 90th percentile.

The Central allowance is 20% and scientific evidence suggests that it is just as likely that the increase in rainfall intensity will be more than 20% as less than 20%. The Upper End allowance is 40% and current scientific evidence suggests that there is a 90% chance that peak rainfall intensity will increase by less than this value, but there remains a 10% chance that peak rainfall intensity will increase by more.

The Planning Practice Guidance suggests that flood risk assessments and strategic flood risk assessments should assess both the Central and Upper End allowances to understand the range of impact.

The surface water calculations include an increase of 20% in peak rainfall intensity for the sizing of structures. The structures are then tested with a 40% increase in peak rainfall intensity. If this results in any flooding, the extent of this flooding and its impact on the development is then considered.

8. Detailed Development Proposals

The proposed development consists of seven new dwellings. Analysis of the layout indicates that potential impermeable surfaces will cover approximately 2,910m^2 consisting of 950m^2 of roof and 1,960m^2 of paving, Figure 16. The impermeable area reduces as a result of the development by 860m^2.

Figure 16. Impermeable development areas.

The peak rate of runoff and volume of runoff for the critical storm duration for the existing and proposed site, is shown in Table 5.

Storm Return Period (years)	Peak Runoff (Q l/s)		Volume of Runoff 360 minute duration storm (m^3)	
	Existing (3,770m^2)	**Proposed (2,910m^2)**	**Existing (3,770m^2)**	**Proposed (2,910m^2)**
1	30	24	70	54
30	98	58	177	137
100	149	115	247	190
100 + 20%	179	138	296	229
100 + 40%	209	161		

Table 5. Peak rate of runoff and volume of runoff from the existing and proposed site.

The proposals represent a reduction in peak runoff and volume of runoff from the site of approximately 23%.

9. Surface Water Management Strategy

Objectives

The aim of the surface water management strategy is to provide storage to limit peak runoff from the site to as close as possible to greenfield runoff rates. Discharge will be to the existing watercourse. This is in line with the Defra and DCLG Non-Statutory Technical Standards which state:

Peak flow control

S3 *For developments which were previously developed, the peak runoff rate from the development to any drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event must be as close as reasonably practicable to the greenfield runoff rate from the development for the same rainfall event, but should never exceed the rate of discharge from the development prior to redevelopment for that event.*

Drainage Elements

The appropriateness of different SuDS is considered in Table 6.

SuDS Type	Appropriate to site	Comment
Permeable paving (Infiltration)	No	Weald Clay is unlikely to support infiltration
Permeable paving (Attenuation)	Yes	Permeable paved areas can be used to attenuate runoff from the development
Green roof	No	Traditional pitched roofs proposed
Filter strips	No	Insufficient space
Swales	No	Insufficient space
Infiltration devices	No	Weald Clay is unlikely to support infiltration
Filter drains	No	Weald Clay is unlikely to support infiltration
Infiltration basin	No	Weald Clay is unlikely to support infiltration
Detention pond	Yes	There is sufficient space for a detention pond
Wet pond	Yes	There is sufficient space for a wet pond
On/offline storage	Yes	If additional attenuation storage is required

Table 6. SuDS suitability for development.

The following drainage elements are identified as being appropriate to the site;

- water butts,
- permeable paving (attenuation),
- detention ponds/wet ponds,
- on/offline storage.

Water Butts

The expectation is that all individual properties will have water butts. Water butts act as source control devices intercepting rainfall early in the management train. It is recognised that water butts may be full during critical rainfall conditions and not provide storage. This surface water management strategy does not include any potential storage available within water butts.

Permeable Paving (Attenuation)

Permeable paving allows water to infiltrate through the surface into a coarse graded sub-base which can store runoff. The base of the pavement is assumed to be lined as the preliminary site investigation indicates that disposal of surface water by infiltration is not feasible. For the sub-base storage to operate effectively the system requires flow controls. These are generally small orifice plates in a control chamber and can be very small, minimum 20mm, because the risk of blockage is low since the water has been filtered through the sub-base. The frequency of runoff from permeable paving is significantly reduced when compared to gully and pipe systems draining impermeable surfaces. Permeable paving acts as interception storage and runoff typically does not occur from permeable paving for rainfall events up to 5mm even without infiltration, due to evaporation.

Detention Ponds

Detention ponds are depressions that are usually dry but can accommodate water during extreme rainfall events. They provide temporary storage for storm water runoff.

Wet Ponds

Wet ponds are basins that have a permanent pool of water. They provide temporary storage for additional storm water runoff above the permanent water level.

On/offline storage

Pipes will be used for conveyance and connections between SuDS elements.

Surface Water Management Strategy

The surface water management strategy is to dispose of surface water runoff to the shallow ditch that runs along the southern side of Hornash Lane. As the ditch is shallow and the site slopes gently from south to north, shallow surface water drainage structures are required.

Kent County Council under its SuDS Policy 3: Mimic Natural Flows and Drainage Flow Paths states that: *Drainage schemes should be designed to match greenfield discharge rates, volumes and follow natural drainage routes as far as possible.*

KCC's Drainage and Planning Policy Statement states:

Low permeability soils - areas underlain by largely impermeable soils (e.g. Weald Clay and London Clay) will require staged discharge to mimic existing greenfield runoff rates from corresponding storm events, with long-term storage provided for any additional volume above the pre-development volume.

It is expected that post development runoff rates will be returned to greenfield rates and runoff will be attenuated on site up to the 1 in 100 year + climate change event.

It also states that:

Small sites are associated with low greenfield runoff rates. Given advances in technology and design of flow controls, it is now possible to achieve controlled flow rates of 2 l/s. This should be considered the minimum rate to be set for small sites, unless agreed with Kent County Council.

For a developed impermeable area of 2,910m^2 the greenfield runoff rate is 1.2 l/s under the 1 year rainfall event, 3.3 l/s under the 1 in 30 rainfall event and 4.6 l/s under the 1 in 100 year rainfall event. A lower limiting discharge of 2 l/s is proposed in accordance with KCC's policy statement.

Permeable paving will be provided for all paving with roof water discharging to the paving via diffuser boxes. An overview of the surface water drainage layout is shown in Figure 17. The paved area covers 1,960m^2 with roofs covering 950m^2. 80% of the paving is assumed to be permeable, 1,600m^2.

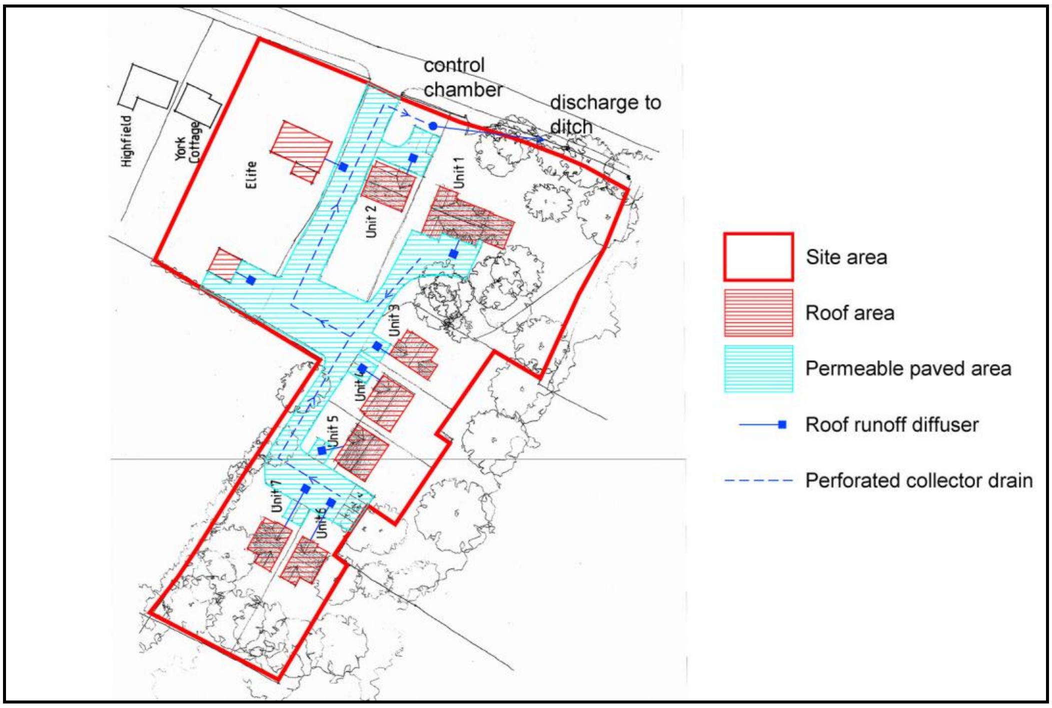


Figure 18. ***Schematic surface water drainage layout****.*

The design parameters for the permeable paving are shown in Table 7. The structures have been analysed using MicroDrainage Source Control published by XP Solutions. The analysis is shown in Appendix B.

Parameter	Permeable Paving			
Rainfall return period	1 year	30 year	100 year + 20%	100 year + 40%
Permeable paving area	1,600m^2	1,600m^2	1,600m^2	1,600m^2
Permeable paving depth	400mm	400mm	400mm	400mm
Contributing area (paved)	1,960m^2	1,960m^2	1,960m^2	1,960m^2
Contributing area (roof)	950m^2	950m^2	950m^2	950m^2
Greenfield discharge	1.2 l/s	3.3 l/s	4.6 //s	4.6 //s
Maximum discharge	2.0 l/s	3.3 l/s	4.6 l/s	5.1 l/s
Orifice control diameter	38mm	38mm	38mm	38mm
Orifice overflow diameter	47mm	47mm	47mm	47mm
Maximum water depth	46mm	176mm	327mm	394mm
Half drain time	97 minutes	334 minutes	556 minutes	645 minutes

Table 7. Design parameters for the permeable paving.

The peak discharge from the site under the 1 in 100 year + 40% allowance for climate change rainfall event is higher than the 1 in 100 year greenfield runoff but the paving does not flood and the discharge is controlled to below existing levels.

A summary of the surface water management strategy is attached at Appendix C.

The above demonstrates that the proposed surface water management strategy reduces the peak rate of runoff from the site significantly and to below greenfield runoff rates for the 100 year storm with an allowance of 20% for climate change.

10. Water Quality

The SuDS Manual gives the following as standards of good practice for water quality:

Water quality standard 1: Prevent runoff from the site to receiving surface waters for the majority of small rainfall events.

No runoff should be discharged from the site to receiving surface waters or sewers for the majority of small (eg < 5 mm) rainfall events. This is termed Interception.

Water quality standard 2: Treat runoff to prevent negative impacts on the receiving water quality.

Runoff should be adequately treated to protect the receiving water body from:

1. Short-term acute pollution that may result from accidental spills or temporary high pollution loadings within the catchment area.
2. Long-term chronic pollution from the spectrum of runoff pollutant sources within the urban environment.

Water Quality Standard 1 - Interception

The permeable paving will act as interception storage. Although the analysis above assumes that all surface water runoff is discharged from the site, in reality runoff from smaller events will be retained within the permeable paving, maximising infiltration and evapo-transpiration. Runoff from rainfall events up to 5mm is unlikely to discharge from the site. The proposed strategy therefore meets the interception standard.

Water Quality Standard 2 - Treatment

The extent of treatment required depends on the land use, the level of pollution prevention in the catchment and for groundwater the natural protection afforded by underlying soil layers. High hazard sites will have a higher potential pollution load and higher potential maximum pollution concentrations. They therefore tend to require more treatment than low hazard sites in order to deliver discharges of an acceptable quality.

The SuDS Manual sets out minimum water quality management requirements for discharges to receiving surface waters and groundwater for various land use types, Table 8. The site consists of two land use types:

1. Roofs to houses and garages classed as *residential roofs*, very low pollution hazard.
2. Drives and the access road classed as *property driveways/low traffic roads*, low pollution hazard.

<table>
<tr><th rowspan="2">Land use</th><th rowspan="2">Pollution hazard level</th><th colspan="2">Requirements for discharge to:</th></tr>
<tr><th>surface waters</th><th>groundwater</th></tr>
<tr><td>Residential roofs</td><td>Very low</td><td colspan="2">Removal of gross solids and sediments only</td></tr>
<tr><td>Individual property driveways, roofs (excluding residential), residential car parks, low traffic roads (eg cul de sacs, home zones, general access roads), non-residential car parking with infrequent change (eg schools, offices)</td><td>Low</td><td colspan="2">Simple index approach
Note: extra measures may be required for discharges to protected resources</td></tr>
<tr><td rowspan="2">Commercial yard and delivery areas, non-residential car parking with frequent change (eg hospitals, retail), all roads except low traffic roads and trunk roads/motorways</td><td rowspan="2">Medium</td><td colspan="2">Simple index approach
Note: extra measures may be required for discharges to protected resources</td></tr>
<tr><td></td><td>In England and Wales, Risk Screening must be undertaken first to determine whether consultation with the environmental regulator is required.</td></tr>
<tr><td>Trunk roads and motorways</td><td>High</td><td colspan="2">Follow the guidance and risk assessment process set out in HA (2009)</td></tr>
<tr><td>Sites with heavy pollution (eg haulage yards , lorry parks, highly frequented lorry approaches to industrial estates, waste sites),sites where chemicals and fuels are to be delivered, handled, stored, used or manufactured, industrial sites</td><td>High</td><td colspan="2">Discharges may require an environmental licence or permit. Obtain pre-permitting advice from the environmental regulator. Risk assessment is likely to be required.</td></tr>
<tr><td colspan="4">Note 1. Filter drains can remove coarse sediments, but their use for this purpose will have significant implications with respect to maintenance requirements, and this should be taken into account in the design and Maintenance Plan.
Note 2. Ponds and wetlands can remove coarse sediments, but their use for this purpose will have significant implications with respect to the maintenance requirements and amenity value of the system. Sediment should normally be removed upstream, unless they are specifically designed to retain sediment in a separate part of the component, where it cannot easily migrate to the main body of water.
Note 3. Where a wetland is not specifically designed to provide significantly enhanced treatment, it should be considered as having the same mitigation indices as a pond.</td></tr>
</table>

Table 8. Minimum water quality management requirements.

For each land use type a simple index approach is appropriate which involves the following steps:

1. Allocate suitable pollution hazard indices for the proposed land use, Table 9.
2. Select SuDS with a total pollution mitigation index that equals or exceeds the pollution hazard index, Table 10.
3. Where the discharge is to protected surface waters or groundwater, consider the need for a more precautionary approach.

Land Use	Pollution hazard level	Total suspended solids	Metals	Hydro-carbons
Residential Roofs	Very low	0.2	0.2	0.05
Other roofs (commercial/industrial)	Low	0.3	0.2[1]	0.05
Individual property driveways, residential car parks, low traffic roads and non-residential car parking with infrequent change (eg schools, offices) <300 traffic movements/day	Low	0.5	0.4	0.4
Commercial yard and delivery areas, non-residential car parking with frequent change (eg hospitals, retail), all roads except low traffic roads and trunk roads/motorways	Medium	0.7	0.6	0.7
Sites with heavy pollution (eg haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites, sites where chemicals and fuels are to be delivered, handled, stored, used or manufactured, industrial sites, trunk roads and motorways[2]	High	0.8[3]	0.8[3]	0.9[3]
Note 1. Up to 0.8 where there is potential for metals to leach from the roof. Note 2. Motorways and trunk roads should follow the guidance and risk assessment process set out in Highways Agency (2009) Note 3. These should only be used if considered appropriate as part of a detailed risk assessment.				

Table 9. Pollution hazard indices for different land use classifications.

To deliver adequate treatment, the selected SuDS components should have a total pollution mitigation index, for each contaminant type, that equals or exceeds the pollution hazard index, for each contaminant type. Where the mitigation index of an individual component is insufficient, two components, or more, in series will be required. A factor of 0.5 is used to account for the reduced performance of secondary or tertiary components.

Type of SuDS component	Total suspended solids	Metals	Hydro-carbons
Filter strip	0.4	0.4	0.5
Filter drain	0.4[1]	0.4	0.4
Swale	0.5	0.6	0.6
Bioretention system	0.8	0.8	0.8
Permeable pavement	0.7	0.6	0.7
Detention pond	0.5	0.5	0.5
Pond	0.7[2]	0.7	0.5
Wetland[3]	0.8[2]	0.8	0.8
Proprietary treatment system	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the 1in 1 year return period event, for inflow concentrations relevant to the contributing drainage area.		
Note 1. Filter drains can remove coarse sediments, but their use for this purpose will have significant implications with respect to maintenance requirements, and this should be taken into account in the design and Maintenance Plan. Note 2. Ponds and wetlands can remove coarse sediments, but their use for this purpose will have significant implications with respect to the maintenance requirements and amenity value of the system. Sediment should normally be removed upstream, unless they are specifically designed to retain sediment in a separate part of the component, where it cannot easily migrate to the main body of water. Note 3. Where a wetland is not specifically designed to provide significantly enhanced treatment, it should be considered as having the same mitigation indices as a pond.			

Table 10. Indicative SuDS mitigation indices for discharge to surface waters.

All runoff will pass through the permeable paving and the total pollution mitigation index will be equal or greater than the pollution hazard index for all pollutants, Table 11. All runoff from the site will therefore receive an appropriate level of water quality treatment.

Indices	Total suspended solids	Metals	Hydro-carbons
Residential roofs			
Maximum hazard index	0.2	0.2	0.05
SuDS mitigation index (permeable paving)	0.7	0.6	0.7
Appropriate treatment	✓	✓	✓
Access road/car parking areas			
Maximum hazard index	0.5	0.4	0.4
SuDS mitigation index (permeable paving)	0.7	0.6	0.7
Appropriate treatment	✓	✓	✓

Table 11. Pollution hazard indices and SuDS mitigation indices for the development.

11. Ashford Borough Council SuDS Checklist

Ashford Borough Council's Sustainable Drainage SPD includes a Sustainable Drainage Checklist. The checklist has been produced to help developers demonstrate compliance with Policy CS20 and is designed to be included with any surface water drainage assessment.

The checklist is reproduced below, Table 12.

SECTION 1 Site Details		
1	Planning Reference Number	Not available
2	Site Name	Elite, Hornash Lane
3	Location (NGR)	598296E 137746N
4	Total size of site	0.96ha
5	Developable area	2,910m^2
6	Current use	Brownfield
7	Catchment	Beult
8	Max allowable discharge rate	achieve a reduction from the existing run-off rate for the site
9	Max discharge	149 l/s
SECTION 2 Assessment of storage volume required		
10	Design life of development	Beyond 2085
11	Indicative storage volume	777 m^3/ha
12	Total indicative storage volume required	226m^3
SECTION 3 Assessment of storage to be provided		
13	Indicative storage to be provided	192m^3 (Analysis indicates that this is sufficient storage for the proposed development)
made up as follows:		

Storage Type	Volume (m^3)	Siltation/vegetation allowance (%)	Total (m^3)
Green roof		-	
Water butts		-	
Other rainwater harvesting		-	
Permeable paving	192	-	192
Soakaways/infiltration		-	

Filter strips		-	
Conveyance (swale/rill etc)		10	
Infiltration basin		10	
Wet ponds (retention basins)		20	
Detention basins/ponds		10	
Construction wetlands		20	
Underground systems including modular storage (not preferred)		10	
Other		-	
Total	192		192
Total indicative storage required	226	Total indicative storage provided	192

Table 12. Ashford Borough Council SuDS Checklist.

The proposed surface water management strategy provides sufficient storage to attenuate runoff from the development to at or below greenfield runoff rates for all rainfall events up to and including the 1 in 100 year plus climate change event.

12. Conclusion

This Foul and Surface Water Management Strategy accompanies a planning application submitted to Ashford Borough Council. The planning application is for residential development at Elite, Hornash Lane, Shadoxhurst, TN26 1HU.

The site is located to the south of Hornash Lane, Shadoxhurst. It is a brownfield site that used to be used for car sales and agriculture and covers 0.96ha.

An outline planning application is being made for the demolition of existing commercial and agricultural buildings and the construction of seven detached dwellings.

Foul Water

The nearest public sewer is 480m east of the site in Hornash Lane. It would be possible to requisition a public sewer connection for the site through s98 of the Water Industry Act 1991. The cost of providing the sewer would be payable by the developer.

Individual package treatment plants are proposed for each of the proposed dwellings. The residents will be responsible for the management of their own plant. Infiltration rates are likely to be low due to the Weald Clay geology. Low infiltration rates may discount the use of a drainage field. Shallow percolation tests should be undertaken to verify this at detailed design stage as discharge to ground is preferable to a discharge to a watercourse.

Discharge of treated effluent to a watercourse is likely to be the most appropriate solution to providing foul drainage. The discharge would need to be pumped to an outlet to the shallow ditch running along the southern side of Hornash Lane. If a drainage field is not feasible a length of perforated pipe should be considered before discharging to the ditch.

If disposal of treated effluent to ground or a watercourse is not feasible, cesspools could be installed. Cesspools need to be sited at least 7m from any habitable parts of buildings and have a capacity of at least 18,000 litres below the level of the inlet for two users, increased by 6,800 litres for each additional user. Cesspools should be sited within 30m of a vehicle access to allow emptying. The layout is illustrative and would need to be amended to meet the requirements for installing cesspools. There is sufficient space on site to accommodate the proposed number of properties and associated cesspools, but this should only be considered as a last resort in terms of foul drainage provision.

An environmental permit is required for discharges to ground of greater than $2m^3$ per day or discharges to surface water of greater than $5m^3$ per day.

Surface Water

The site is a brownfield site. 3,770m^2 of the existing site is covered with impermeable materials consisting of 1,530m^2 of roof and 2,240m^2 of paving. The proposed development consists of seven new dwellings. Analysis of the layout indicates that potential impermeable surfaces will cover approximately 2,910m^2 consisting of 950m^2 of roof and 1,960m^2 of paving. The impermeable area reduces as a result of the development by 860m^2.

The aim of the surface water management strategy is to provide storage to limit peak runoff from the site to as close as possible to greenfield runoff rates. The surface water management strategy is to dispose of surface water runoff to the shallow ditch that runs along the southern side of Hornash Lane. As the ditch is shallow and the site slopes gently from south to north, shallow surface water drainage structures are required. Permeable paving will be provided for all paving with roof water discharging to the paving via diffuser boxes. The paving will have a controlled outlet to the existing ditch.

The permeable paving can be designed to limit surface water runoff from the development to 2.0 l/s under the 1 year event and 4.6 l/s for the 1 in 100 year event plus 20% allowance for climate change. This is below greenfield runoff rate for the 100 year rainfall event and a significant improvement on the peak rate of runoff from the existing site.

The permeable paving will act as interception storage. Although the analysis above assumes that all surface water runoff is discharged from the site, in reality runoff from smaller events will be retained within the permeable paving, maximising infiltration and evapo-transpiration. Runoff from rainfall events up to 5mm is unlikely to discharge from the site. The proposed strategy therefore meets the interception water quality standard.

All runoff will pass through the permeable paving and the total pollution mitigation index will be equal or greater than the pollution hazard index for all pollutants. All runoff from the site will therefore receive an appropriate level of water quality treatment.

Appendix A - FEH Catchment Descriptors

VERSION	"FEH CD-ROM"	Version			
CATCHMENT	GB		597450	137700	TQ 97450 37700
CENTROID	GB		598312	137394	TQ 98312 37394
AREA	1.47				
ALTBAR	43				
ASPBAR	277				
ASPVAR	0.42				
BFIHOST	0.233				
DPLBAR	1.4				
DPSBAR	10.8				
FARL	1				
FPEXT	0.3231				
FPDBAR	1.481				
FPLOC	0.825				
LDP	2.54				
PROPWET	0.34				
RMED-1H	11.7				
RMED-1D	32.4				
RMED-2D	41.8				
SAAR	716				
SAAR4170	691				
SPRHOST	49.06				
URBCONC1990	-999999				
URBEXT1990	0.0043				
URBLOC1990	-999999				
URBCONC2000	0.686				
URBEXT2000	0.0299				
URBLOC2000	1.465				
C	-0.02265				
D1	0.33826				
D2	0.33968				
D3	0.31411				
E	0.31325				
F	2.4671				
C(1 km)	-0.023				
D1(1 km)	0.348				
D2(1 km)	0.326				
D3(1 km)	0.314				
E(1 km)	0.314				
F(1 km)	2.477				

Appendix B - Draft Permeable Paving Design

Summary of Results for 1 year Return Period

Half Drain Time : 97 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	43.414	0.014	0.0	1.9	0.0	1.9	6.8	O K
30 min Summer	43.421	0.021	0.0	1.9	0.0	1.9	10.2	O K
60 min Summer	43.429	0.029	0.0	1.9	0.0	1.9	13.8	O K
120 min Summer	43.435	0.035	0.0	1.9	0.0	1.9	16.6	O K
180 min Summer	43.438	0.038	0.0	2.0	0.0	2.0	18.3	O K
240 min Summer	43.440	0.040	0.0	2.0	0.0	2.0	19.0	O K
360 min Summer	43.440	0.040	0.0	2.0	0.0	2.0	19.3	O K
480 min Summer	43.439	0.039	0.0	2.0	0.0	2.0	18.6	O K
600 min Summer	43.437	0.037	0.0	1.9	0.0	1.9	17.6	O K
720 min Summer	43.434	0.034	0.0	1.9	0.0	1.9	16.5	O K
960 min Summer	43.429	0.029	0.0	1.9	0.0	1.9	14.0	O K
1440 min Summer	43.420	0.020	0.0	1.9	0.0	1.9	9.5	O K
2160 min Summer	43.409	0.009	0.0	1.9	0.0	1.9	4.3	O K
2880 min Summer	43.403	0.003	0.0	1.9	0.0	1.9	1.3	O K
4320 min Summer	43.400	0.000	0.0	1.6	0.0	1.6	0.0	O K
5760 min Summer	43.400	0.000	0.0	1.3	0.0	1.3	0.0	O K
7200 min Summer	43.400	0.000	0.0	1.1	0.0	1.1	0.0	O K
8640 min Summer	43.400	0.000	0.0	1.0	0.0	1.0	0.0	O K
10080 min Summer	43.400	0.000	0.0	0.9	0.0	0.9	0.0	O K
15 min Winter	43.418	0.018	0.0	1.9	0.0	1.9	8.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	29.396	0.0	8.0	0.0	20
30 min Summer	18.708	0.0	12.3	0.0	33
60 min Summer	11.905	0.0	17.8	0.0	62
120 min Summer	7.577	0.0	24.3	0.0	102
180 min Summer	5.817	0.0	29.2	0.0	136
240 min Summer	4.822	0.0	32.9	0.0	170
360 min Summer	3.702	0.0	39.1	0.0	240
480 min Summer	3.069	0.0	43.8	0.0	310
600 min Summer	2.653	0.0	47.6	0.0	378
720 min Summer	2.356	0.0	51.0	0.0	444
960 min Summer	1.940	0.0	56.2	0.0	576
1440 min Summer	1.476	0.0	64.4	0.0	824
2160 min Summer	1.123	0.0	72.9	0.0	1172
2880 min Summer	0.925	0.0	79.4	0.0	1500
4320 min Summer	0.701	0.0	87.7	0.0	0
5760 min Summer	0.575	0.0	93.3	0.0	0
7200 min Summer	0.494	0.0	97.3	0.0	0
8640 min Summer	0.436	0.0	100.1	0.0	0
10080 min Summer	0.392	0.0	102.1	0.0	0
15 min Winter	29.396	0.0	9.9	0.0	20

Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	43.426	0.026	0.0	1.9	0.0	1.9	12.5	O K
60 min Winter	43.435	0.035	0.0	1.9	0.0	1.9	16.7	O K
120 min Winter	43.442	0.042	0.0	2.0	0.0	2.0	20.1	O K
180 min Winter	43.445	0.045	0.0	2.0	0.0	2.0	21.4	O K
240 min Winter	43.446	0.046	0.0	2.0	0.0	2.0	22.1	O K
360 min Winter	43.446	0.046	0.0	2.0	0.0	2.0	21.9	O K
480 min Winter	43.443	0.043	0.0	2.0	0.0	2.0	20.5	O K
600 min Winter	43.439	0.039	0.0	2.0	0.0	2.0	18.7	O K
720 min Winter	43.435	0.035	0.0	1.9	0.0	1.9	16.7	O K
960 min Winter	43.426	0.026	0.0	1.9	0.0	1.9	12.6	O K
1440 min Winter	43.412	0.012	0.0	1.9	0.0	1.9	5.7	O K
2160 min Winter	43.400	0.000	0.0	1.9	0.0	1.9	0.0	O K
2880 min Winter	43.400	0.000	0.0	1.5	0.0	1.5	0.0	O K
4320 min Winter	43.400	0.000	0.0	1.1	0.0	1.1	0.0	O K
5760 min Winter	43.400	0.000	0.0	0.9	0.0	0.9	0.0	O K
7200 min Winter	43.400	0.000	0.0	0.8	0.0	0.8	0.0	O K
8640 min Winter	43.400	0.000	0.0	0.7	0.0	0.7	0.0	O K
10080 min Winter	43.400	0.000	0.0	0.6	0.0	0.6	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
30 min Winter	18.708	0.0	14.8	0.0	33
60 min Winter	11.905	0.0	20.6	0.0	60
120 min Winter	7.577	0.0	28.3	0.0	114
180 min Winter	5.817	0.0	33.7	0.0	144
240 min Winter	4.822	0.0	38.1	0.0	184
360 min Winter	3.702	0.0	44.8	0.0	262
480 min Winter	3.069	0.0	50.1	0.0	336
600 min Winter	2.653	0.0	54.7	0.0	408
720 min Winter	2.356	0.0	58.4	0.0	478
960 min Winter	1.940	0.0	64.4	0.0	610
1440 min Winter	1.476	0.0	73.6	0.0	852
2160 min Winter	1.123	0.0	83.7	0.0	1104
2880 min Winter	0.925	0.0	91.1	0.0	0
4320 min Winter	0.701	0.0	101.1	0.0	0
5760 min Winter	0.575	0.0	108.1	0.0	0
7200 min Winter	0.494	0.0	113.3	0.0	0
8640 min Winter	0.436	0.0	117.2	0.0	0
10080 min Winter	0.392	0.0	120.2	0.0	0

Rainfall Details

Rainfall Model	FEH
Return Period (years)	1
Site Location	GB 597450 137700 TQ 97450 37700
C (1km)	-0.023
D1 (1km)	0.348
D2 (1km)	0.326
D3 (1km)	0.314
E (1km)	0.314
F (1km)	2.477
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.291

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.196	4	8	0.095

Model Details

Storage is Online Cover Level (m) 44.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	40.0
Membrane Percolation (mm/hr)	1000	Length (m)	40.0
Max Percolation (l/s)	444.4	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	43.400	Cap Volume Depth (m)	0.400

Orifice Outflow Control

Diameter (m) 0.038 Discharge Coefficient 0.600 Invert Level (m) 43.000

Orifice Overflow Control

Diameter (m) 0.047 Discharge Coefficient 0.600 Invert Level (m) 43.500

Summary of Results for 30 year Return Period

Half Drain Time : 334 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	43.487	0.087	0.0	2.1	0.0	2.1	41.7	O K
30 min Summer	43.507	0.107	0.0	2.1	0.0	2.1	51.1	O K
60 min Summer	43.527	0.127	0.0	2.1	0.2	2.4	61.0	O K
120 min Summer	43.545	0.145	0.0	2.2	0.5	2.7	69.4	O K
180 min Summer	43.551	0.151	0.0	2.2	0.6	2.8	72.4	O K
240 min Summer	43.553	0.153	0.0	2.2	0.7	2.9	73.2	O K
360 min Summer	43.554	0.154	0.0	2.2	0.7	2.9	73.8	O K
480 min Summer	43.552	0.152	0.0	2.2	0.7	2.9	73.1	O K
600 min Summer	43.550	0.150	0.0	2.2	0.6	2.8	71.9	O K
720 min Summer	43.547	0.147	0.0	2.2	0.6	2.8	70.6	O K
960 min Summer	43.541	0.141	0.0	2.2	0.4	2.6	67.5	O K
1440 min Summer	43.528	0.128	0.0	2.1	0.3	2.4	61.3	O K
2160 min Summer	43.508	0.108	0.0	2.1	0.0	2.1	51.8	O K
2880 min Summer	43.488	0.088	0.0	2.1	0.0	2.1	42.1	O K
4320 min Summer	43.453	0.053	0.0	2.0	0.0	2.0	25.5	O K
5760 min Summer	43.428	0.028	0.0	1.9	0.0	1.9	13.5	O K
7200 min Summer	43.411	0.011	0.0	1.9	0.0	1.9	5.5	O K
8640 min Summer	43.402	0.002	0.0	1.9	0.0	1.9	1.2	O K
10080 min Summer	43.400	0.000	0.0	1.8	0.0	1.8	0.0	O K
15 min Winter	43.500	0.100	0.0	2.1	0.0	2.1	47.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	94.769	0.0	43.3	0.0	22
30 min Summer	57.143	0.0	54.0	0.0	36
60 min Summer	34.455	0.0	66.7	0.7	64
120 min Summer	20.776	0.0	82.0	2.8	122
180 min Summer	15.454	0.0	92.4	4.7	180
240 min Summer	12.527	0.0	100.3	6.1	212
360 min Summer	9.318	0.0	112.5	7.7	274
480 min Summer	7.554	0.0	121.9	8.1	342
600 min Summer	6.418	0.0	129.8	7.9	412
720 min Summer	5.619	0.0	136.6	7.4	484
960 min Summer	4.526	0.0	146.7	5.7	624
1440 min Summer	3.337	0.0	161.7	2.7	908
2160 min Summer	2.460	0.0	177.8	0.2	1320
2880 min Summer	1.981	0.0	189.8	0.0	1704
4320 min Summer	1.454	0.0	205.7	0.0	2424
5760 min Summer	1.167	0.0	217.1	0.0	3120
7200 min Summer	0.984	0.0	225.4	0.0	3816
8640 min Summer	0.856	0.0	232.3	0.0	4416
10080 min Summer	0.761	0.0	237.5	0.0	0
15 min Winter	94.769	0.0	49.6	0.0	22

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	43.522	0.122	0.0	2.1	0.1	2.3	58.5	O K
60 min Winter	43.545	0.145	0.0	2.2	0.5	2.7	69.5	O K
120 min Winter	43.565	0.165	0.0	2.2	0.9	3.1	79.2	O K
180 min Winter	43.573	0.173	0.0	2.2	1.0	3.3	83.0	O K
240 min Winter	43.576	0.176	0.0	2.2	1.1	3.3	84.3	O K
360 min Winter	43.576	0.176	0.0	2.3	1.1	3.3	84.7	O K
480 min Winter	43.575	0.175	0.0	2.2	1.0	3.3	83.8	O K
600 min Winter	43.571	0.171	0.0	2.2	1.0	3.2	82.0	O K
720 min Winter	43.567	0.167	0.0	2.2	1.0	3.2	80.0	O K
960 min Winter	43.557	0.157	0.0	2.2	0.8	3.0	75.2	O K
1440 min Winter	43.538	0.138	0.0	2.2	0.4	2.6	66.1	O K
2160 min Winter	43.509	0.109	0.0	2.1	0.0	2.1	52.3	O K
2880 min Winter	43.479	0.079	0.0	2.0	0.0	2.0	37.7	O K
4320 min Winter	43.430	0.030	0.0	1.9	0.0	1.9	14.5	O K
5760 min Winter	43.402	0.002	0.0	1.9	0.0	1.9	1.1	O K
7200 min Winter	43.400	0.000	0.0	1.6	0.0	1.6	0.0	O K
8640 min Winter	43.400	0.000	0.0	1.4	0.0	1.4	0.0	O K
10080 min Winter	43.400	0.000	0.0	1.3	0.0	1.3	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
30 min Winter	57.143	0.0	61.4	0.3	35
60 min Winter	34.455	0.0	75.8	2.2	64
120 min Winter	20.776	0.0	92.9	6.1	120
180 min Winter	15.454	0.0	104.5	9.0	176
240 min Winter	12.527	0.0	113.5	11.0	228
360 min Winter	9.318	0.0	127.3	13.5	282
480 min Winter	7.554	0.0	137.7	14.8	360
600 min Winter	6.418	0.0	146.6	14.9	438
720 min Winter	5.619	0.0	154.1	14.5	514
960 min Winter	4.526	0.0	165.5	12.1	666
1440 min Winter	3.337	0.0	182.7	6.1	968
2160 min Winter	2.460	0.0	201.2	0.2	1408
2880 min Winter	1.981	0.0	214.8	0.0	1816
4320 min Winter	1.454	0.0	233.3	0.0	2508
5760 min Winter	1.167	0.0	246.9	0.0	3056
7200 min Winter	0.984	0.0	257.0	0.0	0
8640 min Winter	0.856	0.0	264.9	0.0	0
10080 min Winter	0.761	0.0	271.4	0.0	0

Summary of Results for 100 year Return Period (+20%)

Half Drain Time : 556 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	43.575	0.175	0.0	2.2	1.0	3.3	83.8	O K
30 min Summer	43.606	0.206	0.0	2.3	1.3	3.6	98.8	O K
60 min Summer	43.639	0.239	0.0	2.4	1.6	3.9	114.5	O K
120 min Summer	43.667	0.267	0.0	2.4	1.7	4.2	128.3	O K
180 min Summer	43.679	0.279	0.0	2.4	1.8	4.3	134.0	O K
240 min Summer	43.683	0.283	0.0	2.5	1.8	4.3	135.8	O K
360 min Summer	43.685	0.285	0.0	2.5	1.9	4.3	136.7	O K
480 min Summer	43.683	0.283	0.0	2.5	1.8	4.3	136.0	O K
600 min Summer	43.680	0.280	0.0	2.5	1.8	4.3	134.5	O K
720 min Summer	43.675	0.275	0.0	2.4	1.8	4.2	132.2	O K
960 min Summer	43.662	0.262	0.0	2.4	1.7	4.1	125.8	O K
1440 min Summer	43.639	0.239	0.0	2.4	1.6	3.9	114.9	O K
2160 min Summer	43.611	0.211	0.0	2.3	1.4	3.7	101.3	O K
2880 min Summer	43.588	0.188	0.0	2.3	1.2	3.4	90.0	O K
4320 min Summer	43.553	0.153	0.0	2.2	0.7	2.9	73.4	O K
5760 min Summer	43.526	0.126	0.0	2.1	0.2	2.4	60.3	O K
7200 min Summer	43.496	0.096	0.0	2.1	0.0	2.1	46.0	O K
8640 min Summer	43.468	0.068	0.0	2.0	0.0	2.0	32.6	O K
10080 min Summer	43.445	0.045	0.0	2.0	0.0	2.0	21.7	O K
15 min Winter	43.598	0.198	0.0	2.3	1.3	3.5	94.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	173.176	0.0	86.2	6.0	22
30 min Summer	102.415	0.0	103.4	11.8	36
60 min Summer	60.568	0.0	123.7	19.2	64
120 min Summer	35.820	0.0	147.7	28.0	122
180 min Summer	26.344	0.0	163.9	33.7	182
240 min Summer	21.184	0.0	176.1	37.8	234
360 min Summer	15.580	0.0	194.5	43.4	290
480 min Summer	12.528	0.0	208.7	47.0	352
600 min Summer	10.579	0.0	220.7	49.3	422
720 min Summer	9.214	0.0	230.7	50.7	490
960 min Summer	7.362	0.0	245.7	51.2	628
1440 min Summer	5.367	0.0	268.1	49.1	906
2160 min Summer	3.912	0.0	292.1	41.4	1300
2880 min Summer	3.126	0.0	309.6	34.0	1700
4320 min Summer	2.267	0.0	333.8	17.7	2468
5760 min Summer	1.805	0.0	350.9	4.4	3288
7200 min Summer	1.513	0.0	364.3	0.0	4040
8640 min Summer	1.310	0.0	374.8	0.0	4760
10080 min Summer	1.159	0.0	383.1	0.0	5448
15 min Winter	173.176	0.0	97.6	9.9	22

Summary of Results for 100 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	43.633	0.233	0.0	2.4	1.5	3.9	111.9	O K
60 min Winter	43.670	0.270	0.0	2.4	1.8	4.2	129.8	O K
120 min Winter	43.705	0.305	0.0	2.5	2.0	4.5	146.6	O K
180 min Winter	43.720	0.320	0.0	2.5	2.0	4.6	153.6	O K
240 min Winter	43.727	0.327	0.0	2.5	2.1	4.6	156.8	O K
360 min Winter	43.727	0.327	0.0	2.5	2.1	4.6	157.1	O K
480 min Winter	43.726	0.326	0.0	2.5	2.1	4.6	156.5	O K
600 min Winter	43.722	0.322	0.0	2.5	2.1	4.6	154.4	O K
720 min Winter	43.715	0.315	0.0	2.5	2.0	4.5	151.4	O K
960 min Winter	43.697	0.297	0.0	2.5	1.9	4.4	142.7	O K
1440 min Winter	43.662	0.262	0.0	2.4	1.7	4.1	125.9	O K
2160 min Winter	43.621	0.221	0.0	2.3	1.4	3.8	105.9	O K
2880 min Winter	43.588	0.188	0.0	2.3	1.2	3.4	90.4	O K
4320 min Winter	43.545	0.145	0.0	2.2	0.5	2.7	69.6	O K
5760 min Winter	43.505	0.105	0.0	2.1	0.0	2.1	50.4	O K
7200 min Winter	43.459	0.059	0.0	2.0	0.0	2.0	28.4	O K
8640 min Winter	43.425	0.025	0.0	1.9	0.0	1.9	11.8	O K
10080 min Winter	43.403	0.003	0.0	1.9	0.0	1.9	1.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
30 min Winter	102.415	0.0	116.8	16.9	35
60 min Winter	60.568	0.0	139.5	25.8	64
120 min Winter	35.820	0.0	166.4	36.3	120
180 min Winter	26.344	0.0	184.1	43.1	178
240 min Winter	21.184	0.0	198.1	48.1	232
360 min Winter	15.580	0.0	219.0	55.1	326
480 min Winter	12.528	0.0	235.1	59.8	374
600 min Winter	10.579	0.0	248.4	63.0	450
720 min Winter	9.214	0.0	259.7	65.2	528
960 min Winter	7.362	0.0	276.6	66.5	678
1440 min Winter	5.367	0.0	301.7	65.0	968
2160 min Winter	3.912	0.0	329.0	55.5	1384
2880 min Winter	3.126	0.0	349.1	43.6	1788
4320 min Winter	2.267	0.0	376.4	16.8	2596
5760 min Winter	1.805	0.0	396.5	0.1	3512
7200 min Winter	1.513	0.0	411.9	0.0	4184
8640 min Winter	1.310	0.0	424.2	0.0	4840
10080 min Winter	1.159	0.0	434.8	0.0	5336

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

Half Drain Time : 645 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	43.607	0.207	0.0	2.3	1.3	3.6	99.2	O K
30 min Summer	43.644	0.244	0.0	2.4	1.6	4.0	116.9	O K
60 min Summer	43.682	0.282	0.0	2.5	1.8	4.3	135.5	O K
120 min Summer	43.718	0.318	0.0	2.5	2.0	4.6	152.5	O K
180 min Summer	43.733	0.333	0.0	2.5	2.1	4.7	159.9	O K
240 min Summer	43.739	0.339	0.0	2.6	2.1	4.7	163.0	O K
360 min Summer	43.742	0.342	0.0	2.6	2.2	4.7	164.4	O K
480 min Summer	43.742	0.342	0.0	2.6	2.2	4.7	164.2	O K
600 min Summer	43.740	0.340	0.0	2.6	2.1	4.7	163.0	O K
720 min Summer	43.735	0.335	0.0	2.6	2.1	4.7	161.0	O K
960 min Summer	43.721	0.321	0.0	2.5	2.0	4.6	154.1	O K
1440 min Summer	43.694	0.294	0.0	2.5	1.9	4.4	141.2	O K
2160 min Summer	43.661	0.261	0.0	2.4	1.7	4.1	125.4	O K
2880 min Summer	43.634	0.234	0.0	2.4	1.5	3.9	112.2	O K
4320 min Summer	43.589	0.189	0.0	2.3	1.2	3.5	90.9	O K
5760 min Summer	43.560	0.160	0.0	2.2	0.8	3.0	76.6	O K
7200 min Summer	43.537	0.137	0.0	2.2	0.4	2.6	65.8	O K
8640 min Summer	43.514	0.114	0.0	2.1	0.1	2.2	54.9	O K
10080 min Summer	43.488	0.088	0.0	2.1	0.0	2.1	42.0	O K
15 min Winter	43.634	0.234	0.0	2.4	1.5	3.9	112.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	202.038	0.0	102.0	11.5	22
30 min Summer	119.485	0.0	122.0	19.1	36
60 min Summer	70.663	0.0	145.8	28.5	64
120 min Summer	41.790	0.0	173.6	39.6	122
180 min Summer	30.735	0.0	192.2	46.8	182
240 min Summer	24.714	0.0	206.6	52.2	240
360 min Summer	18.176	0.0	228.5	59.6	300
480 min Summer	14.616	0.0	245.3	64.6	362
600 min Summer	12.342	0.0	259.1	68.0	428
720 min Summer	10.749	0.0	270.9	70.5	496
960 min Summer	8.589	0.0	288.4	72.2	636
1440 min Summer	6.261	0.0	314.8	72.4	910
2160 min Summer	4.564	0.0	343.1	66.0	1316
2880 min Summer	3.647	0.0	364.0	58.3	1704
4320 min Summer	2.645	0.0	393.0	42.6	2464
5760 min Summer	2.106	0.0	414.0	26.1	3224
7200 min Summer	1.765	0.0	429.8	11.3	4032
8640 min Summer	1.528	0.0	443.1	1.3	4840
10080 min Summer	1.352	0.0	454.2	0.0	5552
15 min Winter	202.038	0.0	115.2	16.6	22

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	43.676	0.276	0.0	2.4	1.8	4.2	132.3	O K
60 min Winter	43.720	0.320	0.0	2.5	2.0	4.6	153.7	O K
120 min Winter	43.762	0.362	0.0	2.6	2.3	4.9	173.9	O K
180 min Winter	43.782	0.382	0.0	2.6	2.3	5.0	183.2	O K
240 min Winter	43.791	0.391	0.0	2.6	2.4	5.0	187.6	O K
360 min Winter	43.794	0.394	0.0	2.7	2.4	5.1	189.2	O K
480 min Winter	43.793	0.393	0.0	2.7	2.4	5.0	188.5	O K
600 min Winter	43.789	0.389	0.0	2.6	2.4	5.0	186.8	O K
720 min Winter	43.783	0.383	0.0	2.6	2.3	5.0	184.0	O K
960 min Winter	43.765	0.365	0.0	2.6	2.3	4.9	175.0	O K
1440 min Winter	43.724	0.324	0.0	2.5	2.1	4.6	155.4	O K
2160 min Winter	43.675	0.275	0.0	2.4	1.8	4.2	132.1	O K
2880 min Winter	43.636	0.236	0.0	2.4	1.5	3.9	113.4	O K
4320 min Winter	43.579	0.179	0.0	2.3	1.1	3.3	86.0	O K
5760 min Winter	43.546	0.146	0.0	2.2	0.5	2.7	70.1	O K
7200 min Winter	43.515	0.115	0.0	2.1	0.1	2.2	55.0	O K
8640 min Winter	43.472	0.072	0.0	2.0	0.0	2.0	34.7	O K
10080 min Winter	43.437	0.037	0.0	1.9	0.0	1.9	17.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
30 min Winter	119.485	0.0	137.7	25.6	36
60 min Winter	70.663	0.0	164.3	36.8	64
120 min Winter	41.790	0.0	195.6	50.0	120
180 min Winter	30.735	0.0	216.5	58.5	178
240 min Winter	24.714	0.0	232.5	64.9	234
360 min Winter	18.176	0.0	257.0	74.0	336
480 min Winter	14.616	0.0	275.9	80.3	380
600 min Winter	12.342	0.0	291.4	84.9	456
720 min Winter	10.749	0.0	304.5	88.2	534
960 min Winter	8.589	0.0	324.4	91.4	684
1440 min Winter	6.261	0.0	354.1	91.7	980
2160 min Winter	4.564	0.0	386.2	86.6	1404
2880 min Winter	3.647	0.0	409.9	74.8	1792
4320 min Winter	2.645	0.0	442.9	48.9	2556
5760 min Winter	2.106	0.0	467.2	21.4	3400
7200 min Winter	1.765	0.0	485.8	1.7	4320
8640 min Winter	1.528	0.0	501.0	0.0	5016
10080 min Winter	1.352	0.0	513.9	0.0	5656

Appendix C - Surface Water Drainage Summary

Drainage Strategy Summary

1. Site details		
Site/development name	Elite	
Address including post code	Hornash Lane Shadoxhurst TN26 1HU	
Grid reference	E 598296	N 137746
LPA reference	n/a	
Type of application	Outline ☒ Full ☐ Discharge of Conditions ☐ Other ☐	
Site condition	Greenfield ☐	Brownfield ☒

2. Existing drainage			Document/Plan where information is stated:
Total site area (ha)	0.960		Foul and Surface Water Management Strategy
Impermeable area (ha)	0.377		
Final discharge location	Infiltration ☐ Watercourse ☒ Sewer ☐ Tidal reach/sea ☐		
Greenfield discharge rate (l/s) for existing site area	QBAR (l/s)	4.8	Foul and Surface Water Management Strategy
	1 in 1 year (l/s)	4.0	
	1 in 30 year (l/s)	10.9	
	1 in 100 year (l/s)	15.2	

3. Proposed drainage areas			Document/Plan where information is stated:
Impermeable area (ha)	Roof	0.095	Foul and Surface Water Management Strategy
	Highway/road	0.000	
	Other paved areas	0.196	
	Total	0.291	
Permeable area (ha)	Open space	0.669	
	Other permeable areas		
	Total	0.960	
Final discharge location	Infiltration ☐ Infiltration rate ____________m/s Watercourse ☒ Sewer ☐ Tidal reach/sea ☐		Foul and Surface Water Management Strategy
Climate change allowance included in design	20% ☒ 30% ☐ 40% ☐		

4. Post-Development Discharge rates, without mitigation			**Document/Plan where information is stated:**
Developed discharge rates (l/s)	1 in 1 year	24	Foul and Surface Water Management Strategy
	1 in 30 year	58	
	1 in 100 year	115	
	1 in 100 year + CC	138	

5. Post-Development Discharge rates, with mitigation			**Document/Plan where information is stated:**
Describe development drainage strategy in general terms: Permeable paving to attenuate runoff to greenfield runoff rates with discharge to watercourse.			Foul and Surface Water Management Strategy
(a) No control required, all flows infiltrating		☐	
(b) Controlled developed discharge rates (l/s)	1 in 1 year	2.0	Foul and Surface Water Management Strategy
	1 in 30 year	3.3	
	1 in 100 year	4.6	
	1 in 100 year + CC	4.6	

6. Discharge Volumes			**Document/Plan where information is stated:**
	Existing volume (m^3)	Proposed volume (m^3)	Foul and Surface Water Management Strategy
1 in 1 year	70	54	
1 in 30 year	177	137	
1 in 100 year	247	190	
1 in 100 year + CC	296	229	

All information presented above should be contained within the attached Flood Risk Assessment, Drainage Strategy or Statement and be substantiated through plans and appropriate calculations.

Form completed by	Robert Beck
Qualifications	Chartered Civil Engineer
Company	RMB Consultants (Civil Engineering) Ltd
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Email	robert.beck@rmbconsultants.co.uk
On behalf of (client's details)	Elite
Date	31/10/17