PROPOSED SOLAR FARM, BRYN HENLLYS EXTENSION, WAUNLWYD FARM, YSTRADOWN, SWANSEA

CONSTRUCTION TRAFFIC MANAGEMENT PLAN

LIGHTSOURCE BP

AUGUST 2019

PFA Consulting
Stratton Park House
Wanborough Road
Swindon
SN3 4HG

Tel: 01793 828000
Fax: 01793 835500
Email: admin@pfaplc.com
Web: www.pfaplc.com

engineering the future

PAGE LEFT INTENTIONALLY BLANK

DOCUMENT CONTROL

Job No	L470	
File Reference	G:\workfiles\L470 WAUNLWYD SOLAR FARM\REPORTS\L470-DOC01 CTMP.docx	
	Name	Date
Prepared By	P Key	27 June 2019
Checked By	A Miles	28 June 2019

Issue	Approved By	Date	Comments
1	P Key	2 July 2019	Draft for comment
2	P Key	9 August 2019	For submission

PAGE LEFT INTENTIONALLY BLANK

CONTENTS

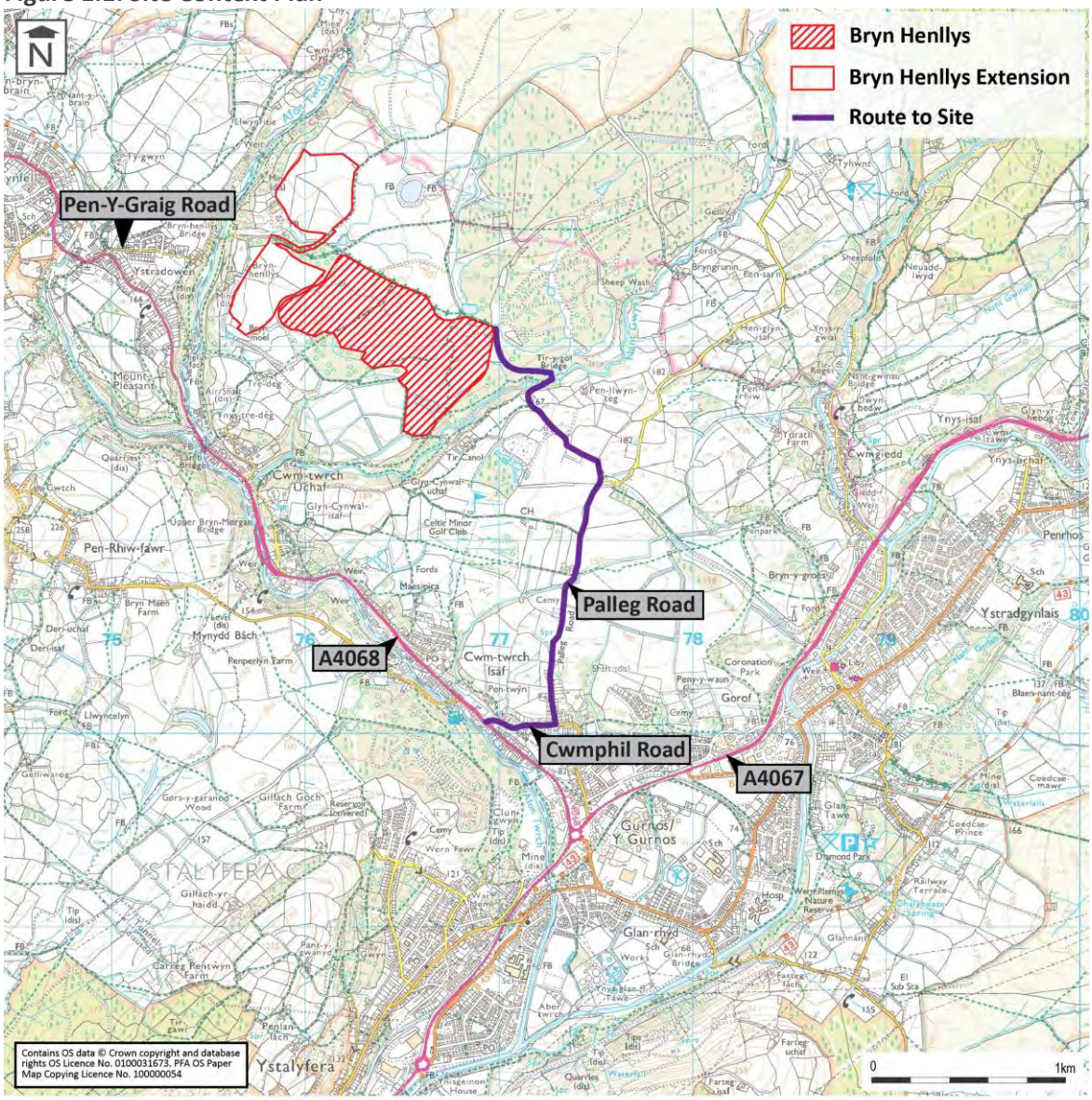
PAGE NO.

1. INTRODUCTION

1.1. This Construction Traffic Management Plan (CTMP) has been prepared by PFA Consulting on behalf of Lightsource BP in support of a planning application for the development of a solar photovoltaic (PV) farm of 12.23MW at Waunlwyd Farm, Ystradown, Swansea.

1.2. The Application Site, referred to as Bryn Henllys Extension is situated at Waunlwyd Farm, covering an area of approximately 63.2 ha. The general location of the site is shown on **Figure 1.1**.

Figure 1.1: Site Context Plan



1.3. The Application Site is split into two parcels. The northern parcel comprises four irregular shaped fields. The Afton Twrch lies to the west of the parcel within dense woodland near to the Application Site's western boundary. A farmstead and aggregate compound lie to the south west. Further fields are present to the north and east.

1.4. The southern parcel comprises six fields of varying shapes and sizes. The Afton Twrch lies to the west of the parcel within dense woodland to the western, northern and eastern boundaries. Further fields with hedgerow boundaries are present to the south, beyond which lies a number of isolated properties to the south and southeast.

Planning Context

1.5. To the immediate east of the southern parcel of the Application Site planning permission has been granted for a 20MW solar farm at Bryn Henllys (Ref: P/2015/0176), but it yet to be constructed.

1.6. The planning application for Bryn Henllys solar farm was supported by a Construction Traffic Management Plan, as agreed with Powys County Council.

1.7. Bryn Henllys solar farm, as shown on **Figure 1.1**, takes access from the existing access from Palleg Road, near the western corner of the site, with construction material transferred within the site. This existing access was used for the previous open cast minerals extraction which ceased in 2003, as such is of a standard and scale to accommodate regular HGV traffic.

1.8. It is proposed to use the same construction access for Bryn Henllys Extension as proposed for the approved Bryn Henllys solar farm, with materials transferred within Bryn Henllys solar farm and the application site. The construction of Bryn Henllys Extension would be undertaken at the same time as Bryn Henllys solar farm, by means of an extended construction period. Bryn Henllys Extension construction would take approximately 3 months.

Report Structure

1.9. To be consistent with Bryn Henllys solar farm a CTMP also supports the planning application for Bryn Henllys Extension. This CTMP sets out the existing highway characteristics, proposed access arrangements, traffic management and the principal traffic impacts that will occur during construction of the solar farm.

2. EXISTING CONDITIONS

2.1. Waunlwyd Farm is accessed off Pen-Y-Graig Road, which connects with the A4068 New Road at a priority junction approximately 800m west of the Application Site. Pen-Y-Graig Road provides access to a number of residential properties before continuing towards Waunlwyd Farm.

2.2. Pen-Y-Graig Road is not considered further in this CTMP as it will not be used for construction access to Bryn Henllys Extension. As set out in paragraph 1.8 it is proposed to use the same construction access as the approved Bryn Henllys solar farm, therefore consideration of the local highway network will focus on the route to this access.

Local Highway Network

2.3. The existing access with Palleg Road, as shown in **Photograph 2.1** is a wide formally surfaced access, which previously provided access to the open cast mine. Gates are set back approximately 18m from the edge of Palleg Road, which lead to an existing area of hardstanding of approximately 35mx45m.

Photograph 2.1: Existing Access with Palleg Road

2.4. The width of Palleg Road is variable along its length however the road is of a good standard and currently carries both large agricultural vehicles and vehicles associated with a waste recycling plant. Palleg Road also provides access to some residential dwellings at its southern end, Celtic Minor Golf Club, a recycling and household recycling plant and landfill site and agricultural fields and properties. The road is subject to national speed limit upon leaving Cwm-twrch lsaf. To the south of this point, the road is subject to a 30mph speed limit.

2.5. Traffic data on Pallleg Road has been taken from the DfT manual count point (Site: 951290) for 2018.Annual average daily two-way flows were recorded of circa 210 vehicles, of which circa 35 (17%) were HGV's.

2.6. At its southern extent, Palleg Road forms a priority junction with Cwmphil Road, which in turn connects the A4068 via a mini-roundabout junction to the south west of the junction with Palleg Road.

2.7. The A4068 links to the A4067, which is a high standard route from the M4 Junction 45, approximately 18 kilometres to the south.

Public Rights Of Way

2.8. There are a number of Public Rights of Way in the vicinity of Bryn Henllys Extension, though none located within the actual fields where solar farm panels and infrastructure would be sited.

2.9. Byway open to all traffic (BOAT) No. 7 continues from Palleg Road along the northern boundary of Bryn Henllys solar farm and between the two parcels of Bryn Henllys Extension.

2.10. Three public footpaths (No. 28, 116A and 117A) route through Bryn Henllys solar farm connecting with BOAT No 7 to the north, whilst footpath 122A routes along the eastern side of the northern parcel of Bryn Henllys Extension connecting with BOAT No. 7 to the south. Further public footpaths route northeast from the northern corner of Bryn Henllys solar farm (No. 37) and between BOAT No. 7 at the northern corner of Bryn Henllys solar farm, west to footpath 122A.

2.11. Existing use of the BOAT and footpaths is typically by farm vehicles, with no other users observed during a site visit, the BOAT and most footpaths are surfaced with scalping or similar surfacing.

3. PROPOSED ACCESS ARRANGEMENTS AND ROUTING

3.1. It is proposed to use the same construction access for Bryn Henllys Extension as proposed for the approved Bryn Henllys solar farm, with materials transferred within Bryn Henllys solar farm and the Application Site. The construction of Bryn Henllys Extension would be undertaken at the same time as Bryn Henllys solar farm, by means of an extended construction period. Bryn Henllys Extension construction would take approximately 3 months.

3.2. The site layout for Bryn Henllys Extension is reproduced at **Appendix A**.

Construction Access

3.3. Construction access is proposed via the existing gated hard-surfaced access from Palleg Road, as shown in **Photograph 2.1**. The access track currently provides a route into the site and to an existing area of hard standing proposed to be utilised as a construction compound area for the duration of the construction phase.

Construction Traffic Routing

3.4. It is proposed that construction traffic will access the site from the A4068 at its junction with Cwmphil Road, proceeding along Cwmphil Road to Palleg Road and onwards, north to the site. **Figure 1.1** illustrates the proposed route between the site and the A4068.

3.5. Large vehicles regularly use the Cwmphil Road and Palleg Road to access other farms and the waste and recycling site. However for clarification, **Appendix B** reproduces swept path analysis drawings submitted for Bryn Henllys solar farm confirming that construction vehicles will be able to undertake specific movements of the construction route.

Management of Construction Traffic

3.6. In line with the approved Bryn Henllys solar farm, it is proposed to implement a 'call-on' system whereby construction vehicle drivers will arrive at a layby on the A4067 at Glantawe Riverside Park, to the east of Pontardawe which is approximately 10km to the south of the site. Drivers will then call the site manager to announce their intention to access the site. The site manager will ensure that no other construction traffic seeks to enter or exit the site compound at the same time, to minimise vehicle conflict.

3.7. In line with the approved Bryn Henllys solar farm, construction hours will be between 08:00 and 18:00 Monday to Friday, and between 08:00 and 16:00 Saturday.

3.8. Deliveries will be scheduled to take place outside of the morning and evening peak hours (08:00-09:00 and 17:00-18:00) to avoid conflict with peak periods on the local highway network on approach to the site.

Construction Compound

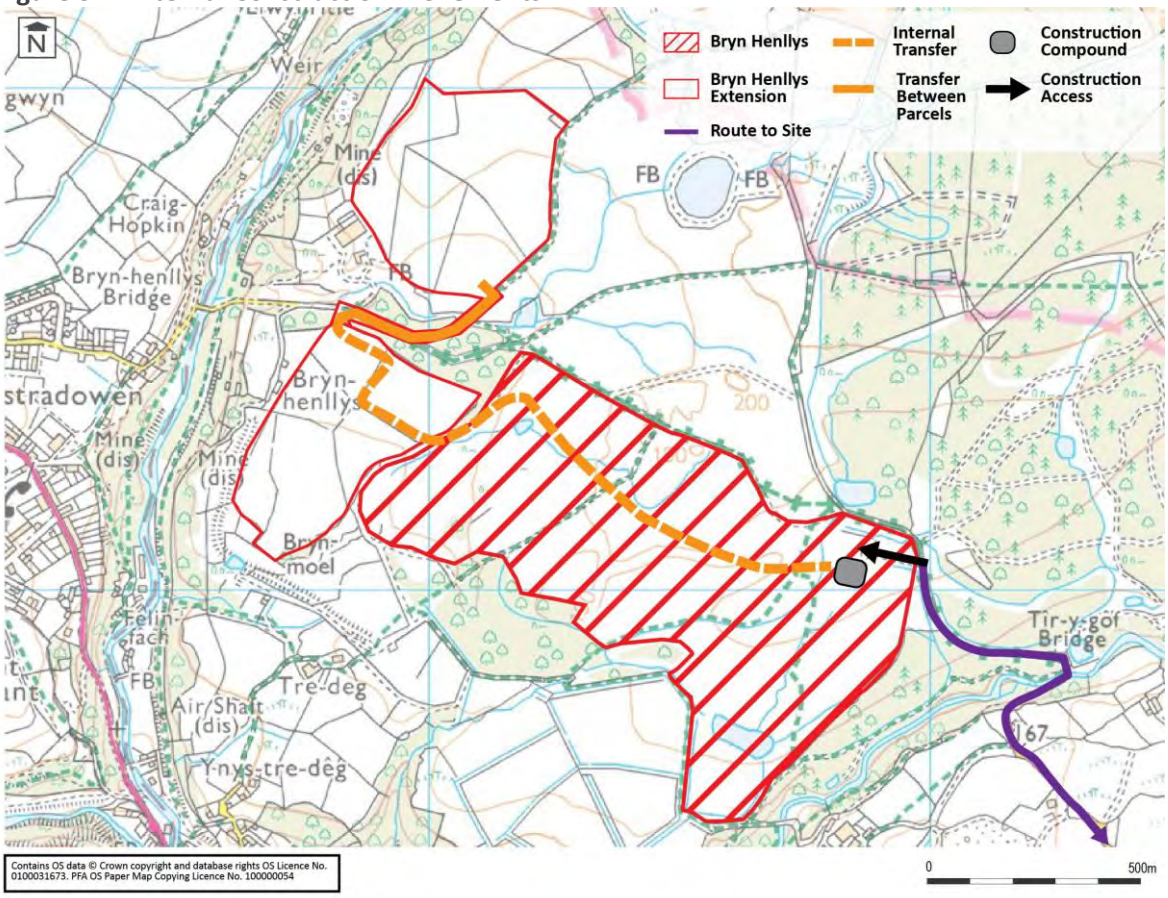
3.9. It is proposed that the existing area of hard standing in Bryn Henllys solar farm also be utilised as the compound area for the construction of Bryn Henllys Extension. The proposed compound area is accessed directly off the existing hard-surfaced track referred to in paragraph 3.3. The location of the construction compound is shown on **Figure 1.1**.

3.10. **Appendix C** reproduces swept path analysis drawings submitted for Bryn Henllys solar farm showing delivery vehicles entering, turning and then exiting the compound.

Internal Site Movements

3.11. From the construction compound area in Bryn Henllys solar farm, the offloading and distributing of the materials will be by telehandlers. Materials will be transported across Bryn Henllys solar farm using internal access tracks, into the southern parcel of Bryn Henllys Extension, at the existing access shown in **Photograph 3.1**, through the southern parcel to the existing access shown in **Photograph 3.2** and to the northern parcel (access shown in **Photograph 3.3**) using the existing access tracks between the two parcels, as indicated in **Figure 3.1**.

Figure 3.1: Internal Construction Movements



3.12. During the construction period, delivery vehicles accessing the compound area and construction vehicles accessing the various parts of the site would travel at slow speeds. Drivers of construction and delivery vehicles will be made aware of the potential for members of the public to be using the PROW routes and informed that they must give way to rights of way users at all times. Equally, users of the Public Rights of Way network will be warned of construction traffic through the use of appropriate signage.

3.13. At night the construction fencing will ensure that no users of the PROW stray into the construction site.

Photograph 3.1: Eastern access to Southern Parcel

Photograph 3.2: Northern access to Southern Parcel

Photograph 3.3: Access to Northern Parcel

Wheel Washing and Waste Management

3.14. The existing surfacing of the access road from Palleg Road to the compound area and that of the compound area itself will enable construction and delivery vehicles to access and egress the site without transporting mud and debris onto the public highway. As identified at paragraph 3.10, distribution of materials from the construction compound to Bryn Henllys Extension will be separately undertaken by telehandlers or other similar vehicles on internal access tracks.

3.15. The removal of any waste products from the site would be minimised by the recycling of excess materials wherever possible.

Enforcement of Construction Traffic Management Plan

3.16. The site manager will ensure that the installation team and other contractors/operatives adhere to the Construction Traffic Management Plan and its measures will be monitored by Powys County Council as the Local Highways Authority.

4. TRAFFIC GENERATION

4.1. As set out in paragraph 3.1 construction of Bryn Henllys Extension would be undertaken at the same time as Bryn Henllys solar farm, by means of an extended construction period. Bryn Henllys Extension construction would take approximately 3 months, with a similar anticipated daily construction vehicle impact to Bryn Henllys solar farm.

Construction Period

4.2. The construction period of the Bryn Henllys Extension is anticipated to take approximately 3 months. During this period there will be trips associated with the arrival and departure of construction staff, and with the delivery of parts and construction materials.

Traffic Generation

HGVs

4.3. The deliveries will be spaced across the construction period, with typically approximately 4 deliveries taking place a day over the 3 month (12 week) period.

4.4. Over this period the number of estimated HGV movements are summarised within **Table 4.1** below.

Table 4.1: Summary of Estimated Trip Generation

Delivery	Estimated Trip Generation
Delivery of Mounting Frames	20
Delivery of Modules	35
Delivery of Cabinets	35
Delivery of Cables	30
Plant Equipment/Recycling	80
Delivery of Gravel / Hard Core Material	50
Total Number of HGV's	**250**

4.5. In total the construction of the solar farm will result in approximately 250 deliveries to the site, spread over the 12 week construction period it is estimated that the site will typically generate up to 4 HGV deliveries (8 HGV movements) per day.

4.6. This is a comparable impact to the permitted Bryn Henllys solar farm of which Powys County Council previously considered not to be a problem given other activities along Palleg Road.

4.7. The expected HGV numbers are based on best estimates at this stage and will be dependent upon the construction programme, such as the shipping of materials.

Light Vehicles

4.8. The number of construction staff on site will vary over the construction period depending on the activity that is taking place. The majority of staff will travel in crew buses, which will park on site during the day. At the peak of activity, there could be 10 buses/minibuses/vans on the site. In addition, there are expected to be a small number of managerial cars/vans. There will be sufficient parking space provided during construction to accommodate these vehicles and the unloading of delivery vehicles.

Operation Period

4.9. The vehicle movements associated with the operational period of solar PV farms are very low, being mainly associated with the monitoring, upkeep and cleaning of the site. These trips would typically be made by small vans or a 4x4 vehicle.

4.10. The frequency of vehicle trips associated with monitoring and upkeep of the site are typically expected to be up to 10 times a year.

4.11. Due to the very low number of vehicular movements being made to and from the site during its operational period, the site is unlikely to have any significant impact to the local highway network once up and running.

5. CONCLUSION

5.1. This Construction Traffic Management Plan (CTMP) has been prepared by PFA Consulting on behalf of Lightsource BP in support of a planning application for the development of a solar photovoltaic (PV) farm of 12.23MW of power at Waunlwyd Farm, Ystradown, Swansea.

5.2. The Application Site is situated at Waunlwyd Farm, covering an area of approximately 63.2 ha. The general location of the site is shown on **Figure 1.1**.

5.3. The Application Site is split into two parcels. The northern parcel comprises four irregular shaped fields. The Afton Twrch lies to the west of the parcel within dense woodland near to the Application Site's western boundary. A farmstead and aggregate compound lie to the south west. Further fields are present to the north and east.

5.4. The southern parcel comprises six fields of varying shapes and sizes. The Afton Twrch lies to the west of the parcel within dense woodland to the western, northern and eastern boundaries. Further fields with hedgerow boundaries are present to the south, beyond which lies a number of isolated properties to the south and southeast.

5.5. It is proposed to use the same construction access for Bryn Henllys Extension as proposed for the approved Bryn Henllys solar farm, with materials transferred within Bryn Henllys solar farm and the application site. The construction of Bryn Henllys Extension would be undertaken at the same time as Bryn Henllys solar farm, resulting in an extension to the previous 30 week construction period to circa 45 weeks.

5.6. From the construction compound area in Bryn Henllys solar farm, the offloading and distributing of the materials will be by telehandlers. Materials will be transported across Bryn Henllys solar farm using access tracks, into the southern parcel of Bryn Henllys Extension, through the southern parcel and to the northern parcel using the existing access tracks between the two parcels.

5.7. During the construction period it is anticipated that there will be approximately 250 HGV deliveries for equipment and materials. These trips will be spread over the entire construction phase of the development. It is estimated that the site will typically generate 4 HGV deliveries per day.

5.8. The proposed development results in negligible trip generation during the operation period, with all trips being associated with maintenance or cleaning.

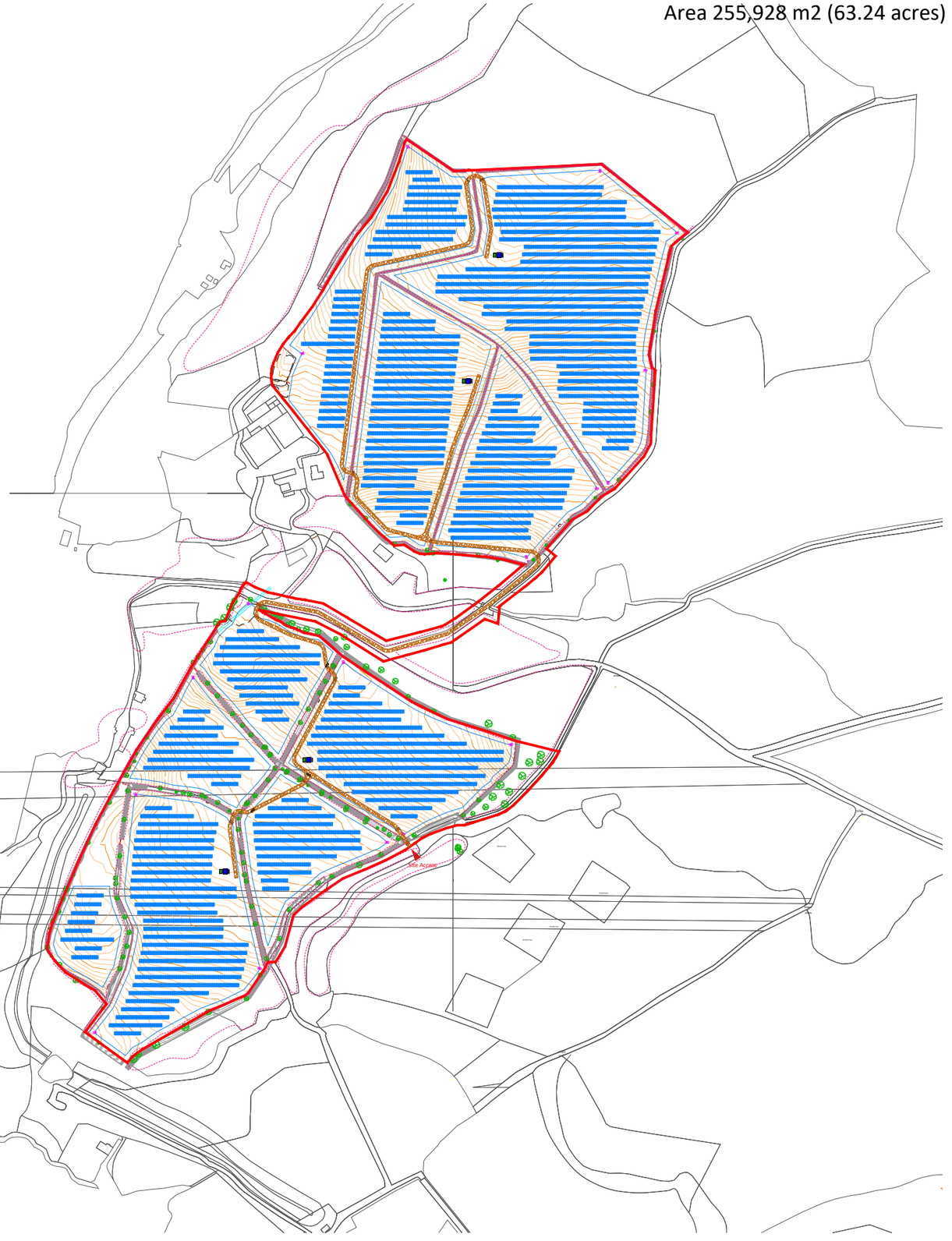
5.9. Given the scale of development and the proposed access arrangements, it is considered that, there should be no highway related objections to the proposed development.

Appendices

Appendix A

Bryn Henllys Extension_Proposed Layout_Rev5

Area 255,928 m2 (63.24 acres)



- Site Boundary
- Site Access
- Security Fence
- Field Boundary
- Module Table 14 x 4
- Module Table 28 x 4
- Transformer
- Switchgear Substation
- AC Box
- Access Road
- Tree
- Access Gates
- CCTV
- Tree-Root Protection Area

Scale 1:10000

A3 - (420 x 297)mm

GM			22.10.18
DRAWN	CHECKED	APPROVED	DATE

PROJECT NAME & ADDRESS:
Location: Waunlwud Farm, Ystradowen, Swansea, UK
Postcode: SA9 2XX

NOTES:
-
-
-
-
-

Paper Size:	Scale:	Sheet:
A3	1:5000	1

CAPACITY: 12.23 MWp

DRAWING TITLE: Bryn Henllys Extension_Proposed Layout_Rev5

DRAWING NUMBER:	STATUS:
BRYN_01	Preliminary

Lightsource Renewable Development Limited,
7th Floor, 33 Holborn, London, EC1N 2HU
General: +44 (0) 333 200 0755
Web: www.lightsourcebp.com
info@lightsourcebp.com

Appendix B

OS NORTH

TO SITE

PALLEG ROAD

DRAWING 14585/AT03

DRAWING 14585/AT04

DRAWING 14585/AT05

CWMPHIL ROAD

CWMPHIL ROAD

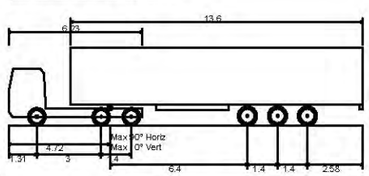
A4068 BETHEL ROAD

TO A4067
AND M4

0m 50m

SCALE BAR (1:1000)

VEHICLE DETAILS



MAX LEGAL LENGTH (UK) ARTICULATED VEHICLE (16.5M)	
OVERALL LENGTH	16.500m
OVERALL WIDTH	2.550m
OVERALL BODY HEIGHT	3.632m
MIN BODY GROUND CLEARANCE	0.396m
MAX TRACK WIDTH	2.500m
LOCK TO LOCK TIME	6.00s
KERB TO KERB TURNING RADIUS	6.870m

Rev	Date	Description	By	Ckd

Hydrock

Over Court Barns, Over Lane, Almondsbury,
Bristol, BS32 4DF.
TEL: 01454 619 533 FAX: 01454 614 125 or visit
www.hydrock.com

Notes:
All dimensions are to be checked on site before the commencement of works. Any discrepancies are to be reported to the Architect & Engineer for verification. Figured dimensions only are to be taken from this drawing. This drawing is to be read in conjunction with all relevant Engineers' and Service Engineers' drawings and specifications. This drawing is copyright.

Project:
PROPOSED SOLAR FARM, LAND AT BRYN HENLLYS, YSTRADOWEN, POWYS

Client:
JUWI RENEWABLE ENERGIES LIMITED

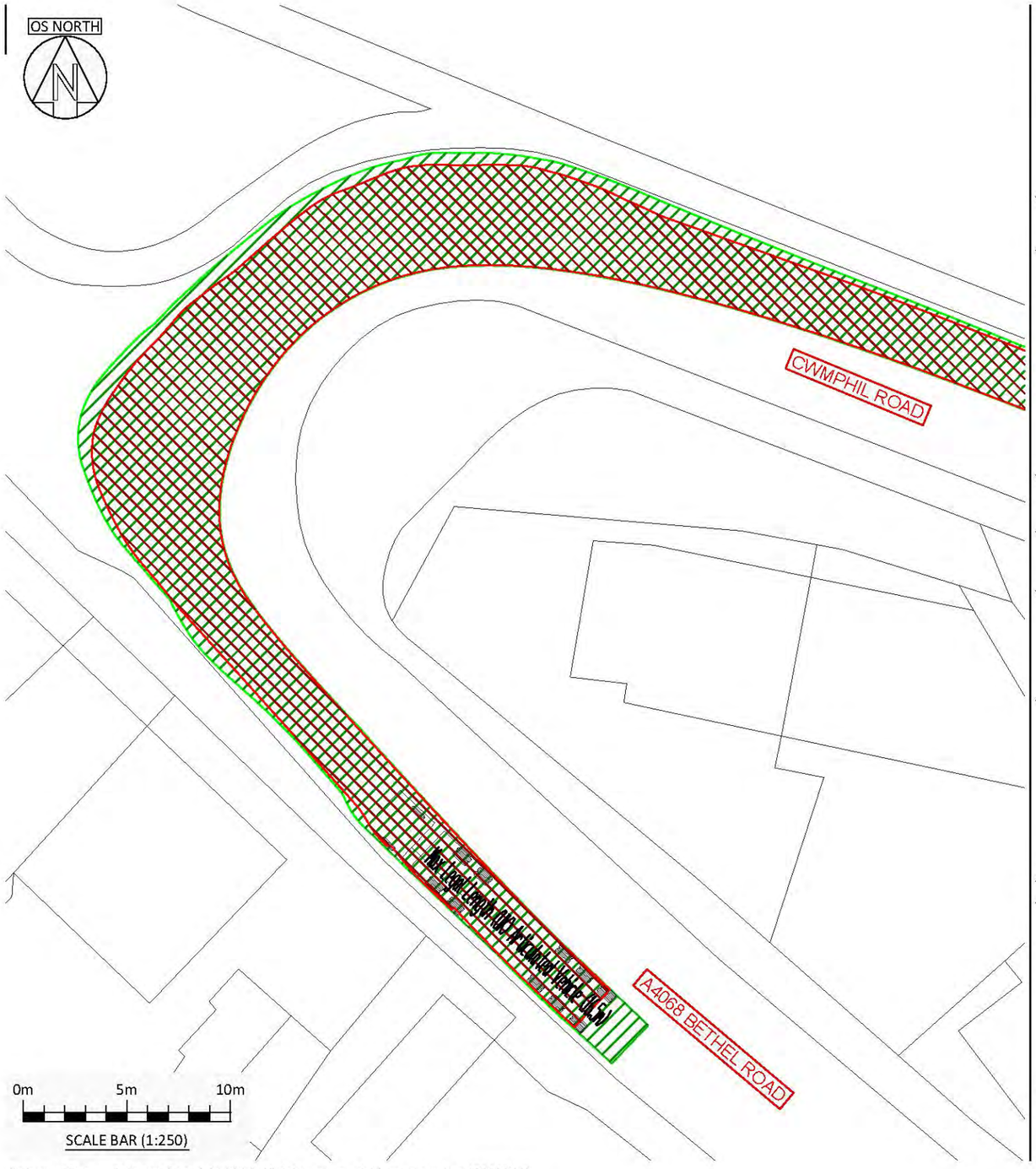
Drawing Title:
LOCATION OF CONSTRUCTION TRAFFIC ROUTE SWEPT PATHS

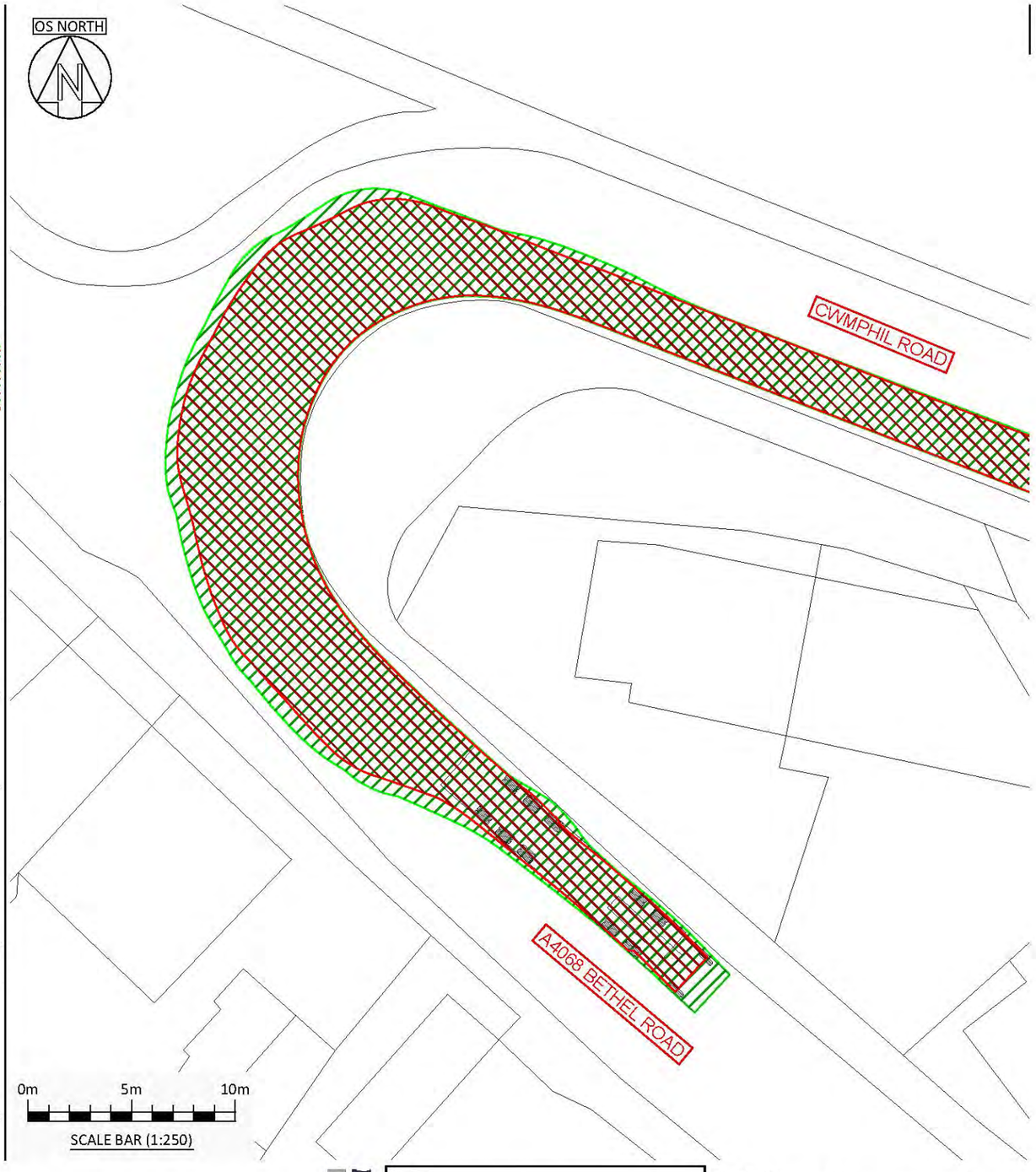
Project Number: C14585

Drawn:	Checked:	Scale @ A3:	Drawn Date:	First Issue:
AJT	EK	1:1000	09/07/2014	10/07/2014

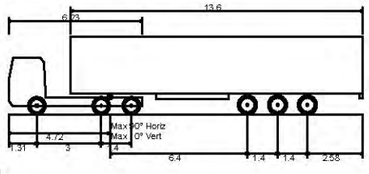
Drawing Status. IN REPORT

Drawing No. 14585/AT06 Revision -





VEHICLE DETAILS



MAX LEGAL LENGTH (UK) ARTICULATED VEHICLE (16.5M)	
OVERALL LENGTH	16.500m
OVERALL WIDTH	2.550m
OVERALL BODY HEIGHT	3.632m
MIN BODY GROUND CLEARANCE	0.396m
MAX TRACK WIDTH	2.500m
LOCK TO LOCK TIME	6.00s
KERB TO KERB TURNING RADIUS	6.870m

Rev	Date	Description	By	Ckd

Hydrock

Over Court Barns, Over Lane, Almondsbury,
Bristol, BS32 4DF.
TEL: 01454 619 533 FAX: 01454 614 125 or visit
www.hydrock.com

Notes:
All dimensions are to be checked on site before the commencement of works. Any discrepancies are to be reported to the Architect & Engineer for verification. Figured dimensions only are to be taken from this drawing.This drawing is to be read in conjunction with all relevant Engineers' and Service Engineers' drawings and specifications. This drawing is copyright.

Project:
PROPOSED SOLAR FARM, LAND AT BRYN HENLLYS, YSTRADOWEN, POWYS

Client:
JUWI RENEWABLE ENERGIES LIMITED

Drawing Title:
SWEPT PATH ANALYSIS OF CONSTRUCTION TRAFFIC ROUTE - A4068 BETHEL ROAD - CWMPHIL ROAD JUNCTION

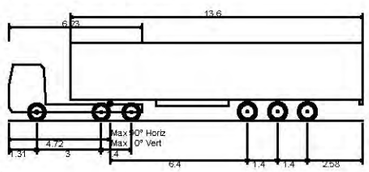
Project Number: C14585

Drawn:	Checked:	Scale @ A3:	Drawn Date:	First Issue:
AJT	EK	1:250	09/07/2014	10/07/2014

Drawing Status: IN REPORT

Drawing No. 14585/AT03 Revision -

VEHICLE DETAILS



MAX LEGAL LENGTH (UK) ARTICULATED VEHICLE (16.5M)	
OVERALL LENGTH	16.500m
OVERALL WIDTH	2.550m
OVERALL BODY HEIGHT	3.632m
MIN BODY GROUND CLEARANCE	0.396m
MAX TRACK WIDTH	2.500m
LOCK TO LOCK TIME	6.00s
KERB TO KERB TURNING RADIUS	6.870m

Rev	Date	Description	By	Ckd

Hydrock

Over Court Barns, Over Lane, Almondsbury,
Bristol, BS32 4DF.
TEL: 01454 619 533 FAX: 01454 614 125 or visit
www.hydrock.com

Notes:
All dimensions are to be checked on site before the commencement of works. Any discrepancies are to be reported to the Architect & Engineer for verification. Figured dimensions only are to be taken from this drawing. This drawing is to be read in conjunction with all relevant Engineers' and Service Engineers' drawings and specifications. This drawing is copyright.

Project:
PROPOSED SOLAR FARM, LAND AT BRYN HENLLYS, YSTRADOWEN, POWYS

Client:
JUWI RENEWABLE ENERGIES LIMITED

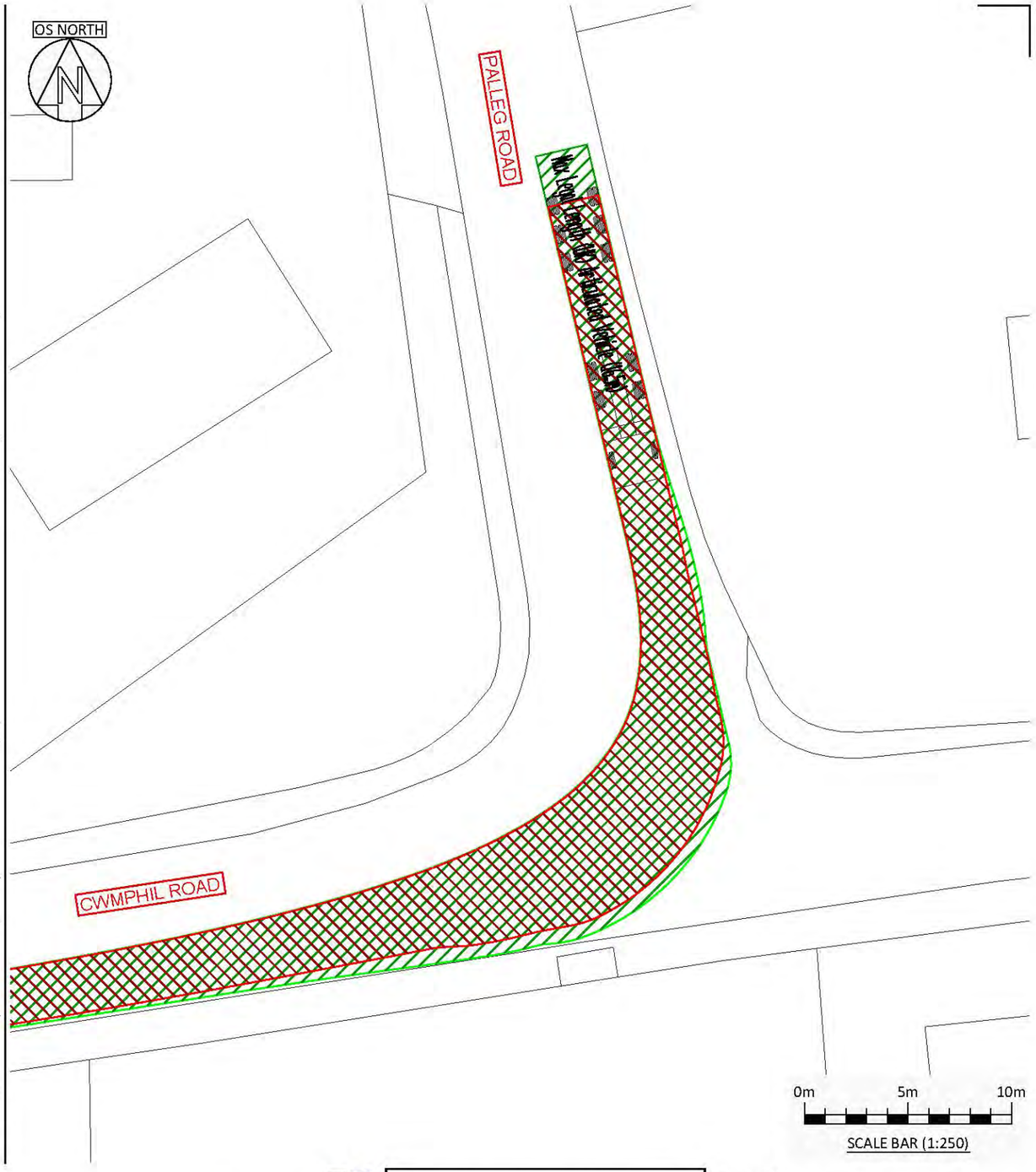
Drawing Title:
SWEPT PATH ANALYSIS OF CONSTRUCTION TRAFFIC ROUTE - CWMPHIL ROAD

Project Number: C14585

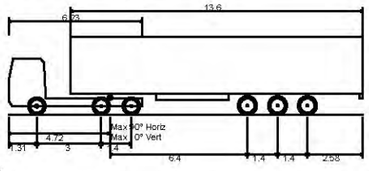
Drawn:	Checked:	Scale @ A3:	Drawn Date:	First Issue:
AJT	EK	1:250	09/07/2014	10/07/2014

Drawing Status: IN REPORT

Drawing No. 14585/AT04 Revision -



VEHICLE DETAILS



MAX LEGAL LENGTH (UK) ARTICULATED VEHICLE (16.5M)	
OVERALL LENGTH	16.500m
OVERALL WIDTH	2.550m
OVERALL BODY HEIGHT	3.632m
MIN BODY GROUND CLEARANCE	0.396m
MAX TRACK WIDTH	2.500m
LOCK TO LOCK TIME	6.00s
KERB TO KERB TURNING RADIUS	6.870m

Rev	Date	Description	By	Ckd

Hydrock

Over Court Barns, Over Lane, Almondsbury,
Bristol, BS32 4DF.
TEL: 01454 619 533 FAX: 01454 614 125 or visit
www.hydrock.com

Notes:
All dimensions are to be checked on site before the commencement of works. Any discrepancies are to be reported to the Architect & Engineer for verification. Figured dimensions only are to be taken from this drawing. This drawing is to be read in conjunction with all relevant Engineers' and Service Engineers' drawings and specifications. This drawing is copyright.

Project:
PROPOSED SOLAR FARM, LAND AT BRYN HENLLYS, YSTRADOWEN, POWYS

Client:
JUWI RENEWABLE ENERGIES LIMITED

Drawing Title:
SWEPT PATH ANALYSIS OF CONSTRUCTION TRAFFIC ROUTE - CWMPHIL ROAD - PALLEG ROAD JUNCTION

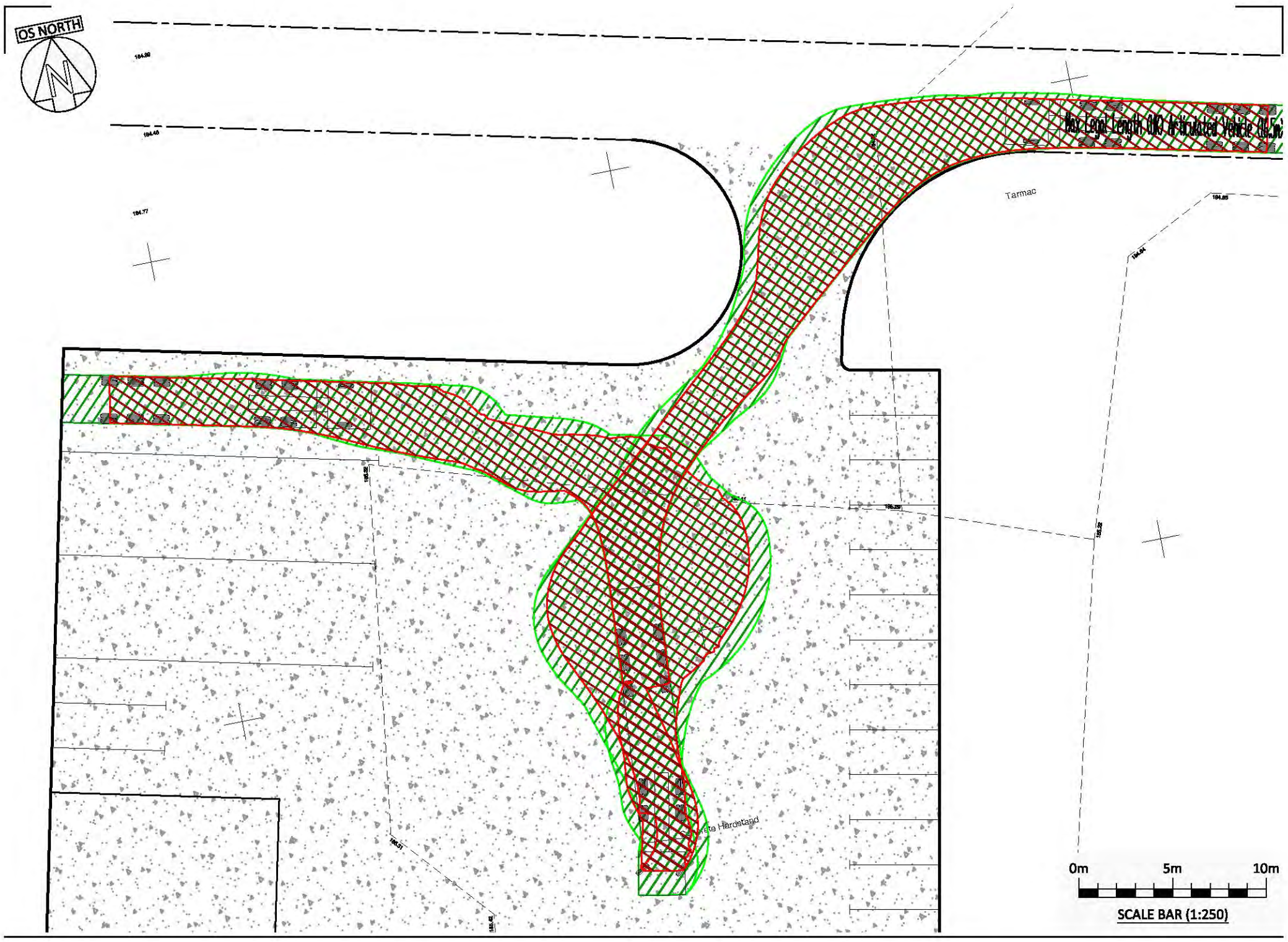
Project Number: C14585

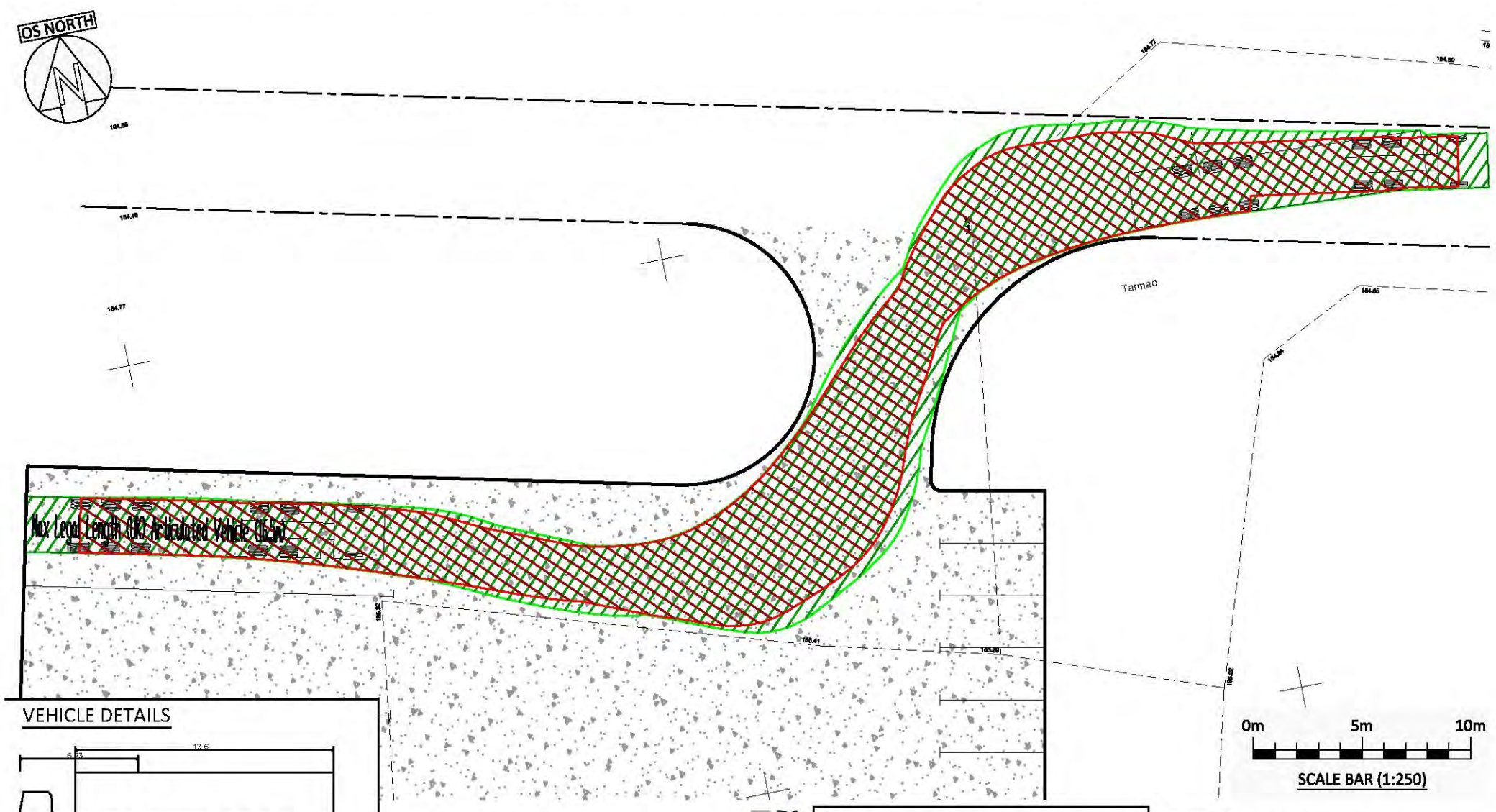
Drawn:	Checked:	Scale @ A3:	Drawn Date:	First Issue:
AJT	EK	1:250	09/07/2014	10/07/2014

Drawing Status. IN REPORT

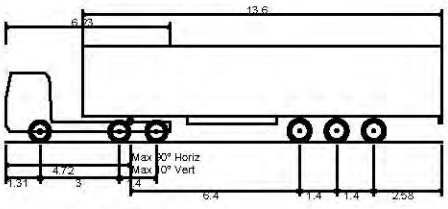
Drawing No. 14585/AT05 Revision -

Appendix C





VEHICLE DETAILS



MAX LEGAL LENGTH (UK) ARTICULATED VEHICLE (16.5M)	
OVERALL LENGTH	16.500m
OVERALL WIDTH	2.550m
OVERALL BODY HEIGHT	3.632m
MIN BODY GROUND CLEARANCE	0.396m
MAX TRACK WIDTH	2.500m
LOCK TO LOCK TIME	6.00s
KERB TO KERB TURNING RADIUS	6.870m

Rev	Date	Description	By	Ckd

Hydrock

Over Court Barns, Over Lane, Almondsbury, Bristol, BS32 4DF.
TEL: 01454 619 533 FAX: 01454 614 125 or visit www.hydrock.com

Notes:
All dimensions are to be checked on site before the commencement of works. Any discrepancies are to be reported to the Architect & Engineer for verification. Figured dimensions only are to be taken from this drawing.This drawing is to be read in conjunction with all relevant Engineers' and Service Engineers' drawings and specifications. This drawing is copyright.

Project:
PROPOSED SOLAR FARM, LAND AT BRYN HENLLYS, YSTRADOWEN, POWYS

Client:
JUWI RENEWABLE ENERGIES LIMITED

Drawing Title:
SWEPT PATH ANALYSIS OF NORTHERNMOST HGV PARKING SPACE

Project Number: C14585

Drawn:	Checked:	Scale @ A3:	Drawn Date:	First Issue:
AJT	EK	1:250	09/07/2014	10/07/2014

Drawing Status. IN REPORT

Drawing No. 14585/AT01 Revision -

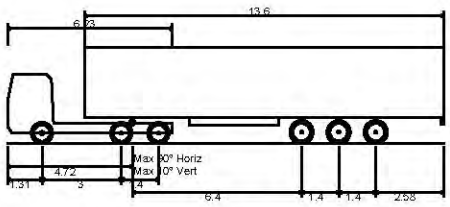
OS NORTH

Tarmac

Concrete Hardstand

Max Legal Length (UK) Articulated Vehicle (16.5m)

VEHICLE DETAILS



MAX LEGAL LENGTH (UK) ARTICULATED VEHICLE (16.5M)

OVERALL LENGTH	16.500m
OVERALL WIDTH	2.550m
OVERALL BODY HEIGHT	3.632m
MIN BODY GROUND CLEARANCE	0.396m
MAX TRACK WIDTH	2.500m
LOCK TO LOCK TIME	6.00s
KERB TO KERB TURNING RADIUS	6.870m

0m 5m 10m

SCALE BAR (1:250)

OS NORTH

Tarmac

Max Legal Length (UK) Articulated Vehicle (16.5m)

0m 5m 10m

SCALE BAR (1:250)

Rev	Date	Description	By	Ckd

Hydrock

Over Court Barns, Over Lane, Almondsbury,
Bristol, BS32 4DF.
TEL: 01454 619 533 FAX: 01454 614 125 or visit
www.hydrock.com

Notes:
All dimensions are to be checked on site before the commencement of works. Any discrepancies are to be reported to the Architect & Engineer for verification. Figured dimensions only are to be taken from this drawing. This drawing is to be read in conjunction with all relevant Engineers' and Service Engineers' drawings and specifications. This drawing is copyright.

Project:
PROPOSED SOLAR FARM,
LAND AT BRYN HENLLYS,
YSTRADOWEN,
POWYS

Client:
JUWI RENEWABLE
ENERGIES LIMITED

Drawing Title:
SWEPT PATH ANALYSIS OF
SOUTHERNMOST HGV
PARKING SPACE

Project Number: C14585

Drawn:	Checked:	Scale @ A3:	Drawn Date:	First Issue:
AJT	EK	1:250	09/07/2014	10/07/2014

Drawing Status. IN REPORT

Drawing No. 14585/AT02 Revision -

PROPOSED SOLAR FARM, BRYN HENLLYS EXTENSION, WAUNLWYD FARM, YSTRADOWEN, SWANSEA

FLOOD CONSEQUENCES ASSESSMENT AND DRAINAGE SCHEME

LIGHTSOURCE BP

AUGUST 2019

PFA Consulting
Stratton Park House
Wanborough Road
Swindon
SN3 4HG

Tel: 01793 828000
Fax: 01793 835500
Email: admin@pfaplc.com
Web: www.pfaplc.com

engineering the future

PAGE LEFT INTENTIONALLY BLANK

DOCUMENT CONTROL

Job No	L470	
File Reference	\\Athena\Admin\workfiles\L470 WAUNLWYD SOLAR FARM\REPORTS\L470-DOC02 FCA-Issue 1.docx	
	Name	Date
Prepared By	D.Buciak	05.08.2019
Checked By	B.Fox	07.08.2019

Issue	Approved	Date	Comments
1	G Eves BSc CEng MICE MCIHT	08.08.2019	-

PAGE LEFT INTENTIONALLY BLANK

CONTENTS

PAGE NO.

FIGURES

TABLES

APPENDICES

1. EXECUTIVE SUMMARY

1.1. The proposed development is a proposed extension (on two separate parcels of land) to an already permitted Solar Farm on land at Waunlwyd Farm, Ystradowen, Swansea and is referred to as Bryn Henllys Extension. The site is around 25.6 hectares in area, and the current use comprises agricultural land and is split into two development parcels north and south of and south of Pen-Y-Graig Road. The Bryn Henllys Solar Farm development site is situated to the east of the southern development parcel which was granted planning permission for a solar farm in June 2018 (planning application reference: P/2015/0176).

1.2. The entire site falls within Flood Zone A which is considered to be at little or no risk of fluvial flooding. There is sufficient fall across the site to prevent ponding of surface water within the northern development parcel and the topography would direct flows south, away from the northern development parcel towards a stone lined ditch bisecting the land between the two parcels of land. It is considered the site lies in an area with a 'Very Low' and 'Low' chance of surface water flooding. This assessment does not record any other sources of flooding which may affect the application site.

1.3. The solar panels are raised above the existing ground allowing a permanent grass sward to be maintained underneath the panels. Rainfall falling onto the photovoltaic panels would runoff directly to the ground beneath the panels and infiltrate into the ground at the same rate as it does in the site's existing greenfield state, and access tracks will be permeable in nature.

1.4. The impermeable area as a result of the Solar Farm structures amounts to only 0.09% of the total site area, which results in a negligible 0.12% increase of runoff rates from the site.

1.5. A sustainable drainage strategy, involving the implementation of SuDS in the form of swales, is proposed for managing the disposal of surface water runoff from the proposed development on the site. Swales are proposed at the low points of the application site to intercept extreme flows which may already run offsite. The volume of storage provided within the proposed swales (80.9m^3) is greater than the additional runoff generated as a result of the extreme 1 in 100 year storm event, including an allowance for climate change (31.1m^3).

1.6. The overall conclusions drawn from this Flood Consequences Assessment and Drainage Scheme are that future users of the development would remain appropriately safe throughout the lifetime of the proposed development, and that subject to a planning condition requiring the drainage arrangements as indicated on plan L470/02 to be implemented and maintained in accordance with the procedures set out at Table E of this FRA and a Check Sheet attached as **Appendix 6**, the development will not increase flood risk elsewhere and will reduce flood risk overall.

2. INTRODUCTION

2.1. This Flood Consequences Assessment and Drainage Scheme has been prepared on behalf of Lightsource BP in support of a planning application for the development of a solar photovoltaic (PV) farm which could produce up to 12.23MW of power on land at Waunlwyd Farm, Ystradowen, Swansea.

2.2. The Application Site, referred to as Bryn Henllys Extension comprises two parcels of land situated at Waunlwyd Farm, covering an area of approximately 25.6 hectares. The general location of the site which is an extension of an already permitted solar farm, is shown on **Figure 1**.

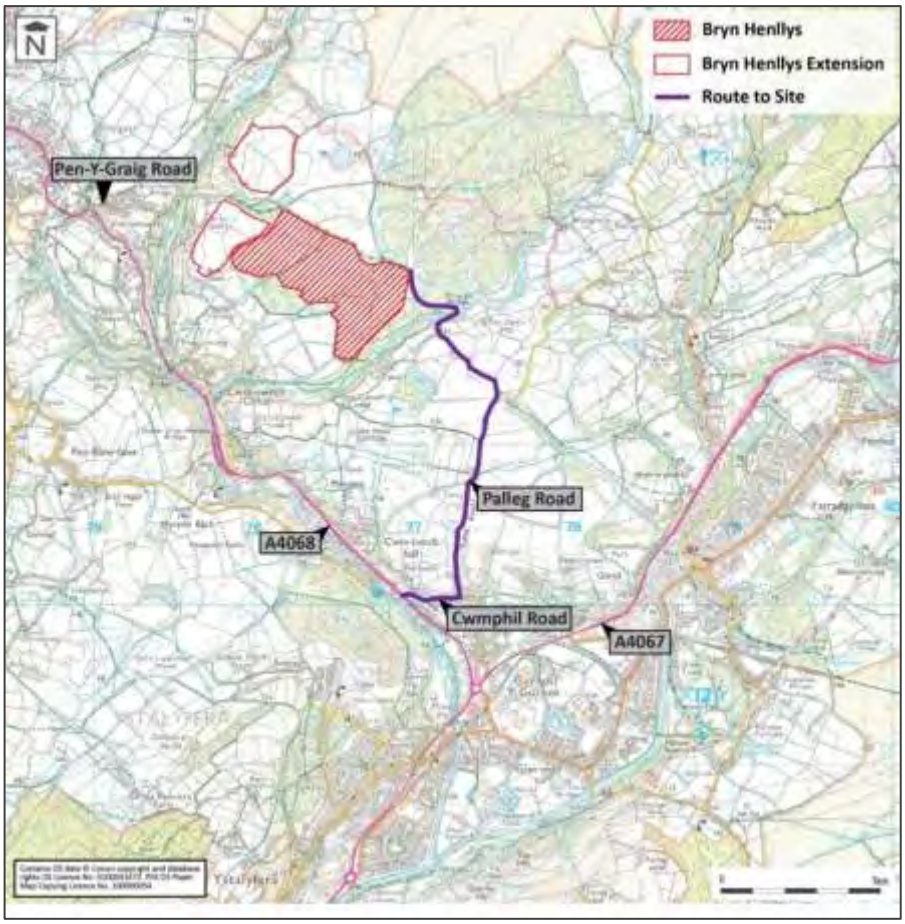


Figure 1: Site Location Plan

2.3. The Application Site is split into two development parcels north and south of Pen-Y-Graig Road. The northern development parcel is approximately 11.3 hectares and comprises four irregular shaped fields. The Afon Twrch watercourse lies to the west at the bottom of the river valley, a farm and aggregate compound lie to the south west, and fields are present to the north and east of the development parcel.

2.4. The southern development parcel is approximately 12.9 hectares and comprises six fields of varying shapes and sizes. The Afon Twrch lies to the west of the parcel and woodland forms the western, northern and eastern boundaries. Fields bound the development parcel to the south, beyond which lies a number of isolated properties to the south and southeast. The Bryn Henllys Solar Farm development site is situated to the east of the southern development parcel and was granted planning permission in June 2018 (planning application reference: P/2015/0176).

2.5. The development proposals comprise the construction of a Solar Farm consisting of photovoltaic modules mounted on metal frames, with associated site infrastructure and ancillary control equipment. A Site Layout is reproduced in **Appendix 1**.

2.6. The main purpose of this site-specific Flood Consequences Assessment and Drainage Scheme is to provide sufficient flood risk information to support a planning application for the development proposals and to demonstrate that the development would be appropriately safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where practicable, would reduce flood risk overall.

3. SCOPE OF THE ASSESSMENT

National Planning Policy

3.1. Planning Policy Wales (PPW) 10th Edition was published by the Welsh Government in December 2018 and provides an overview of the planning system in Wales. It identifies that flood risk is a material consideration in land use planning. Paragraph 6.6.22 states that:

> **"Planning authorities should adopt a precautionary approach of positive avoidance of development in areas of flooding from the sea or from rivers. Surface water flooding will affect choice of location and the layout and design of schemes and these factors should be considered at an early stage in formulating development proposals."**

3.2. Paragraph 6.6.25 states:

> **"Development should reduce, and must not increase, flood risk arising from river and/or coastal flooding on and off the development site itself."**

3.3. Paragraph 6.6.25 states:

> **"Development should not cause additional run-off…"**

3.4. PPW is supplemented by a series of Technical Advice Notes. Technical Advice Note 15 (TAN15): Development and Flood Risk, published in July 2004, sets out the Welsh Assembly Government's policy on development and flood risk.

3.5. TAN 15 sets out a precautionary framework to guide planning decisions for new development in areas at high risk of flooding with the aim to direct new development away from those areas which are at high risk of flooding. Paragraph 7.2 of TAN 15 states that whether a development should proceed or not will depend upon whether the consequences of flooding of that development can be managed down to a level which is acceptable for the nature/type of development being proposed, including its effects on existing development. Appendix 1 of TAN 15 provides guidance on the technical requirements for undertaking an assessment of the potential consequences of a flooding event.

3.6. TAN 15 categorises Wales into three Zones (A, B and C) based on their risk of flooding. The Welsh Government published its Development Advice Map (DAM) based on the best available information considered sufficient to determine when flood risk issues need to be taken into account in planning future development. The maps are based on the Natural Resource Wales' (NRW) extreme flood outlines (Zone C) and the British Geological Survey drift data (Zone B, updated in 2017). An extract from the Welsh Government DAM obtained from its website, which shows the Flood Zones in the vicinity of the site, is reproduced as **Figure 2** below. **The application site lies wholly within Flood Zone A.** Figure 1 within TAN 15 states that Flood Zone A is considered to be at little or no risk of fluvial or tidal/coastal flooding. The justification test is not applicable for development in Zone A. Development in Zone A however still needs to refer to surface water requirements and the acceptability criteria will only be passed if the development will not increase flooding elsewhere.

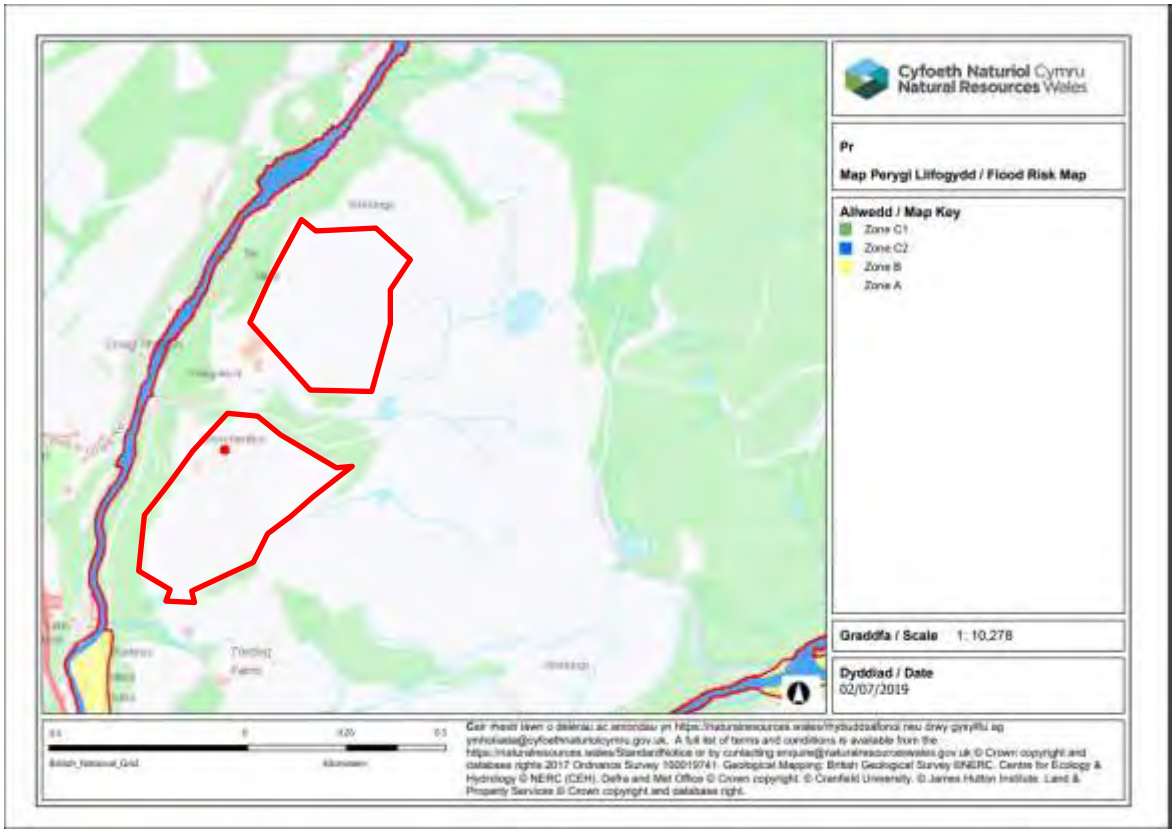


Figure 2: Welsh Government's Development Advice Map

3.7. TAN 15 recognises the need for the assessment of the source of potential flooding from rivers, tidal flooding, coastal flooding, groundwater, surface water or any combination of these.

3.8. The Welsh Government has advised that a Flood Consequences Assessment is not required if a site lies entirely within Flood Zone A. However, for major developments (*i.e. greater than 1 hectare*), where drainage implications can be significant, it suggests that a "Drainage Strategy" Report be prepared to support the application, the details of which are set out in section 4 of this report.

3.9. Paragraph 8.3 in TAN 15 specifically states that development should not increase the risk of flooding elsewhere and that the aim of new development should be to not create additional run-off when compared with the undeveloped situation.

3.10. Due to the size and nature of the proposed development it is prudent to assess flood risk posed to the application site and propose a Drainage Strategy to mitigate any potential increase in the flood risk to others. Paragraph A1.17 contained in Appendix 1 of TAN 15 notes that the detail and technical complexity of an assessment of flood consequences will reflect the scale and potential significance of the development.

Local Planning Policy

3.11. The Powys Local Development Plan (adopted April 2018) contains policies relevant to the proposed development.

3.12. Policy DM5 'Development and Flood Risk' and states:

> **"Development proposals must be located away from tidal or fluvial flood plains unless it can be demonstrated that the site is justified in line with national guidance and an appropriate detailed technical assessment has been undertaken to ensure that the development is designed to reduce / avoid the threat and alleviate the consequences of flooding over its lifetime. In addition the development must not increase flood risk elsewhere, and shall where possible allow floodplains to provide water storage to reduce flooding in the catchment, unless:**
>
> **1. The development is of a very minor nature such as an extension to a dwelling; or**
>
> **2. There is an overriding need in the public interest for the development."**

3.13. Policy DM6 'Flood Prevention Measures and Land Drainage' states:

> **"Development proposals must avoid unnecessary flood risk by assessing the implications of development within areas susceptible to all types of flooding; any development that unacceptably increases risk will be refused.**
>
> **…**
>
> **Satisfactory provision shall be made for land drainage in all developments and this should include consideration of the use of Sustainable Drainage Systems (SuDS)."**

3.14. The scope of this Flood Consequences Assessment and Drainage Strategy is therefore to provide sufficient information to satisfy the relevant requirements of PPW, TAN 15 and local planning policy.

4. DRAINAGE STRATEGY

Site Description and Hydrological Context

4.1. The Ordnance Survey map of the area shows geographical features including watercourses and other bodies of water.

4.2. The site comprises of two parcels, located north and south of Pen-Y-Graig Road and to the east of the Afon Twrch watercourse.

4.3. The Afon Twrch, classified as a 'main river', flows from north to south approximately 150m west of the Application Site. A number of shallow depressions are present adjacent to the hedgerows which intersect the site. A formalised stone lined ditch flowing from east to west, towards the Afon Twrch is situated between the two development parcels flowing through two culverts under existing access tracks which join the farm and Pen-Y-Graig Road. The stone line ditch is unaffected by the Proposed Development.

Site Levels

4.4. Both parcels tend to towards the south and south-west. The northern development parcel slopes from a high point of around 196.5m Above Ordnance Datum (AOD) on the northern boundary to approximately 176m AOD along the southern boundary of the northern development parcel. The southern development parcel falls from a high point of 180m AOD along the north eastern boundary towards a low point of around 161m AOD along the southwestern boundary. The site's topography exhibits a varied gradient between 1 in 12 and 1 in 40, with an average gradient of 1 in 29 for the southern parcel and 1 in 20 for the northern parcel.

4.5. A copy of the Topographical Survey, produced by Brunel Survey Ltd drawing number 20678-500-01, dated June 2019, is reproduced in **Appendix 2**.

4.6. The potential existing overland flow routes have been identified based on the site's topography. These are marked on drawing number L470/02 which is based on the topographical survey of the site contained in **Appendix 3**.

Ground Conditions

4.7. The British Geological Survey© NERC (2019) online geological mapping indicates that the application site is underlain mainly by South Wales Lower and Middle Coal Measures Bedrock Formations (Mudstone, Siltstone and Sandstone). Till, Devensian (Diamicton) superficial deposits are present along the western boundary of the site.

4.8. From an inspection of the NRW Aquifer Designation Map on its website, the site's bedrock is classified as a 'Secondary A' aquifer which is defined as permeable strata 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 superficial deposits are classified as a 'Secondary (undifferentiated)' aquifer which is has been assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type.

4.9. Based on NRW Source Protection Zones (SPZ) Merged online mapping the Application Site does not lie within a groundwater Source Protection Zone.

4.10. Based on the Flood Studies Report (FSR) Winter Rainfall Acceptance Potential (WRAP) Map, as shown on Drawing Number L470/01 reproduced in **Appendix 4**, the site is located in a 'Soil Index Class 5' area.

Definition of the Flood Hazard and Probability

Sources of Information

4.11. A Stage 1 Strategic Flood Consequence Assessment was produced by Powys County Council in March 2012. This provides an overview of flood risk from all sources including from rivers and the sea, directly from rainfall on the ground surface and rising groundwater, overwhelmed sewers and drainage systems, and from reservoirs, canals and lakes and other artificial sources.

4.12. A Stage 2 Strategic Flood Consequences Assessment was produced by Halcrow on behalf of Powys County Council in September 2013. This formed an evidence base through which the LPA could appropriately consider the consequences of flooding to for the thirty Candidate Sites that were being considered for development and inclusion within the Powys County Council Local Development Plan new developments.

4.13. Natural Resource Wales (NRW) interactive Flood Risk Maps, published on its website, show the risk of flooding from rivers and sea, from reservoirs, and from surface water, and indicate the extent, depth and velocity of water for a number of scenarios. These are not suitable for land-use planning and the Development Advice Map needs to be used for this purpose. Nonetheless these Flood Risk Maps contain information which needs to be taken into account as part of assessing flood risks.

Flooding from Watercourses

4.14. The Welsh Government's Development Advice Map obtained from the Natural Resources Wales website, which shows the Flood Zones in the vicinity of the site, and is reproduced as Figure 2 at paragraph 3.6 above. An examination of this mapping identifies that both parcels of land and the surrounding land lies entirely within Flood Zone A, which is considered to be at little or no risk of fluvial flooding.

Flooding from Surface Water

4.15. Natural Resources Wales (NRW) Surface Water Flood Risk interactive map, indicates where surface water may be expected to flood or pond. Surface water flooding happens when rainwater does not drain away through normal drainage system or soak into the ground, but lies on or flows over the ground instead. A copy of the NRW Surface Water Flood Risk Map is reproduced in **Figure 3** below.

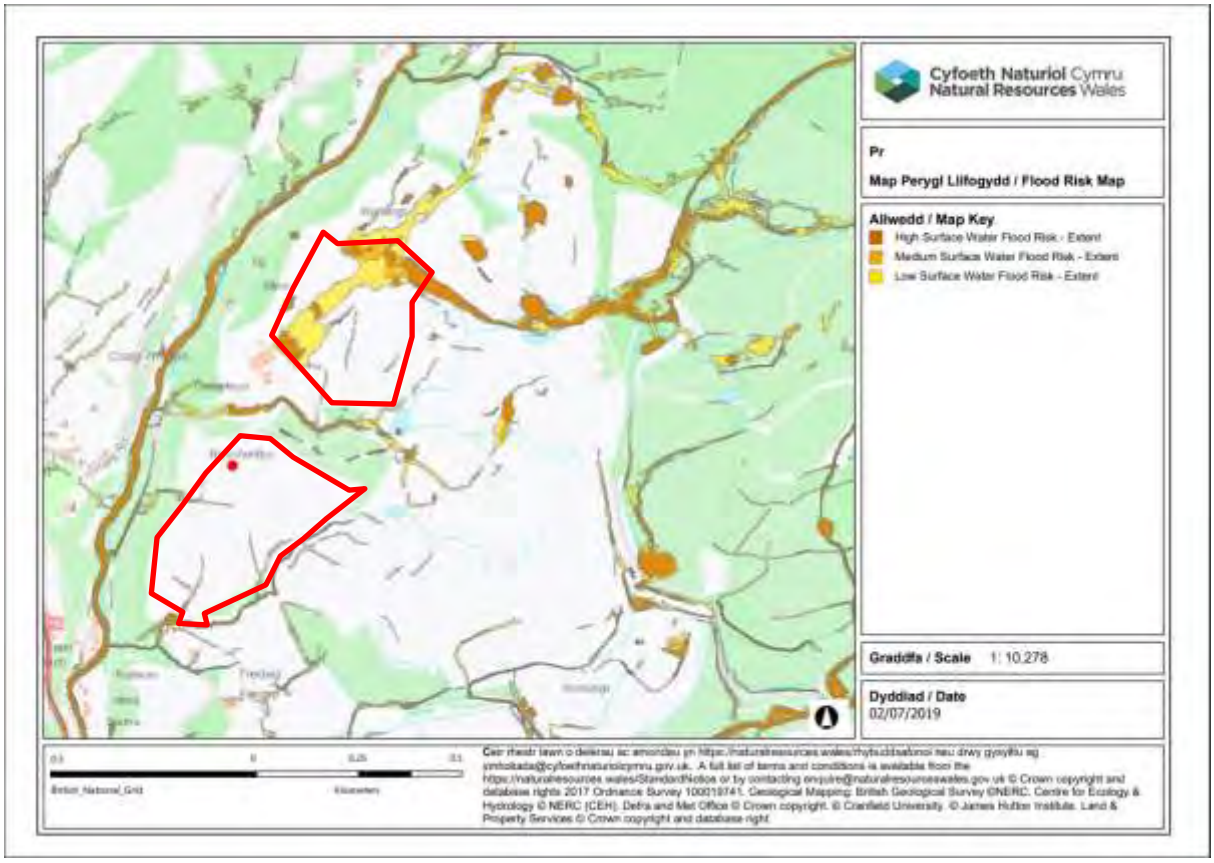


Figure 3: NRW Surface Water Flood Risk Map

4.16. The Risk of Flooding from Surface Water Map shows that the majority of site lies in an area with a 'Very Low' and 'Low' chance of flooding but with some areas of elevated risk identified in the northern development parcel.

4.17. Data that has been obtained from NRW Surface Water Flood Risk Map is displayed in context with the proposed development on the Drawing No. L470/02 reproduced in Appendix 3. This data is evaluated below in order to assess the surface water flood risk associated with site and the proposed development.

4.18. The NRW Surface Water Flood Risk mapping does not appear to accurately reflect the Application Site's topography and it is not therefore considered representative of the site's drainage regime. The topographical survey does not identify a localised low point in the northern development parcel where the surface water map suggests might be subject to surface water flooding would collect. The topographical survey indicates that surface water on the northern development parcel would follow overland flow routes (as shown in Appendix 3) towards the formalised stone lined ditch between the two development parcels. The topographical survey shows that there is sufficient fall across the site to prevent ponding and topography would direct flows south, away from the northern development parcel and into the bisecting stone lined watercourse between the two parcels of land.

4.19. A site visit was conducted in June 2019 and there were no signs of areas where ponding or saturated soil conditions might occur. It is concluded that the areas where surface water is predicted to collect on the Surface Water Flood Risk mapping is unlikely to occur due to a natural fall of the site. Therefore notwithstanding the maps published by NRW showing areas of surface water flood risk a site specific consideration suggests surface water flood risk across the site is considered lies in an area with a 'Very Low' and 'Low' chance of surface water flooding.

4.20. Nevertheless solar panels will be elevated a minimum of 600mm above ground level and no ancillary control equipment will be located within areas associated with 'High' risk of surface water flooding identified on the NRW mapping and all ancillary control equipment will be elevated above ground level reducing the residual risk to surface water to 'Very Low'.

Flooding from Other Sources

4.21. The SFCA does not identify any incident of flooding from overwhelmed sewers and drainage systems affecting the site. No sewers are identified on the site and the risk of this form of flooding is considered to be 'Very Low'.

4.22. Natural Resource Wales Risk of Flooding from reservoirs Map indicates the site is not at risk of flooding from reservoir breaching.

4.23. The SFCA states that there is no local information on historic groundwater flooding incidents, suggesting the risk of flooding from groundwater source in Powys is 'Low'.

4.24. Based on the SFCA there are no historic flood incidents recorded on the site from all sources of potential flooding.

4.25. A summary of the potential risk from all sources of flooding associated with existing conditions pre-development is shown in **Table A** below.

Table A: Pre-development Potential Flood Risk from All Sources of Flooding

Flood Source	Potential Risk				Description
	Very Low	Low	Medium	High	
Watercourses	X				The site is located in Flood Zone A.
Surface Water		X			The topography of the land indicates that any overland flow would be directed into the ditch network away from the site.
Groundwater		X			The SFCA does not identify any groundwater flooding affecting the site and the underlying geology suggests risk of groundwater flooding is low.
Overwhelmed Sewers	X				The SFCA does not identify any incident of sewer flooding affecting the site.
Artificial Sources	X				None identified.

4.26. The pre-development potential flood risk to the site from all sources of flooding is considered to be 'Low' to 'Very Low'. It is therefore considered that the most likely cause of potential other flooding affecting the 'greenfield' site would be extreme rainfall falling on the sub-catchment area exceeding the soil's natural infiltration rate or capacity, leading to an increase in the volume and rate of runoff and resulting in overland flood flows and ponding at localised low spots.

The Development Proposals

4.27. The development proposals comprise the construction of a Solar Farm consisting of photovoltaic (PV) modules mounted on metal frames (known as arrays), with associated site infrastructure and ancillary control equipment. A Site Layout is reproduced in Appendix 2.

4.28. The frames have a minimal cross-sectional area and will be 'pile driven' or 'screw anchored' into the ground. The proposed development does not involve any change in ground levels. The array of panels will be situated in rows running from east to west, south facing inclined at an angle of approximately 25 degrees from the horizontal, with an approximate 5m separation between lines of panels. Each frame contains two rows of PV panels separated by a horizontal 'rainwater' gap. This gap allows rainwater to drain freely to the ground beneath and between the PV panels, replicating the existing greenfield scenario. The lower edge of the panels will be a minimum of 0.6m above ground level, allowing grass to grow underneath the panels. **Figure 4** shows a typical cross section of a Solar Array.

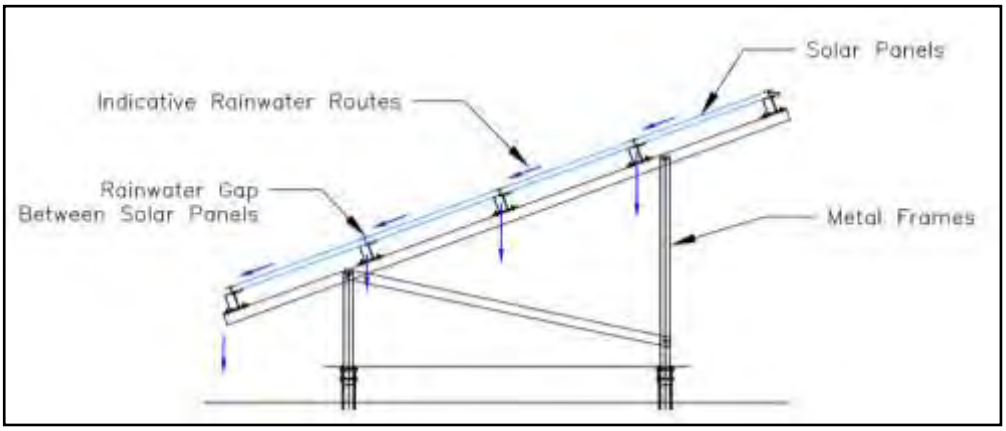


Figure 4: Typical Solar Array Cross Section
Note: Based on four PV panels per frame.

4.29. Any access tracks will be formed using permeable materials (open graded stone or reinforced grass) so as to avoid creating impermeable areas across the site.

4.30. Ancillary equipment will be contained in small buildings, typically Glass Reinforced Plastic (GRP) kiosks. Ancillary equipment includes Inverter Cabinets which contain an Inverter, Transformers and associated switch gear; a separate Control Room; and a Sub-substation. Due to their small size it is proposed that roof water from these buildings will discharge directly onto the surrounding ground. Minimum floor levels for buildings on the site would be set at least 150mm above ground level to prevent the ingress of water.

4.31. BRE published its '*Biodiversity Guidance for Solar Developments*' in 2014. The report recognises that in most solar farms "*normally only 25-40% of the surface is over-sailed by panels*" and "*because panels are raised above the ground on posts greater than 95% of a field utilised for solar farm development is still accessible for plant growth …*" [1]. Subsequently, the majority of the site will remain as "soft" surface, with grassland around and underneath the photovoltaic panels.

4.32. Natural England has produced a '*Technical Information Note TIN101: Solar Parks: Maximising Environmental Benefits*' which provided useful advice which is also relevant in Wales and states:

> **"The key to avoiding increased run-off and soil into watercourses is to maintain soil permeability and vegetative cover. Permeable land surfaces underneath and between panels should be able to absorb rainfall as long as they are not compacted and there is some vegetation to bind the soil surface."**

[1] BRE (2014) Biodiversity Guidance for Solar Development. Eds G E Parker and L Greene.

4.33. **Figure 5** shows a typical scene from an operational Solar Farm with vegetation cover between and under the solar arrays which will delay surface water runoff and prevent soil erosion.

Figure 5: A Typical Operational Solar Farm

4.34. Soil compaction will be limited during construction and operation of the Solar Farm. During construction only light machinery will be required to install the solar array and vehicle movements will be minimised. Low ground pressure vehicles are recommended during wet weather working. Any HGVs will be restricted to a temporary construction compound by the site's entrance.

4.35. If necessary, to alleviate the effects of any compaction during the construction process, any affected areas will be harrowed and seeded prior to final commissioning of the Solar Farm.

4.36. During operation of the Solar Farm maintenance of the panels will be infrequent, minimal and will only require light machinery. Thus, the infiltration rate of the underlying ground is unlikely to be changed by the proposed development.

4.37. During the operation of the Solar Farm the areas under and around the solar array will be suitable for grazing by livestock, typically sheep.

4.38. To protect against soil erosion topsoil and covering vegetation will, as far as practicable, be maintained across the whole site throughout the construction and operation of the Solar Farm, as is the case in the site's existing greenfield state.

Greenfield Runoff

4.39. The proposed development will have a very limited extent of impermeable ground cover. The area beneath the solar panels will remain grassed and the post development site infiltration rate will not change. Rainwater falling onto each panel will drain freely onto the ground beneath the panel and infiltrate into the ground at the same rate as it does in the site's existing greenfield state as indicated in TIN101[2]. Thus, the total surface area of the photovoltaic array will not be considered an impermeable area in this assessment (only the area taken up by the panel supports). Similarly, it can be assumed that any rainwater falling onto the permeable access tracks will soak into the ground beneath or adjacent to the tracks at the same rate that it presently does.

4.40. The extent of impermeable area created as a result of the proposed Solar Farm is summarised in **Table B.**

[2] Natural England (2011) Technical Information Note TIN101: Solar parks: maximising environmental benefits.

Table B: Created Impermeable Areas

	Quantity	Unit Area (m^2)	Total Area (m^2)
Piles	12000	0.006	72
Transformer Kiosk	4	24.75	99
Switchgear Substation	4	12.32	49.28
AC Box	4	4.0	12.0
Total Impermeable Area			232.28
Site Area			255928
Total Impermeable Area = 0.09% of Total Site Area			

4.41. In its current greenfield state the application area is considered to be 100% undeveloped. As a result of the development of the Solar Farm the extent of impermeable area will be approximately 232 m^2 or 0.09% of the total site area.

4.42. The Welsh Government published its 'Statutory standards for sustainable drainage systems – designing, constructing, operating and maintaining surface water drainage systems' (hereafter known as the SuDS Standards). G2.19 in the SuDS Standards states:

> **"The assessment of peak runoff rates from greenfield, previously developed and proposed development sites, and the design of attenuation storage systems is set out in the SuDS Manual."**

4.43. Chapter 24 of the SuDS Manual (Ciria C753) presents the design methods to estimate runoff for a greenfield site and Table 24.1 provides a summary of runoff estimate methods. The Institute of Hydrology report 124[3] (IH124) has been used to calculate Q_{BAR} for the development site. Q_{BAR} is defined as the Mean Annual Flood with a return period in the region of 2.3 years. The formula has been applied for a site with a 50 ha area and results factored based on the ration of the actual site area and the applicate area (50 ha).

4.44. The ICP SuDS Method contained with XP Solutions' Micro Drainage software system calculates Q_{BAR} based on the IH124 methodology with pro-rata values for sites smaller than 50ha. FSSR 2 and 14 regional growth curve factors have been used to calculate the greenfield peak flow rates for 1, 30 and 100 year return periods.

4.45. The FSR WRAP Map, shown in Appendix 2, indicates the site is located in 'Soil Index Class 5', and a Soil Index value of 0.50 has been used to calculate Q_{BAR} using the ICP SuDS Method.

4.46. Q_{BAR} has been calculated for the site in both an undeveloped and post development site. Copies of the MicroDrainage greenfield runoff calculations are included in **Appendix 5.** A summary of the pre and post development greenfield runoff rates for the various return period events is shown in **Table C**. The mean annual peak rate of runoff, referred to as Q_{BAR} in ICP SuDS Method, for the pre-development greenfield site is 426.7 l/s. Whereas the post development site Q_{BAR} is calculated as 427.2l/s.

[3] Marshall and Bayliss (1994) Flood Estimation for Small Catchments, Report 124, Institute of Hydrology, Wallingford, Oxon, UK.

Table C: Greenfield Runoff Rates

Return Period (Years)	1	Q_{BAR} [a]	30	100
Greenfield Runoff Rates (l/s)	375.4	426.7	752.2	930.0
Post Development Unmitigated Runoff Rate (l/s)	375.9	427.2	753.0	930.8

[a] Q_{BAR} = Mean Annual Flood with an approximate return period of 2.3 years.

4.47. The calculations contained in Appendix 5 quantify the effect of the proposed Solar Farm on greenfield runoff rates. These calculations show that this effect of the Solar Farm on Q_{BAR} is negligible and only equates to an increase of 0.5 l/s or 0.12% of the greenfield runoff rate.

4.48. TAN 15 states consideration must be given to the impacts climate change may have on developments. The allowances to be made for climate change effects when assessing flood risk are related to the lifetime of the development. The 'life' of the development is identified as 30 years. With reference to Table 3 in Natural Resources Wales document entitled '*Adapting to Climate Change: Guidance for Flood and Coastal Erosion Risk Management Authorities in Wales*', dated December 2017, the appropriate allowance for climate change is to increase the peak rainfall intensity for the 1 in 100 year storm event by 20%, as a worst case scenario and 10% for the central allowance.

4.49. The Depth-Duration-Frequency (DDF) Model function was used in the Flood Estimation Handbook (FEH) CD-ROM to calculate the depth of rainfall from a 24 hour (or 1440 minutes), 100 year storm event at the application site. The results of this calculation are shown on **Figure 6**. Thus, the 24 hour, 100 year plus climate change design rainfall for the application site is 134.3mm (111.91 x 1.2). The total extent of impermeable area created as a result of the proposed development is 232.3m^2. The volume of runoff generated by this rainfall event falling on 232.3m^2 impermeable area calculated by this method equates to 31.1m^3 (0.134m x 232.3m^2).

4.50. On this basis, the additional runoff generated in the extreme 24 hour duration, 1 in 100 year storm event, including an allowance for climate change, would amount to approximately 31 m^3.

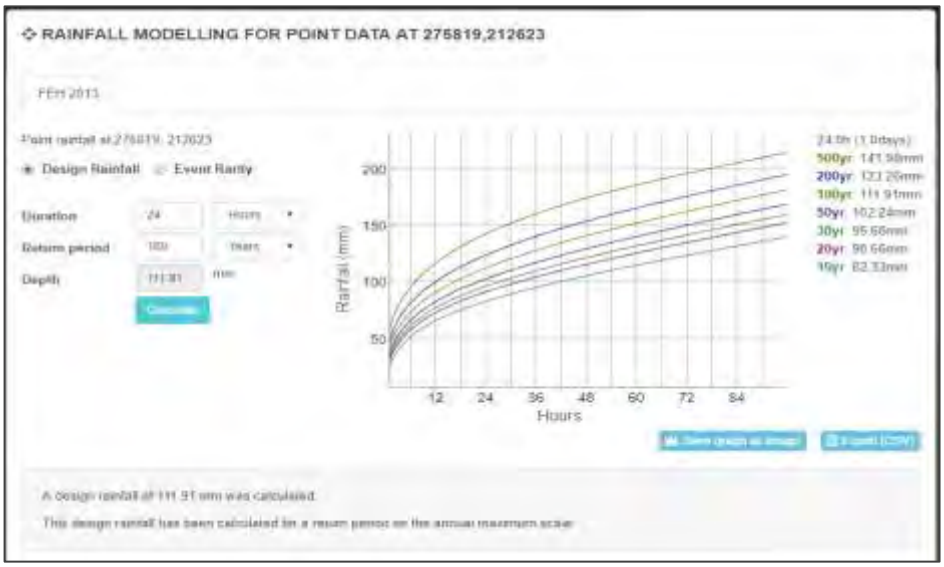


Figure 6: Depth-Duration-Frequency (DDF) Modelling Outputs

Sustainable Drainage Systems

4.51. TAN 15 advocates the use of Sustainable Drainage Systems (SuDS) and states that they *"should be implemented wherever they will be effective, in all new development proposals"*.

4.52. PPW states "*Development should not cause additional run-off, which can be achieved by controlling surface water as near to the source as possible by the use of SuDS.".*

4.53. Appendix 4 of TAN 15 states that *"flood risk and other environmental damage can be managed by minimising changes in the volume and rate of surface runoff from development sites through the use of SuDS".*

4.54. Sustainable drainage systems are designed to control surface water runoff close to where it falls and mimic natural drainage as closely as possible. Sustainable drainage systems provide opportunities to:

- Reduce the causes and impacts of flooding;
- Remove pollutants from urban runoff at source;
- Combine water management with green space with benefits for amenity, recreation and wildlife.

4.55. Guidance on the design and construction of SuDS is provided in the '*The SuDS Manual*' Ciria C753 published in 2015.

Proposed Surface Water Management Measures

4.56. A sustainable drainage strategy, involving the implementation of SuDS, is proposed for managing the disposal of surface water runoff from the proposed development on the site.

4.57. Following the principals set out Natural England's '*Technical Information Note TIN101: Solar Parks: Maximising Environmental Benefits*' this encourages existing land drainage to be maintained. Existing onsite drainage ditches or features will therefore be retained in their existing state, and will continue to intercept overland flows from the site.

4.58. Whilst it is considered that the photovoltaic panels will not result in a material increase in surface water run-off flow rates, it is proposed to provide a SuDS arrangement by way of swales in the lower areas of the site to intercept extreme flows which may already run offsite. It is emphasised that the swales do not form part of a formal drainage scheme for the development but are provided as a form of 'betterment'.

4.59. The approach is considered a practical implementation of Rural Sustainable Drainage Systems (RSuDS)[4] as a means of intercepting runoff and 'slow down flow' with the aim to form 'micro-wetlands' for the benefit of farmland biodiversity and encourage localised recharge of groundwater whilst providing a degree of flood risk betterment. The concept of RSuDS has evolved into the broader field of Natural Flood Risk Management (NFM) and Working With Natural Processes methodology (WWNP). The NRW's WWNP evidence base, published in February 2018, lists swales as a form of 'runoff pathway management'. These techniques aim to delay and even flatten the hydrograph and reduce peak flow locally for small events by intercepting, slowing and filtering of surface water runoff and encouraging infiltration and soil water storage.

4.60. A plan of the proposed drainage arrangements, showing the proposed swale locations which are situated having regard to overland flow routes, is included as Appendix 3.

[4] Environment Agency (2012) Rural Sustainable Drainage Systems (RSuDS)

4.61. Swales will be constructed along the site boundary as series of discrete 'stepped' units parallel to the site's contours to ensure flows are not concentrated or conveyed downhill. Swales will be formed by creating shallow depressions 300mm deep along the lower boundaries of the site. The storage volume of these swales has been calculated on the basis that the swales will be 2/3 full. The material excavated to form the swale will be placed along the lower edge to create a small bund, as shown on the typical details as shown in Appendix 3. This will therefore considerably increase the volume of storage within the swale and further constrain overland flows in an extreme storm event.

4.62. The proposed swales will have a minimum depth of 300mm, with 1 in 3 side slopes, and a base width of 0.5m. The swales provide a total storage volume of approximately 80.9m^3. This is greater than the volume of additional runoff generated as a result of the 24 hour, 100 year plus climate change rainfall event (31.1m^3). It is therefore considered that the swales would adequately mitigate any increase in runoff volume generated as a result of the minor increase in impermeable area.

4.63. Swales will be sown with the appropriate seed mix upon construction and vegetation will be maintained by the landowner thereafter for the life of the proposed development.

4.64. The swales will be located outside of any Root Protection Zones, will not be located closer than 8m to any Main Rivers or within 5m of any ordinary watercourses or drainage ditches and will respect natural topography in accordance with local bye-laws.

4.65. The provision of swales has a benefit in reducing overland flows during extreme rainfall events. On this basis the proposed development would not increase flood risk onsite or elsewhere and would preserve the application site's natural drainage regime.

Swale Construction and Maintenance

4.66. The swales will be maintained throughout the design life of the development by the land owner/ tenant generally in accordance with the recommendations in CIRIA C697 '*The SuDS Manual*'. The proposed maintenance procedures are set out in **Table D.** A maintenance check sheet is reproduced in **Appendix 6**.

Table D: Swale Maintenance Procedures

Maintenance Schedule	Required Action	Frequency
Regular Maintenance	Litter and debris removal.	As required.
	Grass cutting or animal gazing – to retain grass height to site owner's specification.	As required.
	Manage other vegetation and remove nuisance plants.	Monthly (as stated, then as required)
Occasional Maintenance	Check for poor vegetation growth due to lack of sunlight or dropping of leaf litter, and cut back adjacent vegetation where possible.	Annually
	Re-seed areas of poor vegetation growth. Alter plant types to better suit conditions, if required.	Annually, 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.
	Re-level 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.
Monitoring	Inspect infiltration surfaces for ponding, compaction, and silt accumulation. Record areas where water is ponding for > 48 hours.	Monthly, or when required.
	Inspect surface for silt accumulation. Establish appropriate silt removal frequencies.	Half yearly.

4.67. The timing of the provision of the swales is important and dependent upon the existing condition of the site immediately prior to construction commencing, and weather conditions prior to, and during, construction, as any existing vegetation needs to be retained as far as possible during the construction period.

4.68. In circumstances where little vegetation cover is present on commencement of construction, it is recommended that the swales are provided at the outset. Similarly, if during construction it is evident that surface of the site becoming significantly disturbed, then implementing swales immediately would act to restrict potential runoff and act as silt traps.

4.69. If however the site remains "clean" and vegetated during construction, it will be advisable to leave the construction of the swales to the end of the construction programme so as to maximise the benefits of the existing vegetation cover.

4.70. The timing of the provision of the swales is therefore a matter for the construction site manager to determine.

SAB Approval

4.71. PPW states that from 7 January 2019 new developments where the area covered by construction work equals or exceeds 100 square metres require approval from the SuDS Approval Body (SAB) before construction can commence.

4.72. A SAB application will be made to Powys County Council following planning permission being granted and will be on the basis of the details of the SuDS measures set out above.

Off Site Impacts and Residual Risk

4.73. The residual risks posed to a development are the risks remaining after applying mitigation measures (e.g. developing outside flood risk areas and the provision of a SuDS scheme).

4.74. For extreme events the site's topography will convey exceedance flows overland towards the low points as it would in the site's greenfield state. Flow will be intercepted by existing drainage ditches (as in the greenfield state) and as a result of the development by the proposed swales in the lower portion of the application site. It is therefore considered that the proposed development would have adequate flood protection for extreme events over the lifetime of the development and by the provision of the swale promotes a minor benefit in intercepting overland flows.

4.75. Safe access and egress to and from the development is a route that is safe for use without the intervention of the emergency services or others. As the site is located within Flood Zone A it is considered construction staff and occasional maintenance staff can access the proposed development.

4.76. In line with normal building practice it is proposed that any on site buildings will have floor levels raised at least 150mm above ground level with appropriate damp proof course protection. This will ensure that the interior of any such building is kept suitably dry.

4.77. To protect against soil erosion topsoil and covering vegetation will, as far as practicable, be maintained across the whole site throughout the construction and operation of the Solar Farm, as is the case in the site's existing greenfield state.

4.78. A summary of the potential risk from all sources of flooding post-development with the various development mitigation measures incorporated is shown in **Table E** below.

Table E: Post-development Potential Flood Risk from All Sources of Flooding

Flood Source	Potential Risk				Description
	Very Low	Low	Medium	High	
Watercourses	X				No change compared with pre-development risk.
Surface Water		X			Overland flows intercepted by proposed swales providing a degree of betterment downstream.
Groundwater		X			No change compared with pre-development risk.
Overwhelmed Sewers	X				No change compared with pre-development risk.
Artificial Sources	X				No change compared with pre-development risk.
Off-site Impacts		X			By intercepting overland flows the proposed development would reduce flood risk overall.

4.79. On this basis it is considered that the proposed drainage measures can safely manage any residual risks and that the proposed drainage measures would lead to an overall reduction in flood risk. It is therefore considered that the proposed development would have adequate flood protection for extreme events over the lifetime of the development.

5. CONCLUSIONS

5.1. This Flood Consequences Assessment and Drainage Scheme has been prepared on behalf of Lightsource BP in support of a planning application for the development of a solar photovoltaic (PV) farm which could produce up to 12.23MW of power on land at Waunlwyd Farm, Ystradowen, Swansea.

5.2. The Application Site, referred to as Bryn Henllys Extension is situated Waunlwyd Farm extending approximately 25.6 hectares in area and its existing use comprises agricultural land. The Application Site is split into two development parcels north and south of and south of Pen-Y-Graig Road. The Bryn Henllys Solar Farm development site is situated to the east of the southern development parcel and was granted planning permission in June 2018 (planning application reference: P/2015/0176).

5.3. The development proposals comprise the construction of a Solar Farm consisting of photovoltaic modules mounted on metal frames, with associated site infrastructure and ancillary control equipment.

5.4. With reference to the Natural Resource Wales Development Advice Map the entire site falls within Flood Zone A. This is fully in accordance with the aim of the sequential approach set out in TAN 15 which is to steer new development to areas at the lowest probability of flooding in Zone A.

5.5. Natural Resources Wales' (NRW) Surface Water Flood Risk Map identifies an area of elevated surface water flood risk located within the northern parcel of the site. On inspection of the detailed topographical survey of the site and from a site inspection it is concluded that the NRW mapping is not representative of this specific site's drainage regime. There is sufficient fall across the site to prevent ponding and the topography would direct flows south, away from the northern development parcel. It is considered the site lies in an area with a 'Very Low' and 'Low' chance of surface water flooding. Surface water flood risk is further mitigated by ensuring that any sensitive equipment would be elevated above ground level.

5.6. This assessment does not record any other sources of flooding which may affect the Application Site.

5.7. Rainfall falling onto the photovoltaic panels would runoff directly to the ground beneath the panels and infiltrate into the ground at the same rate as it does in the site's existing greenfield state.

5.8. Existing drainage features will be retained and the site will remain vegetated through construction and operation of the Solar Farm to prevent soil erosion.

5.9. The extent of impermeable cover as a result of the Solar Farm amounts to only 0.09% of the total site area. Supporting calculations demonstrate that this effect of the Solar Farm on the Mean Annual Flood (Q_{BAR}) is minimal and only equates to a 0.12 % increase compared with the greenfield runoff rate.

5.10. A sustainable drainage strategy, involving the implementation of SuDS in the form of swales, is proposed for managing the disposal of surface water runoff from the proposed development on the site. Swales are proposed at the low points of the application site to intercept extreme flows which may already run offsite. It is emphasised that the swales do not form part of a formal drainage scheme for the development but are provided as a form of 'betterment'. The volume of storage provided within the proposed swales (80.9 m^3) is greater than the additional runoff generated as a result of the extreme 1 in 100 year storm event, including an allowance for climate change (31.1m^3).

5.11. It is considered that the provision of swales would lead to an overall reduction in surface water flow rates from the site and mitigate any increase in run-off due to the minor reduction in the overall permeable area of the site.

5.12. The proposed drainage strategy would ensure that the development would therefore have a negligible impact upon site drainage and surface water arising from the developed site would mimic the surface water flows arising from the site prior to the proposed development. The natural drainage regime would be retained except in the extreme storm event when a benefit is achieved by reducing the extreme storm run-off flows.

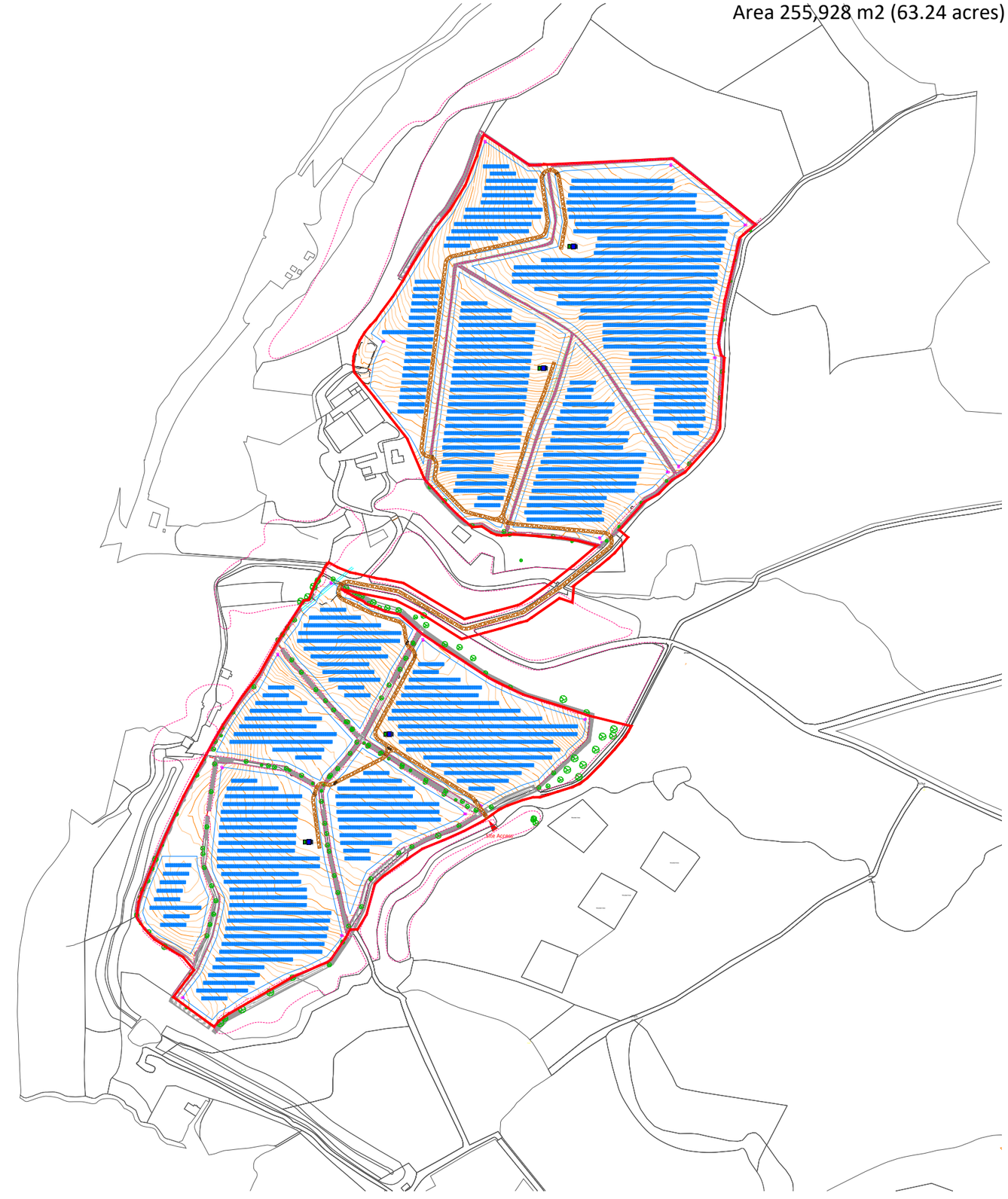
5.13. The overall conclusions drawn from this Flood Consequences Assessment and Drainage Scheme are that future users of the development would remain appropriately safe throughout the lifetime of the proposed development, and that subject to a planning condition requiring the drainage arrangements as indicated on plan L470/02 to be implemented and maintained in accordance with the procedures set out at Table E of this FRA and a Check Sheet attached as **Appendix 6**, the development will not increase flood risk elsewhere and will reduce flood risk overall.

Appendices

Appendix 1

Bryn Henllys Extension_Proposed Layout_Rev5

Area 255,928 m2 (63.24 acres)



- Site Boundary
- Site Access
- Security Fence
- Field Boundary
- Module Table 14 x 4
- Module Table 28 x 4
- Transformer
- Switchgear Substation
- AC Box
- Access Road
- Tree
- Access Gates
- CCTV
- Tree-Root Protection Area

Scale 1:10000

A3 - (420 x 297)mm

GM			22.10.18
DRAWN	CHECKED	APPROVED	DATE

PROJECT NAME & ADDRESS:
Location: Waunlwud Farm, Ystradowen, Swansea, UK
Postcode: SA9 2XX

NOTES:
-
-
-
-
-

Paper Size:	Scale:	Sheet:
A3	1:5000	1

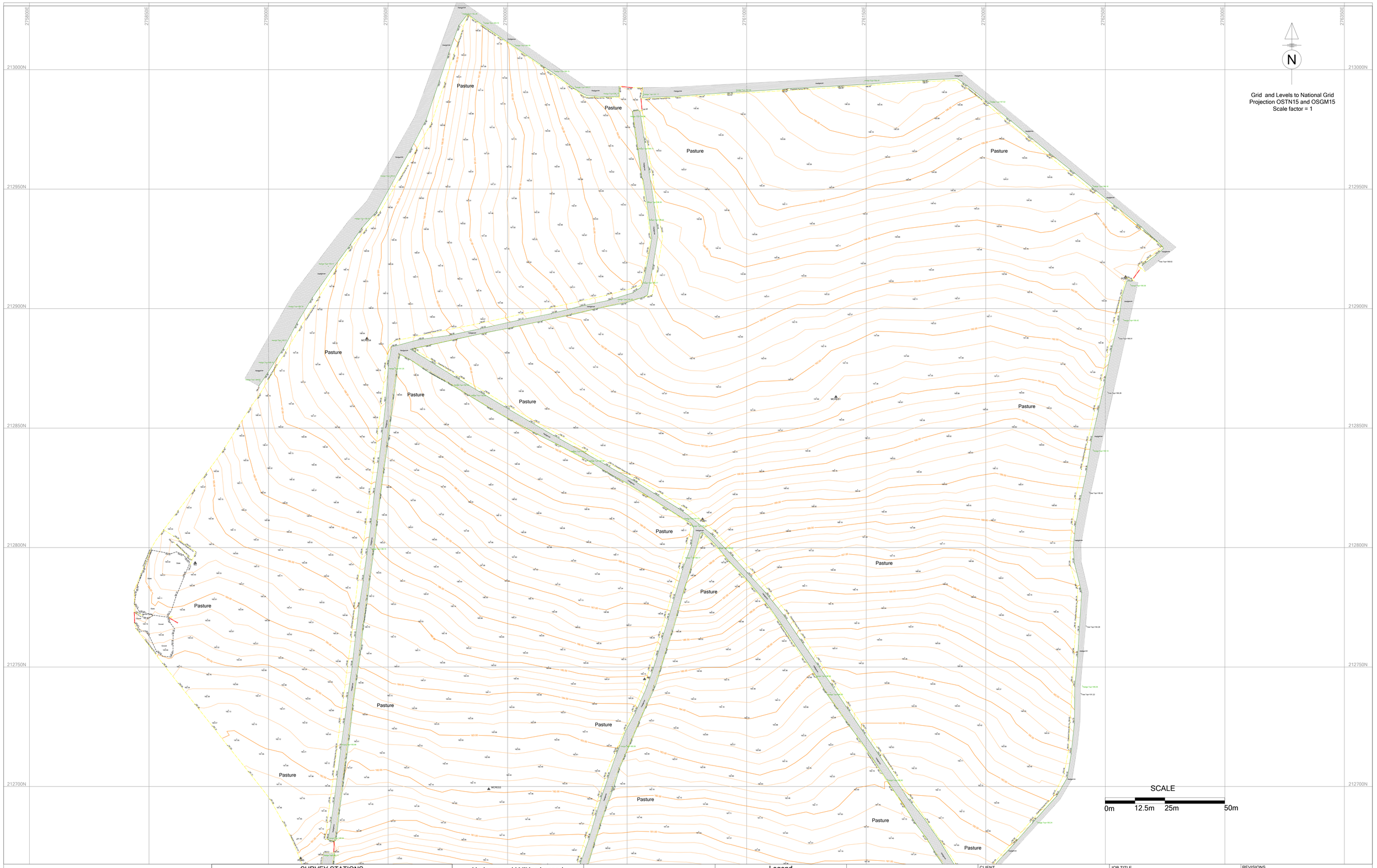
CAPACITY: 12.23 MWp

DRAWING TITLE: Bryn Henllys Extension_Proposed Layout_Rev5

DRAWING NUMBER:	STATUS:
BRYN_01	Preliminary

Lightsource Renewable Development Limited,
7th Floor, 33 Holborn, London, EC1N 2HU
General: +44 (0) 333 200 0755
Web: www.lightsourcebp.com
info@lightsourcebp.com

Appendix 2



Sheet1

SURVEY STATIONS

Name	Easting	Northing	Height	Remark
PGM1	276081.545	212811.923	189.274	PGM
PGM2	276258.486	212913.319	193.480	PGM
PGM3	276154.486	212631.180	179.790	PGM
PGM4	276005.832	212600.032	175.977	PGM
PGM5	275913.448	212669.970	180.751	PGM
PGM6	275762.467	212470.977	173.163	PGM
PGM7	275908.618	212468.886	177.019	PGM
PGM8	275873.671	212350.366	171.210	PGM
PGM9	275682.086	212291.156	166.602	PGM
PGM10	275808.897	212323.860	169.937	PGM
M1	275830.903	212542.039	176.105	Nail
M2	275869.317	212793.627	184.731	Peg
M3	275685.608	212348.706	165.237	Peg
M6	276057.276	212744.940	184.889	Peg

Underground Utilities Legend

- STORM WATER SEWER (SWS)
- FOUL WATER SEWER (FWS)
- COMBINED SEWER (CWS)
- ELECTRIC CABLE
- HV — HIGH VOLTAGE CABLE
- LV — LOW VOLTAGE CABLE
- TELECOMS CABLE
- CATV — CABLE TELEVISION
- TLC — TRAFFIC LIGHT SIGNAL CABLE
- WATER — UNDERGROUND WATER SUPPLY
- GAS
- GAS (MP) — GAS MEDIUM PRESSURE
- GAS (IP) — GAS INTERMEDIATE PRESSURE
- GAS (HP) — GAS HIGH PRESSURE
- OIL — OIL PIPE
- MSR — MULTIPLE SERVICE ROUTE
- MSD — MULTIPLE SERVICE DUCT
- UNK — M — UNKNOWN SERVICE METALLIC
- UNK — GPR — UNKNOWN SERVICE FOUND WITH GPR
- UNK — CABLE — UNKNOWN SERVICE CABLE
- EO — EMPTY DUCT

D=0.6 - Depth = 0.6 approx

SURVEY STATION | GATE | BANK | FOLIAGE | CLIFF

50m — MAJOR CONTOUR

MINOR CONTOUR (0.25m interval)

UNDERGROUND UTILITY SURVEY NOTES:
This survey has been carried out to the standard, as described by The Survey Association (TSA), for a Level 4 Survey, (PAS128 Type B) Utilities on this drawing have been detected using non invasive technologies. The performance of these technologies can be adversely affected by ground conditions which are out of the control of Brunel Surveys . Consequently some utilities may be undetectable and therefore, whilst Brunel Surveys uses best endeavours to detect all utilities we cannot guarantee that 100% detection can always be achieved.
Irrespective of the information provided by a utility survey and statutory plans, any groundworks should be undertaken with extreme caution and in accordance with health and safety executive guidelines HSG 47 AVOIDING DANGER FROM UNDERGROUND SERVICES

Legend

AV	Air Valve	MK	Marker Post
BH	Bore Hole	MK-BT	Marker Post (Telecoms)
Bin	Litter Bin	MK-FH	Marker Post (Fire Hydrant)
BL	Bollard	MK-GV	Marker Post (Gas Valve)
BS	Bus Stop	MK-SV	Marker Post (Stop Valve)
BT	Telecom Cover	MK-WM	Marker Post (Water Meter)
BT CAB	Telecom Cabinet	OHC	Overhead Cable
CATV	Cable TV Cover	PB	Post Box
CL	Cover Level	RE	Rodding Eye
DP	Down Pipe	RS	Road Sign
EB	Electricity Box	SC	Stop Cock (Water)
ECAB	Electrical Cabinet	SL	Soffit Level
EIC	Electrical Inspection Cover	SNP	Street Name Plate
EOT	End of Trace	SP	Sign Post
EP	Electricity Pole	SV	Stop Valve (Water)
ER	Earth Rod	THL	Threshold Level
FFL	Finished Floor Level	TL	Traffic Light
FH	Fire Hydrant	TL CAB	Traffic Light Cabinet
FP	Fence Post	TP	Telegraph Pole
GP	Gate Post	TS	Traffic Sign
GPR	Ground Penetrating Radar	TVIC	Cable TV Inspection Cover
GV	Gas Valve	UTL	Unable to Lift
GY	Gulley	UTS	Unable to Survey
Ht	Height	UTT	Unable to Trace
IL	Invert Level	VP	Vent Pipe
KI	Kerb Inlet	WL	Water Level
LC	Lamp Column	WM	Water Meter
MH	Manhole	WO	Wash Out

Brunel Surveys Ltd
UNIT 59, SHRIVENHAM HUNDRED BUSINESS PARK
WATCHFIELD, SWINDON, WILTSHIRE, SN6 8TZ
TEL : (01793) 784700 FAX : (01793)784664
WEB : www.brunelsurveys.com
Email:admin@brunelsurveys.com

Land and Measured Building Surveyors
Photogrammetrage, 3D Visualisations and
Underground Utility Surveyors

CLIENT: Lightsource BP

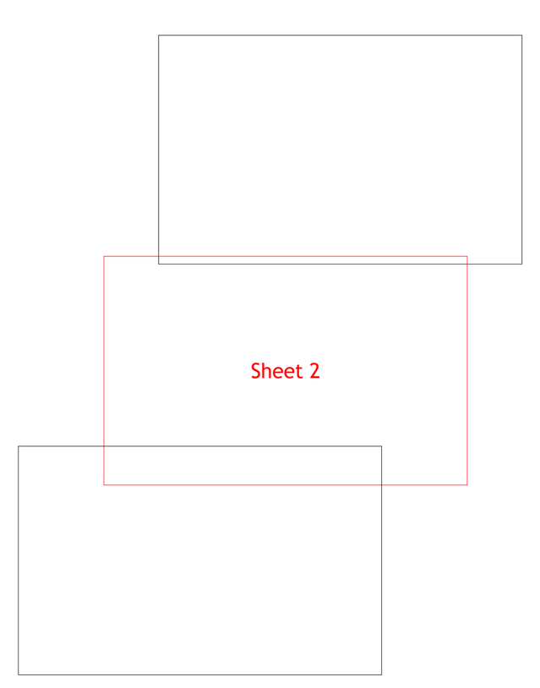
JOB TITLE: Topographical Survey

Waunlwyd Farm,
Ystradowen,
Swansea,
SA9 2XX.

REVISIONS

SCALE	A0 Sheet @ 1 to 500
DATE: June 2019	SURVEYED BY: MC/ND
DRAWN BY: MC	CHECKED BY: PAH

DRAWING No.
20678-500-01
Sheet 1



SURVEY STATIONS

Name	Easting	Northing	Height	Remark
PGM1	276081.545	212811.923	189.274	PGM
PGM2	276258.486	212913.319	193.480	PGM
PGM3	276154.486	212631.180	179.790	PGM
PGM4	276005.832	212600.032	175.977	PGM
PGM5	275913.448	212669.970	180.751	PGM
PGM6	275762.467	212470.977	173.163	PGM
PGM7	275908.618	212468.886	177.019	PGM
PGM8	275873.671	212350.366	171.210	PGM
PGM9	275682.086	212291.156	166.602	PGM
PGM10	275808.897	212323.860	169.937	PGM
M1	275830.903	212542.039	176.105	Nail
M2	275869.317	212793.627	184.731	Peg
M3	275685.608	212348.706	165.237	Peg
M6	276057.276	212744.940	184.889	Peg

Underground Utilities Legend

STORM WATER SEWER (SWS)
FOUL WATER SEWER (FWS)
COMBINED SEWER (CWS)
ELECTRIC CABLE
HV — HIGH VOLTAGE CABLE
LV — LOW VOLTAGE CABLE
TELECOMS CABLE
CATV — CABLE TELEVISION
TLS — TRAFFIC LIGHT SIGNAL CABLE
WATER — UNDERGROUND WATER SUPPLY
GAS — GAS
GAS (MP) — GAS MEDIUM PRESSURE
GAS (IP) — GAS INTERMEDIATE PRESSURE
GAS (HP) — GAS HIGH PRESSURE
OIL — OIL PIPE
MSR — MULTIPLE SERVICE ROUTE
MSD — MULTIPLE SERVICE DUCT
UNK — M — UNKNOWN SERVICE METALLIC
UNK — GPR — UNKNOWN SERVICE FOUND WITH GPR
UNK — CABLE — UNKNOWN SERVICE CABLE
ED — EMPTY DUCT

D=0.6 - Depth = 0.6 approx

R1 SURVEY STATION · GATE · BANK · FOLIAGE · CLIFF

50m — MAJOR CONTOUR

MINOR CONTOUR (0.25m interval)

UNDERGROUND UTILITY SURVEY NOTES:
This survey has been carried out to the standard, as described by The Survey Association (TSA), for a Level 4 Survey, (PAS128 Type B) Utilities on this drawing have been detected using non invasive technologies. The performance of these technologies can be adversely affected by ground conditions which are out of the control of Brunel Surveys . Consequently some utilities may be undetectable and therefore, whilst Brunel Surveys uses best endeavours to detect all utilities we cannot guarantee that 100% detection can always be achieved.
Irrespective of the information provided by a utility survey and statutory plans, any groundworks should be undertaken with extreme caution and in accordance with health and safety executive guidelines HSG 47 AVOIDING DANGER FROM UNDERGROUND SERVICES

Legend

AV	Air Valve	MK	Marker Post
BH	Bore Hole	MK-BT	Marker Post (Telecoms)
Bin	Litter Bin	MK-FH	Marker Post (Fire Hydrant)
BL	Bollard	MK-GV	Marker Post (Gas Valve)
BS	Bus Stop	MK-SV	Marker Post (Stop Valve)
BT	Telecom Cover	MK-WM	Marker Post (Water Meter)
BT CAB	Telecom Cabinet	OHC	Overhead Cable
CATV	Cable TV Cover	PB	Post Box
CL	Cover Level	RE	Rodding Eye
DP	Down Pipe	RS	Road Sign
EB	Electricity Box	SC	Stop Cock (Water)
ECAB	Electrical Cabinet	SL	Soffitt Level
EIC	Electrical Inspection Cover	SNP	Street Name Plate
EOT	End of Trace	SP	Sign Post
EP	Electricity Pole	SV	Stop Valve (Water)
ER	Earth Rod	THL	Threshold Level
FFL	Finished Floor Level	TL	Traffic Light
FH	Fire Hydrant	TL CAB	Traffic Light Cabinet
FP	Fence Post	TP	Telegraph Pole
GP	Gate Post	TS	Traffic Sign
GPR	Ground Penetrating Radar	TVIC	Cable TV Inspection Cover
GV	Gas Valve	UTL	Unable to Lift
GY	Gulley	UTS	Unable to Survey
Ht	Height	UTT	Unable to Trace
IL	Invert Level	VP	Vent Pipe
KI	Kerb Inlet	WL	Water Level
LC	Lamp Column	WM	Water Meter
MH	Manhole	WO	Wash Out

Brunel Surveys Ltd

UNIT 59, SHRIVENHAM HUNDRED BUSINESS PARK
WATCHFIELD, SWINDON, WILTSHIRE, SN6 8TZ
TEL : (01793) 784700 FAX : (01793)784664
WEB : www.brunelsurveys.com
Email:admin@brunelsurveys.com

Land and Measured Building Surveyors
Photomontage, 3D Visualisations and
Underground Utility Surveyors

CLIENT
Lightsource BP

JOB TITLE
Topographical Survey

Waunlwyd Farm,
Ystradowen,
Swansea,
SA9 2XX.

REVISIONS

SCALE	A0 Sheet @ 1 to 500		
DATE	June 2019	SURVEYED BY	MC/ND
DRAWN BY	MC	CHECKED BY	PAH

DRAWING No.
20678-500-01
Sheet 2

Sheet 3

SURVEY STATIONS

Name	Easting	Northing	Height	Remark
PGM1	276081.545	212811.923	189.274	PGM
PGM2	276258.486	212913.319	193.480	PGM
PGM3	276154.486	212631.180	179.790	PGM
PGM4	276005.832	212600.032	175.977	PGM
PGM5	275913.448	212669.970	180.751	PGM
PGM6	275762.467	212470.977	173.163	PGM
PGM7	275908.618	212468.886	177.019	PGM
PGM8	275873.671	212350.366	171.210	PGM
PGM9	275682.086	212291.156	166.602	PGM
PGM10	275808.897	212323.860	169.937	PGM
M1	275830.903	212542.039	176.105	Nail
M2	275869.317	212793.627	184.731	Peg
M3	275685.608	212348.706	165.237	Peg
M6	276057.276	212744.940	184.889	Peg

Underground Utilities Legend

- STORM WATER SEWER (SWS)
- FOUL WATER SEWER (FWS)
- COMBINED SEWER (CWS)
- ELECTRIC CABLE
- HV — HIGH VOLTAGE CABLE
- LV — LOW VOLTAGE CABLE
- TELECOMS CABLE
- CATV — CABLE TELEVISION
- TLS — TRAFFIC LIGHT SIGNAL CABLE
- WATER — UNDERGROUND WATER SUPPLY
- GAS
- GAS (MP) — GAS MEDIUM PRESSURE
- GAS (IP) — GAS INTERMEDIATE PRESSURE
- GAS (HP) — GAS HIGH PRESSURE
- OIL — OIL PIPE
- MSR — MULTIPLE SERVICE ROUTE
- MSD — MULTIPLE SERVICE DUCT
- UNK — M — UNKNOWN SERVICE METALLIC
- UNK — GPR — UNKNOWN SERVICE FOUND WITH GPR
- UNK — CABLE — UNKNOWN SERVICE CABLE
- ED — EMPTY DUCT

D=0.6 - Depth = 0.6 approx

R1 SURVEY STATION · GATE · BANK · FOLIAGE · CLIFF

50m — MAJOR CONTOUR

MINOR CONTOUR (0.25m interval)

UNDERGROUND UTILITY SURVEY NOTES:
This survey has been carried out to the standard, as described by The Survey Association (TSA), for a Level 4 Survey, (PAS128 Type B) Utilities on this drawing have been detected using non invasive technologies. The performance of these technologies can be adversely affected by ground conditions which are out of the control of Brunel Surveys . Consequently some utilities may be undetectable and therefore, whilst Brunel Surveys uses best endeavours to detect all utilities we cannot guarantee that 100% detection can always be achieved.
Irrespective of the information provided by a utility survey and statutory plans, any groundworks should be undertaken with extreme caution and in accordance with health and safety executive guidelines HSG 47 AVOIDING DANGER FROM UNDERGROUND SERVICES

Legend

AV	Air Valve	MK	Marker Post
BH	Bore Hole	MK-BT	Marker Post (Telecoms)
Bin	Litter Bin	MK-FH	Marker Post (Fire Hydrant)
BL	Bollard	MK-GV	Marker Post (Gas Valve)
BS	Bus Stop	MK-SV	Marker Post (Stop Valve)
BT	Telecom Cover	MK-WM	Marker Post (Water Meter)
BT CAB	Telecom Cabinet	OHC	Overhead Cable
CATV	Cable TV Cover	PB	Post Box
CL	Cover Level	RE	Rodding Eye
DP	Down Pipe	RS	Road Sign
EB	Electricity Box	SC	Stop Cock (Water)
ECAB	Electrical Cabinet	SL	Soffit Level
EIC	Electrical Inspection Cover	SNP	Street Name Plate
EOT	End of Trace	SP	Sign Post
EP	Electricity Pole	SV	Stop Valve (Water)
ER	Earth Rod	THL	Threshold Level
FFL	Finished Floor Level	TL	Traffic Light
FH	Fire Hydrant	TL CAB	Traffic Light Cabinet
FP	Fence Post	TP	Telegraph Pole
GP	Gate Post	TS	Traffic Sign
GPR	Ground Penetrating Radar	TVIC	Cable TV Inspection Cover
GV	Gas Valve	UTL	Unable to Lift
GY	Gulley	UTS	Unable to Survey
Ht	Height	UTT	Unable to Trace
IL	Invert Level	VP	Vent Pipe
KI	Kerb Inlet	WL	Water Level
LC	Lamp Column	WM	Water Meter
MH	Manhole	WO	Wash Out

Brunel Surveys Ltd
UNIT 59, SHRIVENHAM HUNDRED BUSINESS PARK
WATCHFIELD, SWINDON, WILTSHIRE, SN6 8TZ
TEL : (01793) 784700 FAX : (01793)784664
WEB : www.brunelsurveys.com
Email:admin@brunelsurveys.com

Land and Measured Building Surveyors
Photomontage, 3D Visualisations and
Underground Utility Surveyors

CLIENT
Lightsource BP

JOB TITLE
Topographical Survey

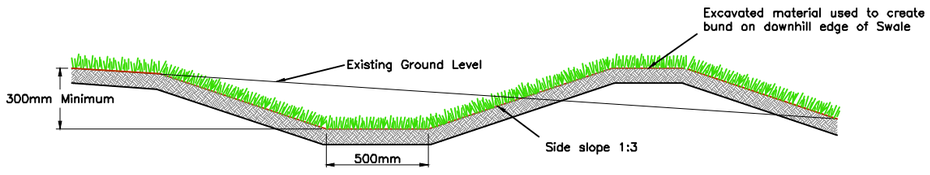
Waunlwyd Farm,
Ystradowen,
Swansea,
SA9 2XX.

REVISIONS

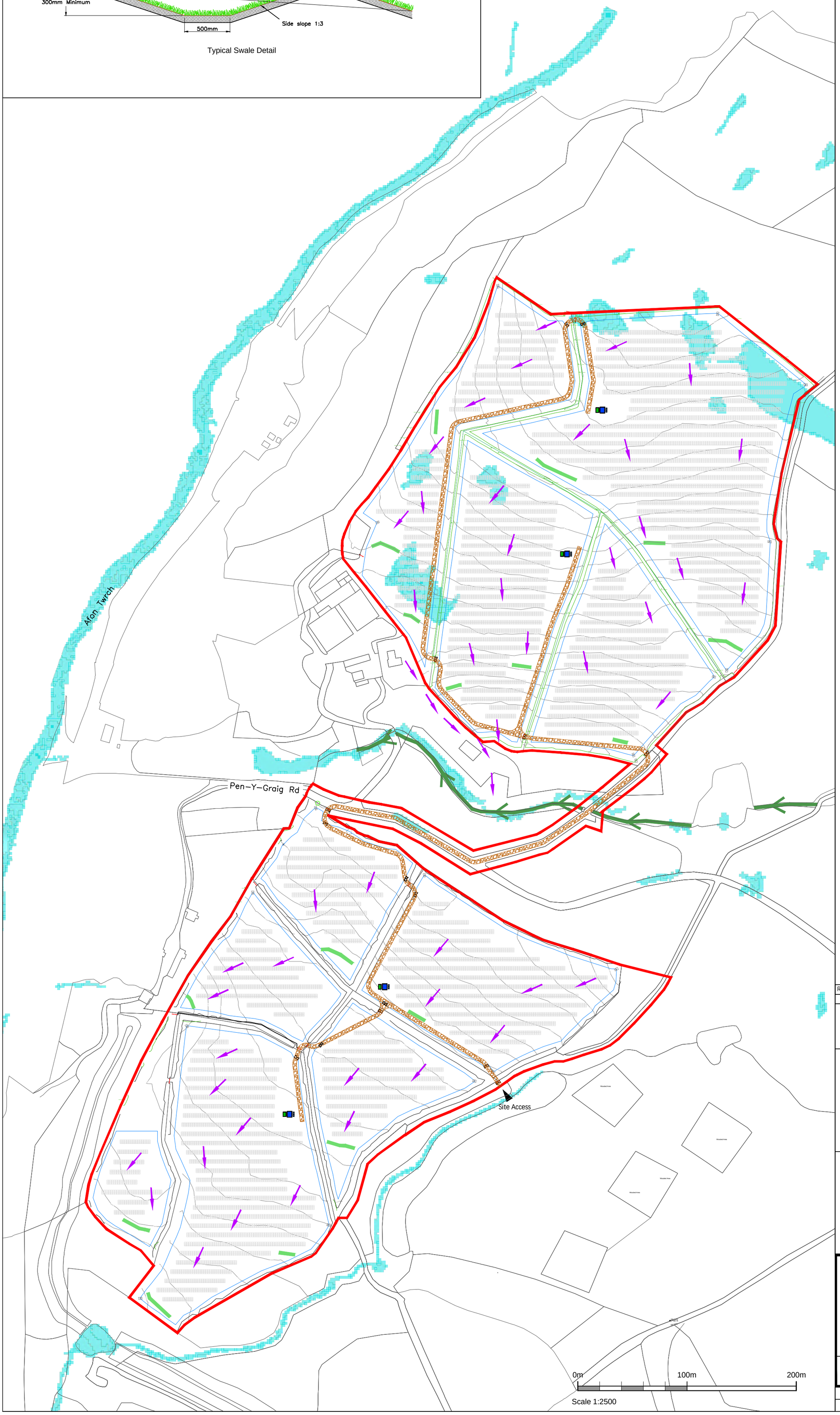
SCALE	A0 Sheet @ 1 to 500
DATE	June 2019
SURVEYED BY	MC/ND
DRAWN BY	MC
CHECKED BY	PAH

DRAWING No.
20678-500-01
Sheet 3

Appendix 3



Typical Swale Detail



PFA consulting

Stratton Park House, Wanborough Road
Swindon, SN3 4HG

Telephone
01793 828000

Website
www.pfaplc.com

For Planning
This drawing is produced for the purposes of supporting a planning application and should not be relied upon for tender, pricing, or construction purposes.

NOTES

1. This drawing is based on a topographical survey from Brunel Survey Ltd, drawing number 20678–500–01, dated June 2019.
2. Bryn Henllys Extension Proposed Layout was provided by Lightsource bp, drawing number BRYN_01 REV 5, dated 22/10/2018.
3. Risk of flooding from surface water data was obtained from the data catalogue from the Lle Geo–Portal in July 2019.
4. As a form of betterment, swales are proposed in the lower areas of the site to intercept extreme flows which may already run offsite.

KEY

- Indicative Overland Flow Route
- Indicative Site Boundary
- Existing Formilsied Ditch
- Proposed Swales

Surface Water Flood Risk Area

- Up to 1 in 30 Surface Water Flood Risk (High Risk)

Rev	Date	Description	Drawn	Check
#	05/08/19	First Issue.	DAB	BF

Status

FOR PLANNING

Client

Lightsource bp

Project

Proposed Solar Farm
Bryn Henllys Extension

Drawing Title

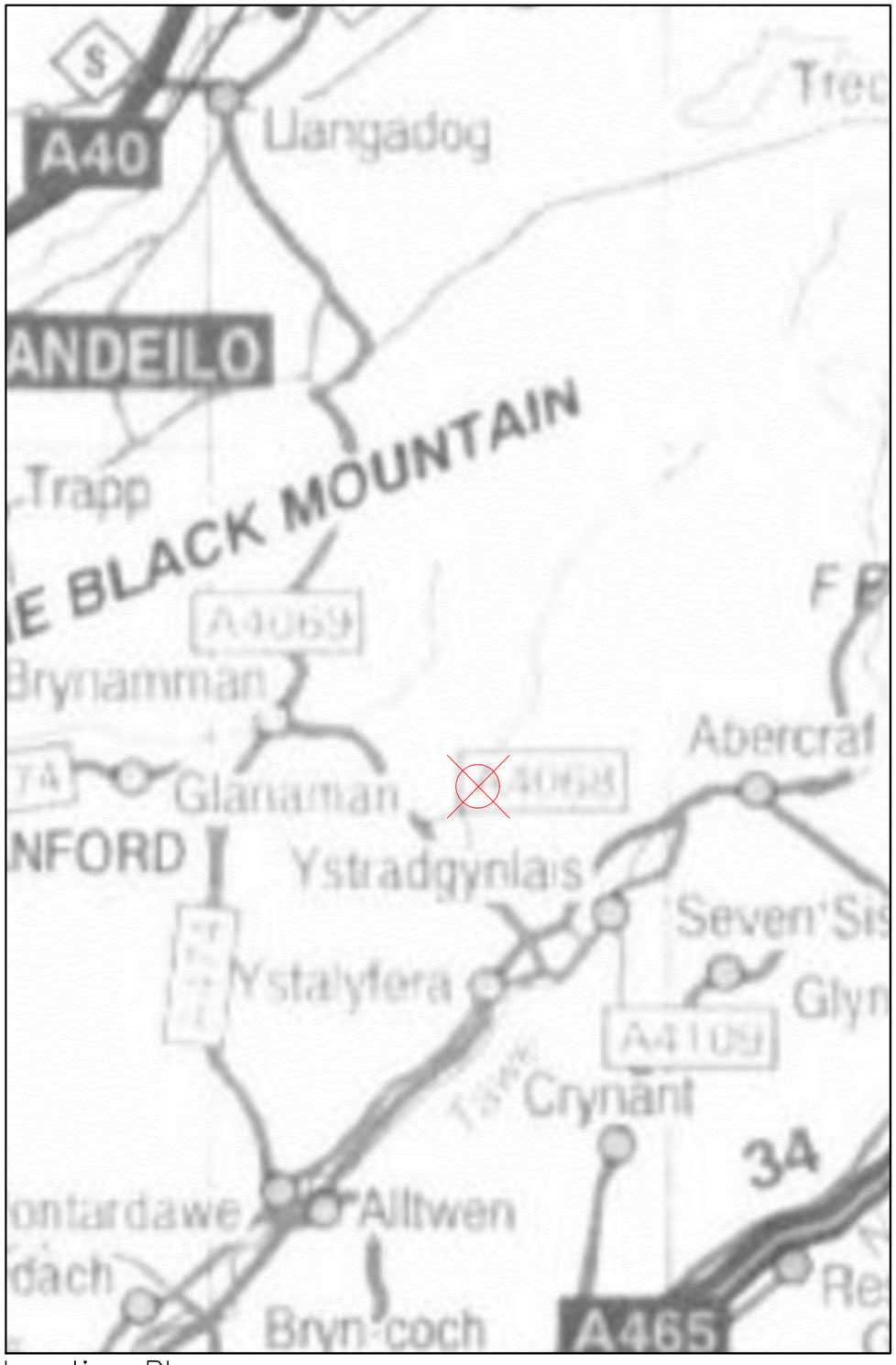
Proposed Drainage Arrangements

Drawing No. L470/02

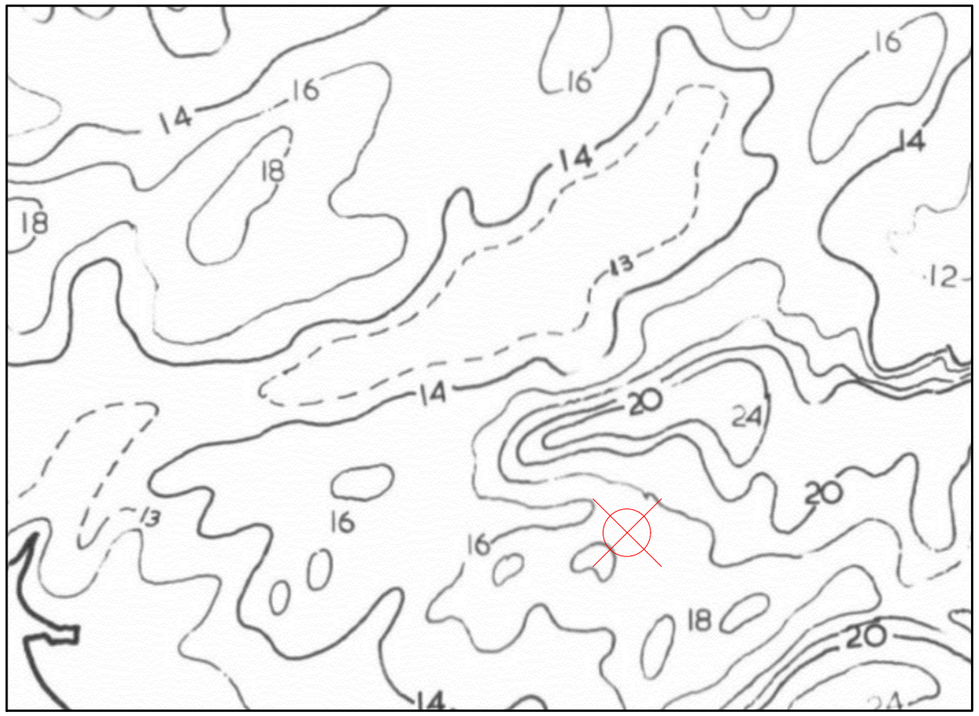
Date: August 2019 | Scale: 1:2500 @ A2

E-Mail: Dbuciak@pfaplc.com

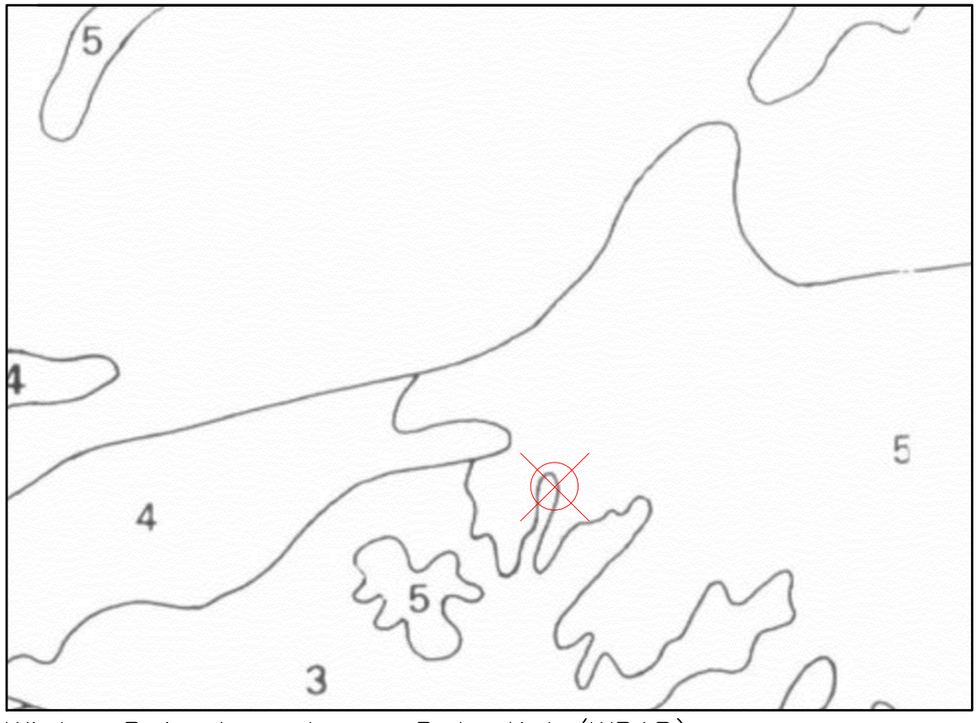
Appendix 4



Location Plan



Standard Average Annual Rainfall (SAAR) (in hundreds of mm)



Winter Rain Acceptance Potential (WRAP)

PFA consulting

Stratton Park House, Wanborough Road
Swindon, SN3 4HG

Telephone
01793 828000

Website
www.pfaplc.com

For Planning
These drawings are produced for the purposes of supporting a planning application and should not be relied upon for tender, pricing, or construction purposes.

NOTES

1. Standard Average Annual Rainfall (SAAR) and Winter Rain Acceptance Potential (WRAP) map extracts shown on this drawing are reproduced from the maps contained in Volume V of the Flood Studies Report – NERC:1975.

Soil Classification			
Soil Class (WRAP)	Soil Index (IoH)	SPR (FEH)	St (ADAS)
1	0.15	10	0.1
2	0.30	30	0.5
3	0.40	37	0.8
4	0.45	47	1.0
5	0.50	53	1.3

Rev	Date	Description	Drawn	Check
#	28/06/19	First issue.	DAB	BF

Status
FOR PLANNING

Client
Lightsource BP

Project
PROPOSED SOLAR FARM, BRYN HENLLYS EXTENSION

Drawing Title
SAAR and WRAP Maps

Drawing No.
L470/01

Date: June 2019 | Scale: NTS @A3

E-Mail: dbuciak@pfaplc.com

Appendix 5

ICP SUDS Mean Annual Flood

Input

Return Period (years)	1	Soil	0.500
Area (ha)	25.593	Urban	0.000
SAAR (mm)	1800	Region Number	Region 9

Results l/s

QBAR Rural	426.7
QBAR Urban	426.7
Q1 year	375.5
Q1 year	375.5
Q30 years	752.3
Q100 years	930.1

ICP SUDS Mean Annual Flood

Input

Return Period (years)	1	Soil	0.500
Area (ha)	25.593	Urban	0.001
SAAR (mm)	1800	Region Number	Region 9

Results l/s

QBAR Rural	426.7
QBAR Urban	427.2
Q1 year	376.0
Q1 year	376.0
Q30 years	753.1
Q100 years	930.9

Appendix 6

SOLAR FARM AT WAUNLWYD FARM, BRYN HENLLYS EXTENSION

SURFACE WATER DRAINAGE CHECK SHEET

1. Surface Water Drainage Arrangements

1.1. Swales are proposed at the low points of the development site to intercept overland flows. The locations of the Swales are shown on the attached drawing (PFA Consulting, Drawing Number L470/02.

1.2. Upon commissioning of the Solar Park the Site Manager should complete **Table A**.

Table A: Commissioning Checklist

Drainage Feature	Constructed as designed (Y/N)	Planted with covering vegetation (Y/N)	Notes
Swale 1			
Swale 2			
Swale 3			
Swale 4			
Swale 5			
Swale 6			
Swale 7			
Swale 8			
Swale 9			
Swale 10			
Swale 11			
Swale 12			

1.3. During any regular maintenance visits (at intervals no greater than 3 months) the Maintenance Engineer should complete the first column of the Drainage Checklist in the Inspection Report below. The Inspection Report will then be passed onto the Site Manager who will then arrange for the appropriate actions to be initiated.

2. Maintenance Regime

2.1. A guide to the general swale maintenance regime is set out in **Table B**.

Table B – Swale Maintenance Procedures

Maintenance Schedule	Required Action
Regular Maintenance (Quarterly)	Litter and debris removal.
	Grass cutting or animal gazing – to retain grass height to site owner's specification.
	Manage other vegetation and remove nuisance plants.
	Inspect infiltration surfaces for ponding, compaction, and silt accumulation. Record areas where water is ponding for > 48 hours.
	Inspect surface for silt accumulation.
Occasional Maintenance (Annually)	Check for poor vegetation growth due to lack of sunlight or dropping of leaf litter, and cut back adjacent vegetation where possible.
	Re-seed areas of poor vegetation growth. Alter plant types to better suit conditions, if required.

Inspection Report

To be completed at approximately 3 month intervals

Date of Inspection: ……..

Inspector: ……

DRAINAGE CHECKLIST

	Y/N	Actions
1. Do any parts of the swales contain standing water?		
2. Is any water overflowing from the swales?		
3. Are some of the swales overgrown or silted up?		
4. Has there been recent excessive rainfall or local flooding issues near the site?		
5. Are any rivulets (small channels) forming or is there soil erosion due to rainwater?		

Notes:

a) **If YES to Question 3 additional maintenance may be required.**

b) **If YES to Questions 4 and 5 then further investigation may be required and consultation with a drainage engineer would be prudent.**