FLOOD RISK ASSESSMENT

Ling Hall Solar Project

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Surface Water Calculations
1.0 INTRODUCTION
Golder Associates (UK) Ltd (Golder) has prepared this Flood Risk Assessment (FRA) report on behalf of REG Solar Power in support of a planning application for the proposed solar development at Ling Hall, Warwickshire.

1.1 Objective
This Flood Risk Assessment report has been prepared to address the requirements of the National Planning Policy Framework (NPPF), through the following:

- Assessing whether the site is likely to be affected by flooding;
- Assessing whether the proposed development is appropriate in the suggested location; and
- Presenting any flood risk mitigation measures necessary to ensure that the proposed development and users will be safe, whilst ensuring flood risk is not increased elsewhere.

2.0 SITE DETAILS

2.1 Site Context
The red line planning boundary for the proposed re-development (the Site) is shown in on Drawing LH002: Site Boundary Plan accompanying the planning application. The Site is located adjacent to Lawford Heath Industrial Estate, approximately 5km west of Rugby. The Site is accessed from Coalpit Lane, Lawford Heath, CV23 9HH. The nearest watercourse is a small stream located approximately 700m to the south east of the Site which discharges to the River Avon, the floodplain for which does not encroach upon the Site.

The Site is approximately 35 ha and currently covered by restored landfill.

2.2 Existing Land Use
The landfill, which has been restored to grassland and natural ground within the red line boundary, was restored with a cap, sub soil, topsoil, underground gas extraction pipes and appropriate surface drainage (Drawing LH002:Site Boundary). An existing private access road runs north to south through the centre of the Site, for the purpose of existing waste management operations.

2.3 Proposed Development
The proposed development is a restored landfill, on which fixed arrays of solar panels, inverter transformers, two substations and fencing will be installed to provide delivery of power supply to the grid. The Site layout is shown on Site Design Plan 004, which is submitted separately as part of the planning application.

The foundation for each of the solar panels will be on raised concrete blocks 3.3 m long by 0.6 m wide by 0.36 m high, constructed at ground level. Grassland will be retained between the panel foundation blocks.

New access and construction tracks constructed as part of the development will be 5.5 m wide and will consist of compacted stone road base and sub base.

There will be no changes to the existing topography as part of the development.
3.0 FLOOD RISKS

3.1 Potential Sources of Flooding

Table 1 presents a summary of the potential flood risks at the proposed Site.

<table>
<thead>
<tr>
<th>Type of Flooding</th>
<th>Further Consideration Required?</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluvial</td>
<td>No</td>
<td>The Site is shown on published Environment Agency maps to lie in Zone 1, (&lt;0.1% annual probability of fluvial flooding).</td>
</tr>
<tr>
<td>Surface Water Runoff</td>
<td>Yes</td>
<td>The changes to the surface water runoff regime on Site will require management and any increase in volume of runoff during storm events will require attenuation prior to controlled discharge to the environment to ensure no detriment to the existing situation.</td>
</tr>
<tr>
<td>Groundwater</td>
<td>No</td>
<td>No evidence of historical groundwater flooding within the Site.</td>
</tr>
<tr>
<td>Foul Sewer</td>
<td>No</td>
<td>No Sewerage at the Site.</td>
</tr>
<tr>
<td>Tidal</td>
<td>No</td>
<td>The Site is not located near any tidal influences.</td>
</tr>
<tr>
<td>Infrastructure Failure</td>
<td>No</td>
<td>No risk from reservoir flooding.</td>
</tr>
</tbody>
</table>

3.2 Fluvial flooding

The online Environment Agency flood map shows the Site is located in Flood Zone 1 (<0.1% annual probability of fluvial flooding).

Figure 1 presents the Environment Agency flood map, which shows that the flood plain of the nearest small watercourse is approximately 700m from the Site.

Figure 1: Environment Agency Flood Map (June 2014) and indicative red line boundary (for comparison).
The strategic flood risk assessment (SFRA) for Rugby Borough Council was produced in 2013. The SFRA states that there was flooding on the River Avon in 1981, 1985 and 1992, however few properties were flooded. By extension it is clear there has been no historical flooding on the Site.

### 3.3 Surface Water Flood Risk

The re-development is greater than 1 hectare and therefore in accordance with the NPPF, an FRA is required to assess the risk of surface water flooding. The re-development of the Site has the potential to alter the rate and volume of surface water entering the existing drainage system.

Rainfall will flow freely from the solar panels onto the ground or foundations beneath and therefore the panels themselves will not directly affect the existing hydrological conditions. Finished ground levels across the Site will be comparable to existing ground levels; however the raised solar panel foundation blocks have the potential to alter flow paths, both on and from the Site.

The increase in impermeable ground surface cover due to solar panel foundation blocks and new access tracks will require surface water management to ensure there will be no detrimental change to surface water flood risk from the development. The increase in surface water runoff associated to any change to ground cover can be estimated and attenuation offered on Site to manage post-development runoff volumes and rates to those of the pre-development scenario.

There is no statutory responsibility to reduce discharge to greenfield runoff rates during extreme storms. However, the Environment Agency encourages discharge to be attenuated and discharge rates to be reduced wherever practicable. NPPF recommends an additional allowance of 10% be incorporated into peak rainfall intensities to incorporate climate change up to the year 2055. Golder provides the following information to assist in the surface water management of the Site:

- The Flood Estimation Handbook CD Rom Version 3 indicates that a 24 hour 1% Annual Exceedance Probability (AEP) design rainfall event at the Site would be 92 mm;
- The pre development Site runoff coefficient is estimated as 40.7%. The estimated post-development runoff coefficient is 42.2%. In order to manage the discharge to the pre development volumes and rates during rainfall events up to and including the 1% AEP plus climate change; the development would need to incorporate 549 m$^3$ of surface water attenuation during the 1% AEP plus climate change intensity storm with a 24 hour duration (Appendix A);
- The greenfield runoff rate, calculated using the Institute of Hydrology (IoH) 124 method, is 2.6 l/s/ha for the Site; and
- As the Site is a re-development and not a green field Site, there is no requirement to manage discharge to a greenfield rate. However for information purposes, in order to manage the discharge at a rate of 2.6 l/s/ha (equivalent to 91 l/s for the Site) during rainfall events up to and including the 1% AEP plus climate change; the development would need to incorporate 9,190 m$^3$ of surface water attenuation during the worst case intensity storm with a 9 hour duration (Appendix A).

### 3.4 Sewer System

The Site is a restored landfill and sewerage has not been located on the Site. Therefore historical flooding from the sewer system will not be considered.

### 3.5 Groundwater Flooding

Any ingress of water in the quarry workings, the landfill and the restored landfill will have been managed on Site under the operational water management plan. The Site is on high ground in a sand and gravel area away from potential surface water flooding. Therefore flooding from groundwater will not be considered.
3.6 Vulnerability Classification

The proposed re-development of the Site is considered to come under the category of “electricity generating station”, which, according to Table 2 in the NPPF classifies “electricity generating stations and grid and primary substations the proposed residential development as “essential infrastructure”. Table 3 in the NPPF document shows that essential infrastructure is appropriate within Flood Zone 1.

4.0 MITIGATION

Surface water management will be required on-site to mitigate the likely increase in runoff following re-development. The following mitigation measures should be considered:

- Permeable paving should be considered wherever areas of hardstanding may be located;
- Surface water storage of 549 m$^3$ will be required to allow surface water runoff for all events up to and including the 1% AEP plus climate change design rainfall event to be to the pre-development volumes and rates;
- Storage requirements could be provided within the existing surface water system for the Landfill site, with additional capacity constructed if required. Alternatively surface water swales located around the downslope perimeter of the solar panel arrays could be provided;
- Storage could be provided within surface water attenuation ponds and drainage ditches within the Site located outside of restored landfill areas;
- French drains and/or swales could be constructed parallel to Site contours to manage any change in velocity of surface water runoff and mitigate any increase in surface water runoff from solar panel foundations and associated infrastructure such as inverters and transformers;
- Gravel strips could be constructed around the raised concrete foundation blocks to infiltrate runoff from foundations and manage erosion from surface water flow paths; and
- Maintaining grass length as long as is practicable will also reduce the velocity of surface water runoff.

5.0 CONCLUSION

In accordance with Table 3 of the NPPF Technical Guidance, and given the proposed mitigation, taking into account the mitigation measures presented herein, the proposed development is considered appropriate and will not increase the flood risk to or from the Site.

6.0 REFERENCES

1) Department for Communities and Local Government (March 2012), Technical Guidance to the National Planning Policy Framework
2) URS (September 2013), Stratford-on-Avon DC, Warwickshire CC, North Warwickshire BC & Rugby BC Level 1 Strategic Flood Risk Assessment Final Report
APPENDIX A
Surface Water Calculations
Storage Volume Calculations

Pre-Development
Site Areas:
Landscaping  345,380 m²
Hardstanding  4,620 m²  Existing access tracks

Combined Runoff Coefficient  0.407

Post-Development
Site Areas:
Landscaping  334,552 m²
Hardstanding  15,448 m²  Access tracks and panel foundations

Combined Runoff Coefficient  0.422

Flow Rate \( Q \) (m³/s) = C \( i \) A
where C = coefficient of runoff; i = rainfall intensity; A = catchment area
then Runoff Volume = \( Q \times \text{Duration} \)

<table>
<thead>
<tr>
<th>Duration (mins)</th>
<th>Rainfall (mm)</th>
<th>Volume of Runoff (Post-Development) (m³)</th>
<th>Volume of Runoff (Pre-Development) (m³)</th>
<th>Storage Required to Retain to Pre-Development Rate (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>40</td>
<td>5,861</td>
<td>5,646</td>
<td>215</td>
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<tr>
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<td>720</td>
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<td>14,436</td>
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Maximum  549

Date: June 2014
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Storage Volume Calculations

Greenfield Runoff Rate 2.6 l/s/ha

Post-Development
Site Areas

<table>
<thead>
<tr>
<th>Landscaping</th>
<th>334,552 m²</th>
<th>Access tracks and panel foundations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardstanding</td>
<td>15,448 m²</td>
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</table>

Runoff Coefficients

<table>
<thead>
<tr>
<th>Landscaping</th>
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</thead>
<tbody>
<tr>
<td>Hardstanding</td>
<td>0.9</td>
</tr>
</tbody>
</table>

Flow Rate Q (m³/s) = C i A
where C = coefficient of runoff; i = rainfall intensity; A = catchment area
then Runoff Volume = Q x Duration

<table>
<thead>
<tr>
<th>Duration (mins)</th>
<th>Rainfall (mm)</th>
<th>Volume of Runoff (Post-Development) (m³)</th>
<th>Existing Volume of Runoff (Greenfield) (m³)</th>
<th>Storage Required to Retain Greenfield Rate (m³)</th>
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<tbody>
<tr>
<td>30</td>
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<td>5,861</td>
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<tr>
<td><strong>Maximum</strong></td>
<td></td>
<td><strong>9,190</strong></td>
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