

Our ref: 680623 L02  
Application ref: 22/03873/F

13<sup>th</sup> April 2023

FAO Kabier Salam

**Installation and operation of a renewable energy generating station comprising ground mounted photovoltaic solar arrays and battery-based electricity storage containers together with substation, switchgear container, inverter/transformer units, Site access, internal access tracks, security measures, access gates, other ancillary infrastructure and landscaping and biodiversity enhancements.**

I refer to the consultation response from Oxfordshire County Council LLFA dated 27th February 2023. The below details how the additional impermeable areas from the development have been calculated and the measures proposed to manage surface water.

The response from OCC noted the following 4no. comments which require further information.

- Drainage strategy drawing required - Drainage drawing required to illustrate the permeable surface for the access roads and all other permeable surfaces.
- Permeable road construction detail to be provided - Construction details drawing to be provided for the permeable surface.
- Surface water flood exceedance plan to be provided - Provide surface water flood exceedance plan, illustrating that all surface water will be kept away from structures and within the site boundary.
- Maintenance regime to be provided for the permeable surfaces - Provide maintenance regime for the proposed SuDS features.

### **Drainage Philosophy**

With respect to the first point raised by OCC, the surface water drainage for the site has been designed in conjunction with the following sources:

- Hydrologic Response of Solar Farms (Cook and McCuen 2013<sup>1</sup>);
- BRE Planning Guidance for the development of large scale ground mounted solar PV systems<sup>2</sup>;
- The drainage principles outlined in the FRA<sup>3</sup>.

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<sup>1</sup> Cook, L.M and McCuen, R. H (2013), Hydrologic Response of Solar Panels, Journal of Hyrdologic Engineering, American Society of Civil Engineers, May 2013

<sup>2</sup> BRE Planning Guidance for the development of large scale ground mounted solar PV systems, <https://www.bre.co.uk/filelibrary/nsc/Documents%20Library/NSC%20Publications/NSC-publication-planning-guidance.pdf>

<sup>3</sup> RSK (2022), Padbury Brook Solar Farm, Flood Risk Assessment & Outline Drainage Strategy, 680623-R1(04)-FRA

The guiding principles aim to achieve sheet flow conditions from the solar development as surface water runoff from the site would be without the solar panels with minimal change to ground cover / conditions.

Surface water drainage will be provided for impermeable structures (inverter units, spares containers and battery storage) where rainfall will be prevented from falling directly to the ground, with the permeable access track surfacing and permeable subbase locations for the raised structures included in the attached permeable drainage drawings.

### **Ancillary Structures**

Surface water drainage for the temporary impermeable structures has been outlined in the FRA. It is intended for surface water runoff from the transformer stations, inverter stations, spares cabinets and battery storage facilities to be discharged to the ground after passing through a permeable gravel subbase. It is noted all units are raised 500mm above the existing ground level, with a minimum 300mm gravel subbase situated beneath the units

The design rainfall event for this assessment has been taken as the 6 hour, 1 in 100-year event from FEH with the intention of retaining any additional surface water runoff generated as a result of the development on the site in the drainage feature.

The gravel subbase will accommodate the surface water runoff volume for the 1 in 100 year plus 25% climate chance allowance. The subbase will drain by using natural infiltration / evaporation. Exceedance of the gravel subbase will result in sheet flows overspilling the subbase. The permeable subbase will be backfilled with gravel for safety and stability, the void ratio of the gravel has been accounted for within the calculations.

The placement of gravel subbase has been outlined on the surface water drainage strategy drawing in **Appendix A**, a with volumetrics outlined in **Table 1**.

**Table 1: Approximate gravel subbase area sizing and volumes**

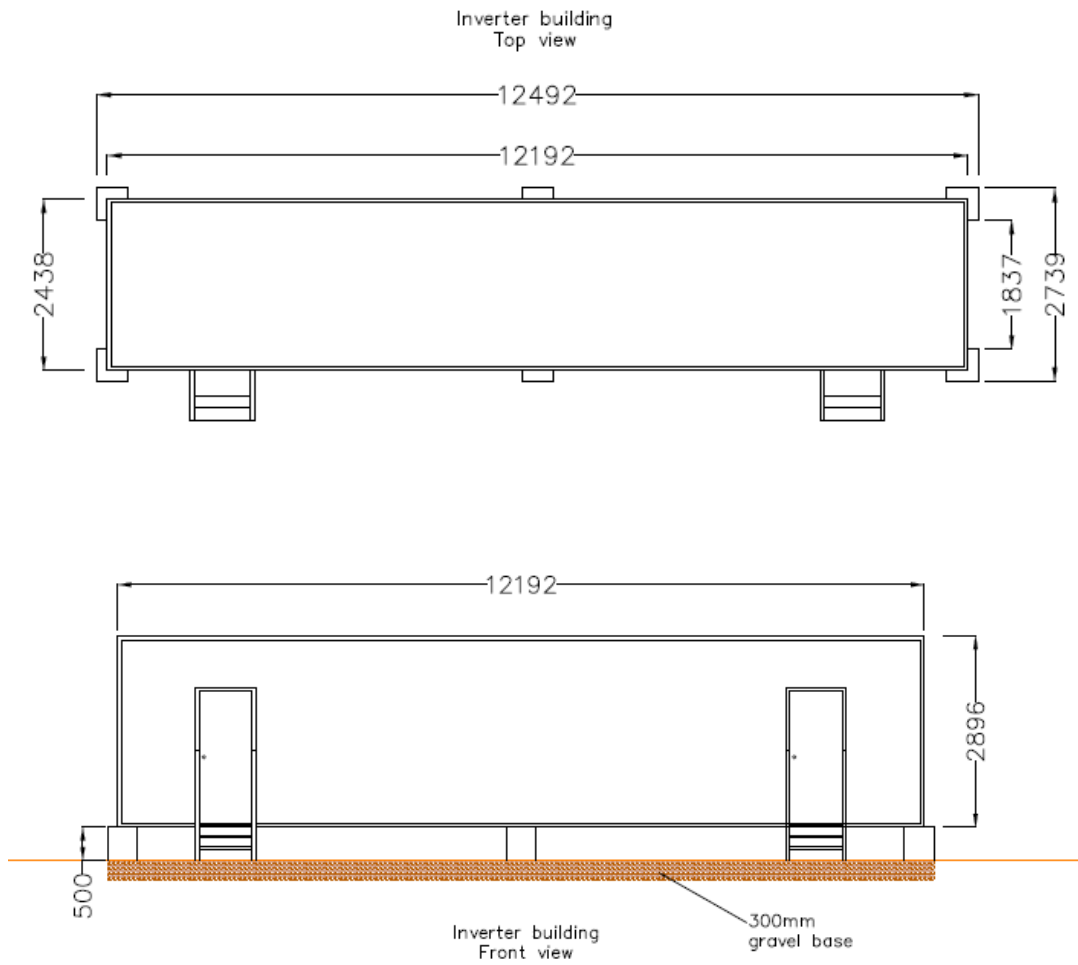
Description	1 in 100-year Rainfall* (m)	Approx. Impermeable Development Area per unit (m <sup>2</sup> )	1 in 100 yr Surface Water Volume Required (m <sup>3</sup> )	1 in 100yr Volume Required with 25% Climate Change (m <sup>3</sup> )	Minimum Gravel Base Sizing				Volume Created (m <sup>3</sup> )**
					Side Slope	Min Area (m <sup>2</sup> )	Depth (m)	Void ratio	
DC-DC Converters	0.069	0.8	0.05	0.0625	Vertical	1	0.3	0.3	0.09
Battery Container / Inverter	0.069	30.3***	2.09	2.61	Vertical	33	0.3	0.3	2.97
Inverter building	0.069	30.3***	2.09	2.61	Vertical	33	0.3	0.3	2.97
Customer Switchgear	0.069	30.3***	2.09	2.61	Vertical	33	0.3	0.3	2.97

\* Rainfall from the Centre of Ecology and Hydrology's Flood Estimation Handbook rainfall database

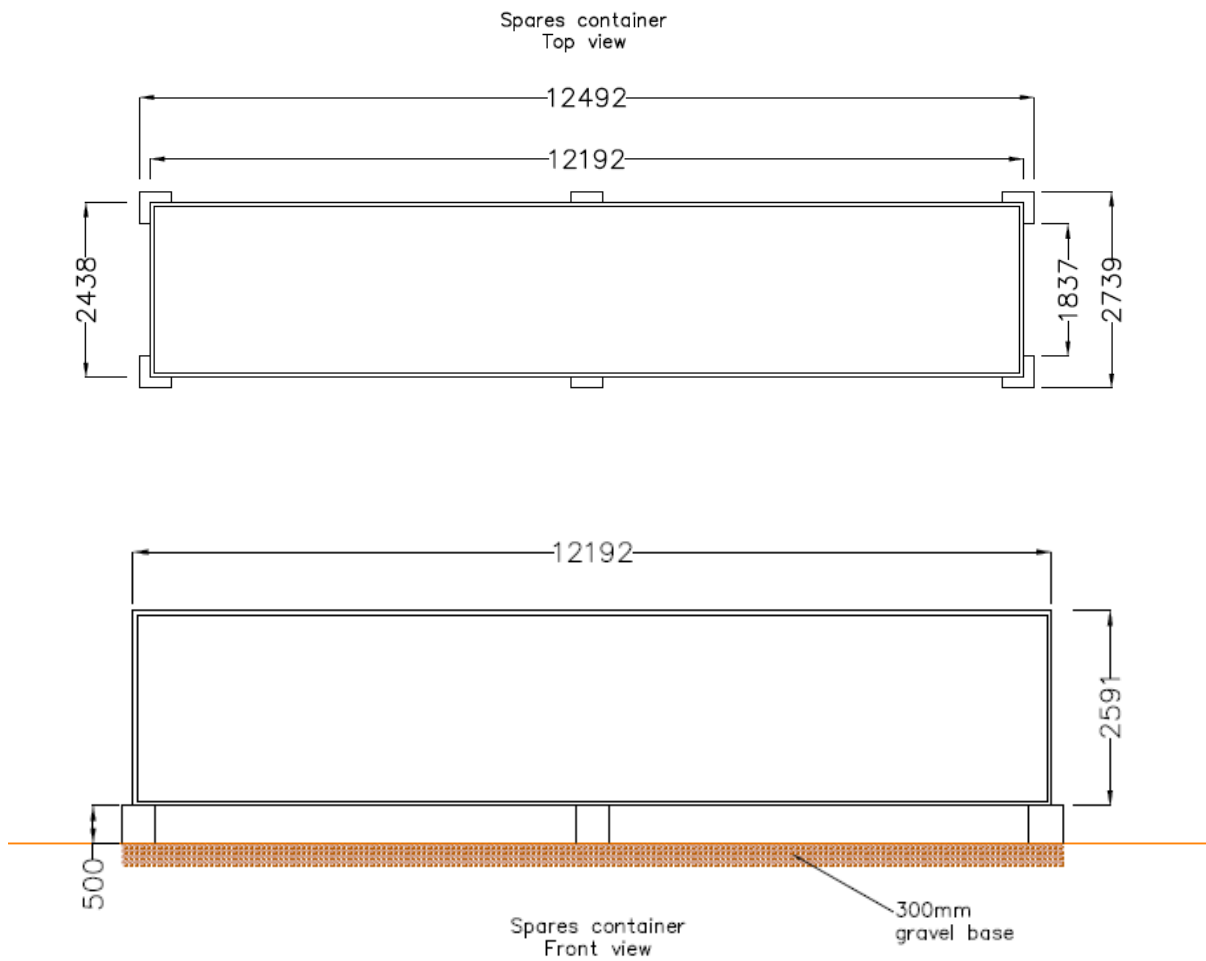
\*\*Assuming a 0.3 void ratio for gravel subbase

\*\*\*Container area + area of concrete stands / feet beyond container area

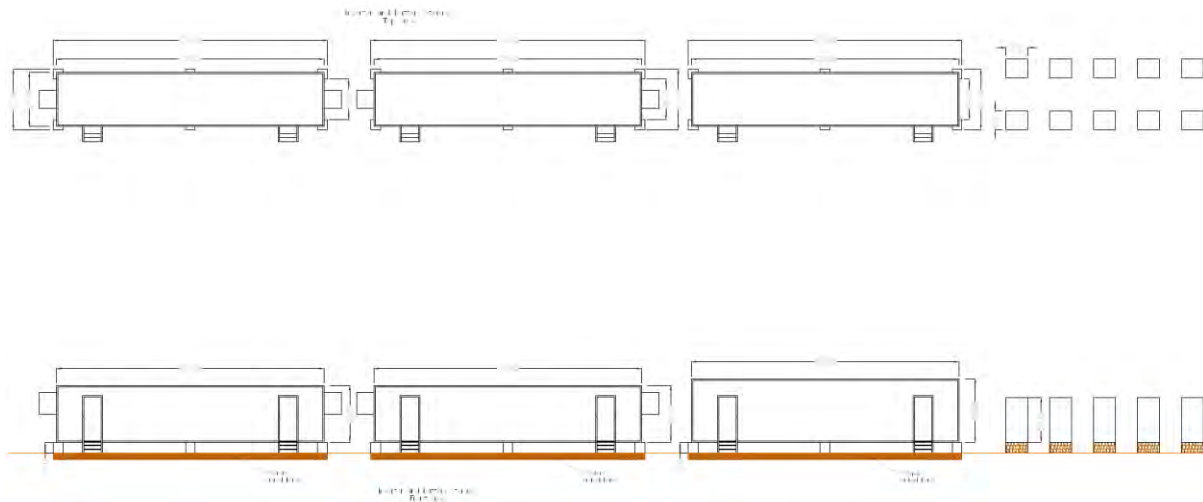
**Figures 1 – 3** show a top-down and side-elevation plan for the inverter units, spares containers and battery storage units. All units are shown to be raised above the existing ground levels on 500mm plinths/blocks and also allow for a 300mm deep gravel subbase for the units proposed at Padbury Brook.



**Figure 1: Inverter Building Specifications**



**Figure 2: Spares Container Specifications**



**Figure 3: Battery Storage Specifications**

Notwithstanding the below (Solar Array) impermeable areas, the onsite inverter building, spares containers and battery storage components equate to 1,292m<sup>2</sup> (40 x inverter building / spares container / battery storage components + 100 DC-DC Converters) and represents an impermeable area covering 0.224% of the total site area.

### Solar Array

The majority of the developable area of the Padbury Brook site will be occupied by solar arrays. Although the solar arrays cover a large area of the site, the actual ground impact is negligible. The only intrusion will be from the pile-driven posts which generally have a base size of between 0.0012m<sup>2</sup> - 0.0014m<sup>2</sup>. There will be one post for about 6-7 panels, so likely to be 6-7m between each post. Each post would be approx. 6-7 meters apart in an array (row) with 4-6m gaps between rows of arrays.

The solar panels themselves do not contribute to any ground impact as any rainfall which directly falls upon the panels will run off the panels to reach the ground. The runoff will then flow underneath the next array of panels, its direction based upon the site's topography, where it will then infiltrate to the ground, as per the existing scenario. The panel posts are the only components of the solar arrays which contribute to any impermeable areas

This means the impermeable area contributed by the solar arrays have a worse case assumption of 0.0014m<sup>2</sup> of impermeable area per post, within the 57.6Ha of the site which contains the solar arrays. The remainder of the site are exclusion zones which do not contribute any additional impermeable area.

Exact numbers of posts have not been provided and will be determined as the scheme progresses, but taking an approximation of 35,000 posts for the 57.6ha site, the total impermeable area attributable to the posts would equate to 49m<sup>2</sup> (0.0085% of the total site area).

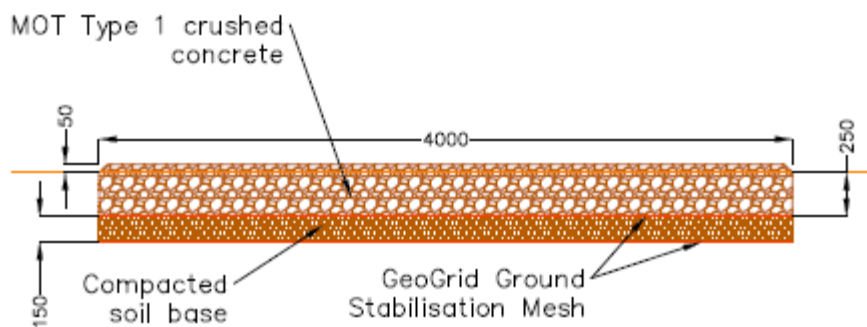
Between and beneath the solar panels, appropriate grass planting will be used to act as a natural filter strip (SuDS). The grass will improve the current land use of arable land by promoting natural

infiltration and low erosivity sheet flow. The grass should be inspected and maintained at least twice a year or after periods of significant drought.

**Temporary Access Tracks**

With respect to the second point raised by OCC, across the site where will be designated routes for the vehicular access to the solar arrays. The access tracks are predominantly comprised of the existing vehicular tracks used by agricultural machinery under existing conditions.

Where new access track is required this will be comprised of a layer of geotextile and overlain with a layer of crushed stone/gravel and will therefore be a permeable surface as noted in **Figure 4** below.



Access track cross section

**Figure 4: Permeable access track specification**

In addition to the permeable access track / gravel subbase beneath the containers, a significant amount (2.4km) of new hedgerows / trees will be being planted as part of the development which would aid in water attenuation.

**Table 2** below is provide to reflect the impermeable areas contributed by the solar panel posts, 40no. inverter building / spares container / battery storage components and 100no. DC-DC Converters.

**Table 2: Proposed site land uses**

Land use	Area (Ha)	Percentage
Impermeable	0.134	0.23%
Permeable	54.446	99.77%
Total	57.600	100.0%

### Surface Water and Exceedance Flows

With respect to the third point raised by OCC, the LLFA plan notes that a surface water exceedance plan should be provided illustrating that all surface water will be kept away from structures and within the site boundary. As noted above, the structures on site (PV panels, inverters, spares cabinets and battery storage elements) are raised a minimum of 500mm above the existing ground level. To justify that the development will have no adverse impact on surface water flows (beyond the surface water drainage philosophy outlined above) the EA's surface water depth mapping for a 100 year event has been considered in greater detail. **Figures 5 – 10** below provide the banded surface water flood depth with relation to the overall site and site specific features.



**Figure 5: EA 100 year surface water flood depths (southern section of site)**





**Figure 6: EA 100 year surface water flood depths (central section of site)**

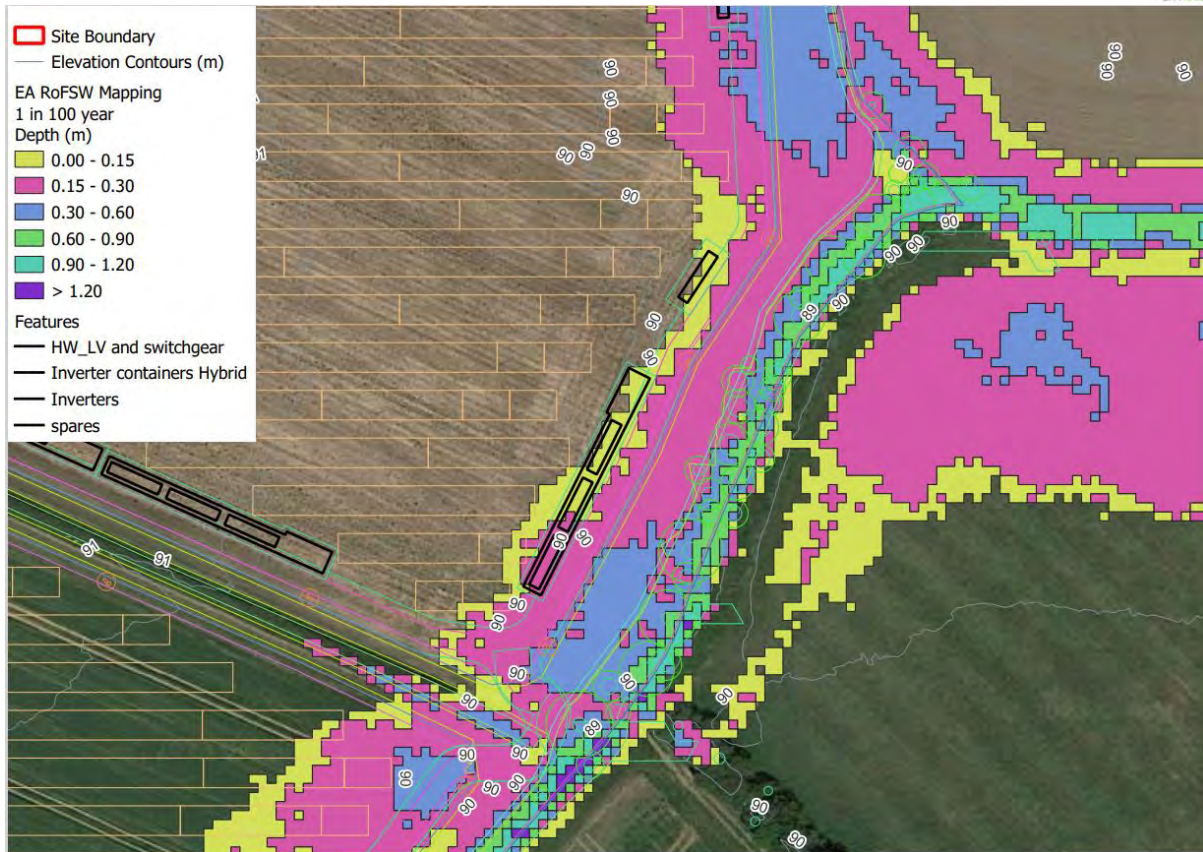


**Figure 7: EA 100 year surface water flood depths (northern section of site)**



**Figure 8: EA 100 year surface water flood depths (central field focus)**

The EA's surface water mapping shows a flow path running through the central field on the site. The development proposes a series of rows of PV panels within this field crossing the flow path. The surface water flood depths in this field in the vicinity of the panels are shown to be typically <150mm and not shown to exceed 300mm, a level below the toe of the solar panels. With minimal on ground structures (excluding piles) these PV panels in this location will not be adversely impacted by the surface water flow path, nor result in any changes to the flow path or the local depths.



**Figure 9: EA 100 year surface water flood depths (inverter station focus)**

In the eastern section of the site there are a series of inverter stations which are sited within the EA's surface water 100 year flood extent. As noted in the drainage philosophy section, the inverter stations are to be raised a minimum of 500mm above the ground level and the surface water depths in the vicinity of the inverter units do not exceed 300mm. As with the panels the siting of the inverter units will not have an adverse impact on the surface water exceedance routes.



**Figure 10: EA 100 year surface water flood depths (inverter station focus)**

In the north eastern section of the site there are a series of inverter stations which are sited within the EA's surface water 100 year flood extent. As noted in the drainage philosophy section, the inverter stations are to be raised a minimum of 500mm above the ground level and the surface water depths in the vicinity of the northern 4no. battery storage / inverter units do not exceed 300mm. The 2no southern units are located in an area where a flood depth of between 300mm and 600mm could occur, however as the inverters are to be raised a minimum of 500mm above the existing ground level, and impact on these 2no structures is minimal. As with the panels the siting of the inverter units will not have an adverse impact on the surface water exceedance routes.

### **SuDS Maintenance Plan**

With respect to the fourth and final point raised by OCC, a management strategy has been prepared by RSK Land and Development Engineering Ltd on behalf of JBM Solar, to satisfy planning conditions related to Solar PV at Padbury Brook (The Development).

The SuDS considered for the purposes of this statement, include drainage features that will be employed to reduce and manage surface water runoff from the development to a design return period of 100 years plus climate change. This is required so that The Development will not increase the risk of flooding to the site and its environs. The drainage features are comprised of the gravel subbase at the relevant locations across the site.

## Maintenance Responsibilities

Responsibility for drainage within England and Wales rests with various bodies. For the Development, the drainage responsibilities will be with the private owner of the solar development or any appointed Management Company.

## Maintenance Regime

The following section describes the required maintenance for each feature in turn. The SUDS maintenance requirements listed below should be reviewed after the first 5 years, with a view to agreeing a new regime for the ongoing maintenance. Notwithstanding the routine inspections and maintenance requirements, after severe storm events all features shall be inspected to clear debris and repair damaged structures or features. Records of the maintenance carried out shall be prepared by the Management Company.

## Backfilled Gravel Subbase

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Remove litter (including leaf litter) and debris from filter material surface.	Monthly or as required
	Inspect drain surface for blockages, clogging, standing water and structural damage	Monthly
	Inspect filter drain for silt accumulation, and establish appropriate silt removal frequencies	Six monthly
	Remove sediment from pre-treatment devices	Six monthly or as required
Occasional maintenance	Remove or control tree roots where they are encroaching the sides of the trench, using recommended methods (e.g. NJUG, 2007 or BS 398:2010)	As required
	At locations with high pollution loads, remove surface geotextile and replace, and wash or replace overlying filter medium	Five yearly or as required
Remedial actions	Reconstruct trench and/or replace or clean void fill if performance deteriorates or failure occurs	As required

## Conclusions

The units are raised a minimum of 500mm above the ground level and also being built above a permeable 300mm gravel sub-base and are not changing any underlying conditions beyond the topsoil. The gravel provides extra storage capacity in comparison to the topsoil in the event that underlying conditions are not supporting effective infiltration.

As a result, in response to the second comment, the drainage for the units will be managed through the gravel sub-bases provided beneath the structures, promoting infiltration and acting as storage. Any excess runoff will pass as overland flow across the site at approximate greenfield rates, mimicking the existing scenario.

In addition, the grass between and below the arrays will act as natural filter strips (SuDS) and help manage excess flow across the site. The full year-round grass cover provides good soil structure and is a positive improvement, compared to existing arable use, by avoiding kinetic compaction and ensuring rivulet formation of the soil is minimised.

As the proposals for the site includes all structures to be raised a minimum of 500mm above the ground levels, the impacts on surface water exceedance flows are minimal, both in terms of drainage (as storage is provided beneath the structures) and overland flow, with minimal imposition posed by the structures based on the EA's 100 year flood depth outputs.

We trust that the above meets with your approval and should you have any additional queries, please do not hesitate to contact the writer.

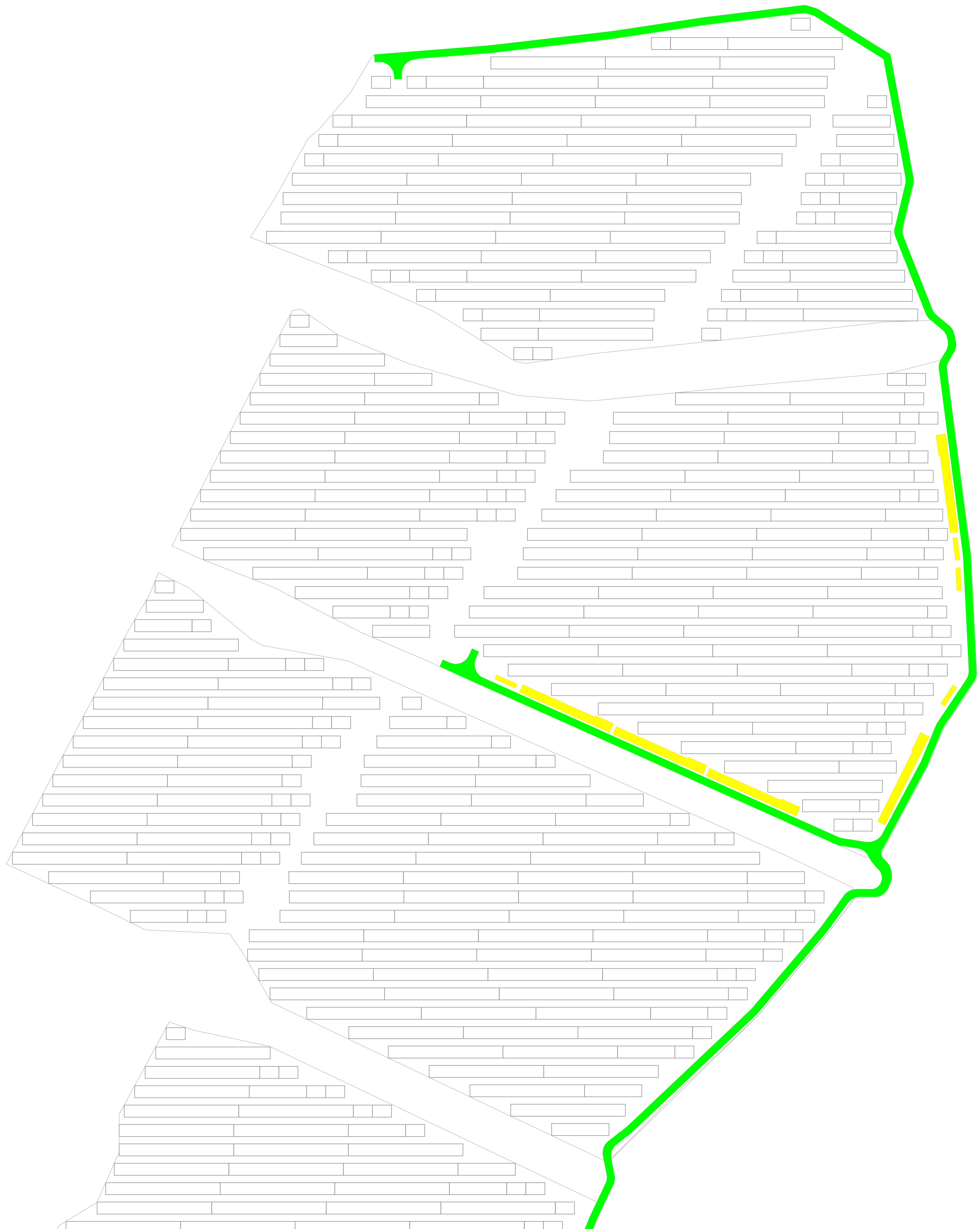
Yours sincerely,  
For RSK LDE Limited



**Kristian Jackson BA(hons) MCD MCIWEM**

Principal Hydrologist

Enc. Drainage Drawings – Permeable access track and subbase locations



RSK LDE LTD - Hydrology Drawing

Notes:

1. This drawing has been produced to planning/viability purposes only.
2. This drawing is indicative and subject to change following layout revisions
3. This drawing is to be read in conjunction with all other relevant drawings.
4. Development Plan provided by the client
5. Topographic Survey provided by the client
6. All dimensions are in metres U.N.O
7. All levels in metres.
8. Do Not Scale from this drawing

KEY

- █ Permeable Surfacing - Access Track
- █ Permeable Surfacing - Areas Beneath Raised Structures


Rev.	Date	Amendment	Drawn	Chkd.	Appd.
P01	24.03.23	Preliminary Issue	KJ	RW	KJ



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Client  
**JBM Solar Projects 8 Ltd**

Project Title  
**Padbury Brook  
Northern Section**

Status  
**WORK IN PROGRESS**

Drawing Title  
**PROPOSED DRAINAGE STRATEGY  
Permeable Surfaces**

Drawn	Date	Checked	Date	Approved	Date
KJ	24.03.23	RW	24.03.23	KJ	24.03.23

Scale	Orig Size	Dimensions	Revision
NTS	A1	M	P01

Drawing File  
LAYOUT.DWG

Project No.	Originator	Unit	Site Area	Series	Number	Sheet
680623	LDE		ALL	01	01	01





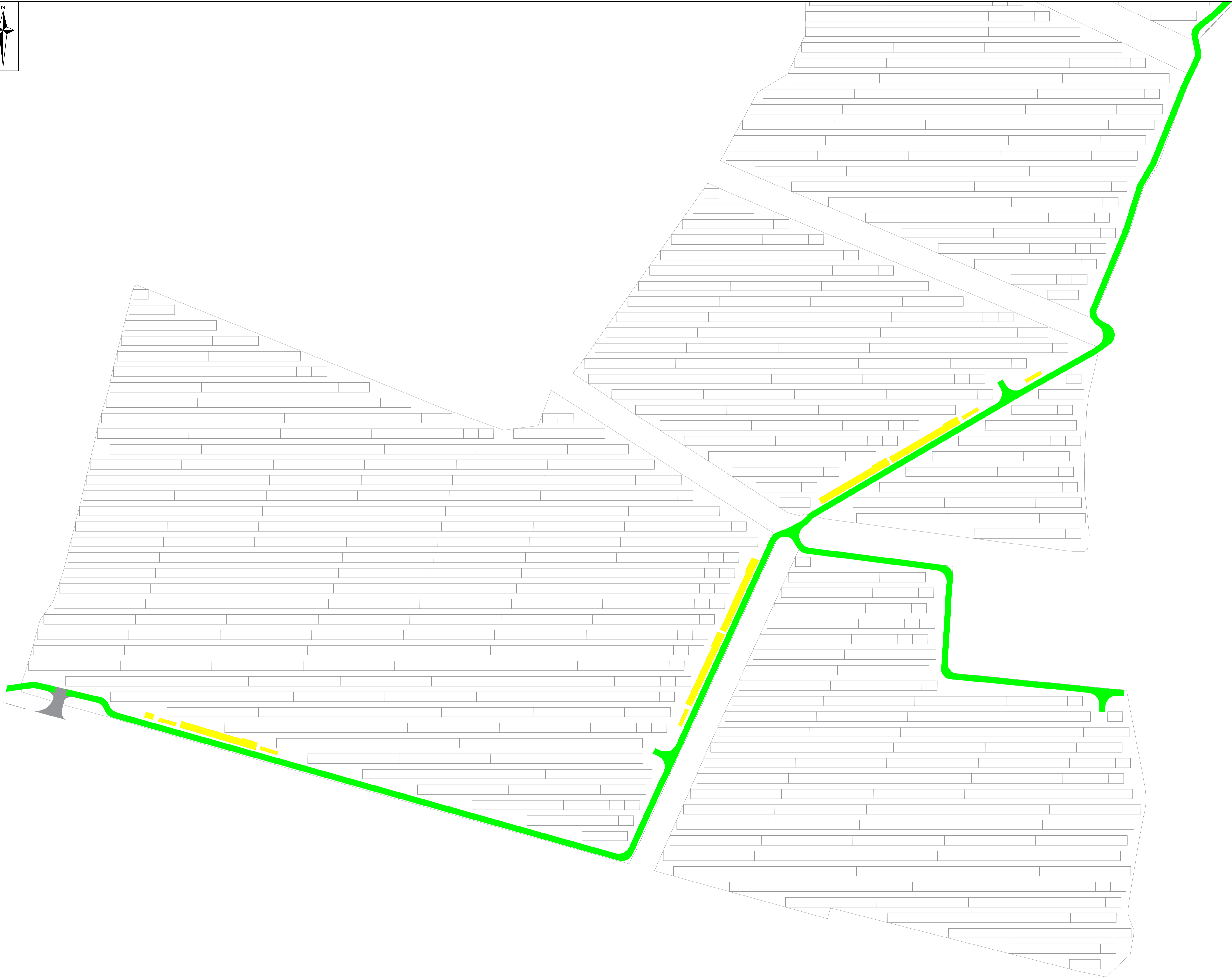
RSK LDE LTD - Hydrology Drawing

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Client  
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Project Title  
**Padbury Brook  
Southern Section**

Status  
**WORK IN PROGRESS**

Drawing Title  
**PROPOSED DRAINAGE STRATEGY  
Permeable Surfaces**

Drawn	Date	Checked	Date	Approved	Date
KJ	24.03.23	RW	24.03.23	KJ	24.03.23

Scale	Orig Size	Dimensions	Revision
NTS	A1	M	P01

Drawing File  
LAYOUT.DWG

Project No.	Originator	Unit	Site Area	Series	Number	Sheet
680623	LDE		ALL	01	01	01









