OAKLANDS FARM SOLAR PARK

Applicant: Oaklands Farm Solar Ltd

Environmental Statement

Appendix 8.1 – Flood Risk Assessment and Outline Drainage Strategy

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Oaklands Farm Solar Park - Environmental Statement Volume 3

Appendix 8.1: Flood Risk Assessment and Outline Drainage Strategy

Final report
Prepared by LUC
January 2024

Oaklands Solar Farm: Flood Risk Assessment and Outline Drainage Strategy

A REPORT FOR OAKLANDS SOLAR FARM LTD
SEPTEMBER 2023
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Oaklands Solar Farm: Flood Risk Assessment and Outline Drainage Strategy

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1 Introduction

1.1 INSTRUCTION

Yellow Sub Geo Ltd (Yellow Sub) was instructed by BayWa R.E. UK Ltd (the Client) to provide a Flood Risk Assessment (FRA) and outline drainage strategy for a large parcel of land between Oaklands Farm and Park Farm (the Site).

1.2 BRIEF

The brief was to provide a suitable Flood Risk Assessment (FRA) and Outline Sustainable Drainage (SuDS) Strategy for the Site to support the application for a Development Consent Order and Environmental Impact Assessment (EIA) for a proposed solar farm.

1.3 BACKGROUND

The Site is located in Swadlincote to the south of Burton-on-Trent. The proposed development involves the installation of a solar farm comprising ground mounted photovoltaic (PV) panels across 37No. agricultural fields with associated Battery Energy Storage System (BESS) and a connection established to the nearby former Drakelow Power Station.

1.4 SCOPE

This report presents the findings of an FRA and Outline SuDS Strategy for the Site that demonstrates that the proposed development meets the requirements of the National Planning Policy Framework (NPPF) and Planning Practice Guidance (PPG).

1.5 LIMITATIONS

This report is written strictly for the benefit of the Client and bound by the conditions presented in Appendix A.

2 Development description and location

2.1 THE SITE

The Site (Figure 2-1) lies within the administrative boundaries of South Derbyshire District Council (SDDC) and Derbyshire County Council (DCC), located approximately 0.25km west of the village of Rosliston and 0.7km south east of Walton-on-Trent and stretching from the former Drakelow Power Station, north of Walton Road, to the south of Coton Road. The Site occupies a total area of approximately 137 hectares (ha).

The Site itself includes land within three farms, Park Farm in the north, Fairfields Farm in the centre of the Site and Oaklands Farm in the south. The Drakelow substation land, where the Proposed Development will connect to the grid, is north of Walton Road within the former Drakelow Power Station site.

The southern part of the Site (Oaklands Farm area) comprises a large area of agricultural land to the south of Rosliston Road and west of Catton Lane that wraps around the north and east of the farmstead at Oaklands Farm. A small part of the Site extends south of Coton Road.

A small section of the Cross Britain Way / National Forest Way long distance path (which runs between the villages of Walton Upon Trent and Rosliston), crosses the northern fields of the Oaklands Farm area and is partly enclosed by woodland associated with the Rosliston Forestry Centre to the north-east. The Site is located within the National Forest.

Immediately north of Rosliston Road is the land holding of Fairfields Farm and, further north, the Park Farm area up to Walton Road. Land use here comprises medium-large scale mixed arable and pastoral fields.

Two separate overhead electricity transmission lines run north to south through the Site, connecting into Drakelow substation. One 11kV overhead electricity distribution line also runs north into the Park Farm buildings.

Several adopted roads either border or run through the Site. These include:

- Coton Road, which connects Walton-on-Trent to Coton in the Elms and runs through the southern part of the Site.
- Catton Lane which links Rosliston to Lads Grave and borders the south eastern edge of the Site.
- Rosliston Road, which connects Walton-on-Trent to Rosliston and runs east-west through the Site.
- Walton Road, which connects Walton-on-Trent to the south west with Stapenhill to the north east, runs through the north of the Site along the southern boundary of the Drakelow Power Station area.

2.2 TOPOGRAPHY

The Site is variable in elevation generally sloping down from an elevated high point of 92m above Ordnance Datum (m aOD) in the southern section of Site to around 64m aOD at the northern extent.

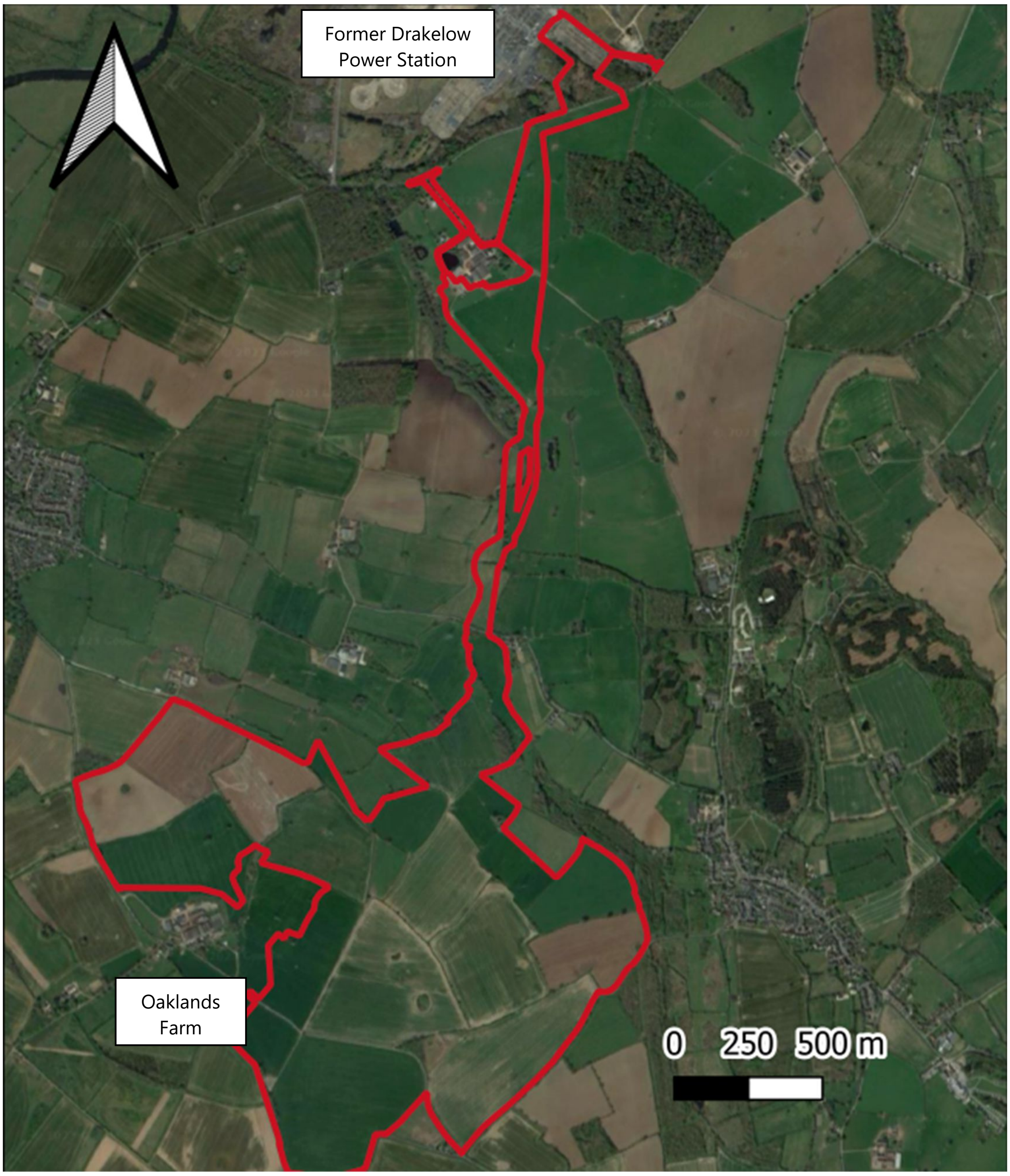
2.3 PROPOSED DEVELOPMENT

The Oaklands Farm Solar Park Project comprises a proposed solar farm with an associated battery energy storage facility ('the Proposed Development'). The Proposed Development would have a generating capacity of over 50MW and would be situated on 191 hectares of land at Oaklands Farm to the south-east of Walton-on-Trent and to the west of Rosliston in south Derbyshire.

The solar farm itself, comprising photovoltaic panel arrays, a central electricity substation and Battery Energy Storage System (BESS) together with access, landscaping and other works would be located on 135 hectares of agricultural land currently in use for arable production and grazing. A high voltage underground electricity cable would then run through land at Fairfields Farm and Park Farm to the north to connect the solar farm to the national grid via an electricity substation located at the former Drakelow Power Station which sits south of Burton-upon-Trent.

As the Proposed Development would be an onshore generating station with a generating capacity of over 50MW an application for a Development Consent Order is being made under the Planning Act 2008 to the Planning Inspectorate, for determination by the Secretary of State for Energy Security and Net Zero.

Figure 2-1 Site location



2.4 GEOLOGY AND HYDROGEOLOGY

British Geological Survey (BGS) published geology indicates that the Site bedrock comprises the Edwalton Member (siltstone and very fine-grained sandstone). This is partly overlain by superficial deposits, comprising fluvioglacial diamicton in the south and some areas of alluvium in the north typically along watercourses through the Site. The soils close to the watercourse are described as slowly permeable, seasonally wet, with impeded drainage, whilst those away from the watercourse are described as "loamy and clayey soils with slightly impeded drainage".

The alluvium and glaciofluvial deposits beneath some areas of the Site are classified by the Environment Agency (EA) as a high vulnerability Secondary A Aquifers. These are defined by the EA as 'permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers'.

The Edwalton Member bedrock beneath the Site is classified as a Secondary B Aquifer. These are defined by the EA as 'predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering'.

2.5 HYDROLOGY

The vast majority of the Site is within the catchment of the River Trent with a very small area along the far southern edge of the southern-most parcel of the Site lies in the catchment of the River Mease, a tributary of the River Trent.

The majority of the Site drains to the River Trent approximately (1.4km to the west and north-west of the Site) via an unnamed tributary that flows though the Site. This is an Ordinary Watercourse[3] and is shown on Ordnance Survey (OS) mapping to originate south of the village of Rosliston.

A small tributary of the River Trent runs to the east of the Site boundary in the south which crosses the area of Site between Oaklands Farm and Park Farm and then lies on the western site boundary of Park Farm. A second small stream is located north of Rosliston road (east of Old Barn Farm) crossing the Site approximately east to west. A surface water features survey was undertaken during a walkover of the Site which is presented in Appendix B.

2.5.1 Flood Defences

There are no formal flood defences throughout the area.

2.5.2 Greenfield Runoff

Greenfield Runoff has been calculated using the online Greenfield runoff rate estimation tool available on uksuds.com and the results are shown in Table 2-1 calculated for 1 ha in the centre of the Oaklands Farm parcel of land as a representative calculation. Further details are provided in Appendix C.

Table 2-1 Greenfield runoff rates per Hectare for the Site

Results using the IH124 method

Estimated site discharges

	My values
Qbar (l/s)	4.34
Greenfield runoff rates	
1 in 1 year (l/s)	3.6
1 in 30 years (l/s)	8.68
1 in 100 years (l/s)	11.15
1 in 200 years (l/s)	13.19

3 Planning Policy

3.1 NATIONAL FLOOD POLICY

National policy on planning and flood risk is provided by the National Planning Policy Framework (NPPF) and supplementary guidance. The acceptability of different types of development depends on its vulnerability to flooding and the flood zone in which the proposed development is to take place.

Vulnerability classes are defined in technical guidance to the NPPF[4] but solar farms are not explicitly listed. Electricity generating power stations are defined as "Essential Infrastructure" in the technical guidance. Solar arrays have a much lower vulnerability to flooding than a traditional power station, and it has been accepted in other applications that they should be regarded as similar to other commercial development and therefore classed as "less vulnerable".

Flood risk has been mapped nationally by the EA to show the flood zones used in the NPPF. Figure 3-1 shows the planning flood zones through the Site and indicates that the majority of the Site is in Flood Zone 1 with an annual risk of fluvial flooding less than 1 in 1,000 but parts bordering the Ordinary Watercourse are in Flood Zones 2 and 3, with an annual risk of fluvial flooding greater than 1 in 1,000. The planning flood zones only consider the risk of flooding from main rivers. Other sources are also considered in subsequent sections of this report.

Less vulnerable development, such as is proposed at the Site, is considered by the NPPF as acceptable in Flood Zones 1, 2 and 3, but in the latter should be subject to the sequential test, which steers development to areas of lowest flood risk, as summarised in Figure 3-2.

Figure 3-1 Planning flood zones 2 & 3

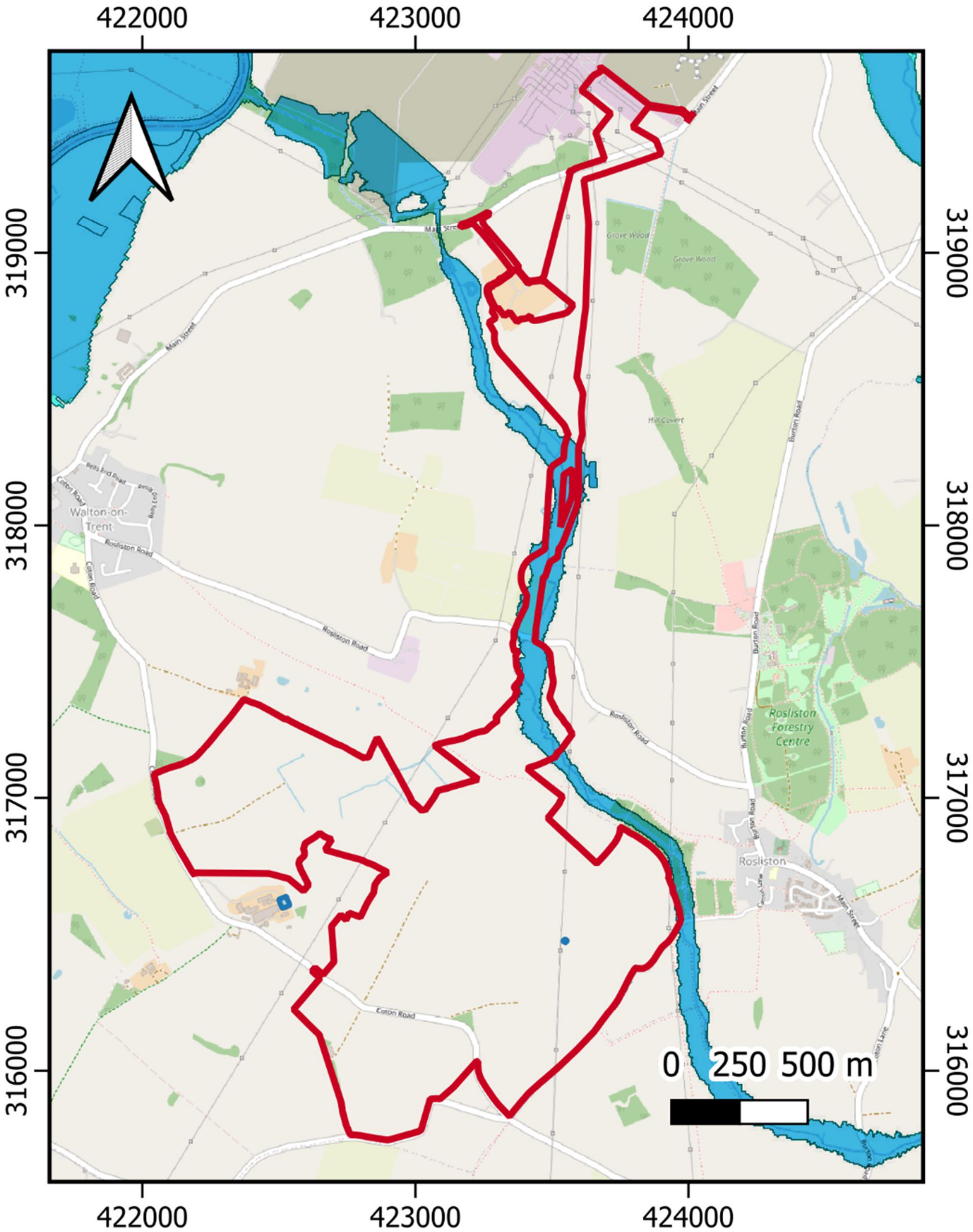


Figure 3-2 Acceptability of development in flood zones

Flood Zones	Flood Risk Vulnerability Classification				
	Essential infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a †	Exception Test required †	✗	Exception Test required	✓	✓
Zone 3b *	Exception Test required *	✗	✗	✗	✓ *

Key:

✓ Development is appropriate

✗ Development should not be permitted.

4 Definition of Flood Hazard

4.1 HISTORICAL RECORDS

There is no mapping of events for the Site in the EA historic flood dataset

4.2 SOURCES OF FLOODING

4.2.1 Fluvial and Tidal flooding

The flood risk arising from rivers and the sea is mapped nationally by the EA, and their on-Site flood map is shown in Figure 4-1. This indicates the current annual flood risk from these sources range from low to high. Flood risk is generally low (Annual Exceedance Probability [AEP] less than 0.1%) except for a corridor following the unnamed Ordinary Watercourse.

The quality of the topography and modelling used to produce this map is low, as can be seen in areas where the flood risk fails to follow the line of the watercourse and provides an indication rather than an accurate description of the true flood risk areas.

The EA were asked to provide flood depths for the flood risk areas but do not have any more detailed information, reflecting the low priority given to modelling flood risk in an Ordinary Watercourse.

As the catchment area is small, parts are excluded from the fluvial flood mapping produced by the Environment Agency and it is likely that the surface water flood mapping in the next section provides a more accurate description of flood risk along all the watercourses as this mapping covers the whole country in a greater detail and is more recent.

The Site is not subject to tidal flooding.

4.2.2 Surface water flooding

Surface water flooding arises from rainfall intensities exceeding the rate at which the ground can absorb the water and the local drainage system has capacity for. Excess water will flow over the surface, generally following the topography but can also be diverted by walls and buildings and possibly directed preferentially along roadways. Surface water can collect in low areas and pond, causing localised flooding.

For a small watercourse where all the flood runoff is being generated locally the surface water flood maps give a more accurate representation of flood risk than the fluvial flood mapping.

Figure 4-2 shows modelled surface water flood extents for the 3.33% AEP (blue) and 1% AEP (purple) flood events. This indicates a network of flow paths channelling excess water across the Site to the watercourse with some limited areas of ponding where surface water may collect before slowly infiltrating into the soil.

The likely depth of flooding in a medium risk event is shown in Figure 4-3 and indicates that outside of the river channel, these are less than 300mm.

Figure 4-1 Flood risk from rivers and the sea

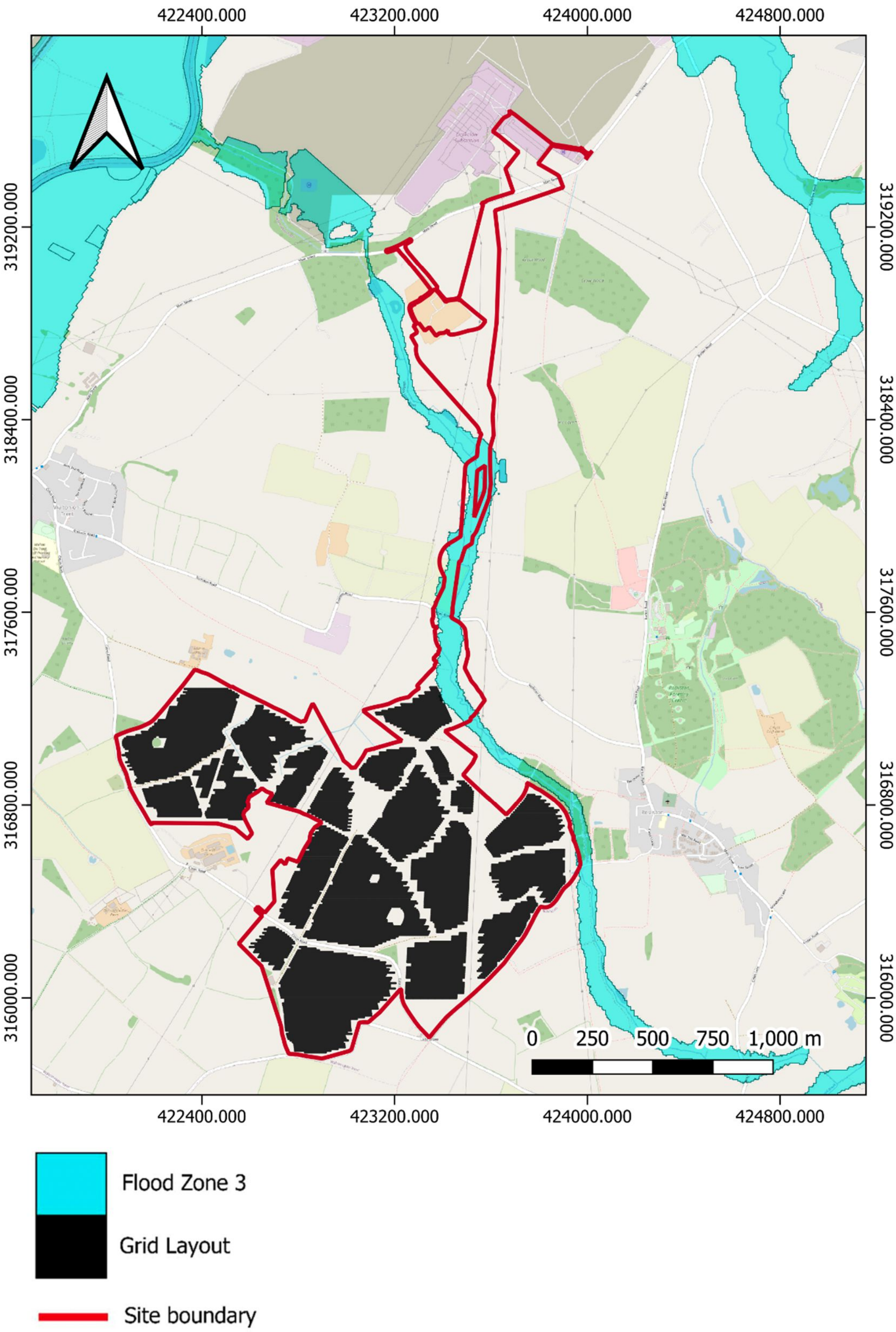


Figure 4-2 Flood risk from surface water

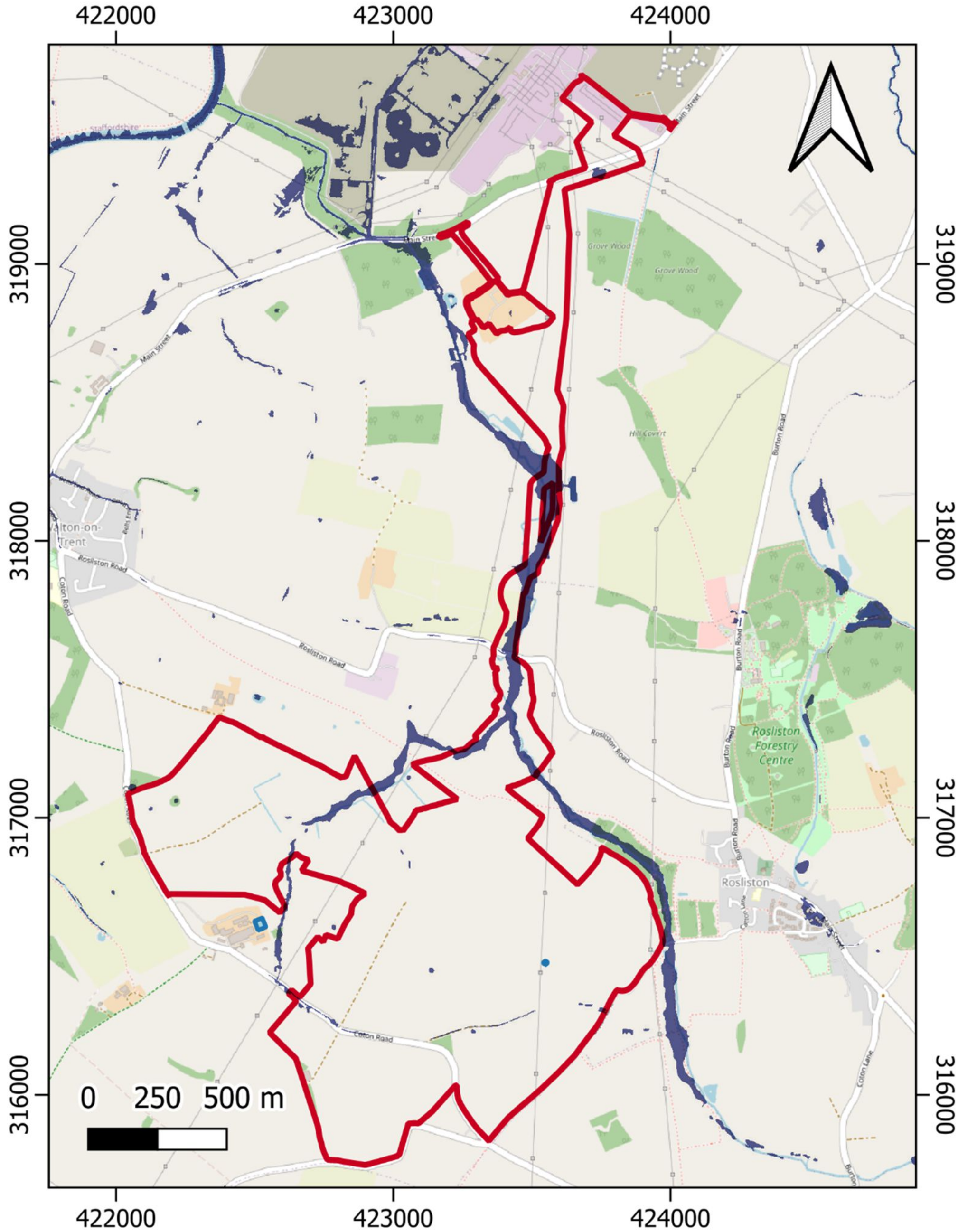


Figure 4-3 Depth of flooding in a 1% surface water flood event

Surface water flood risk: water depth in a medium risk scenario
Flood depth (millimetres)

Over 900mm | 300 to 900mm | Below 300mm | Location you selected

4.2.3 Groundwater flooding

Groundwater flooding is caused when water held within porous strata rises to the land surface due to excess rainfall generally over a long time period.

The majority of the Site is underlain by a secondary B aquifer which is likely to hold very limited volumes of groundwater, and soils which are only slowly permeable. In areas where superficial deposits are present the volumes of groundwater will also be limited due to the limited extent of the deposit and these are also covered by slowly permeable soils.

Groundwater flooding is therefore considered a low risk on the Site.

4.2.4 Catastrophic flooding

This source includes release of large volumes of stored water, such as in reservoirs and canals, due to catastrophic failure. The EA have mapped areas that are at risk of flooding from failure of large reservoirs and the Site is not shown to be potentially at risk from these sources.

There are no other identified large sources of stored water that may affect the site and the risk of flooding from this source is considered to be negligible.

4.3 CLIMATE CHANGE

Climate will have a limited impact on flood risk over the lifetime of the proposed development. A worst case assessment[6] of the potential expansion of the 1% flood extent concluded it is unlikely to exceed the present day 0.1% flood extent.

Use of the 0.1% flood extent will therefore provide a conservative estimate of the future 1% flood, especially as the Site use is expected to be complete well within 100 years.

4.4 OVERALL FLOOD RISK AT THE SITE

The above review has indicated that flood risk on the Site is restricted to the Ordinary Watercourse and a network of surface water flow paths, some of which are in channels and some overground or in isolated areas of ponding.

Outside of the watercourse channels the likely depth of flooding is less than 300 mm in a 1% AEP event.

Flood risk from other sources considered is low or very low.

5 Detailed Development Proposal

5.1 DEVELOPMENT LAYOUT

The proposed development comprises solar panels, inverters, transformers, a substation and battery storage containers. There will be underground cabling connecting these elements and gravel tracks to provide access. Further details on each of these elements is provided below.

The proposed indicative layout is shown in the works plans found within Appendix 1.3 of the Environmental Statement.

The solar panels are located outside of the modelled fluvial flood risk areas, shown in Figure 4-1, but not entirely out of the modelled surface water flood extent, which is more widespread.

There will be a minimum 8m easement between the top of any watercourse bank and any infrastructure (including panels, the substation and the Battery Energy Storage System (BESS)) to allow for maintenance access to river channels. Cable ducts will be located a minimum of 8m away from the top of the bank of the watercourse, as far as possible. However, tracks may be constructed within 8m as these do not prevent access to the watercourse.

Any watercourse crossings, or changes to existing crossings, may need Ordinary Watercourse Consent from the LLFA and should be designed so as to not impede flow or drainage. The LLFA were consulted in relation to the proposed development on the 8th June 2023.

5.2 SOLAR PANELS

The solar panels are mounted on a frame supported by steel posts. The arrays are approximately 2.7m in height, with the lower edge approx. 0.8m above ground level (+/- 0.1m), which varies with local undulations in the ground surface. The frame foundations will consist of steel piles rammed/pushed into the ground, with a maximum piling depth of 2m below ground level. Vegetation will be retained or re-sown under the panels which will then maintain a year-round cover of vegetation, unlike the current agricultural cropping regime which can result in bare ground exposed during winter and spring.

5.3 ACCESS TRACKS

Internal access tracks for construction purposes will be 3.5 – 6.0m wide and made up of 200mm of Type 1 compacted stone/gravel with a geotextile membrane or other surfacing solutions, and, where appropriate, may simply be mown grass corridors. The access tracks will have an edge gradient of 2.5° to facilitate surface runoff. Some of these temporary access tracks will be removed, whilst others remain for operations and maintenance following construction of the Proposed Development. A typical cross section is shown in Appendix D.

5.4 WATERCOURSE CROSSINGS

There are five proposed watercourse crossings of which at least two comprise existing crossings which may need to be reinforced for construction traffic. There are also three additional cable crossing which shall either be trenched across and reinstated or directionally drilled. Permanent watercourse crossings will be constructed of concrete with soil or other organic material for load-bearing and to secure culvert structure. The culvert pipe diameter will be up to 1m and the lengths will be determined at construction.

5.5 BATTERY STORAGE

The BESS will comprise a fenced compound containing a series of batteries within containers, power conversion system units (which convert electricity between DC and AC during import or export processes), and an auxiliary transformer to provide necessary power for controls and monitoring systems. Details are provided in Appendix E. Note this drawing provides a general example and details of the base may not be included. Due to the potential risk of fire associated with these units, and the subsequent risk of contaminated firewater, the ground must be impermeable and water should be collected and contained within a storage area, which can be isolated if required.

5.6 SUBSTATION

The substation and welfare compound incorporates a number of features, including two substation transformers, Statcom Units, 132KV harmonic filter compound, substation control building, welfare unit, and fire water storage and deluge system. Details are provided in Appendix F. Note this drawing provides a general example and details of the base may not be included. Due to the potential risk of fire associated with these units, and the subsequent risk of contaminated firewater, at least part of the compound area must be impermeable and water should be collected and contained within a storage area, which can be isolated if required.

6 Site Drainage

6.1 INTRODUCTION

The following sections describe the outline SuDS Strategy for the proposed development with due regard to DEFRA's Non-Statutory Technical Standards for SuDS (DEFRA, 2015) which recommends the following hierarchy for the disposal of surface water:

- Discharge to ground via infiltration;
- Discharge to a surface water body;
- Discharge to a surface water sewer, local highway drain or another drainage system;
- Discharge to a combined sewer.

6.2 GREENFIELD RUNOFF AND PERMISSIBLE DISCHARGE RATES

For greenfield sites, the peak runoff rate from the development should not exceed the peak greenfield runoff rate for the same event (DEFRA, 2015). Additionally, where reasonably practical, the runoff volume from the development in the 1% AEP 6-hour rainfall event should not exceed the greenfield runoff volume for the same event.

The existing greenfield runoff rates and volumes for the BESS (8,000m^2) and substation (6,000m^2) areas have been estimated and are summarised in Table 6-1. These were derived using the Revitalised Flood Hydrograph (ReFH2) model and a 6-hour storm duration assumed to calculate the volumes. The catchment descriptors at the Site were obtained from the FEH Webservice.

6.2.1 Climate change

The potential increase in rainfall intensity due to climate change needs to be considered when designing drainage strategies. The recommended allowances for rainfall intensity in the Adur and Ouse Management Catchment are included in Table 6-1.

The solar farm has a design life of 40 years, assuming development is completed in the next 5 years the Site will be in use until the 2060s. Therefore, based on the EA guidance for climate change allowances in flood risk assessments (Environment Agency, 2022), the central allowance for the 2070's epoch should be used (see Table 6-2).

Table 6-1 Greenfield runoff rates and volumes for BESS and substation areas

Flood event AEP	Runoff rate (l/s)		Runoff volume (m^3)	
	BESS	Substation	BESS	Substation
50% (1 in 2)	3.92	1.83	64	32
10% (1 in 10)	6.71	3.06	109	53
3.3% (1 in 30)	9.27	4.17	153	73
1% (1 in 100)	13.70	6.03	229	108
1% + 25% climate change	18.34	7.83	307	142

Table 6-2 Climate change allowances for rainfall in the tame Anker and Mease Management Catchment

Epoch	Central allowance	Upper end allowance
3.3% AEP (1 in 30)		
2050s	20%	35%
2070s	25%	35%
1% AEP (1 in 100)		
2050s	20%	40%
2070s	25%	40%

6.3 ATTENUATION STORAGE VOLUMES

In order to achieve the above discharge rates within the BESS and substation areas, attenuation storage will be required. The estimated storage volumes are shown in Table 6-3.

These storage volumes were derived by calculating the flow exceeding the peak greenfield runoff rate for the 1% AEP event.

ReFH2 software has been used to calculate flow hydrographs for a 1% AEP + 25% storm event using a range of storm durations. Catchment descriptors at the site were obtained from the FEH Webservice. An imperviousness factor of 1.0 and 0.2 have been applied for the BESS and substation respectively, no allowance for urban creep has been applied as the hardstanding areas are unlikely to expand.

Volumes were then calculated from the flow exceeding the peak greenfield runoff rate for each storm duration, and the maximum value taken. An additional allowance of 25% has been applied to the volumes as recommended in the SuDS manual (CIRIA, 2015).

Table 6-3 Attenuation volumes for BESS and substation areas

Flood event AEP	BESS (m^3)	Substation (m^3)
1% + 25% climate change	442	66

6.4 RUNOFF DESTINATION AND PROPOSED SUDS DESIGN

The majority of the Site consists of solar panels mounted on a metal frame, underlain with vegetation. For these areas, no formal surface water collection system is proposed. The BESS and substation pose a theoretical risk of fire, with the potential of contaminant mobilisation due to the chemicals within the electrical units and/or firefighting fluids. Therefore it is recommended that a surface water system is designed that controls the surface water runoff during a fire event in these areas, preventing it from leaving the locality and allowing the potential contaminants to be treated.

As detailed in the Environmental Statement, a Soil Management Plan will be compiled for the Proposed Development. The purpose of this document will be to demonstrate how damage to soil horizons and ground cover will be mitigated and remediated during and after construction and for future decommissioning. Detailed measures to manage runoff from the various areas in the proposed development are provided below.

6.4.1 Solar Panels

In these areas of the Site rainfall will be allowed to percolate into the underlying soil as occurs at present. This includes rain falling on the solar panels and the supporting infrastructure, which will be drained to ground.

The solar arrays contain frequent gaps up and along the arrays, to allow the individual panels to manage thermal expansion along the array, which are fundamental for thermal movement. These gaps allow rainwater to disperse through the array and avoid concentrated flows landing on the ground.

Runoff from the panels can therefore be intercepted and buffered by the vegetation growing underneath the panels and retained prior to infiltration as with the greenfield situation. The impact of the panels on runoff is therefore likely to be positive, as rainfall compaction of bare ground will be eradicated and soakage into the soil will be feasible throughout the year.

Overall runoff will be reduced as the vegetation will be in place all year round and the underlying soil will not be left bare or compacted by agricultural activities.

A typical example is shown in Figure 6.1. This example site is near Frome in Somerset and sited on mudstone bedrock, with soils described as "slowly permeable seasonally wet slightly loamy and clayey soils with impeded drainage", i.e. the same as at the proposed development. Rainfall is allowed to fall onto the ground beneath: there is no evidence of erosion or runoff from underneath the panels and sufficient vegetation occurs to prevent bare ground developing.

6.4.2 Access tracks

All field access tracks will be constructed of compacted gravel such that they are permeable to negate impacts to drainage. Each track shall be designed with a fall to a gravel filled longitudinal trench into which excess water will flow. These trenches will act as attenuation and treatment prior to infiltration.

Figure 6-1 Drainage of solar panels onto grass

Figure 6-2 Typical battery containers used on a solar farm

6.4.3 BESS and substation

The proposed development will include inverter units and a main substation. Inverter units will be within cabins on concrete pads within the site, which will be connected to cables in backfilled trenches. Each inverter is positioned on legs raised above the base.

The site will also incorporate a BESS to satisfy the modern needs of solar farms. The BESS is made up of batteries in sealed shipping type containers, supported on legs on pads. A typical example is shown in Figure 6-2.

Due to the potential risk of fire associated with these units, and the subsequent risk of contaminated firewater, infiltration is not considered a suitable SuDS measure in these areas. Instead water should be collected and contained within a storage area, which can be isolated if required.

It is proposed that underground storage areas are created beneath the BESS and substation areas which are filled with single sized granular material. The BESS and substation will be surrounded by suitable bunds to separate runoff from adjacent areas and the storage provision lined to prevent the potential leaching of contaminants in the event of a fire. Under normal circumstances the storage areas will be drained to the northeast towards the existing drainage channel, approximately 300m north-west of the BESS/substation. However, pollution control devices (valves) will be fitted to the tank outfall to prevent the release of water when a fire is detected on Site.

Sizing of storage areas has been undertaken based upon a 100yr + 25% climate change scenario (see Table 6-3). This assumes that water would be released at a rate equivalent to the existing greenfield runoff rate of 13.7l/s and 6l/s at the BESS and substation respectively.

Additionally, storage volumes have been calculated to replicate a fire situation where no water is released from the storage areas. A 24 hr storm duration has been used, based upon the assumption that this is the longest time period required for a tanker to arrive at the Site and pump out potentially contaminated water. Table 6-4 shows the resulting volumes for a range of storm durations, including an additional 300m^3 and 100m^3 volume for firefighting water at the BESS and substation respectively.

The joint probability of a fire occurring simultaneously with a 1% AEP storm is very remote, therefore a 10% AEP event has been chosen to determine the storage requirements during a fire scenario. The fire scenario attenuation requirements are significantly larger than the normal conditions scenario, despite a smaller storm being considered. At the BESS the storage required to contain a 10% AEP + CC event during a fire scenario is 910m^3, whilst only 442m^3 is required for a 1% AEP + CC under normal conditions. Therefore the storage areas will generally be underutilised during normal conditions.

Table 6-4 Attenuation volumes for BESS and substation areas during a fire event

Flood event AEP plus fire	BESS (m^3)	Substation (m^3)
50% AEP+ 25% CC	753	314
10% AEP+ 25% CC	910	423
3.3% AEP+ 25% CC	1082	514

Flood event AEP plus fire	BESS (m^3)	Substation (m^3)
2% AEP+ 25% CC	1186	570
1% AEP+ 25% CC	1342	652

A preliminary design of the storage areas has been undertaken. It's assumed that the storage areas would be located beneath the BESS and substation areas, which are bunded and lined to prevent infiltration and filled with single sized granular material to provide attenuation. The amount of storage offered would be dependent upon the subgrade depth and Site gradient. The use of permeable surfacing should be considered at the detailed design stage.

An approximate area of 8,000m^2 and 6,000m^2 are available at the BESS and substation areas respectively. By creating storage areas with a depth of 0.4m and 0.3m and a void ratio of 30% within the granular fill material, a storage volume of 960m^3 and 540m^3 would be created at the BESS and substation respectively. Table 6-5 summarises the attenuation area dimensions. A layout of the proposed SuDS scheme is included in Appendix G.

Table 6-5 Preliminary sizing of BESS and substation attenuation areas

	BESS	Substation
Area (m^2)	8,000	6,000
Depth (m)	0.4	0.3
Volume (m^3)	960	540

6.5 EVENT EXCEEDANCE

Storage at the BESS and substation areas has been provided for the 1% AEP + 25% climate change, as well as for the 10% AEP + 25% climate change under a fire scenario with no release of water. Storm events in excess of these will result in the storage areas being exceeded, the exceedance flows will be designed to follow the existing preferential surface water flow route towards the drain to the northeast. The flow route is detailed in Appendix G. A more detailed analysis of exceedance flows can be undertaken once the Site elevations and storage area design has been finalised and modelled.

6.6 WATER QUALITY

SuDS techniques can be used to effectively manage the quality of surface water flowing across a site. Different methods can be used to intercept pollutants and allow them to degrade or be stored in-situ without impacting the quality of water further downstream. Frequent and short duration rainfall events are those that are most loaded with potential contaminants (silts, fines, heavy metals and various organic and inorganic contaminants). Therefore, the first 5mm to 10mm of rainfall (i.e. the 'first flush') should be adequately treated using SuDS.

The proposed development will include low traffic roads, which the CIRIA SuDS manual categorises as presenting a low hazard rating.

Table 6-6 shows the pollution hazard indices for each land use.

Table 6-6 Pollution hazard indices

Land use	Pollution hazard level	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Low traffic roads	Low	0.5	0.4	0.4

Where practical, runoff will be directed to permeable surfacing. Within the BESS and substation areas, water will be contained within a storage area prior to discharging to a nearby drainage channel. Table 6-7 below demonstrates that these SuDS methods provide sufficient treatment.

Table 6-7 SuDS mitigation indices

Type of SuDS	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Permeable surfacing	0.7	0.6	0.7
Detention basin	0.5	0.5	0.6

7 Maintenance schedules

7.1 OVERVIEW

This section outlines the maintenance and management schedules for the proposed stormwater drainage system. The schedules have been formulated in line with guidelines contained within the CIRIA SuDS Manual (C753) (Woods Ballard, et al., 2015).

There are three categories of maintenance activities (including inspections and monitoring) referred to in this report:

- **Regular maintenance** – tasks which are required to be undertaken on a weekly or monthly basis, or as required.
- **Occasional maintenance** – tasks which are required to be undertaken periodically, typically at intervals of 3 months or more.
- **Remedial maintenance** – tasks which are not required on a regular basis but are done when necessary.

This section is intended to give an overview of the operation and maintenance for the range of drainage features included within the surface water drainage strategy and in relation to typical/ standard details only.

Maintenance schedules for the proposed SuDS components are provided in the following tables. These schedules are not exhaustive and should be reassessed at regular intervals to determine if any additional maintenance requirements are required to preserve the performance and condition of the drainage system.

7.2 MAINTENANCE SCHEDULES

7.2.1 Pipes and manholes

A typical schedule of maintenance activities for pipes and manholes is included in Table 7-1.

Table 7-1 Pipes and manholes

Maintenance schedule	Required action	Frequency
Regular maintenance	Remove any accumulation of silt, sediment, leaves and debris etc	Monthly, or as required
	Inspect for evidence of poor operation	Monthly (during the first year), then half yearly
Occasional maintenance	High pressure water jet removal of silt build-up and avoid blockages, particularly at bends or changes in direction	Six monthly, or as required
	Remove or control tree roots where they are encroaching pipe runs, using recommended methods	As required
Remedial actions	Clear pipework and gully grates of blockages	As required
	Replace any damaged or failed pipes, gullies or manholes	As required

7.2.2 Permeable paving

A typical schedule of maintenance activities for permeable paving is included in Table 7-2.

Table 7-2 Permeable paving

Maintenance schedule	Required action	Frequency
Occasional maintenance	Initial inspection	Monthly for three months after installation
	Inspect for evidence of poor operation and/or weed growth – if required, take remedial action	Three-monthly, 48 hours after large storm in first six months
	Inspect silt accumulation rates and establish appropriate jetting frequencies	Annually
	Monitor inspection chambers	Annually
	Stabilise and mow contributing and adjacent areas	As required
	Removal of weeds or management using glyphosate applied directly into the weeds by an applicator rather than spraying	As required – once per year on less frequently used pavements
Remedial actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50mm of the level of the paving	As required
	Remedial work to any depressions or ruts considered detrimental to the structural performance or a hazard to users.	As required
	Rehabilitation of surface.	As required

7.2.3 Granular Sub-base

A typical schedule of maintenance activities is included in Table 7-3.

Table 7-3 Granular sub-base

Maintenance schedule	Required action	Frequency
Regular maintenance	Inspect/ check all inlets, outlets, inspection/access chamber, vents to ensure that they are in good condition and operating as designed	Monthly for 3 months, then annually
	Inspect silt traps and note rate of sediment accumulation	Monthly in the first year and then annually
	Inspect and identify any areas that are not operating correctly. If required take remedial action	Monthly for 3 months, then annually
Occasional maintenance	Remove sediment from pre-treatment structures	Annually, or as required
Remedial actions	Repair/rehabilitate inlets, outlets, overflows, inspection/access chamber and vents	As required

7.2.4 Flow controls

A typical schedule of maintenance activities for flow control devices is included in Table 7-4.

Table 7-4 Flow control devices

Maintenance schedule	Required action	Frequency
Regular maintenance	Inspect/check pipework to ensure that the flow control is in good condition and operating as designed	Monthly
	Inspect for evidence of poor operation	Monthly, or as required
Occasional maintenance	High pressure water jet removal of silt build-up	Six monthly, or as required
Remedial actions	Replace the flow control if it becomes damaged	As required
	Clear pipework of blockages	As required

8 Flood Risk Management Measures

8.1 MITIGATION FOR ON SITE FLOODING

Outside of the fluvial flood zone the area is not at significant flood risk and climate change will not alter this for the expected lifetime of the proposed development. Parts of the proposed development remain at risk of flooding from surface water, and this includes from small channels and ditches within the Site. The flood depth in these areas is expected to be less than 300mm.

The solar panels are raised 800 mm above ground level and therefore unlikely to be affected by this flooding, should it occur. No additional specific mitigation is required to protect them.

Inverters, transformers and substations should not be sited within the surface water flood risk areas or, if this is unavoidable, vulnerable parts of these structures should be raised at least 300 mm above the ground level. It is proposed to raise them by 600 mm above ground level on piers as a precaution and this approach will also avoid any potential blockage or diversion of surface flow paths.

Gravel tracks will not be raised above the ground surface in the surface water flood risk areas to avoid diverting flow paths.

The Site will not be normally occupied. Maintenance will be timetabled and restricted to daylight hours. Maintenance visits should be cancelled and any on-Site personnel withdrawn on receipt of a flood warning.

All runoff from the proposed structures will be dealt with locally with source control measures and the Site will not generate extra runoff. Further mitigation for flood risk is not considered to be required but a construction phase surface water management plan should be developed within the CEMP to ensure flood risks and flood runoff are not increased during construction.

8.2 FLOOD COMPENSATION VOLUME

Occupation of the flood storage areas by structures will be minimal (as pathways rather than storage areas) and the alternative routes will offer similar storage characteristics. Explicit compensation for lost storage is therefore not required.

Moving vulnerable structures away from surface water flow paths avoids this requirement entirely.

8.3 SAFE ACCESS AND EXIT

Whilst Rosliston Road, and the access tracks off it, are located within the flucial flood risk area, alternative routes outwith the flood risk area are available such as via Coton Road. The local road network may be affected by flooding where it crosses the unnamed watercourse and by surface water, particularly Coton Road between Oaklands Farm and Lad's Grave. Flood depths along these routes are expected not to exceed 300 mm however, and they should remain passable with care.

8.4 FLOOD WARNING

Flood warning is unlikely to be of use in the area as the catchment is mostly out of the flood risk area and the response of the small watercourses to rainfall could be very rapid. Nevertheless, the site operators should sign up for the flood alert service provided by the EA in order to avoid working on Site when flooding is possible and have measures in place to inform any personnel on Site of the need to close and evacuate. Further information is provided here:

https://flood-warning-information.service.gov.uk/warnings

8.5 OFF-SITE IMPACTS

As the proposed development will not reduce flood storage volume, increase discharge runoff or impede surface water flows it is very unlikely to impact on flood risk elsewhere.

Appendices

Appendix A: Report Conditions

Report Conditions

This report has been prepared by Yellow Sub Geo Ltd. (Yellow Sub Geo) in its professional capacity as soil and groundwater specialists, with reasonable skill, care and diligence within the agreed scope and terms of contract and taking account of the manpower and resources devoted to it by agreement with its client, and is provided by Yellow Sub Geo solely for the internal use of its client.

The advice and opinions in this report should be read and relied on only in the context of the report as a whole, taking account of the terms of reference agreed with the client. The findings are based on the information made available to Yellow Sub Geo at the date of the report (and will have been assumed to be correct) and on current UK standards, codes, technology and practices as at that time. They do not purport to include any manner of legal advice or opinion. New information or changes in conditions and regulatory requirements may occur in future, which will change the conclusions presented here.

Where necessary and appropriate, the report represents and relies on published information from third party, publicly and commercially available sources which is used in good faith of its accuracy and efficacy. Yellow Sub Geo cannot accept responsibility for the work of others.

This report is confidential to the client. The client may submit the report to regulatory bodies, where appropriate. Should the client wish to release this report to any other third party for that party's reliance, Yellow Sub Geo may, by prior written agreement, agree to such release, provided that it is acknowledged that Yellow Sub Geo accepts no responsibility of any nature to any third party to whom this report or any part thereof is made known. Yellow Sub Geo accepts no responsibility for any loss or damage incurred as a result, and the third party does not acquire any rights whatsoever, contractual or otherwise, against Yellow Sub Geo except as expressly agreed with Yellow Sub Geo in writing. Yellow Sub Geo reserves the right to withhold and/ or negotiate the transference of reliance on this report, subject to legal and commercial review.

Appendix B: Surface Water Features Survey

Oaklands Farm Solar Park
BayWar.e

Figure 9.1: Field and historic map observations

Legend

- Site boundary
- 500m buffer for Study Area
- Field numbering
- Historic gravel/ marl pits
- Historic ponds/ reservoirs
- Current ponds/ reservoirs

Source: Google Satellite Mapping

CB: XX EB: XX LUC: DOC NAME AND DATE
Source:

Map scale
1:18,500 @ A3

Appendix C: Greenfield Runoff Calculations

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Bob Sargent
Site name:	Oaklands Farm
Site location:	Rosliston

Site Details

Latitude:	52.75009° N
Longitude:	1.65737° W
Reference:	894148917
Date:	Dec 09 2021 17:08

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.

Runoff estimation approach IH124

Site characteristics

Total site area (ha): 1

Methodology

Q_{BAR} estimation method: Calculate from SPR and SAAR

SPR estimation method: Calculate from SOIL type

Soil characteristics	Default	Edited
SOIL type:	4	4
HOST class:	N/A	N/A
SPR/SPRHOST:	0.47	0.47

Hydrological characteristics	Default	Edited
SAAR (mm):	639	639
Hydrological region:	4	4
Growth curve factor 1 year:	0.83	0.83
Growth curve factor 30 years:	2	2
Growth curve factor 100 years:	2.57	2.57

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?

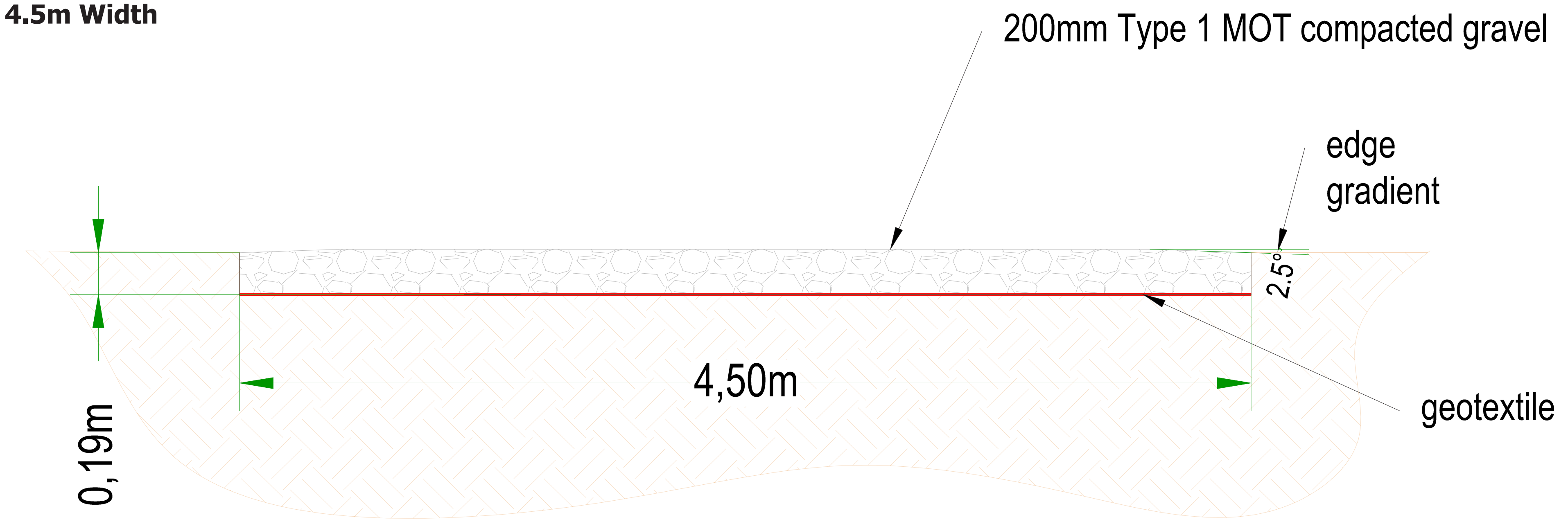
Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Growth curve factor 200 years:	3.04	3.04

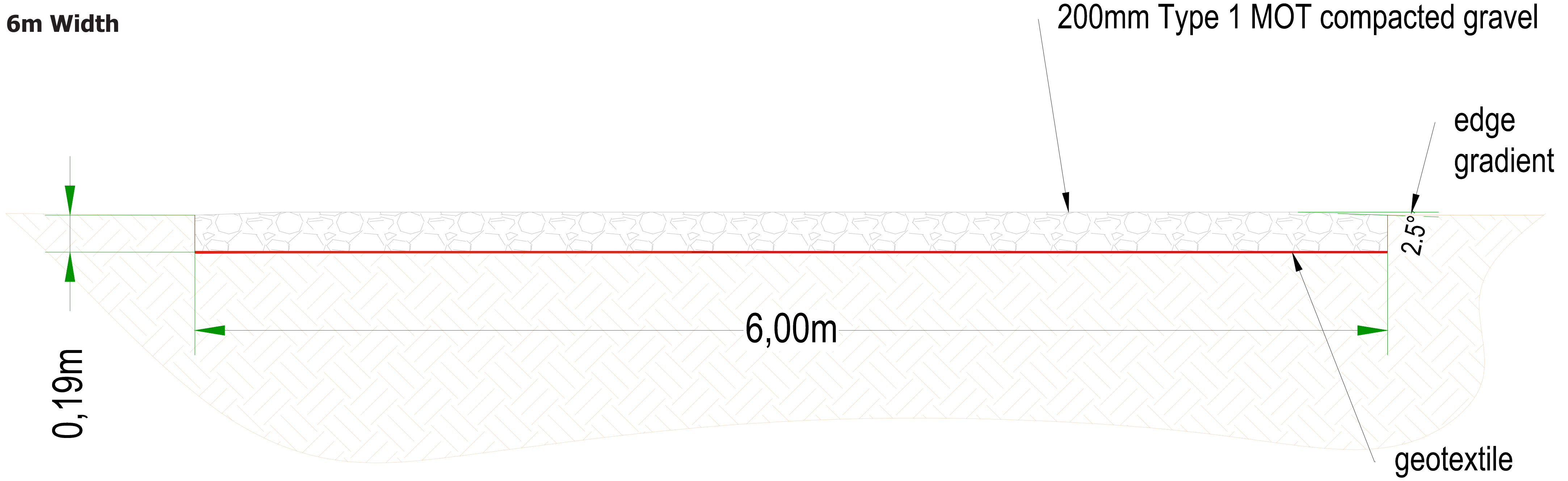
Greenfield runoff rates	Default	Edited
Q_{BAR} (l/s):	4.34	4.34
1 in 1 year (l/s):	3.6	3.6
1 in 30 years (l/s):	8.68	8.68
1 in 100 year (l/s):	11.15	11.15
1 in 200 years (l/s):	13.19	13.19

Appendix D: Access Track Cross Sections

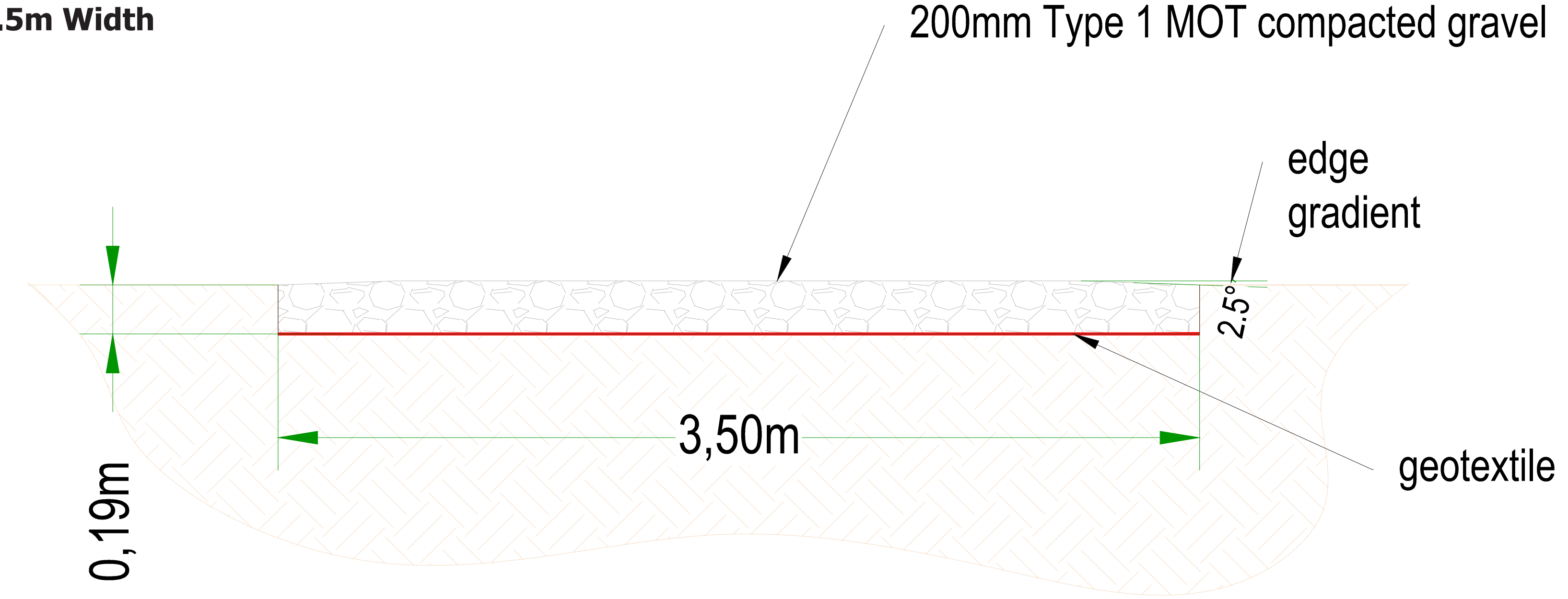
4.5m Width



6m Width



3.5m Width



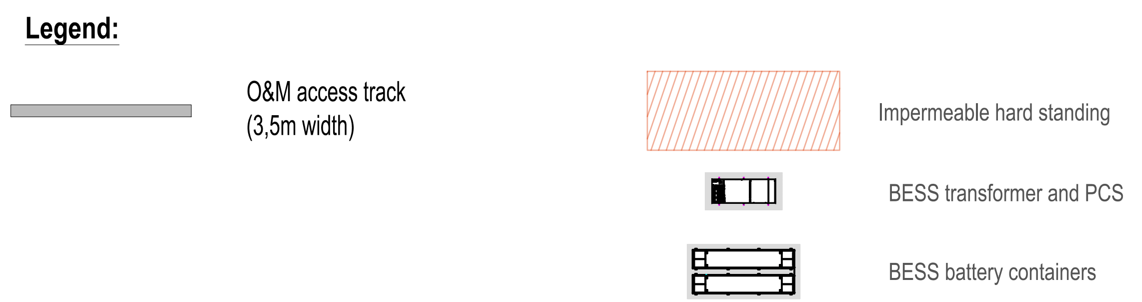
Oaklands Farm Solar Park
for Oaklands Farm Solar Ltd

Figure 4.11: Indicative Access Track Cross Sections (4.5m/6m/3.5m)

PINS reference: EN010122

11477_INTRO_r1_A3L_Fig4-3/11477_OAK_Fig4_11_TrackXSection_4_5m_A3L 13/12/2023EB:Hardie_T

Appendix E: Battery Storage Details



BayWa r.e.

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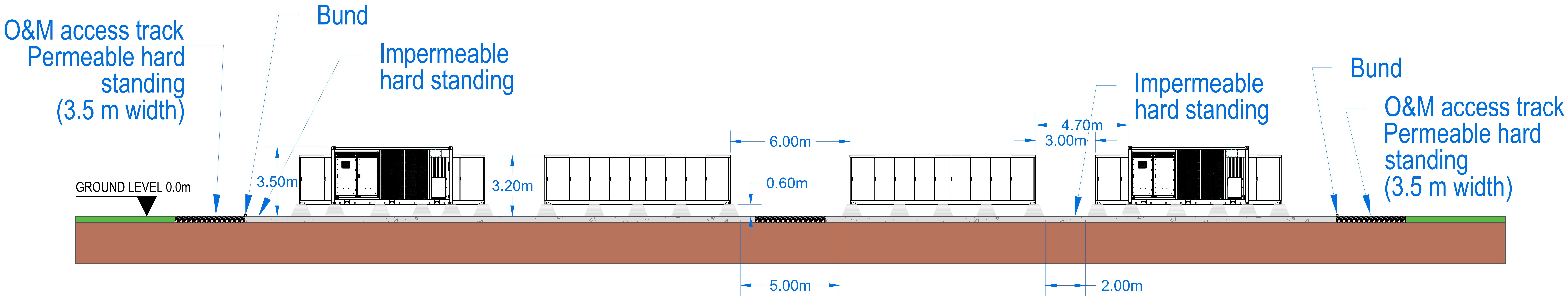
	Date	Name:
Drawn	08.03.2022	gky
Changed	19.10.2023	moa
Checked		
Drawing Title:	Indicative arrangement battery storage - Compound	
file name:	Battery Storage Elevation Drawing.dwg	

Project:	Oaklands UK Battery Storage
Client:	Oaklands Farm Solar Limited
Scale	1:250
Planning Period:	Preliminary
Format	A2

BESS - BATTERY STORAGE COMPOUND
SECTION A-A'



Note: See also drawing "Indicative arrangement battery storage - Compound" or "Figure 2 - BESS compound"

Legend:

BESS battery container

BESS transformer and PCS

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	Date	Name:
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Changed	19.10.2023	moa
Checked		
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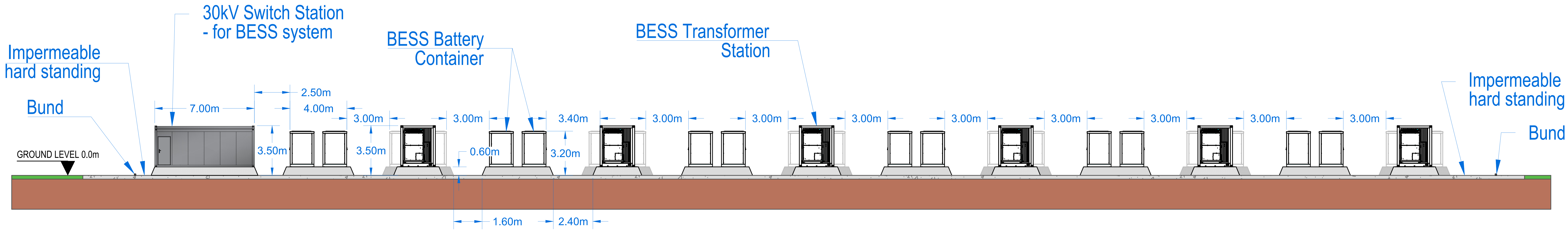
file name:	Battery Storage Elevation Drawing.dwg	

Project:	Oaklands UK Battery Storage	
Client:	Oaklands Farm Solar Limited	Scale 1:50
Planning Period:	Preliminary	Format A2

BESS - BATTERY STORAGE COMPOUND
SECTION B-B'



Note: See also drawing "Indicative arrangement battery storage - Compound" or "Figure 2 - BESS compound"

Legend:

- O&M access track (3,5m width)
- BESS transformer and PCS
- BESS battery container

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	Date	Name:
Drawn	08.03.2022	gky
Changed	19.10.2023	moa
Checked		

Drawing Title: Indicative arrangement battery storage Section B-B'

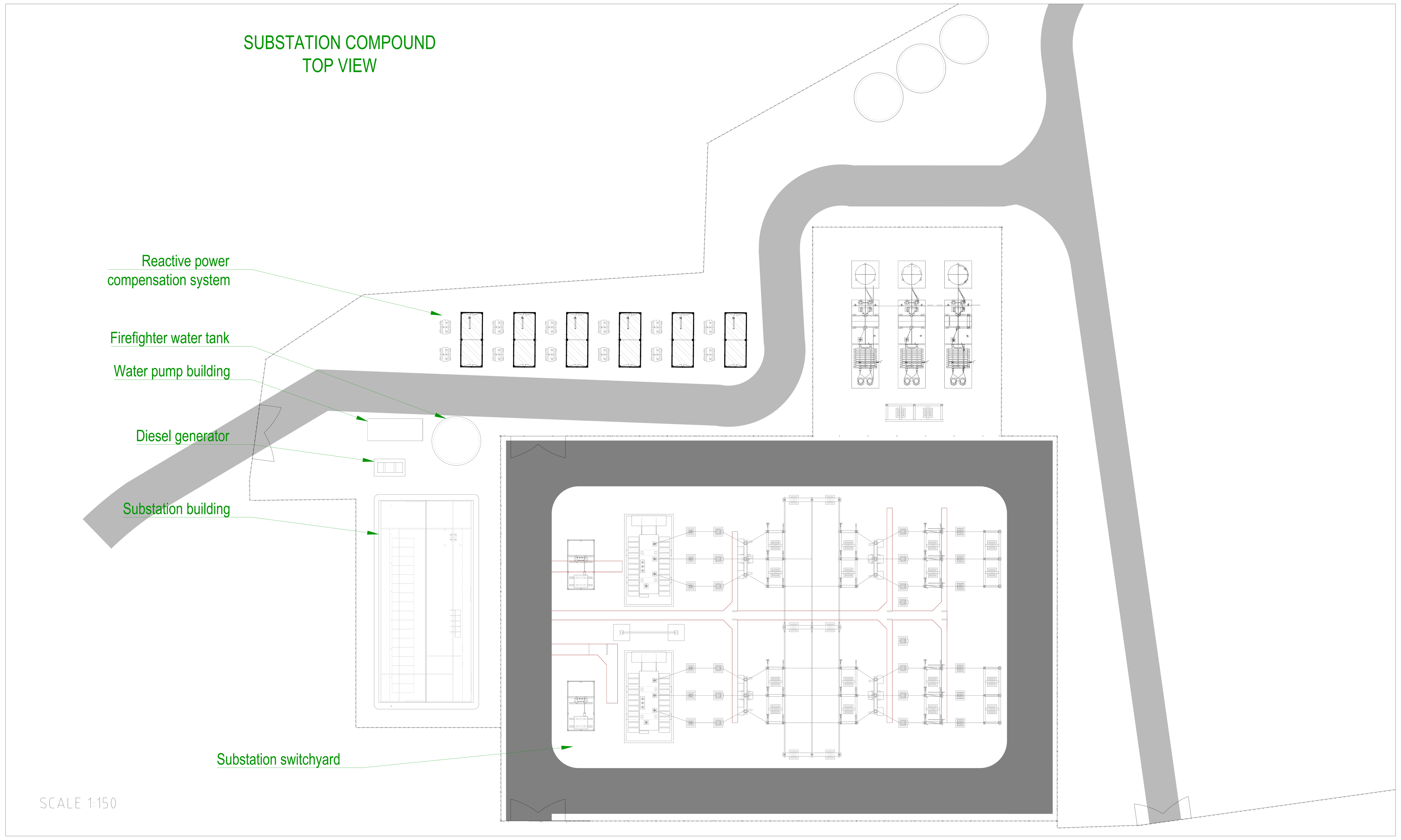
file name: Battery Storage Elevation Drawing.dwg

Project: Oaklands
UK
Battery Storage

Client:	Scale
Oaklands Farm Solar Limited	1:200
Planning Period:	Format
Preliminary	A2

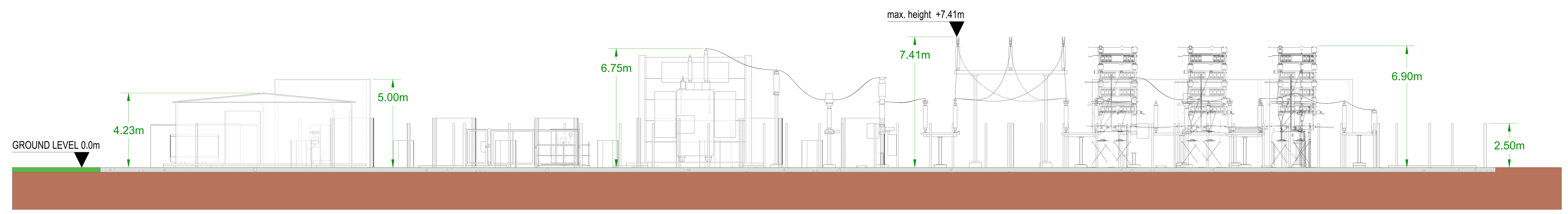
Appendix F: Substation Details

SUBSTATION COMPOUND TOP VIEW



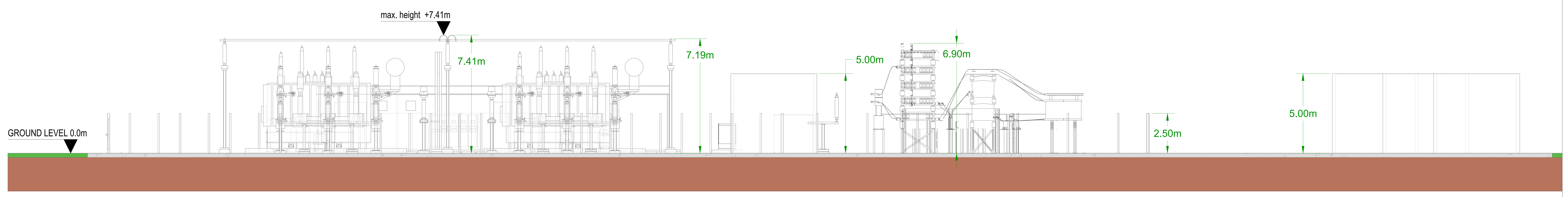
SCALE 1:150

SIDE VIEW



SCALE 1:150

FRONT VIEW



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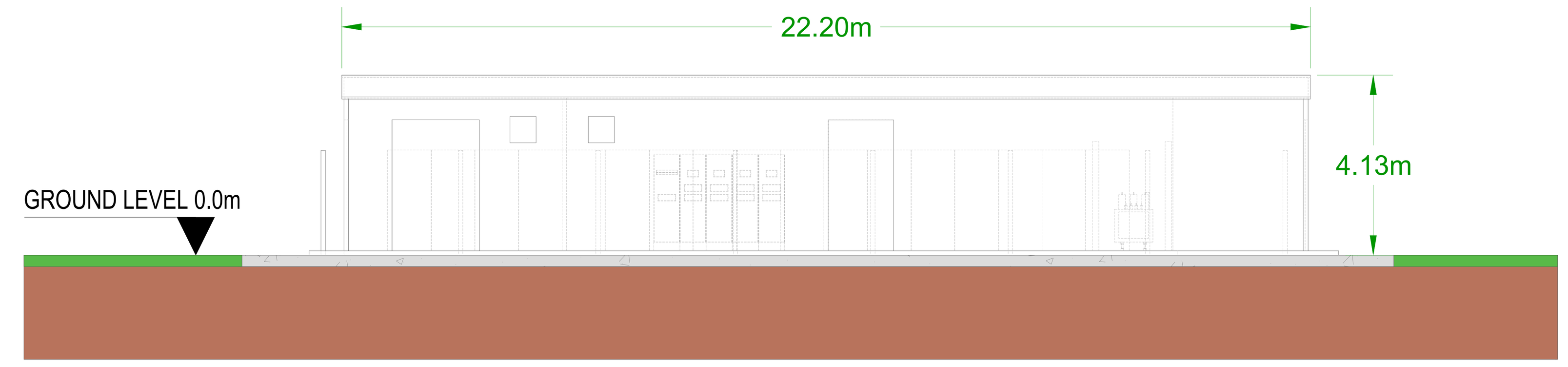
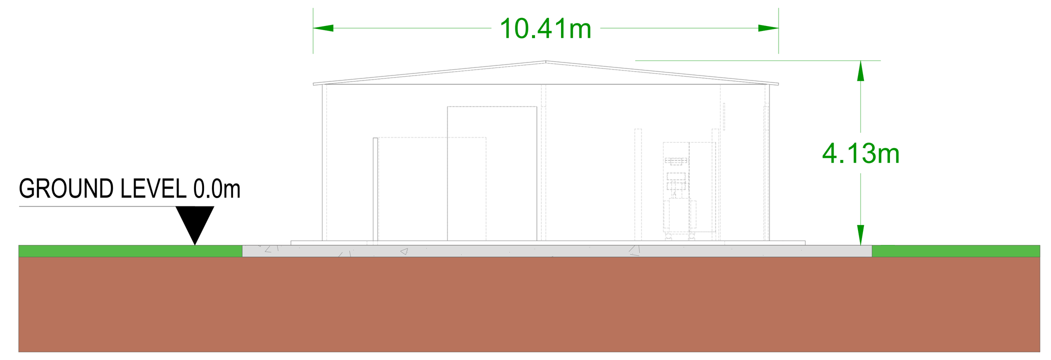
SUBSTATION BUILDING SIDE VIEW



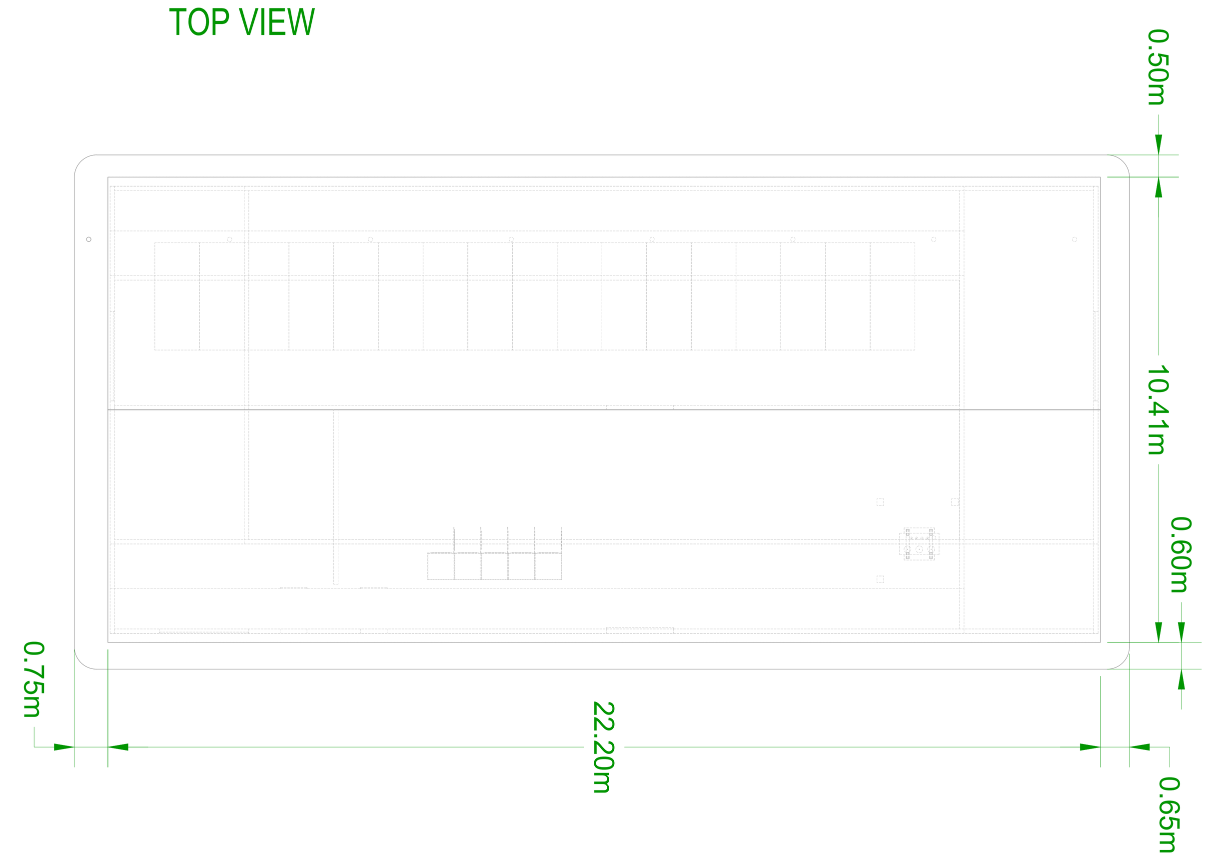
SCALE 1:100

SUBSTATION BUILDING FRONT VIEW



SCALE 1:100

SUBSTATION BUILDING TOP VIEW



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1:150

0 10 20 Meter

1:100

0 2.5 5 Meter

Index	Date	Name Editor	Modification / Adaptation of the drawing
j			
i			
h			
g			
f			
e			
d			
c			
b			
a	11.09.2023	moa	revised section views, added reactors and water tanks

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Project: Oaklands
The UK
Ground Mounted PV

	Date:	Name:
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Changed:		
Checked		
Drawing Title:	01_details substation_v2	
file name:	BWre-OAKF-PD-dHV.dwg	

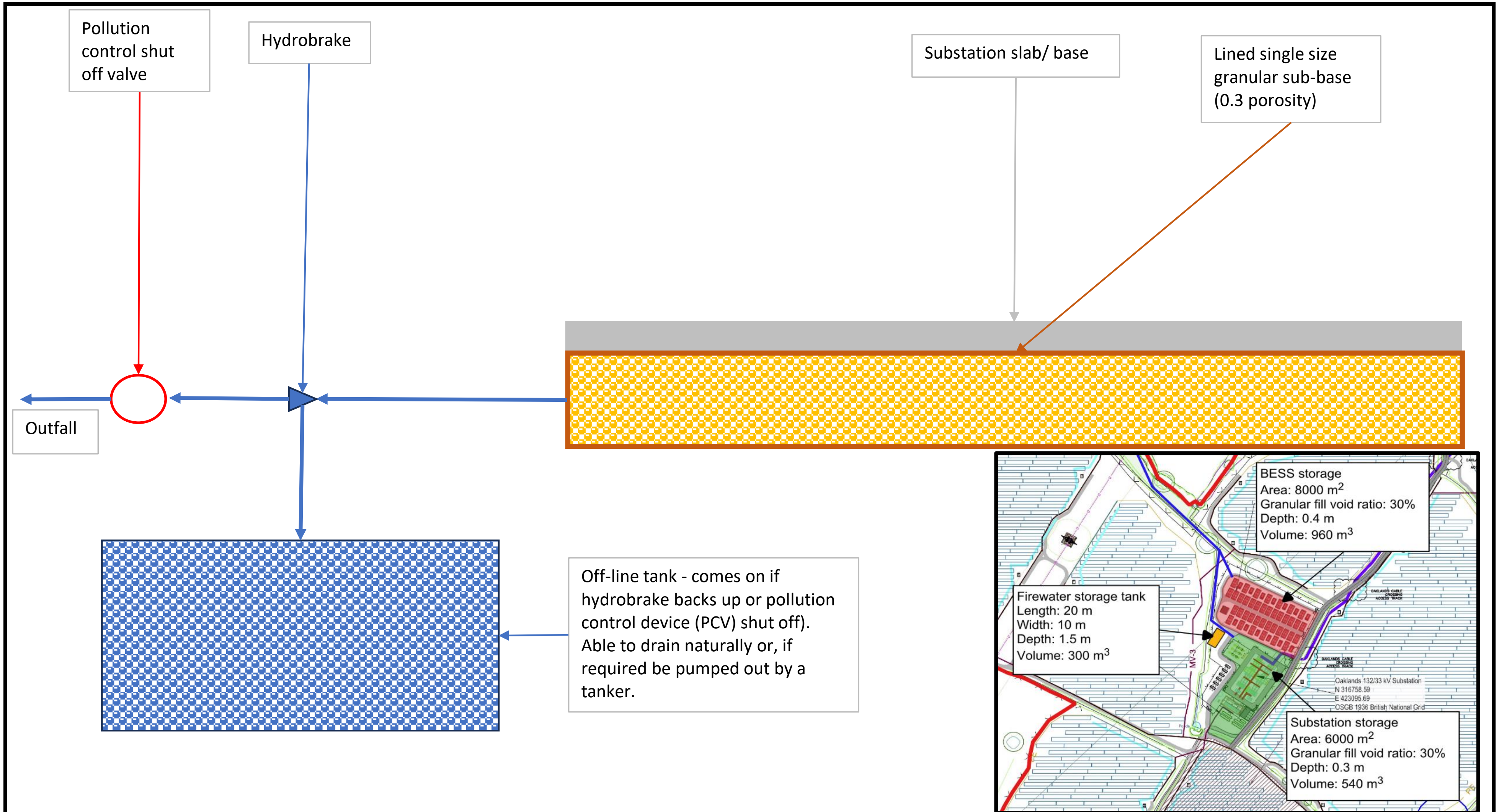
Client: BayWa r.e. Solar Project

Scale

Planning Period: Preliminary Designa

Format: A0

Appendix G: SuDS layout



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		Revision	**0**
Drawing Number	-	Drawn by	**JEM**
Project Name	**Oaklands Solar Farm**	Checked by	-
Project Number	**P20209**	Notes	
Client	**BayWa**		