Outline Surface Water Drainage Strategy

Land to the West of Marden

Final Report

April 2023

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Revision History

Revision Ref/Date	Amendments	Issued to
P01 / November 2021	Draft Report	Donna Clarke (Origin Power Services Limited)
P02 / February 2022	Draft Report (revision of site layout)	Donna Clarke (Origin Power Services Limited)
C01 / February 2022	Final Report	Donna Clarke (Origin Power Services Limited)
C02 / March 2023	Amended Final Report	Donna Clarke (Origin Power Services Limited)

Contract

This report describes work commissioned by Donna Clarke of Origin Power Services Ltd by an email dated 07 July 2021. Tom Smith of JBA Consulting carried out this work.

Subsequent to the preparation of the initial report, JBA was instructed to complete amendments to the outline Surface Water Drainage Strategy to reflect revisions to the site layout. The most notable changes include alterations to impermeable surfacing associated with the DNO/Customer HV compound. The additional tasks were commissioned by Donna Clarke of Origin Power Services Ltd by an email dated 31st January 2023. Matthew Morrison of JBA Consulting carried out this work.

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Purpose

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Executive summary

JBA Consulting was commissioned by Donna Clarke of Origin Power Services Ltd in July 2021 to prepare an outline Surface Water Drainage Strategy to support a planning application for development of a solar energy farm at Land to the West of Marden, Kent. In January 2023, following receipt of the initial draft drainage strategy report, JBA were requested to revise changes to the proposed layout in response to statutory consultation responses. The layout has been revised to address the report, and associated MicroDrainage calculations, to reflect provision of new DNO/Customer HV Compound layout. This report details the revised Surface Water Drainage scheme.

The proposed development site is approximately 74.5ha in size and is situated to the north of Sheephurst Lane, some 0.74km to the west of Marden. The site is currently occupied by agricultural fields thus considered greenfield land.

The proposed planning application relates to development of a solar energy farm including installation of photovoltaic panels and construction of a DNO/Customer HV Compound and site access roads.

Post development the total impermeable area at the site will amount to 1050m^2, comprising of hardstanding associated with the DNO/Customer HV Compound.

It is understood that the individual solar panels will drain directly onto the ground and the site access roads will be underlain by permeable gravel surfaces (MOT Type 3 or similar).

The majority of the DNO/Customer HV Compound will remain underlain by permeable surfacing post development. Therefore, swale storage sizing for DNO/Customer HV Compound has been based on slab runoff and roof runoff only, amounting to a total area of 1050m^2.

Precipitation which lands upon the impermeable slab within the Customer Compound will runoff straight into a vegetated swale with level spreader. Precipitation which lands upon roof areas associated with the Transformation Station and Switchgear Station will be directed towards filter drains which will be conveyed towards a vegetated swale with level spreader. The level spreaders will dissipate the surface water runoff back into the environment.

The main purpose of the swale and level spreaders will be to dissipate the surface water runoff generated by the DNO/Customer HV Compound and turn it into a sheet flow to reduce the risks of erosion and eliminate point discharges to the watercourses and land drainage. The use of above ground SuDS will also provide ecological and amenity benefits.

Preliminary calculations indicate that a swale with a length of 5m for roof areas associated with the Transformation Station and Switchgear Station and 40m for the impermeable slab within the Customer Compound. Both swales have a base width of 1.0m, 1:3 side slopes and have a max water depth of 200mm which will capture the first flush of runoff generated by impermeable surfacing from all storm events. Collected surface water will either infiltrate into the ground, be assimilated by the vegetation within the swale, or dissipated into the surrounding area as sheet flow.

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Abbreviations

AEP	Annual Exceedance Probability
FEH	Flood Estimation Handbook
FRA	Flood Risk Assessment
FSR	Flood Studies Report
Ha	Hectare
LIDAR	Light Detection and Ranging
m AOD	metres Above Ordnance Datum
NPPF	National Planning Policy Framework
SAAR	Standard Annual Average Rainfall
SFRA	Strategic Flood Risk Assessment
SuDS	Sustainable Drainage Systems
SWDS	Surface Water Drainage Strategy
SWMP	Surface Water Management Plan
TSS	Total Suspended Solids

1 Introduction

1.1 Terms of Reference

JBA Consulting was commissioned by Donna Clarke of Origin Power Services Ltd in July 2021 to prepare an outline Surface Water Drainage Strategy to support a planning application for development of a solar energy farm at Land to the West of Marden, Kent.

In February 2023, following receipt of the initial draft drainage strategy report, JBA were requested to revise changes to the proposed layout in response to statutory consultation responses. The layout has been revised to address the report, and associated MicroDrainage calculations, to reflect provision of new DNO/Customer HV Compound layout. This report details the revised Surface Water Drainage scheme.

The site is currently vacant and comprises agricultural land. According to plans provided by the client, the proposals include installation of photovoltaic panels across the majority of the site along with construction of a DNO/Customer HV Compound and access roads.

1.2 Site Description

The proposed development site is approximately 74.5ha in size and is situated to the north of Sheephurst Lane, some 0.74km to the west of Marden. The site is currently occupied by agricultural fields thus considered greenfield land.

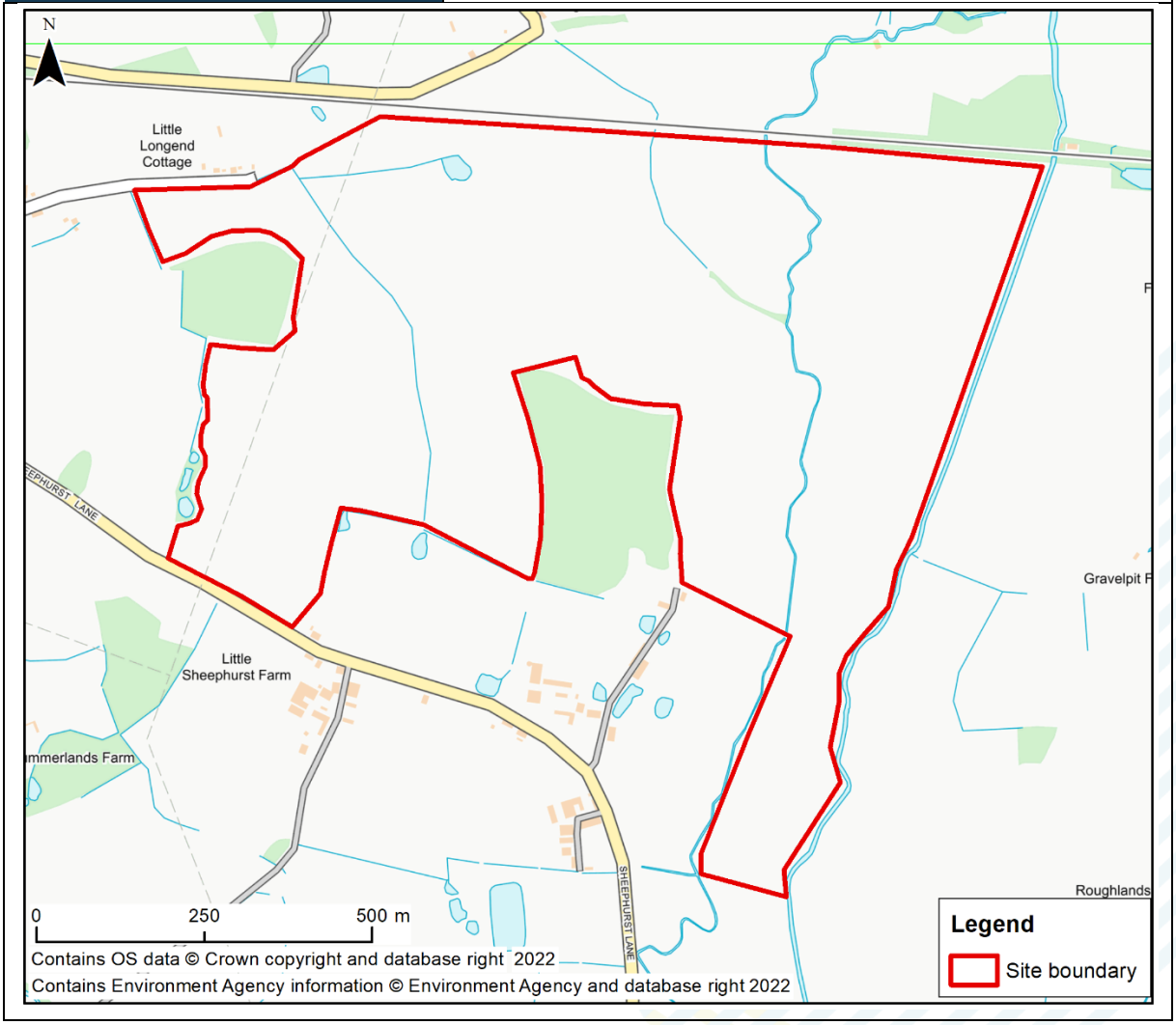
Having reviewed aerial imagery, the north of the site is bound by a railway track with Sheephurst Lane adjacent to the south. Agricultural fields extend beyond the site to the west with a number of residential dwellings located adjacent north west along Burtons Lane.

The Lesser Teise flows along the eastern periphery of the red outline application boundary with the River Teise situated some 0.65km to the south.

A summary of the site details has been included in Table 1-1.

Table 1-1: Summary of site details

Site name	Land to the West of Marden, Kent TN12 9NP
Site area	Approximately 74.5ha
Existing land use	Greenfield – Agricultural Land
Proposal	Development of a solar energy farm
OS NGR	TQ7259044548
Country	England (NPPF applies)
Local Planning Authority	Kent County Council
Lead Local Flood Authority	Kent County Council
Sewerage Undertaker	Southern Water



1.3 Development Proposal

The proposed planning application relates to development of a solar energy farm including installation of photovoltaic panels and, construction of a DNO/Customer HV Compound and site access roads.

According to plans provided the compound areas will comprise of the following:

- DNO Compound
- Customers Compound

- Transformation Station
- Switchgear Station
- LV Switchboard

Post development the total impermeable area at site will amount to 1050m^2, comprising of hardstanding associated with the DNO/Customer HV Compound.

It is understood that the individual solar panels will drain directly onto the ground and the site access roads will be underlain by permeable gravel surfaces (MOT Type 3 or similar).

Additionally, it is understood that the majority of the DNO/Customer HV Compound will remain underlain by permeable surfacing post development. Therefore, storage sizing for DNO/Customer HV Compound has been based on slab runoff and roof runoff only.

Given that the development will introduce impermeable surfacing at the site, SuDS will be incorporated within the scheme to manage post development runoff.

Proposed site plans are shown in Appendix A.

2 Details of Proposed Development Site

2.1 Site Topography

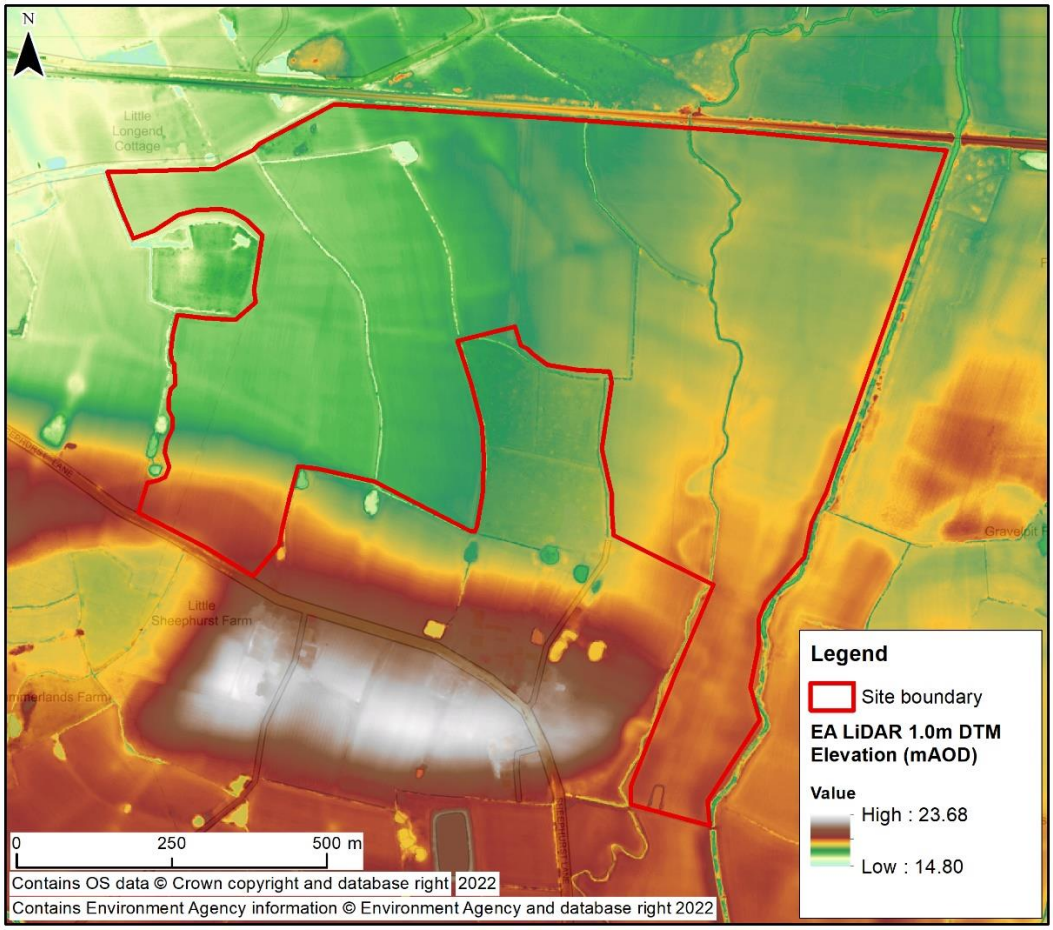
A topographic survey was undertaken at the site by Above Surveying Ltd in October 2021 and provided by the client for inclusion within this report. The survey indicates that the site has a 5.50m gradient and generally slopes down from land along the southern boundary towards the north-western corner. Topographic levels within the red outline boundary are reported to range between 16.50m AOD and 22.00m AOD.

According to development plans provided by the client, the proposed DNO/Customer HV Compound in the south-west of the site will be constructed upon land with an approximate elevation of between 17.30m AOD and 18.20m AOD.

1.0m LIDAR elevation data obtained from the Environment Agency indicates that land to the south is elevated higher than the site. Having reviewed EA topographic data, the site appears to be located on the edge of a plateau with land at the site and within the surrounding area sloping in the northerly direction towards the railway embankment.

Figure 2-1 shows the topography of the site and the surrounding area, using Environment Agency 1.0m LIDAR DTM. The topographic survey is included in Appendix B.

Figure 2-1: Topography of proposed development site and surrounding area



2.2 Geology

The British Geological Survey's (BGS) Geology of Britain Viewer[1] indicates that the proposed development site is located upon Weald Clay Formation (Mudstone) bedrock geology. This Lithology is characterised by dark grey thinly-bedded shales and mudstones with subordinate siltstones, sandstones (including Horsham Stone Member), shelly limestones and clay ironstones.

According to BGS mapping the site is also underlain by superficial deposits comprising River Terrace Deposits (Clay and Silt) and Alluvium (Clay, Silt, Sand and Peat). Review of Cranfield Soilscapes online viewer indicates that the site is underlain by loamy and clayey floodplain soils with naturally high groundwater.

Given that online records suggested that high groundwater may be present beneath the site, in-situ groundwater monitoring was undertaken in August 2021 by Southern Testing to establish the true, resting groundwater level beneath the site.

Four machine dug trial pits were excavated across the site, positioned within the areas proposed to be developed as the compound and access road, to a depth of between 2.50 and 3.10mbgl. The general geological profile encountered within the machine excavated trial pits was summarised by Southern Testing as follows:

Depth (m)	Thickness (m)	Soil Type	Description
GL – 0.2/0.3	0.2 – 0.3	Topsoil	Dark brown silty clay TOPSOIL with rootlets.
0.2/0.3 – 0.5/0.7	0.3 – 0.4	Subsoil	Firm pale brown slightly silty CLAY with rootlets.
0.5 – 2.7/2.9	2.2	Clay	Stiff and very stiff pale grey mottle dark brown CLAY becoming laminated at depth.
1.4 – 2.1/2.9 (TP03 and TP04 only – refer to appendix D)	0.7 – 1.5	Gravel	Pale brown and dark orange brown silty sandy GRAVEL. Gravel is fine to medium flat SILTSTONE, SANDSTONE and rounded flint with some black ironstaining.
2.5/2.6-2.53/2.63 (TP01 and TP02 only – refer to appendix D)	0.03	Limestone	Dark grey and cream shelly LIMESTONE band.
2.7/2.9 – 3.0/3.1+	0.3+	Clay/ Mudstone	Stiff and very stiff pale blue grey fissured CLAY (becoming weak MUDSTONE at base of pit is TP01 and TP02)

[1] British Geological Survey. Geology of Britain viewer http://mapapps.bgs.ac.uk/geologyofbritain/home.html?

Southern Testing also reported that groundwater was encountered within all the trial pits ranging from 2.00mbgl in TP04 to 2.90mbgl in TP02.

Given that the underlying strata, above the resting groundwater level, comprises clay the site is not considered suitable for infiltration SuDS drainage as the main disposal method and an alternative means of surface water discharge will be required.

2.3 Watercourses

Several drains have been identified throughout the site (refer to Figure 2-2). These are classified as ordinary watercourses, managed by the Upper Medway Internal Drainage Board (IDB), and follow the topographic profile of the site, generally flowing in a northerly direction towards the railway embankment.

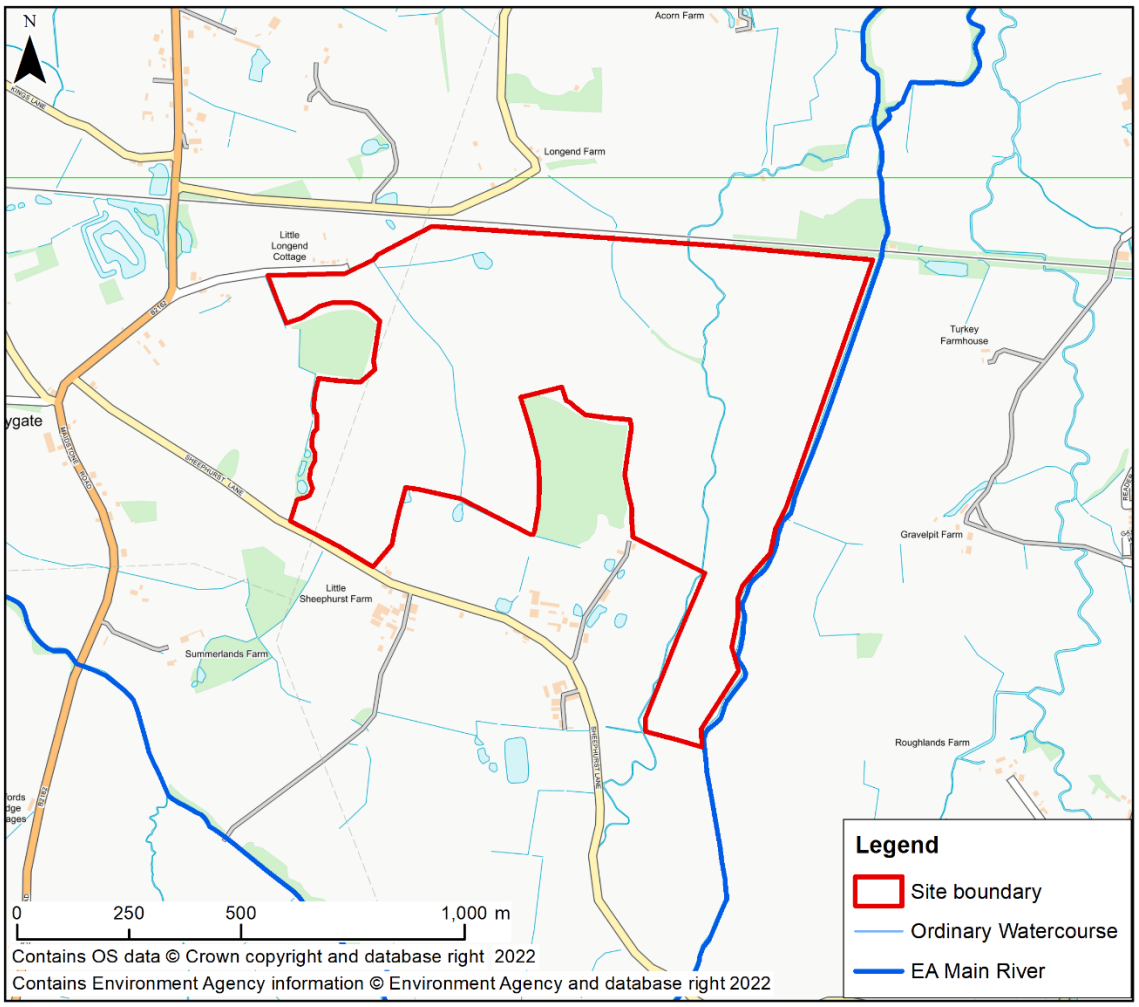
In addition to the ordinary watercourses, a number of 'main' watercourses (managed by the Environment Agency) have been identified within proximity to the development. These include:

- The Lesser Tiese which flows in a northerly direction along the eastern boundary of the site, and;
- The River Tiese approximately 650m to the south which flows in a westerly direction.

The River Tiese is a tributary of the River Medway. The Tiese's source is in Tunbridge Wells in the High Weald to join the Medway at Yalding in the Low Weald

According to the Environment Agency, the section of River Tiese and Lesser Tiese which flows past the site is not designated artificial or heavily modified and has an overall Water Body Classification of moderate.

Figure 2-2: Open watercourses within proximity to the site



The ordinary watercourses were surveyed in October 2021 by EDI Surveys Ltd with details of the bank and bed levels provided on a watercourse plan (refer to Appendix C).

Given the present use of the site it is likely that runoff generated within the red outline boundary currently drains to ground and via overland flow into the nearby drainage channels.

The drainage channels which cross the site, are located within proximity to the DNO/Customer HV Compound, are classified as ordinary watercourses and are managed by the Upper Medway IDB. Therefore, should post development discharge to the watercourse be proposed prior approval will be required from Upper Medway IDB.

2.4 Utility Service Infrastructure

The application area is currently occupied by greenfield agricultural land therefore no formal drainage infrastructure is considered to currently serve the site.

Despite this, a utility search has been provided by the client (undertaken by Landmark Information Group) to gain an understanding of the service arrangements within vicinity to the site. The utility search includes asset information obtained from:

- Environment Agency
- Instalcom – [CenturyLink, Global Crossing, Fibernet & Fiberspan]
- LinesearchbeforeUdig
- Network Rail
- Openreach – [British Telecommunications]
- South East Water
- Southern Water
- UK Power Networks
- Utility Assets

Review of the search report indicates that the majority of identified infrastructure at the site or within close proximity is located in the west (beneath land associated with the wildlife corridor) or along the southern boundary.

According to the Landmark utilities report no service infrastructure is located in the vicinity of the proposed DNO/Customer HV Compound. Despite this, it is recommended that a detailed utility survey is carried out prior to construction commencing to confirm the location and details of the existing services and check for any unidentified services.

2.5 Flood Risk

This section provides an overview of the risk posed by fluvial, tidal, surface water and reservoir flooding. Refer to report reference FKO-JBAU-XX-XX-RP-HM-0001-S3-P01-Marden_FRA for details of the full Flood Risk Assessment; undertaken for the development in April 2021 by JBA Consulting.

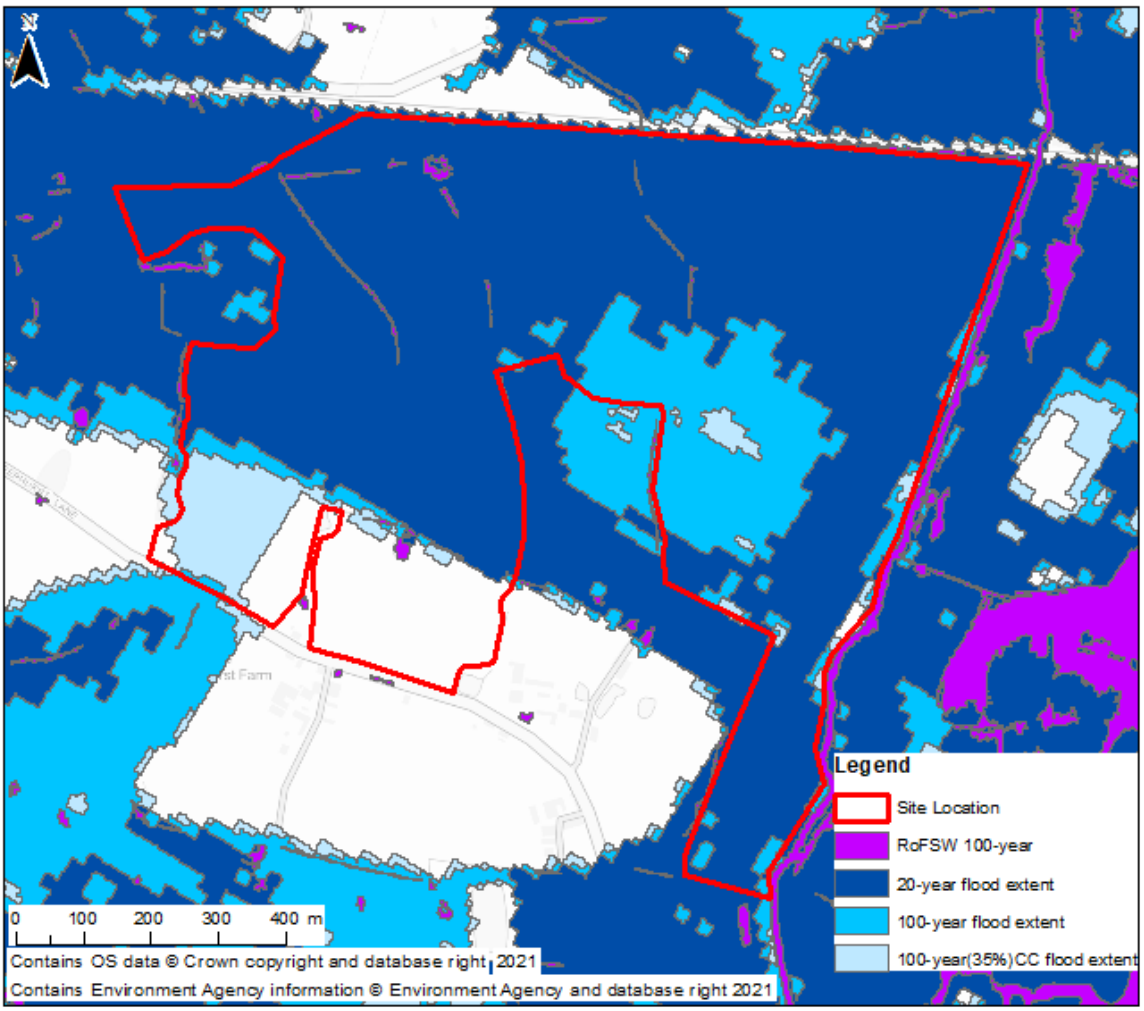
A summary of the report finding are as follows:

A large proportion of the site is located within flood zone 3; defined as land with a greater than 1 in 100-year (1.0% AEP) probability of fluvial flooding. However, an area of land in the centre south of the site is located entirely within Flood Zone 1 thus outside of both Flood Zone 2 and Flood Zone 3 extents.

The Flood Risk Assessment included analysis of modelled flood depths for the 20-year and 100-year scenarios, derived from the Medway Model 2015. Additionally, given the nature of the development and its design lifetime, in line with guidance, it was considered appropriate to assess the development for the 1 in 100-year event with 35% allowance for climate change.

Figure 2-3 shows the fluvial flood extents for the 20-year, 100-year, 100-year plus 35% climate change events and the 100-year risk of surface water flooding (taken from FKO-JBAU-XX-XX-RP-HM-0001-S3-P01-Marden_FRA).

Figure 2-3: Environment Agency Modelled Fluvial and Pluvial Extents



The proposed layout of the DNO/Customer HV Compound is located within the 100-year plus 35% CC flood extent. Based upon the findings of the Flood Risk Assessment the developer adopted a sequential approach when redesigning the site layout and has moved the most vulnerable element of the DNO/Customer HV Compound, the Switchgear Station, to a lower risk area.

3 Outline Surface Water Drainage Strategy

3.1 Overview

As the development will introduce areas of impermeable surfacing to the site, there will be changes to the rates and volumes of surface water runoff generated within the application boundary in comparison with the existing Greenfield site. Any development should look to maximise the use of SuDS through considerate design layout to reduce runoff from future development and to introduce a multitude of benefits for the surrounding area and local community.

This Surface Water Drainage Strategy (SWDS) provides a summary of the preferred options for managing surface water runoff from the site, so that the development will not increase surface water flood risk to the surrounding areas. The strategy is supported by initial calculations of pre- and post-development runoff rates and storage volumes. These calculations have been used to inform the type and sizing of SuDS proposed on the application site.

3.2 Design Guidance

A drainage strategy outlining the means of surface water disposal from the proposed development has been produced in line with guidance in relation to development sites as follows:

- Kent County Council Masterplanning Sustainable Drainage into Developments Guidance, September 2013
- Maidstone Borough Council Planning Policy Advice note: Large Scale (>50kW) Solar PV Arrays, January 2014
- CIRIA 753 "The SuDS Manual", November 2015
- Design of public sewers shall be undertaken in accordance with Sewerage Sector Guidance – v1.0 – October 2019
- Draft Overarching National Policy Statement for Energy (EN-1), September 2021

Where surface water is managed through sewers, they should be designed for 1 year/2-year storm 'in-pipe' flow and to ensure no surface water flooding during a 30-year storm event.

In line with the industry standards any flows up to the 30-year storm event should be accommodated underground (with no surface flooding), unless overground storage facilities are provided as part of the design. Any exceedance flows beyond the 30-year storm event and including the 100-year plus climate change storm event should be managed in a safe manner on site to reduce the risk of flooding to the development and elsewhere. A dedicated overland flow route should be provided through the development to convey any exceedance flows beyond the 100-year plus climate change event in a safe manner.

3.3 Water Quantity

Local ground conditions are not suitable for the primary disposal of surface water runoff into the ground. However, the small increase in runoff volume and peak flow can be readily managed and reduced using dissipation techniques. Appropriate dissipation structures that convert point flows into sheet flows mimic natural runoff characteristics and provide a more robust method of managing runoff than point discharges waterbodies. The method disconnects drainage from waterbodies and allows runoff to flow through the natural environment encouraging infiltration and assimilation, slowing the flow and reducing the volume that eventually reach local waterbodies.

To mitigate against increasing downstream flooding due to the additional volume of runoff, the approach has been utilised. This will be achieved by the swale retaining the first flush of surface water within the swales to a depth of 200mm, flows in excess of this will be converted into very shallow sheet flows (ranging between 1mm and 12mm for the 1 in 100-year plus 45% climate change rainfall event) spilling over the edge of a dropped kerb to act as a high-level overflow. Dissipation, takes away the need to use a single point discharge into the Ordinary Watercourse located (50m) in the south of the site, which would require consent.

3.4 Water Quality

To mitigate against adverse impacts on the water quality in the receiving water environment, the SuDS Manual recommends the following steps to determine the required water quality management for discharges to surface water and groundwaters:

- Plan land use to prevent runoff and associated pollutants for most rainfall events up to 5mm in depth
- Identify the pollution hazard level associated with the given type of development
- Select risk assessment approach based on receiving water environment and the pollution hazard level
- Carry out the risk assessment for each outfall taking into account the pollution hazard level, the status of the receiving water environment and effectiveness of the proposed SuDS techniques.

Access roads and non-residential car parking with infrequent use are shown to present 'low' pollution hazard level and require application of a 'simple index approach' for water quality risk assessment for discharge to surface water.

To mitigate the very low risk of water quality affecting the water environment it is proposed to capture, treat and assimilate the first flush of surface water and then dissipate into the natural environment disconnecting the SuDS from the watercourses.

It is assumed that no chemicals will be stored on site during operation. However, if at a later date, chemicals are to be stored appropriate pollution prevention guidelines will need to be followed potentially isolating storage areas from the sustainable drainage system.

3.5 Environment Agency, Flood Risk Assessment: Climate Change Allowance (2022)

The Environment Agency has produced guidance to support the National Planning Policy Framework (NPPF). Within this guidance, the EA set out the anticipated changes in extreme rainfall intensity on small and urban catchments. The details of the EA intensity allowances are set out in Table 3-1.

Table 3-1: Environment Agency Climate Change Allowances (2022)

Applies across all of England	Total potential change anticipated for the '2020s' (2015 to 2039)	Total Potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper End Projection	10%	45%	40%
Central Projection	5%	20%	20%

Given the nature of the proposed development, and its associated design life (assumed to be 30-50 years), it could be considered appropriate to adopt the '2050s' scenario for the purpose of this strategy. A conservative approach has been adopted and a 45% allowance for climate change has been applied to rainfall intensity to reflect the Upper End Projection for the '2050s' scenario. This has been reflected within all MicroDrainage calculations.

3.6 Drainage Hierarchy

The following discharge hierarchy has been considered in line with NPPF guidance and Kent County Council Masterplanning Sustainable Drainage into Developments Guidance:

Discharge to the ground

The British Geological Survey's (BGS) Geology of Britain Viewer[2] indicates that the proposed development site is located upon Weald Clay Formation (Mudstone) bedrock geology.

Groundwater monitoring was undertaken at the site in August 2021 by Southern Testing to establish the true, resting groundwater level beneath the site. It is reported that groundwater was encountered within all four trial pits ranging from 2.00mbgl in TP04 to 2.90mbgl in TP02. In addition, the ground investigation confirmed that the underlying strata, above the resting groundwater level, comprises clay.

Given the findings of ground investigations, primary disposal of surface water using infiltration to ground is not considered a feasible method of discharge and therefore has not been considered further within this assessment.

[2] British Geological Survey. Geology of Britain viewer http://mapapps.bgs.ac.uk/geologyofbritain/home.html?

Discharge to watercourse

Several Ordinary Watercourses have been identified at the site. These generally flow in a northerly direction following the topographic gradient of the site. In addition, the Lesser Teise is reported to flow along the eastern boundary of the development (refer to Figure 2-2).

A single point discharge at a controlled rate to the Ordinary Watercourse located in the south of the site is acceptable, but other methods of managing surface water have been identified that negate the need for direct connections. If a direct discharge is desirable it would require approval from the Upper Medway IDB.

It is proposed that runoff from the DNO/Customer HV Compound will be managed utilising swales and level spreaders to intercept surface water runoff encouraging infiltration and assimilation within the vegetation and dissipate excess into the natural environment via sheet flows mimicking natural processes.

3.7 Runoff Rate and Volume Calculations

3.7.1 Solar Panels

As the solar panels will be mounted above ground, at an angle to the ground surface, the rain falling on the panels will immediately drop onto the existing soft landscaping under the panels. There will therefore be no increase in the runoff rates and volumes due to the panels.

As no panels are proposed perpendicular to the ground contours the risk of soil erosion and water channelling down the slope are minimised. It is therefore not deemed necessary to incorporate filter trenches/swales under the rows of panels.

3.7.2 Access Tracks

Internal access roads will be constructed from permeable materials such as MOT Type 3 (reduced fines aggregate) with a geogrid to enable surface water runoff to either infiltrate to the ground or run off at or below the greenfield runoff rate.

The surrounding area is greenfield land, as a result any additional runoff that is unable to infiltrate should not lead to any detrimental impacts either on or off-site.

3.7.3 DNO/Customer HV Compound

A DNO/Customer HV Compound will be constructed in the south west of the site measuring a total area of approximately 1050m^2. The compound area will comprise a DNO Compound, Customers Compound, Transformation Station and Switchgear Station.

Given that development of the DNO/Customer HV Compound area will introduce impermeable surfacing to the site post development water quality and quantity need to be considered. Both water quantity and quality from the DNO/Customer HV Compound area will be managed via combination of filter drains, swales and level spreaders.

3.7.4 Greenfield runoff rates

Formal attenuation is not proposed for this development but to gain an understanding of the impact of the DNO/Customer HV Compound on runoff the FEH Method was used to estimate the greenfield runoff rates for the whole site and the areas of impermeable surfacing associated with the compound and battery storage, assuming that these areas were completely undeveloped, based on FEH catchment descriptors and the parameters listed below.

- Whole Site area – 74.5Ha
- DNO/Customer HV Compound) area – 0.154 Ha
- SAAR – 671
- BFI / BFIHOST – 0.67
- Hydrometric region – 7

Table 3-2: Greenfield runoff peak rates

Storm Event	Greenfield Site Runoff Rates (l/s)	
	Whole Site	**DNO/Customer HV Compound**
QBAR Rural	113.03	0.57
1 in 1-year	96.08	0.48
1 in 30-year	259.97	1.31
1 in 100-year	360.57	1.81

The QBAR runoff rate for the DNO/Customer HV Compound has been estimated as 0.57 l/s.

3.7.5 DNO/Customer HV Compound

Preliminary sizing of the required swale storage for the DNO/Customer HV Compound area has been carried out using the Source Control module in MicroDrainage. Simulations were run to calculate the required volume to capture the first flush of runoff generated by impermeable surfacing within the DNO/Customer HV Compound from all storm events.

It is understood that the majority of the DNO/Customer HV Compound will remain underlain by permeable gravel surfacing post development. Therefore, swale storage sizing for DNO/Customer HV Compound has been conservatively (high) based on slab runoff and roof runoff, amounting to a total area of 1050m^2.

Precipitation which lands upon the impermeable slab within the Customer Compound will runoff straight into a vegetated swale with level spreader. Precipitation which lands upon roof areas associated with the Transformation Station and Switchgear Station will be directed towards filter drains which will be conveyed towards a vegetated swale with level spreader. Runoff that exceeds the interception capacity of the swale will dissipate the surface water via level spreaders back into the environment.

The main purpose of the swale and level spreaders will be to intercept and dissipate the surface water runoff generated by the DNO/Customer HV Compound and turn it into a sheet flow to mimic natural runoff conditions. The use of above ground SuDS will also provide ecological and amenity benefits.

The swale sizing has been estimated based on the following design parameters:

Design rainfall using FEH catchment descriptor data imported into MicroDrainage software

Runoff coefficient values as 0.75 and 0.84 (default values from MicroDrainage) (summer and winter accordingly)

Impermeable area – 1050m^2 / 0.105 Ha. Calculated from drawing reference SCUKX-MARDN-001-100G (20211222) External Release.

The MicroDrainage calculation sheets are shown in Appendix E.

Calculations indicate that approximately 16.3m^3 of storage will be required to capture the first flush of runoff from 1050m^2 of impermeable surfacing from all storm events.

Preliminary calculations indicate that a swale with a length of 5m for roof areas associated with the Transformation Station and Switchgear Station and 40m for the impermeable slab within the Customer Compound. Both swales have a base width of 1.0m, 1:3 side slopes and have a max water depth of 200mm which will capture the first flush of runoff generated by impermeable surfacing from all storm events.

Flows in excess of the 16.3m^3 will be converted into very shallow sheet flows (ranging between 1mm and 12mm for the 1 in 100-year plus 45% climate change rainfall event) spilling over the edge of a dropped kerb to act as a high-level overflow.

The calculated required storage volumes for the DNO/Customer HV Compound is based on currently available information and design parameters described in this report. If any design parameters, including the current proposed site layout change, the calculations will need to be revisited to confirm their suitability.

The proposed surface water drainage plan is given in Appendix F.

3.7.6 Runoff Treatment

In accordance will the CIRIA SuDS Manual runoff from roof areas is considered to have a pollution hazard rating of very low. Nevertheless, it is suggested to include debris / sediment traps on any new drainage.

Runoff from both Catchments will be directed towards vegetated swales via filter drains before discharging into an ordinary watercourse and the Lesser Teise, respectively.

The simple Index Approach in the CIRIA SuDS Manual states that other roofs (typically commercial and industrial roofs) have pollution hazard indices of 0.3, 0.2 and 0.05 for total suspended solids (TSS), metals and hydrocarbons respectively. Low traffic roads and non-residential car parking with infrequent changes (ie < 300 traffic movements a day) have pollution hazard indices of 0.5, 0.4 and 0.4 for TSS, metals and hydrocarbons respectively.

The indicative SuDS mitigation indices for the proposed SuDS features are as follows:

- Filter drains: 0.4, 0.4 and 0.4 for TSS, metals and hydrocarbons respectively. And;
- Swales: 0.5, 0.6 and 0.6 for TSS, metals and hydrocarbons respectively.

As such, the proposed SuDS features have a mitigation index higher than the pollution hazard index.

The proposed SuDS components will therefore provide adequate treatment for surface water runoff.

3.7.7 Amenity and Biodiversity

The proposed strategy utilises a combination of filter drains and swales to manage surface water runoff from the development.

The ecological potential of the SuDS system can be maximised by utilising local planting and locating SuDS adjacent to proposed impermeable features. The strategy should create a range of habitats and provide varied water depths within the SuDS features which should be sustained by ensuring that an effective management regime is implemented.

3.7.8 Design for exceedance

All SuDS features have been sized to sufficiently accommodate all surface water runoff during the modelled 1 in 100-year plus 45% climate change event.

Despite this, final site level setting and landscaping should be considered such that any exceedance surface water flows, caused as a result of blockage or extreme rainfall event, are directed away from the proposed structures and towards the formal drainage systems or less vulnerable areas such as open spaces.

3.8 Construction stage

Surface water runoff will need to be managed during the construction stage of the development to minimise the risk of flooding and pollution to the surrounding environment. This will be addressed within an Environmental Management Plan prepared for the development by an appointed contractor for the works prior to construction commencing.

4 Long Term Management

It is envisaged that the surface water drainage system will remain in private ownership and be maintained by the site owner/occupier or their appointed management company.

A maintenance plan will be prepared prior to the site occupancy to ensure the drainage system remains operational and effective for the lifetime of the development.

The long-term management strategy will be confirmed at condition discharge stage, however the following maintenance items are recommended for the conveyance system, filter drain and swale:

Table 4-1: Drainage System Maintenance Requirements

Element	Activity	Frequency
Conveyance pipes and chambers	Visual inspection and jetting /cleaning	Every five years or as required
	Visual inspection for physical damage and remediation	Annually or as required
Catchpits	Visual inspection and jetting /cleaning	Annually or as required
	Visual inspection and replacement/ re-setting covers if damaged and/or dislodged	Annually or as required
Level Spreader	Visual inspection and remediation of any faults	Annually or as required following significant storm event

Notes:

1. Jetting of pipes should only be carried out after removal of larger debris, as jetting alone may dislodge the debris further downstream leading to an increased flood risk elsewhere.
2. The removed waste material (both solids and liquids) from the drainage conveyance/ storage system should be treated as contaminated and disposed of at a licenced waste management facility. It should not be re-used within the development or outside its boundary to minimise the risk of pollution to the environment.

The CIRIA SuDS manual 2015 stipulates the following maintenance requirements for the proposed SuDS elements.

Figure 4-1: Swale Maintenance Requirements (From CIRIA SuDS Manual 2015)

TABLE 17.1 Operation and maintenance requirements for swales

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Remove litter and debris	Monthly, or as required
	Cut grass – to retain grass height within specified design range	Monthly (during growing season), or as required
	Manage other vegetation and remove nuisance plants	Monthly at start, then as required
	Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly
	Inspect infiltration surfaces for ponding, compaction, silt accumulation, record areas where water is ponding for > 48 hours	Monthly, or when required
	Inspect vegetation coverage	Monthly for 6 months, quarterly for 2 years, then half yearly
	Inspect inlets and facility surface for silt accumulation, establish appropriate silt removal frequencies	Half yearly
Occasional maintenance	Reseed areas of poor vegetation growth, alter plant types to better suit conditions, if required	As required or if bare soil is exposed over 10% or more of the swale treatment area
Remedial actions	Repair erosion or other damage by re-turfing or reseeding	As required
	Relevel uneven surfaces and reinstate design levels	As required
	Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface	As required
	Remove build-up of sediment on upstream gravel trench, flow spreader or at top of filter strip	As required
	Remove and dispose of oils or petrol residues using safe standard practices	As required

Figure 4-2: Filter Drain Maintenance Requirements (From CIRIA SuDS Manual 2015)

TABLE 16.1 Operation and maintenance requirements for filter drains

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Remove litter (including leaf litter) and debris from filter drain surface, access chambers and pre-treatment devices	Monthly (or as required)
	Inspect filter drain surface, inlet/outlet pipework and control systems for blockages, clogging, standing water and structural damage	Monthly
	Inspect pre-treatment systems, inlets and perforated pipework for silt accumulation, and establish appropriate silt removal frequencies	Six monthly
	Remove sediment from pre-treatment devices	Six monthly, or as required
Occasional maintenance	Remove or control tree roots where they are encroaching the sides of the filter drain, using recommended methods (eg NJUG, 2007 or BS 3998:2010)	As required
	At locations with high pollution loads, remove surface geotextile and replace, and wash or replace overlying filter medium	Five yearly, or as required
	Clear perforated pipework of blockages	As required

5 Construction (Design and Management) review

Under the construction (Design and Management) Regulations (CDM 2015) it is the designer's duty to:

- Eliminate foreseeable health and safety risks to anyone affected by the project
- Take steps to reduce or control any risks that cannot be eliminated
- Communicate, cooperate and coordinate with the client, other designers and contractors involved in the project so that designs are compatible, and health and safety risks accounted for during the project and beyond.

The following hazards associated with construction, operation and maintenance of the mitigation measures outlined in Section 3 and 4 have been identified during the preliminary site assessment:

Activity	Hazard / Risk	Eliminate Hazard / Reduce Risk	Control Measures
Construction Stage			
Construction of drainage system/ Excavations	Underground services - any potential unidentified services within the site boundary	Further information, including utility detection survey, will be needed in order to fully check for clashes at the detailed design stage.	Detailed utility survey to be carried out prior to construction commencing to confirm the location and details of the existing services and check for any unidentified services.
Construction of drainage system/ Excavations	Hazard - Ground and groundwater conditions Risks: • Collapse of drainage systems due to soil stability issues; • Potential residual contaminants; • Pollution to surface water.	Proposed SuDS to be shallow and lined. Despite this, ground investigations should be undertaken to check soil stability and groundwater.	Long term groundwater monitoring and testing of geotechnical properties of soils to confirm design parameters.
Plant / Material Delivery	Hazard -Vehicular access to the site from Sheephurst Lane; Risk - Collisions and injury/ damage to people/vehicles.	Hazard cannot be eliminated by design. Hazard not specific to drainage construction but applicable to the wider site construction.	Site managed to minimise risks. Traffic management to be prepared prior to

			construction activities commencing. Public to be notified of construction activities to take place.
Excavations/ Connection to watercourse	Hazards - working at height, flowing water; Risk - fall into excavation, injury, ill health, asphyxiation, drowning.	Hazard cannot be eliminated by design. The proposed drainage system is to be designed to achieve the required hydraulic conditions whilst minimising depth of excavation.	Trench supports as required. Minimise man entry to confined spaces.
Construction activities	Environmental: • Pollution to soil and the local water environment	Early identification of any TPOs and other environmental / ecological factors which may impact upon design and construction.	Surveys undertaken. Site managed to minimise risks.
Construction activities	Unexploded ordnance	Unexploded bomb (UXB) risk map has been reviewed through https://zeticauxo.com/ The website shows the site has a 'moderate' UXB risk.	Unexploded bomb (UXB) risk map reviewed. Observation during excavations
Maintenance Stage			
Working in watercourse	Hazards: • Working near water Risks: • Drowning • Asphyxiation • Ill/health/ death	Hazard cannot be eliminated by design.	Over-pumping/bung at upstream section of watercourse may be required to manage the existing flow in the channel. Work to be undertaken in dry weather conditions.
Working near open SuDS features	Hazards: • Working near water • Uneven Ground	It is recommended that all SuDS features are constructed following best practice guidance.	shallow side slopes, maximum design water depth with

	Risks: • Drowning • Slips trips and falls • Ill/health/ death		overflow, passive surveillance, detailed design in accordance with Health and safety principles for SuDS: framework and checklists CIRIA RP992 The SuDS Manual Update Paper RP992/17
Clearance of drainage system	Hazards - oil/fuel, sediment, working at height Risks -pollution, falls in watercourse/ ill health	Hazard cannot be eliminated by design. Non-man entry inspection chambers should be used, where possible, to eliminate confined space entry.	Any sediment / debris removed from the drainage system should be considered as contaminated and disposed of to a licenced waste management facility.
Decommissioning Stage			
Removal of the drainage system.	Hazards and risks: largely as per the construction stage, except that the removal of the drainage system will increase a risk of flooding / pollution to the site and the local area.	It is recommended to reinstate the site to greenfield condition or install replacement SuDS based drainage in line with the current guidance.	Reinstate the site to greenfield condition or install replacement SuDS based drainage in line with the current guidance.

It should be noted that the potential hazards have been identified through a desk study of currently available information and this list should not be considered as exhaustive. A detailed site survey should be undertaken prior to any construction / installation activities commencing to confirm the presence of potential unidentified hazards on and in the immediate vicinity of the site.

6 Conclusions and recommendations

JBA Consulting was commissioned by Donna Clarke of Origin Power Services Ltd in July 2021 to prepare an outline Surface Water Drainage Strategy to support a planning application for development of a solar energy farm at Land to the West of Marden, Kent. In February 2023, JBA were requested to revise the report, and associated MicroDrainage calculations, to reflect provision of new DNO/Customer HV layout. This report details the revised Surface Water Drainage scheme.

The proposed development site is approximately 74.5ha in size and is situated to the north of Sheephurst Lane, some 0.74km to the west of Marden. The site is currently occupied by agricultural fields thus considered greenfield land.

The proposed planning application relates to development of a solar energy farm including installation of photovoltaic panels and, construction of a DNO/Customer HV Compound and site access roads.

Post development the total impermeable area at the site will amount to 1050m^2, comprising of hardstanding associated with the DNO/Customer HV Compound.

It is understood that the individual solar panels will drain directly onto the ground and the site access roads will be underlain by permeable gravel surfaces (MOT Type 3 or similar).

It is understood that the majority of the DNO/Customer HV Compound will remain underlain by permeable surfacing post development. Therefore, swale storage sizing for DNO/Customer HV Compound has been based on slab runoff and roof runoff only, amounting to a total area of 1050m^2.

Precipitation which lands upon the impermeable slab within the Customer Compound will runoff straight into a vegetated swale with level spreader. Precipitation which lands upon roof areas associated with the Transformation Station and Switchgear Station will be directed towards filter drains which will be conveyed towards a vegetated swale with level spreader. The level spreaders will dissipate the surface water runoff back into the environment.

The main purpose of the swale and level spreaders will be to disconnect formal drainage from the local watercourses, intercept and dissipate the surface water runoff generated by the DNO/Customer HV Compound and turn it into a sheet flow to mimic natural processes. The use of above ground SuDS will also provide ecological and amenity benefits.

Calculations indicate that approximately 16.3m^3 of storage will be required to capture the first flush of runoff from 1050m^2 of impermeable surfacing from all storm events.

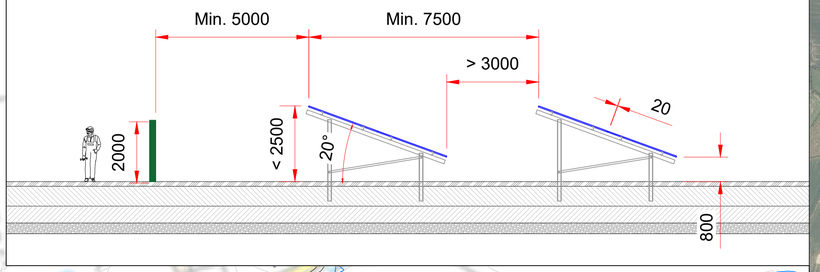
Preliminary calculations indicate that a swale with a length of 5m for roof areas associated with the Transformation Station and Switchgear Station and 40m for the impermeable slab within the Customer Compound. Both swales have a base width of 1.0m, 1:3 side slopes and have a max water depth of 200mm which will capture the first flush of runoff generated by impermeable surfacing from all storm events.

Flows in excess of the 16.3m^3 will be converted into very shallow sheet flows (ranging between 1mm and 12mm for the 1 in 100-year plus 45% climate change rainfall event) spilling over the edge of a dropped kerb to act as a high-level overflow.

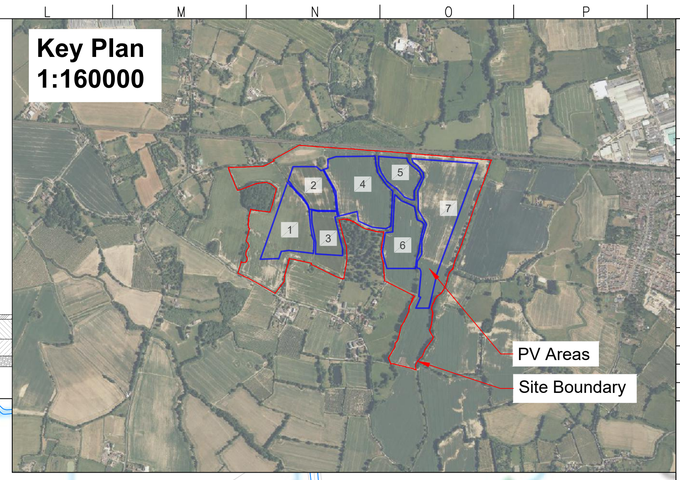
Appendices

A Proposed Site Plan

Cross-section of framework
M 10:1@A1



Key Plan
1:160000



SUMMARY NOTES

1. All dimensions are in 'mm' unless otherwise indicated.
2. Any deviations to be recorded and communicated to Statkraft.
3. A site visit conducted 06/09/2022 showed no presence of the banked area.

COORDINATES	
COORDINATE SYSTEM (CRS)	OSGB1936.NationalGrid
COORDINATE	51.171684, 0.460796

SYSTEM SUMMARY	
LAND OWNERSHIP AREA (GROSS)	74.51 ha
FENCED PV AREA	48.44 ha
INVERTER TYPE	String
TILT ANGLE	20°
AZIMUTH ANGLE	0
PITCH	7.5 m
STRUCTURE TYPE	Fixed Tilt
TABLE CONFIGURATION	2P
MAX TABLE HEIGHT	< 2.5 m

LEGEND

- Railway
- Overhead Line (OHL)
- Connection Route
- Perimeter Fence
- Site Boundary
- Public Footpath
- Public Footpath (Removed)
- Public Footpath (Permissive)
- Proposed Hedgerow (2m wide)
- Gapping Up Hedgerow
- Proposed Meadow Mix
- Proposed Woodland Screening
- Proposed Orchard
- Proposed Biodiversity Woodland
- Maintenance Road
- Ditch
- Water body
- Pond Proposal
- Trees
- Transformer Stations
- PV Structure 2P30
- PV Structure 2P15
- Point of Connection (POC)

33 kV OHL
Proposed Woodland Screening
Pond Proposal
Public Footpath
Min. 35 000 to PV Framework
Min. 30 000 to Fence
Proposed Biodiversity Woodland
Site Boundary
132 kV OHL
Edge of Park Switchgear Station
Point of Connection (POC)
Connection Route
Pond Proposal
Ditch Crossing
Removed Banked Area (see notes)
Monitoring Cabin
Site Access Gate
DNO/Customer HV Compound
DNO accessible via internal road
OHL to consider
33 kV OHL
Railway
Public Footpath (Permissive)
Public Footpath
Public Footpath (Removed)
Proposed Orchard
Proposed Meadow Mix
Proposed Hedgerow
Gapping Up Hedgerow
Perimeter Fence
Min. 5000
2000
Proposed Woodland Screening

0m 50m 100m 150m 200m 250m 300m

PROPOSAL ONLY

Statkraft

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REV	DATE	DETAIL	DRAWN	APPROVER
M	24/11/2022	PV Area Revised	AM	PP
L	17/11/2022	PV Area Revised	AM	AP
P	22/03/2023	Fence & HV Compound Revised	AM	
O	23/02/2023	Layout Updates	MB	AM
N	23/01/2023	Inverter Quantity Revised	AM	AP

100 General PV Layout		SCALE	1:3000 A1
SCUKX-SHEEP-000 100 (P)		SHEET	1 of 1

B Topographic Survey

SCALE OF MAIN DRAWING:
1:2000 when printed 100% on A0
Do not scale from this plot. All dimensions to be checked on-site.

LEGEND

- Tree canopy/hedgerow/foliage. Heights where given are to nearest meter.[1]
- Tree shapes for use in *PVcase*. **These do not represent exact tree locations**, but rather, entities which will be automatically recognised and converted to appropriate shading elements by *PVcase*. Areas of forest are therefore filled with trees of appropriate height. Height to nearest meter.[1]
- Water (dashed for apparent drainage feature or approx. path)
- Sealed road
- Unsealed track
- Power-line (or other overhead line) with utility post
- Fence, gate
- Railway track
- Public footpath/bridleway
- Apparent field boundary (As seen from aerial survey. NOT official boundary.)
- UAV mapping boundary (approx.)
- Building or other permanent structure
- Stone wall

ELEVATIONS

- Elevation of point above vertical datum (see 'COORDINATE REFERENCE SYSTEM AND DATUM' at bottom).[2]
- Contours (0.25 m) of digital surface model (dashed when over areas of obvious crop or vegetation).[3,4]

G.I.S. DATA

- 100m grid in OSGB36 map projection
- LAT. LONG. The specific lines of latitude and longitude which pass through the site are marked in degrees, minutes, seconds (WGS84).
- NORTH Grid North follows the direction of the North-South lines of the OSGB36 grid.
  True North follows lines of longitude, which converge on the axis of rotation of the Earth. True South points to the equator.
  The convergence angle (precision 2 d.p.) between Grid North and True North for this specific location is given.
  Magnetic North is not shown (but will be different again).

Third-party data

Site boundaries from client. Approx. public footpath routes from OS map.

NOTES

1. Heights of hedgerows and dense trees are marked alongside the foliage. All tree/hedge heights given are approximate heights above nearby ground, based on the Digital Surface Model.
2. It is important to note that this grid is from a Surface Model, not a Terrain Model, and therefore point-heights can only be interpreted as terrain when on areas of earth or hardstanding.
3. Likewise, the Contours are surface contours, not terrain contours, so should be interpreted carefully. Where contours are obviously not on earth or hardstanding, they are dashed.
4. Contours are generated from a subsampled (10m) terrain model to provide smooth but representative contour lines. Where contours cross trees, the path of the contour below the tree(s) is approximated.
5. Lat./long. lines are precisely calculated, but should be considered approximate because they represent a spherical coordinate system on a map projection. Locations and dimensions are accurate in the underlying map projection. But conversion of coordinates from the map projection to lat./long. (if required) should be performed using the appropriate transformation, not by inference from this plot.
6. Features hidden under dense vegetation (e.g. walls, fences) are only marked if visible from drone footage (or location otherwise provided or noted).

REVISIONS

1.0	8 Oct. 2021	Published to client [TMH]

PROJECT
STATKRAFT - UAV SURFACE TOPOGRAPHY
Sheepwash Project in Kent, U.K.

TITLE
SHEEPWASH LINEWORK ("CAD")

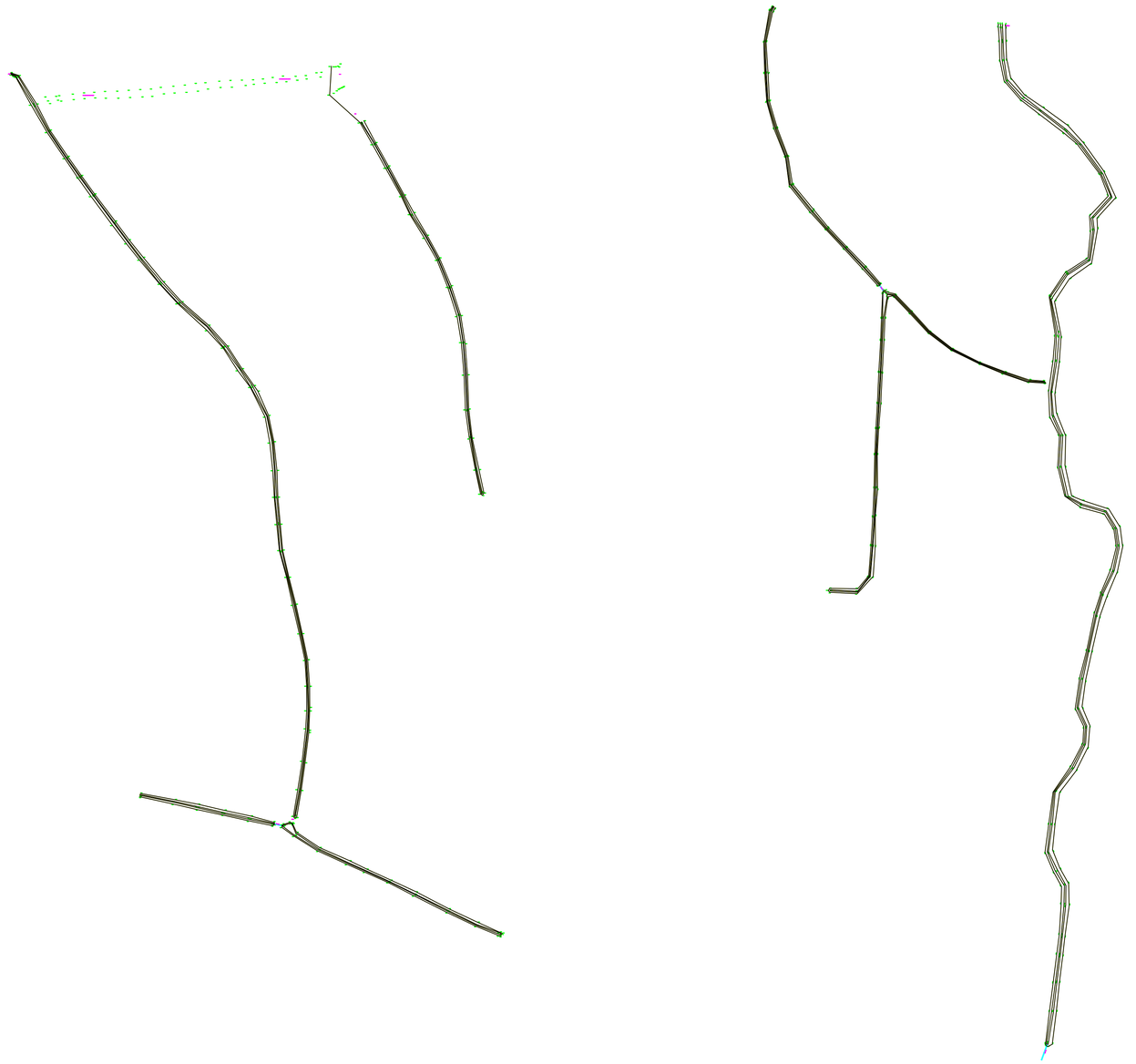
DETAILS
Statkraft, 19th Floor, 22 Bishopsgate, EC2N 4BQ,
London (Gareth Hawkins)

above
Above Surveying Ltd.
Block C2 Knowledge Gateway
Nesfield Road,
Colchester, CO4 3ZL, U.K.
T: +44 1206 483043
E: support@abovesurveying.com

LOCATION
West of Marden, Kent, TN12 9NZ

COORDINATE SYSTEM AND DATUM
OSGB36, British National Grid Map Projection (EPSG: 27700). Units: meters
Elevations relative to sea level as height in meters above Ordnance Datum Newlyn (ODN) (EPSG: 5101). Geoid model, OSGM15.

C Watercourse Survey



GRID
NORTH

0 25 50 75 100 m

Original Drawing Size: A1

NOTES:–

The accuracy and content of this drawing are dependent on the original specification and EDI should be consulted before use at other scales.

Where underground services are shown, all reasonable care has been taken within the spirit of the original specification and requirement. Before use of this information the user should consult EDI and satisfy themselves of the completeness and accuracy of such detail before undertaking any works. Due to the nature of this work and limitations imposed by ground conditions and the detection equipment no guarantee can be given that all services have been recorded. Trial holes should be dug at critical locations.

All reasonable care has been taken in the survey detail represented on this drawing but any discrepancies must be reported to EDI immediately.

Our aim is to produce the best possible results within the specification and cost constraints of our clients. Any comments are most welcome.

Levels shown at kerbs are channel level unless stated.

LEGEND

Features:
AV Air Valve
AB Air Brick
BO Bollard
BH Borehole
BM Benchmark
BP Boundary Post
BS Bus Stop
BT British Telecom
CL Cover Level
COL Column
CTV Cable TV Cover
DCH Drainage Channel
DF Drinking Fountain
DIS Disused
DK Drop Kerb
DPC Damp proof Course
EIC Electricity IC
EJ Expansion Joint
FP Forth Rod
FH Fire Hydrant
FHR Fire Hose Reel
FO Flagstaff
G Gully
GV Gas Valve
IC Inspection Cover
IL Invert Level
JBX Junction Box
KO Kerb Outlet
LB Letter Box
LBN Litter Bin
LLP Low Level LP
LP Lamp Post
MP Marker Post
MS Mile Stone
MT Mercury Telecom
OHL Overhead Line
OP Overflow Pipe
PM Parking Meter
PP Power Pole
RAD Radiator
RE Rodding Eye
RNP Road Name Plate
RS Road Sign
RSD Roller Shutter Door
RWP Rain Water Pipe
SD Service Duct
SV Stop Valve
TCB Telephone Call Box
TP Telegraph Pole
TS Traffic Signal
UB Universal Beam
UNK Unknown
UR Urinal
UTL Unable to lift
V Vent
VP Vent Pipe
WM Water Meter
WO Wash Out
WP Waste Pipe

Building Level Details:
D Door
EL Eave Level
FFL Floor Level
FRL Flat Roof Level
HL Head Level
PPL Parapet Level
RL Ridge Level
SL Sill Level
SP Springer of Arch
TA Top of Arch
W Window
62.30 Ceiling/Beam Soffit

Boundary Types:
BW Barbed Wire
CB Close Boarded
CH Chainlink
CI Corrugated Iron
CP Chestnut Paling
IR Iron Railing
IW Interwoven
LL Larch Lap
PAL Palisade
PR Post & Rail
PW Post & Wire
TNR Timber Knee Rail
RTW Retaining Wall
VSF Vehicle Safety Fence
WMF Wire Mesh Fence

Surfaces & Finishes:
B Brickwork
BB Breeze Block
C Concrete
CLT Ceiling Tiles
CP Carpet
CPS Concrete Paving Slabs
CPT Carpet Tiles
CR Concrete Render
CT Ceramic Tiles
FT Floor Tiles
HBD Hardboard
L Linoleum
P Plaster
PAV Brick Paviors
S Steel work
T Tarmac
TSP Textured Safety Paving
VT Vinyl Tiles

Services:
E CATV cables
CCTV cables
D Data cables
E Electric cables
Foul water
G Gas pipes
Heating duct
SD Service ducts
Storm water
T Telecom cab.
Unidentified
W Water pipes
150ø Pipe Diameter/Flow
Overhead Lines

Survey Station
Fence
Gate
Painted Road Markings
Edge of Vegetation
Kerb/Drop Kerb
Tree
Top
Bottom
Banks
Building
Overhead Building Detail
Wall

Control: All levels and co-ordinates are related to the datums described.

The horizontal control of this survey is based on Ordnance Survey grid as translated from GPS coordinates using Leica's SmartNet service. We have not applied a reverse scale factor and therefore all dimensions will be scaled by the local OS scale factor. The vertical control of this survey is based on OS datum as translated from GPS coordinates using the OSGM02 transformation as supplied by the OS. This may differ from the existing OS benchmarks in the area which should be disregarded; all levels should be taken from EDI survey stations.

Rev.	Job No.	Date	Revision Detail	Surveyor	Chkd

CLIENT

Statkraft (Gareth Hawkins)
Unit C2
19th Floor, 22 Bishopsgate
London
EC2N 4BQ

PROJECT

Ditch Surveys
"Sheepwash" Project
West of Marden
Kent
TN12 9NZ

Job No.	Surveyor	Checked	Date	Scale
19914	S.Cullum	LW	Oct. 2021	NTS

GROUND SURVEYING CONDUCTED BY:

EDI SURVEYS LTD
163-165 Ranelagh Road, Ipswich, Suffolk IP2 0AH
Telephone | 01473 211222
Email | enquiries@edisurveys.co.uk
Our Services:- Topographic Surveys, Measured Building Surveys, GPS Surveying and Control, 3D laser Scanning, Utility Surveying and Drainage Investigation.
Click the link below to visit our website and find out more.
www.edisurveys.co.uk

DRAWING No. 19914/T/01-01

REV. -

DELIVERABLES PROVIDED BY:

above
Above Surveying Ltd.
Block C2 Knowledge Gateway
Nesfield Road,
Colchester, CO4 3ZL, U.K.

T: +44 1206 483043
E: support@abovesurveying.com

D Southern Testing Ground Water Monitoring

Our Ref: PS/KJ/J14893

25 August 2021

Origin Power Services Limited
Lower Ground Floor
40 Bloomsbury Way
London
WC1A 2SE

For the attention of Donna Clarke
Email: donna.clarke@originpower.co.uk

Southern Testing
Environmental & Geotechnical

Southern Testing Laboratories Ltd
Keeble House, Stuart Way
East Grinstead, West Sussex RH19 4QA

t 01342 333100 f 01342 410321
e info@southerntesting.co.uk w southerntesting.co.uk

Dear Madam,

Re: Trial Pitting Investigation at: Land West of Marden, Kent, TN12 9SD
National Grid Reference: TQ 72233 44554
Geology: Alluvium / River Terrace Deposits over Weald Clay

1 Authority

Our authority for carrying out this work is contained in our completed Project Order Form from Donna Clarke of Origin Power, dated 10 August 2021.

2 Background and Objectives

The object of the investigation was to understand the in-situ ground and groundwater conditions in the area of the proposed compound and access road, to assist the drainage strategy to be completed by the Engineer.

3 Scope

This letter report presents our exploratory hole logs and water monitoring results. As with any site there may be differences in soil conditions between exploratory hole positions.

This report is not an engineering design and the figures and calculations contained in the report should be used by the Engineer, taking note that variations will apply, according to variations in design loading, in techniques used, and in site conditions. Our figures therefore should not supersede the Engineer's design.

Contamination issues are not considered in this report.

The findings and opinions conveyed via this Site Investigation Report are based on information obtained from a variety of sources as detailed within this report, and which Southern Testing Laboratories Limited believes are reliable. Nevertheless, Southern Testing Laboratories Limited cannot and does not guarantee the authenticity or reliability of the information it has obtained from others.

The site investigation was conducted and this report has been prepared for the sole internal use and reliance of Origin Power Ltd and their appointed Engineers. This report shall not be relied upon or transferred to any other parties without the express written authorization of Southern Testing Laboratories Limited. If an unauthorised third party comes into possession of this report they rely on it at their peril and the authors owe them no duty of care and skill.

Recommendations contained in this report may not be appropriate to alternative development schemes.

4 Geology

The published geology for the site comprises River Terrace Deposits over Weald Clay (with Limestone in the Weald Clay marked to the south of the subject site).

4.1 Terrace Gravels

Terrace Gravels are sheets of irregular and sub-rounded gravel and sand, laid down as terraces alongside rivers. Lenses of silt, clay or peat may also be present. Their composition reflects the geology of the river catchment area.

Terrace Gravels were commonly worked in the past, often on a piecemeal basis in 'borrow pits' as well as larger mineral workings. Old pits may have been infilled with poor quality or waste materials, and can contain contamination.

4.2 Weald Clay Formation

The Weald Clay Formation comprises dark grey thinly-bedded shales and mudstones with subordinate siltstones, sandstones (including the Horsham Stone Member), shelly limestones and clay ironstones. The mudstones weather to yellow and brown clays. Conspicuous bands of red clay also occur, usually in close association with sandstone beds.

The clays have often been worked for various purposes, and the clay ironstone, a low-grade iron ore, was worked from sporadic beds across the Wealden area. The steep sides of the degraded remains of former workings are usually unstable. Other workings have been filled with a variety of materials.

This formation is known to contain pyrite.

5 Site Description

The site comprised a series of agricultural fields which lay to the north of Sheephurst Lane.

The fields were generally level and were divided by drainage ditches and tree lined hedgerows. There were a number of mature oak trees within the hedgerows. Some of the fields were planted with wheat.

Access to the site was via an access track to the west of Little Cheveney Farm. A 6m wide grassed conservation strip was present around the boundaries of the fields.

6 Fieldwork

The fieldwork comprised the excavation of 4 No. trial pits at locations indicated by the Engineer. These were within the grassed margins of the fields and are shown on the appended plan (Figure 1).

The trial pits were excavated on 19 August 2021 at which time the weather was mild and dry.

7 Soils as found

The soils encountered are described in detail in the attached exploratory hole logs, but in general comprised a covering of weathered Terrace Gravels or weathered Clay over Weald Clay. A summary is given below.

Depth (m)	Thickness (m)	Soil Type	Description
GL – 0.2/0.3	0.2-0.3	Topsoil	Dark brown silty clay TOPSOIL with rootlets
0.2/0.3 – 0.5/0.7	0.3	Subsoil	Firm pale brown slightly silty CLAY with rootlets

Depth (m)	Thickness (m)	Soil Type	Description
0.5 – 2.7/2.9	2.2	CLAY	Stiff and very stiff pale grey mottle dark brown CLAY becoming laminated at depth. (Abundant selenite crystals from 2.0m in TP01 and TP02).
1.4 - 2.1/2.9 TP03 & TP04 only	0.7-1.5	GRAVEL	Pale brown and dark orange brown silty sandy GRAVEL. Gravel is fine to medium flat SILTSTONE, SANDSTONE and rounded flint with some black ironstaining. (Moist)
2.5/2.6 - 2.53/2.63 TP01 & TP02 only	0.03	LIMESTONE	Dark grey and cream shelly LIMESTONE band
2.7/2.9 -3.0/3.1+	0.3+	CLAY / MUDSTONE	Stiff and very stiff pale blue grey fissured CLAY (becoming weak MUDSTONE at base of pit in TP01 and TP02)

8 Groundwater Observations

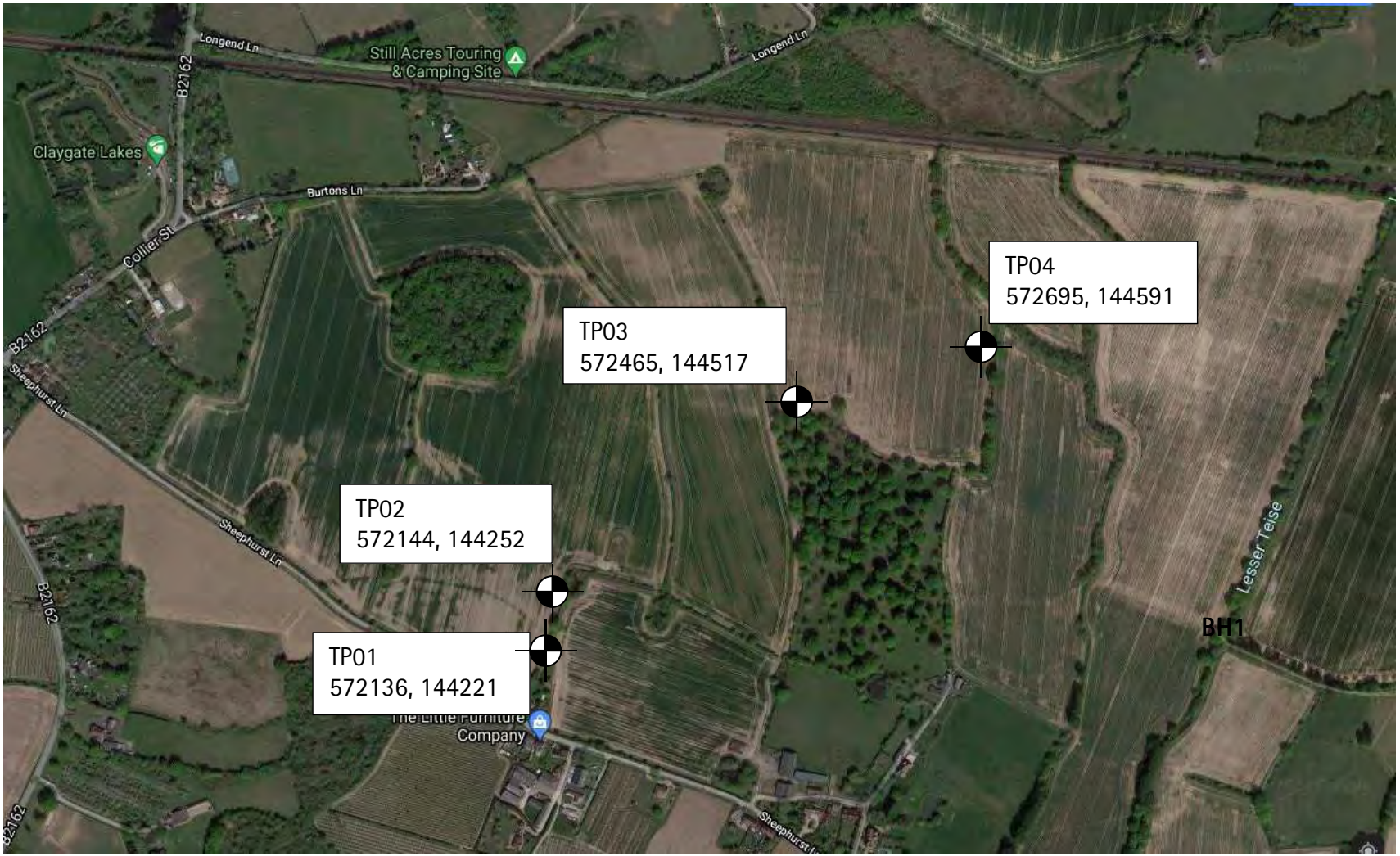
Groundwater was encountered in all the trial pits and was observed as follows.

Trial Pit	Initial Strike (m bgl)	Depth of Pit (m bgl)	Water Level Observation (m bgl)
TP01	Slow seep 3.0m	3.0	After 30mins = 2.85 After 60mins = 2.80 After 90mins = 2.75 After 120mins = 2.70
TP02	Slow seep 3.0m	3.1	After 30mins = 2.95 After 60mins = 2.90 After 90mins = 2.90
TP03	Moderate seep 2.1m	2.5	After 30mins = 2.20 After 90mins = 2.15 After 135mins = 2.10
TP04	Moderate seep 1.9m	3.1	After 15mins = 2.25 After 30mins = 2.20 After 45mins = 2.05 After 60mins = 2.00

If you have any queries or we can be of further assistance, please do not hesitate to contact us

Yours faithfully,

P J Sugden MSc FGS
For and on behalf of
Southern Testing Laboratories Limited
Email: psugden@southerntesting.co.uk



NB: Positions trial pits are only indicative unless dimensioned

Site: Land to West of Marden, Kent	STL: J14893	Fig No: 1
Date: 19 August 2021	Trial Pit Location Plan	

Southern Testing

Southern Testing: Keeble House, Stuart Way, East Grinstead, West Sussex RH19 4QA
ST Consult: Twigden Barns, Brixworth Road, Creaton, Northampton NN6 8NN

ST Consult

Southern Testing ST Consult

www.southerntesting.co.uk tel:01342 333100 www.stconsult.co.uk tel:01604 500020

Start - End Date:	Project ID:	Machine Type:	TP01
19/08/2021	J14893	JCB 3CX	Sheet 1 of 1

Project Name:	Land West of Marden, Kent, TN12 9SD	Remarks:	Co-ordinates:	Level (m AOD):	Logger:
			E 572136 - N 144221		PJS
Location:	Land West of Marden, Kent, TN12 9SD				
Client:	Origin Power Services Limited				

Samples and Insitu Testing			Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description
Depth (m)	Type	Results					
				(0.20)		0.20	Dark brown silty clay TOPSOIL
				(0.30)		0.50	Pale brown slighly silty CLAY
				(2.03)			Very stiff pale grey mottled dark orange brown CLAY with some roots. Becoming laminated with depth. Abundant fine selenite crystals from 2.0m
				(0.17)		2.53	2.5-2.53m Dark grey and cream shelly LIMESTONE band
							Very stiff pale grey mottled dark orange brown laminated CLAY
				(0.30)		2.70	Very stiff pale blue grey fissured CLAY / MUDSTONE
						3.00	Pit terminated at 3.00m.

1 2 3 4

Pit Dimension (m)		Pit Stability:	Water Strikes:
Width:	0.60	Stable	Groundwater encountered at 3.0m - slow seepage
Length:	2.20		
Depth:	3.00		

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Start - End Date:	Project ID:	Machine Type:	TP02
19/08/2021	J14893	JCB 3CX	Sheet 1 of 1

Project Name:	Land West of Marden, Kent, TN12 9SD	Remarks:	Co-ordinates:	Level (m AOD):	Logger:
			E 572144 - N 144252		JAC
Location:	Land West of Marden, Kent, TN12 9SD				
Client:	Origin Power Services Limited				

Samples and Insitu Testing			Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description
Depth (m)	Type	Results					
				(0.30)			Dark brown silty clay TOPSOIL with occasion flint gravel and roots
						0.30	
				(0.20)			Stiff dark orange / dark brown gravelly CLAY. Gravel is balck fine to medium ironstained SILTSTONE
						0.50	
				(2.13)			Very stiff pale grey mottled pale orange laminated CLAY with fine rootlets throughout. Abundant fine selenite crystals from 2.0m.
						2.63	2.6-2.63m Dark grey and cream shelly LIMESTONE band
				(0.27)			Very stiff pale grey mottled pale orange laminated CLAY.
						2.90	
				(0.20)			Very stiff pale blue grey fissured CLAY / MUDSTONE
						3.10	Pit terminated at 3.10m.

1 2 3 4

Pit Dimension (m)		Pit Stability:	Water Strikes:
Width:	0.60	Stable.	Groundwater encountered at 3.0m
Length:	2.40		
Depth:	3.10		

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Start - End Date:	Project ID:	Machine Type:	TP03
19/08/2021	J14893	JCB 3CX	Sheet 1 of 1

Project Name:	Land West of Marden, Kent, TN12 9SD	Remarks:	Co-ordinates:	Level (m AOD):	Logger:
			E 572465 - N 144517		PJS
Location:	Land West of Marden, Kent, TN12 9SD				
Client:	Origin Power Services Limited				

Samples and Insitu Testing			Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description
Depth (m)	Type	Results					
				(0.30)		0.30	Brown silty clay TOPSOIL with rootlets
				(0.40)		0.70	Firm brown mottled orange silty CLAY
				(0.70)		1.40	Stiff orange brown mottled creamy grey silty CLAY withn frequent black ironstined patech, and occasional thinly bedded weak ironstained SILTSTONE bands
				(0.70)		2.10	Pale brown and dark orange brown silty sandy GRAVEL. Gravel is fine to medium flat SILTSTONE, SANDSTONE and rounded flint with some black ironstaining. (Moist)
				(0.40)		2.50	Stiff pale blue grey CLAY
							Pit terminated at 2.50m.

1 2 3 4

Pit Dimension (m)		Pit Stability:	Water Strikes:
Width:	0.60	Unstable in gravel	Groundwater encountered at 2.1m
Length:	2.20		
Depth:	2.50		

Southern Testing ST Consult	Start - End Date:	Project ID:	Machine Type:	TP04
www.southerntesting.co.uk tel:01342 333100 www.stconsult.co.uk tel:01604 500020	19/08/2021	J14893	JCB 3CX	Sheet 1 of 1

Project Name:	Land West of Marden, Kent, TN12 9SD	**Remarks:**	**Co-ordinates:**	**Level (m AOD):** / **Logger:**
Location:	Land West of Marden, Kent, TN12 9SD		E 572695 - N 144591	PJS
Client:	Origin Power Services Limited			

Samples and Insitu Testing			Level (m AOD)	Thickness (m)	Legend	Depth (m bgl)	Stratum Description
Depth (m)	Type	Results					
				(0.20)		0.20	Dark orange brown silty clay TOPSOIL with rootlets
				(0.40)		0.60	Firm pale yellow brown very silty CLAY with some black ironstained patches.
				(0.80)		1.40	Stiff yellow / orange mottled creamy grey CLAY with some black ironstained patches.
				(1.50)		2.90	Dark orange and dark brown slightly clayey sandy GRAVEL. Gravel is fine to coarse flat SILTSTONE and rounded flint with some black ironstaining. (Moist)
				(0.20)		3.10	Stiff pale blue grey CLAY
							Pit terminated at 3.10m.

Pit Dimension (m)		Pit Stability:	Water Strikes:
Width:	0.60	Unstable in gravel	Groundwater encountered at 1.9m
Length:	2.40		
Depth:	2.10		

TP01 Section

TP01 Section and Side

TP01 Arisings

TP01 Backfilled

TP02 Section

TP02 Arisings

TP02 Backfilled

TP03 Section

TP03 Stockpile showing gravels

TP03 Stockpile showing clay

TP03 Backfilled

TP04 Section

TP04 Stockpile showing gravels

TP04 Stockpile showing clay

TP04 Backfilled

E MicroDrainage Calculation Sheets

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Matthew Morrison
Site name:	DNO/Customer HV
Site location:	West of Marden

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:	51.17174° N
Longitude:	0.46085° E
Reference:	901717046
Date:	Feb 24 2023 14:03

Runoff estimation approach FEH Statistical

Site characteristics

Total site area (ha): 0.154

Methodology

Q_{MED} estimation method: Specify QMed manually

Q_{MED} (l/s): 0.5

Q_{BAR} / Q_{MED} factor: 1.14

Hydrological characteristics	Default	Edited
SAAR (mm):	671	671
Hydrological region:	7	7
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 30 years:	2.3	2.3
Growth curve factor 100 years:	3.19	3.19
Growth curve factor 200 years:	3.74	3.74

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):		0.57
1 in 1 year (l/s):		0.48
1 in 30 years (l/s):		1.31
1 in 100 year (l/s):		1.81
1 in 200 years (l/s):		2.12

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Matthew Morrison
Site name:	West of Marden
Site location:	West of Marden

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:	51.17174° N
Longitude:	0.46085° E
Reference:	3640994243
Date:	Feb 24 2023 14:37

Runoff estimation approach FEH Statistical

Site characteristics

Total site area (ha): 74.5

Methodology

Q_{MED} estimation method: Specify QMed manually

Q_{MED} (l/s): 99.5

Q_{BAR} / Q_{MED} factor: 1.14

Hydrological characteristics	Default	Edited
SAAR (mm):	671	671
Hydrological region:	7	7
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 30 years:	2.3	2.3
Growth curve factor 100 years:	3.19	3.19
Growth curve factor 200 years:	3.74	3.74

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):		113.03
1 in 1 year (l/s):		96.08
1 in 30 years (l/s):		259.97
1 in 100 year (l/s):		360.57
1 in 200 years (l/s):		422.74

Summary of Results for 100 year Return Period (+45%)

Half Drain Time : 2 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	17.114	0.214	0.0	14.5	14.5	1.8	Flood Risk
30 min Summer	17.110	0.210	0.0	8.8	8.8	1.7	Flood Risk
60 min Summer	17.108	0.208	0.0	6.4	6.4	1.7	Flood Risk
120 min Summer	17.106	0.206	0.0	3.7	3.7	1.7	Flood Risk
180 min Summer	17.105	0.205	0.0	2.8	2.8	1.7	Flood Risk
240 min Summer	17.104	0.204	0.0	2.4	2.4	1.6	Flood Risk
360 min Summer	17.103	0.203	0.0	1.6	1.6	1.6	Flood Risk
480 min Summer	17.103	0.203	0.0	1.6	1.6	1.6	Flood Risk
600 min Summer	17.103	0.203	0.0	1.2	1.2	1.6	Flood Risk
720 min Summer	17.103	0.203	0.0	1.2	1.2	1.6	Flood Risk
960 min Summer	17.102	0.202	0.0	0.9	0.9	1.6	Flood Risk
1440 min Summer	17.102	0.202	0.0	0.6	0.6	1.6	Flood Risk
2160 min Summer	17.102	0.202	0.0	0.6	0.6	1.6	Flood Risk
2880 min Summer	17.102	0.202	0.0	0.6	0.6	1.6	Flood Risk
4320 min Summer	17.101	0.201	0.0	0.4	0.4	1.6	Flood Risk
5760 min Summer	17.101	0.201	0.0	0.4	0.4	1.6	Flood Risk
7200 min Summer	17.101	0.201	0.0	0.4	0.4	1.6	Flood Risk
8640 min Summer	17.101	0.201	0.0	0.4	0.4	1.6	Flood Risk
10080 min Summer	17.101	0.201	0.0	0.2	0.2	1.6	Flood Risk
15 min Winter	17.112	0.212	0.0	10.9	10.9	1.7	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	206.740	0.0	2.7	10
30 min Summer	120.498	0.0	3.4	16
60 min Summer	70.232	0.0	4.2	34
120 min Summer	40.935	0.0	5.2	62
180 min Summer	29.851	0.0	5.8	98
240 min Summer	23.859	0.0	6.3	132
360 min Summer	17.398	0.0	7.0	188
480 min Summer	13.906	0.0	7.6	258
600 min Summer	11.688	0.0	8.0	298
720 min Summer	10.141	0.0	8.4	376
960 min Summer	8.251	0.0	9.3	452
1440 min Summer	6.170	0.0	10.6	728
2160 min Summer	4.614	0.0	12.1	1120
2880 min Summer	3.754	0.0	13.3	1416
4320 min Summer	2.691	0.0	14.4	2032
5760 min Summer	2.125	0.0	15.2	3096
7200 min Summer	1.770	0.0	15.9	3688
8640 min Summer	1.524	0.0	16.5	4256
10080 min Summer	1.343	0.0	17.0	5024
15 min Winter	206.740	0.0	3.2	10

Summary of Results for 100 year Return Period (+45%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	17.110	0.210	0.0	8.2	8.2	1.7	Flood Risk
60 min Winter	17.107	0.207	0.0	5.3	5.3	1.7	Flood Risk
120 min Winter	17.105	0.205	0.0	2.8	2.8	1.7	Flood Risk
180 min Winter	17.104	0.204	0.0	2.4	2.4	1.7	Flood Risk
240 min Winter	17.104	0.204	0.0	2.0	2.0	1.6	Flood Risk
360 min Winter	17.103	0.203	0.0	1.2	1.2	1.6	Flood Risk
480 min Winter	17.103	0.203	0.0	1.2	1.2	1.6	Flood Risk
600 min Winter	17.102	0.202	0.0	0.9	0.9	1.6	Flood Risk
720 min Winter	17.102	0.202	0.0	0.9	0.9	1.6	Flood Risk
960 min Winter	17.102	0.202	0.0	0.6	0.6	1.6	Flood Risk
1440 min Winter	17.102	0.202	0.0	0.6	0.6	1.6	Flood Risk
2160 min Winter	17.101	0.201	0.0	0.4	0.4	1.6	Flood Risk
2880 min Winter	17.101	0.201	0.0	0.4	0.4	1.6	Flood Risk
4320 min Winter	17.101	0.201	0.0	0.4	0.4	1.6	Flood Risk
5760 min Winter	17.101	0.201	0.0	0.4	0.4	1.6	Flood Risk
7200 min Winter	17.101	0.201	0.0	0.2	0.2	1.6	Flood Risk
8640 min Winter	17.101	0.201	0.0	0.2	0.2	1.6	Flood Risk
10080 min Winter	17.101	0.201	0.0	0.2	0.2	1.6	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	120.498	0.0	4.0	15
60 min Winter	70.232	0.0	4.9	32
120 min Winter	40.935	0.0	6.0	56
180 min Winter	29.851	0.0	6.7	96
240 min Winter	23.859	0.0	7.2	132
360 min Winter	17.398	0.0	8.0	166
480 min Winter	13.906	0.0	8.7	260
600 min Winter	11.688	0.0	9.2	250
720 min Winter	10.141	0.0	9.6	376
960 min Winter	8.251	0.0	10.6	494
1440 min Winter	6.170	0.0	12.1	708
2160 min Winter	4.614	0.0	13.8	1112
2880 min Winter	3.754	0.0	15.1	1708
4320 min Winter	2.691	0.0	16.3	1900
5760 min Winter	2.125	0.0	17.3	2984
7200 min Winter	1.770	0.0	18.0	3472
8640 min Winter	1.524	0.0	18.7	3696
10080 min Winter	1.343	0.0	19.3	6064

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 572800 144850 TQ 72800 44850
C (1km)	-0.023
D1 (1km)	0.327
D2 (1km)	0.389
D3 (1km)	0.285
E (1km)	0.307
F (1km)	2.468
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+45

Time Area Diagram

Total Area (ha) 0.011

Time (mins) From:	To:	Area (ha)
0	4	0.011

Model Details

Storage is Online Cover Level (m) 17.400

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	5.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	0.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	16.900	Cap Infiltration Depth (m)	0.000
Base Width (m)	1.0		

Weir Outflow Control

Discharge Coef 0.544 Width (m) 5.000 Invert Level (m) 17.100

Summary of Results for 100 year Return Period (+45%)

Half Drain Time : 2 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	17.117	0.217	0.0	110.8	110.8	14.3	Flood Risk
30 min Summer	17.114	0.214	0.0	82.4	82.4	14.1	Flood Risk
60 min Summer	17.109	0.209	0.0	45.5	45.5	13.5	Flood Risk
120 min Summer	17.107	0.207	0.0	31.6	31.6	13.5	Flood Risk
180 min Summer	17.106	0.206	0.0	22.3	22.3	13.3	Flood Risk
240 min Summer	17.105	0.205	0.0	19.4	19.4	13.3	Flood Risk
360 min Summer	17.104	0.204	0.0	14.2	14.2	13.2	Flood Risk
480 min Summer	17.104	0.204	0.0	14.2	14.2	13.2	Flood Risk
600 min Summer	17.103	0.203	0.0	9.5	9.5	13.1	Flood Risk
720 min Summer	17.103	0.203	0.0	9.5	9.5	13.1	Flood Risk
960 min Summer	17.103	0.203	0.0	7.4	7.4	13.1	Flood Risk
1440 min Summer	17.102	0.202	0.0	5.5	5.5	13.0	Flood Risk
2160 min Summer	17.102	0.202	0.0	5.5	5.5	13.0	Flood Risk
2880 min Summer	17.102	0.202	0.0	3.7	3.7	13.0	Flood Risk
4320 min Summer	17.102	0.202	0.0	3.7	3.7	13.0	Flood Risk
5760 min Summer	17.101	0.201	0.0	2.3	2.3	13.0	Flood Risk
7200 min Summer	17.101	0.201	0.0	2.3	2.3	13.0	Flood Risk
8640 min Summer	17.101	0.201	0.0	2.3	2.3	13.0	Flood Risk
10080 min Summer	17.101	0.201	0.0	2.3	2.3	13.0	Flood Risk
15 min Winter	17.117	0.217	0.0	110.8	110.8	14.3	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	206.740	0.0	23.6	10
30 min Summer	120.498	0.0	29.7	16
60 min Summer	70.232	0.0	36.7	34
120 min Summer	40.935	0.0	44.9	62
180 min Summer	29.851	0.0	50.3	100
240 min Summer	23.859	0.0	54.5	128
360 min Summer	17.398	0.0	60.8	186
480 min Summer	13.906	0.0	65.7	244
600 min Summer	11.688	0.0	69.6	302
720 min Summer	10.141	0.0	73.0	370
960 min Summer	8.251	0.0	80.3	468
1440 min Summer	6.170	0.0	91.6	724
2160 min Summer	4.614	0.0	104.3	1052
2880 min Summer	3.754	0.0	114.3	1532
4320 min Summer	2.691	0.0	123.8	2200
5760 min Summer	2.125	0.0	131.0	2968
7200 min Summer	1.770	0.0	137.0	4024
8640 min Summer	1.524	0.0	142.0	4496
10080 min Summer	1.343	0.0	146.2	4824
15 min Winter	206.740	0.0	28.0	9

Summary of Results for 100 year Return Period (+45%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	17.112	0.212	0.0	65.1	65.1	13.9	Flood Risk
60 min Winter	17.109	0.209	0.0	41.8	41.8	13.6	Flood Risk
120 min Winter	17.106	0.206	0.0	22.3	22.3	13.4	Flood Risk
180 min Winter	17.105	0.205	0.0	16.7	16.7	13.3	Flood Risk
240 min Winter	17.104	0.204	0.0	14.2	14.2	13.2	Flood Risk
360 min Winter	17.104	0.204	0.0	11.7	11.7	13.2	Flood Risk
480 min Winter	17.103	0.203	0.0	9.5	9.5	13.1	Flood Risk
600 min Winter	17.103	0.203	0.0	7.4	7.4	13.1	Flood Risk
720 min Winter	17.103	0.203	0.0	7.4	7.4	13.1	Flood Risk
960 min Winter	17.102	0.202	0.0	5.5	5.5	13.0	Flood Risk
1440 min Winter	17.102	0.202	0.0	3.7	3.7	13.0	Flood Risk
2160 min Winter	17.102	0.202	0.0	3.7	3.7	13.0	Flood Risk
2880 min Winter	17.102	0.202	0.0	3.7	3.7	13.0	Flood Risk
4320 min Winter	17.101	0.201	0.0	2.3	2.3	13.0	Flood Risk
5760 min Winter	17.101	0.201	0.0	2.3	2.3	13.0	Flood Risk
7200 min Winter	17.101	0.201	0.0	2.3	2.3	13.0	Flood Risk
8640 min Winter	17.101	0.201	0.0	2.3	2.3	13.0	Flood Risk
10080 min Winter	17.101	0.201	0.0	1.0	1.0	13.0	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	120.498	0.0	34.8	15
60 min Winter	70.232	0.0	42.7	30
120 min Winter	40.935	0.0	51.9	68
180 min Winter	29.851	0.0	57.9	98
240 min Winter	23.859	0.0	62.6	126
360 min Winter	17.398	0.0	69.6	166
480 min Winter	13.906	0.0	75.0	252
600 min Winter	11.688	0.0	79.5	306
720 min Winter	10.141	0.0	83.3	328
960 min Winter	8.251	0.0	91.5	526
1440 min Winter	6.170	0.0	104.1	716
2160 min Winter	4.614	0.0	118.4	872
2880 min Winter	3.754	0.0	129.5	1540
4320 min Winter	2.691	0.0	140.2	2552
5760 min Winter	2.125	0.0	148.3	3120
7200 min Winter	1.770	0.0	154.9	4040
8640 min Winter	1.524	0.0	160.5	4336
10080 min Winter	1.343	0.0	165.4	4936

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 572800 144850 TQ 72800 44850
C (1km)	-0.023
D1 (1km)	0.327
D2 (1km)	0.389
D3 (1km)	0.285
E (1km)	0.307
F (1km)	2.468
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+45

Time Area Diagram

Total Area (ha) 0.094

Time (mins) From:	To:	Area (ha)
0	4	0.094

Model Details

Storage is Online Cover Level (m) 17.400

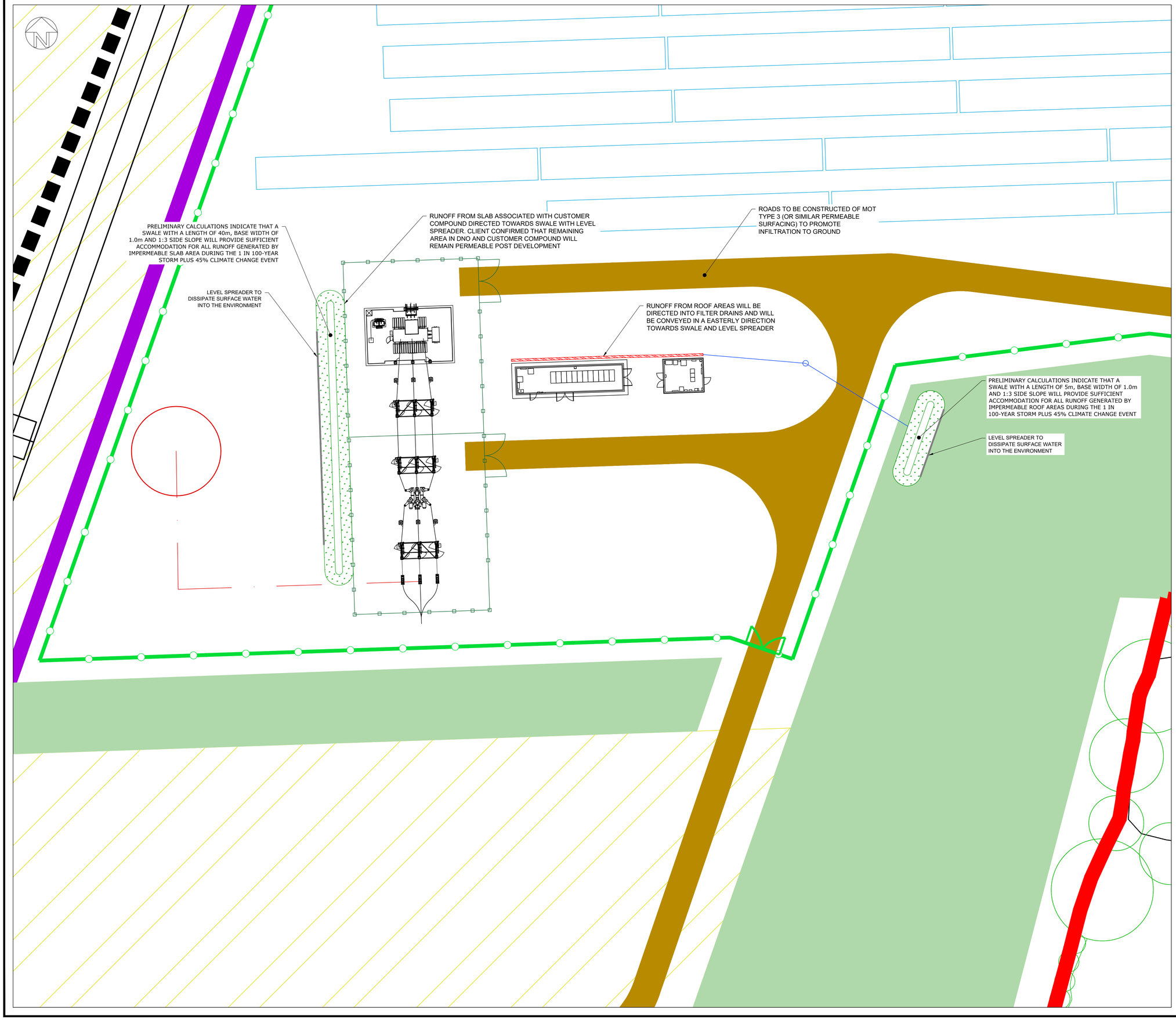
Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	40.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	0.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	16.900	Cap Infiltration Depth (m)	0.000
Base Width (m)	1.0		

Weir Outflow Control

Discharge Coef 0.544 Width (m) 30.000 Invert Level (m) 17.100

F Conceptual Drainage Plan



1	Flood Risk	Vehicle/Pedestrian collision	Potential disturbance to protected species
2	Unknown existing services	Members of the public accessing site	Effects on drainage from tree roots and leaf litter
3	Ground Conditionspossible instability, contamination and groundwater ingress		Pollution of surface water sewers/watercourses
4	Risk of UXOs on site		Fuel spillage
5	Working at height		
6	Working near water		
7	Confined spaces, asphyxiation		
No.	Construction Risk	Maintenance Risk	Demolition Risk

In addition to the hazards/risks normally associated with the types of work detailed on this drawing take note of the above.

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION BOX

Drawing Notes

1. All dimensions shown are in millimetres unless otherwise stated and levels in metres to Ordnance Datum.
2. Do not scale from this drawing. All dimensions must be checked/verified on site.
3. Any discrepancies noted on site are to be reported to the engineer immediately.
4. This drawing is based on the revised site layout titled SCUKX-SHEEP-000-100M Annotated DEC v1.1 External Release by Statkraft provided to JBA on 14/02/2023.
5. Surface water drainage strategy has been developed based on levels detailed within the topographic survey and watercourse survey. Details provided in drawing reference Sheepwash_UAV-TOPO_Linework_OSGB36_Rev1_20211008 and Sheepwash_DITCH-GROUND-SURVEY_Linework_OSGB36_Rev1_20211008.
6. No deep rooted trees to be planted in vicinity of any underground drainage elements.
7. No detailed modelling of the drainage system has been carried out at this stage and therefore the drainage layout should be read as indicative only.
8. Details of underground services provided within Landmark Information Group Utilities Report. However, final detailed survey of existing infrastructure on site should be undertaken prior to the detailed design stage. Presence and location of any other services is unknown at this stage.
9. It is proposed that runoff from the DNO/Customer HV Compound area will dissipate surface water into the environment.
10. The proposed surface water drainage scheme will not cross third-party land.
11. The electronic model of this drawing is not to be used for setting out.
12. The drawing is for approvals and consultations with third party only - not for construction.
13. All cover levels assumed pending external design levels by others.

Rev.:	Comments	Date	Drawn	Designed	Checked	Approved

Client Approval

- A - Approved
- B - Approved with Revisions
- C - Do Not Use

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DRAFT

Project

Marden SWDS

Title

Surface Water
Drainage Strategy
DNO/Customer HV Compound

for

Client

Origin Power Services Ltd

Drawn:	M. Morrison	23/03/2023	Designed:	M. Morrison	23/03/2023
Checked:	R. Dobson	23/03/2023	Approved:	R. Dobson	23/03/2023
Project Reference:	2022s0934		Scale:	As Shown @ A1	

Drawing Number:	Status:	Revision:	Sheet Size:
GGO-JBAU-XX-XX-DR-D-0001	A1	C02	A1

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