4 FLOOD RISK AND HYDROLOGY

4.1 INTRODUCTION

4.1.1 The reason for undertaking this assessment is to consider the effect of the proposed development of the solar farm on the receiving water body.

4.1.2 The proposed solar farm is in a rural location and occupies about 104.61Ha of arable farmland and is entirely greenfield.

4.1.3 The development comprises solar arrays on supports driven into the ground, linked by underground cables to transformers and a central substation which feed the energy into the grid. Access to key equipment is achieved along permeable tracks.

4.2 ASSESSMENT APPROACH

Methodology

4.2.1 The threshold criteria are as follows;

- Ensure that runoff rates from the site do not increase current rates and therefore ensure that flooding is not increased downstream, and preferably reduced;
- To effectively assess the potential hydrological effects of the scheme on the designated sites;
- Consider the construction phase and operational phase;
- Ensure that the designated sites are not adversely affected.

4.2.2 The key criteria from the hydrological point of view will therefore be to avoid silt and construction waste (such as hydrocarbons and debris) from entering the receiving waters.

4.2.3 On completion of the works, vegetation should be maintained to prevent silt being mobilised from bare areas of earth.

4.2.4 If there was long term damage to the receiving watercourses due to silt and waste during construction, this would be considered adverse, and major adverse event if downstream habitats were adversely affected.

Policy Framework

4.2.5 This assessment considers the requirements and guidance set out in the following documents:

- National Planning Policy Framework (NPPF) (July 2021)
- Environment Agency Flood Risk Assessment guidance (February 2017) and planning maps
- Leicestershire and Leicester City Level 1 Strategic Flood Risk Assessment (SFRA) (October 2017)

Scoping Criteria

4.2.6 This assessment considers the following potential effects;

- Construction Phase - silt entering the watercourses;
- Construction Phase - hydrocarbons and construction waste entering the watercourses;
- Construction Phase – compaction and damage to soil structure in areas of impeded drainage or seasonally wet soils;
- Construction Phase – increased runoff rates from the site causing worse flooding downstream than would otherwise occur during normal farming activities at the site in the same weather conditions;
- Operational Phase - silt entering the watercourses;
- Operational Phase - polluted water entering the watercourses;
- Operational Phase - increased runoff rates from the site causing worse flooding downstream than would otherwise occur during the normal farming activities at the site in the same weather conditions.

Assessment of Significance

4.2.7 The approach followed during the assessment considered the degree (or the "significance") of the potential effects upon the hydrological and hydrogeological characteristics of the site.

4.2.8 The significance has been defined taking into account the sensitivity of the receiving environment and the potential magnitude of the impact.

Table 4-1: Definition of the Receiving Environment

Sensitivity	Definition
High	Receptor with a high quality and rarity, regional or national scale and limited potential for substitution/replacement Inner Source Protection zone (Zone 1) Site of Special Scientific Interest (SSSI) or Special Area of Conservation (SAC) Excellent water quality Large scale industrial agricultural abstractions >1000m^3/day within 2km downstream, or abstractions for public drinking water supply Designated salmonid fishery and/or salmonid spawning grounds present Watercourse widely used for recreation, directly related to watercourse quality (e.g. swimming, salmon fishery etc.) within 2km downstream Conveyance of flow and material, main river >10m wide Active floodplain area (important in relation to flood defence)
Medium	Receptor with a medium quality and rarity, local scale and limited potential for substitution/replacement or receptor with a medium quality and rarity, regional or national scale and limited potential for substitution/replacement Outer Source Protection Zone (Zone 2) Nitrate Vulnerable Zone Principal Aquifer Good water quality Large scale industrial agricultural abstractions 500-1000m^3/day within 2km downstream Surface water abstractions for private water supply for more than 15 people

	Designated salmonid fishery and/or cyprinid fishery Watercourse used for recreation, directly related to watercourse quality (e.g. swimming, salmon fishery etc.) Conveyance of flow and material, main river >10m wide Active floodplain area (important in relation to flood defence)
Low	Receptor with a low quality and rarity, local scale and limited potential for substitution/replacement or receptor with a low quality and rarity, regional or national scale and limited potential for substitution/replacement Total Catchment Source Protection Zone (Zone 3) Secondary Aquifer Fair water quality Industrial/agricultural abstractions 50-499m^3/day within 2km downstream Designated cyprinid fishery or undesignated for fisheries - Occasional or local recreation (e.g. local angling clubs) Groundwater abstractions 50-500m^3/day - Private water supplies present Designated cyprinid fishery, salmonid species may be present and catchment locally important for fisheries Watercourse not widely used for recreation, or recreation use not directly related to watercourse quality
Negligible	Receptor with a negligible quality and rarity, local scale and limited potential for substitution/replacement No SPZ Unproductive Strata Environmental equilibrium stable and resilient to changes that are greater than natural fluctuations, without detriment to its present character Polluted/poor water quality Industrial/agricultural abstractions < 50m^3/day within 2km downstream Fish sporadically present or restricted, no designated fisheries; not used for recreation Watercourse < 5m wide Area does not flood / is located in Environment Agency Flood Zone 1 Receptor heavily engineered or artificially modified and may dry up during summer months

4.2.9 The magnitude of the effect/change includes the timing, scale, size and duration of the potential effect. For the purposes of this assessment the magnitude criteria are defined in Table 4-2.

Table 4-2: Magnitude of Change

Magnitude	Criteria	Description and example
High	Results in loss of attribute	Fundamental (long term or permanent) changes to the hydrology/hydrogeology • Loss of EC designated Salmonid fishery • Loss of designated species/habitats • Change in water quality status of river reach • Compromise employment source • Pollution of potable source of abstraction • Loss of flood storage/increased flood risk
Medium	Results in effect on integrity of attribute or loss of part of attribute	Material but non-fundamental and short to medium term changes to the hydrogeology or water quality • Loss in productivity of a fishery • Contribution of a significant proportion of the effluent in the receiving water, but insufficient to change its water quality status • Reduction in the economic value of the feature

		• Reduced reliability and quality of a supply at a groundwater abstraction source
Low	Result in minor effect on attribute	Detectable but non-material and transitory changes to the hydrogeology or water quality • Measurable change in attribute, but of limited size and/or proportion • Measurable but limited change in a groundwater supply reliability and quality
Negligible	Results in an effect on attribute but of insufficient magnitude to affect the use / integrity	No perceptible changes to hydrogeology or water quality • No significant effect on the economic value of the receptor • No change in a groundwater supply reliability and quality • No increase in flood risk

4.2.10 The sensitivity of the receiving environment together with the magnitude of the effect defines the significance of the effect prior to application of mitigation measures as outlined in Table 4-3.

Table 4-3: Significance Criteria

Magnitude of Change	**Sensitivity of Receptor**				
		High	**Medium**	**Low**	**Negligible**
	High	Major	Major	Moderate	Negligible
	Medium	Major	Moderate	Minor to Moderate	Negligible
	Low	Moderate	Minor to Moderate	Minor	Negligible
	Negligible	Negligible	Negligible	Negligible	Negligible

4.2.11 Potential effects are therefore concluded to be of major, moderate, minor or negligible. The shaded boxes in Table4-3 represent effects considered to be significant in terms of the Environmental Impact Assessment Regulations.

Limitations to the Assessment

4.2.12 This Chapter of the ES is limited to the impact from rainfall falling on the site and its management in flow and quality in relation to the receiving watercourses. It does not consider the ecology of the habitats, which is covered in other chapters.

4.2.13 By its nature, rainfall and antecedent conditions and characteristics vary, and conditions related to normal rainfall standards; exceedance events could potentially cause nuisance which are beyond the scope of this assessment.

4.3 BASELINE CONDITIONS

Site Description and Context

4.3.1 The site is arable farmland as existing and is entirely greenfield. Maintenance of soil and vegetation quality as key to ensuring that runoff from the site is reduced and the quality of surface water runoff is increased.

4.3.2 The below assessment of significant effects includes ways in which the quality of soil, and vegetation and surface water runoff will be impacted by the proposed development.

Baseline Survey Information

4.3.3 The Flood Risk Assessment included within Appendix 4.1 provides an assessment of existing baseline information relating to flood risk and drainage. A summary of the findings are included below.

4.3.4 The information utilised includes:

- EA Flood Maps for Planning
- British Geological Survey information
- Soilscape Soils data
- Flooding records within the Leicestershire and Leicester City Level 1 Strategic Flood Risk Assessment (SFRA) (October 2017)

4.3.5 The site is entirely greenfield with existing watercourses located to the west and southern parts of the site, as well as existing ditches throughout the development.

4.3.6 The site is located within Flood Zone 1, with a small area within Flood Zone 3 to the far west of the site adjacent to the existing Winter Beck watercourse.

4.4 ASSESSMENT OF LIKELY SIGNIFICANT EFFECTS

4.4.1 On completion of the solar farm once the vegetation has restored and established, the soil will improve in quality due to the absence of ploughing and compaction during trafficking by farm machinery.

4.4.2 The dense grass and meadow type vegetation will intercept and disperse rainfall and the soil will become knitted with the roots and, develop a biodiversity and condition which will absorb more water than occurs during normal farming practices.

4.4.3 The vegetation will remain throughout the seasons, and the soil will continue to improve in quality.

4.4.4 Service vehicles will be constrained to the permeable tracks, avoiding compaction of the soil and allowing it to continue to improve in quality.

4.4.5 Silt runoff will therefore be significantly diminished throughout the seasons when compared with farming activities.

4.4.6 Removal of any cattle from the fields will remove the risk of pollution in the receiving watercourses from animal waste and feed, and the damage to soil at the focussed feeding points.

4.4.7 Solar arrays will be more than 4m from ditches and watercourses, measured from the top of bank, thus providing a significant buffer for vegetation to establish. Distances are generally greater due to the orthogonal arrangement of the panels.

4.4.8 Proposed swales or filter drains adjacent to access roads will convey overland flows through the site to the proposed outfalls. These systems will slow surface water flows and improve water quality on site.

The operation of the solar farm is therefore seen as beneficial and will reduce runoff rates, improve runoff quality and provide more uniform flows in the receiving watercourses, which will enhance watercourse habitats and biodiversity.

Construction

4.4.9 During construction there is a risk of silt runoff especially if construction continues during wet weather, similar to the circumstances during harvesting.

4.4.10 Forming the trenches for the cables could potentially convey water more quickly to the watercourses and increase the risk of contamination.

4.4.11 Operation of machines and fuelling of machines could pose a risk to the receiving waters in the event of spillages.

4.4.12 Debris from packaging can be blown into the watercourses and conveyed by water causing potential nuisance, obstruction of watercourses and risk to wildlife.

4.4.13 Based on the significance criteria in Table 8-3, the effects of the construction phase are categorised Minor to Moderate.

Operation

4.4.14 Solar farm sites are operated remotely and only visited during routine inspection and maintenance, and that will be the case at the Belvoir Solar site.

4.4.15 Routine maintenance of the vegetation (to prevent shading of the panels), hedges and ditches will be undertaken during dry weather, for safety and efficiency.

4.4.16 Maintenance of the solar panel infrastructure, transformers etc involves electricity and would be done during dry weather for safety. It does not involve materials which might cause pollution.

4.4.17 Based on the Significance criteria in Table 8-3, the effects of the solar farm during operation are negligible.

Decommissioning

4.4.18 Decommissioning involves the complete removal of all the solar farm plant and equipment, above and below ground.

4.4.19 The ground conditions will be improved from the years during which the vegetation has established and formed a dense root and soil matrix.

4.4.20 Trafficking the surfaces will follow the established tracks and the soil is at low risk of erosion and causing silt runoff.

4.4.21 The decommissioning will follow the date when oil-based machinery will be banned, and the risk of pollution will therefore be diminished.

4.5 MITIGATION AND ENHANCEMENT

Mitigation by Design

4.5.1 Mitigation is required during construction to reduce the risk of silt and other pollution entering the receiving watercourses. During operation it is considered that mitigation is not required – it is inherent in the design and the facility.

4.5.2 The risk of damage to soil structure and silt runoff is increased if the works are undertaken during wet weather.

4.5.3 The Contractor will be required to prepare a Construction Environmental Management Plan (CEMP) which will be reviewed for adequacy and approved when acceptable. The CEMP will be required to include precautions taken if the weather is wet during construction.

4.5.4 Precautions include the following;

- Planning the construction work to minimise repeated trips over the ground;
- Forming the permeable tracks early in the process;
- Using machines with low pressure tyres – i.e. farm type machinery;
- Monitoring the weather and being alert to the implications of wet weather;
- Inspecting surfaces to identify areas at risk of causing silt pollution to watercourses;
- Restricting operations in areas vulnerable to causing pollution, especially in wet weather;
- Keeping a store of straw/hay bales and geofabric fence equipment to delay and filter runoff;
- Being ready with trained staff to deploy the equipment if a risk of silt pollution arises;
- Early preparation, seeding and protection to encourage vegetation to establish on all bare areas as soon as possible after construction.

Additional Mitigation

4.5.5 Mitigation measures have been described above.

4.5.6 Mitigation measures during the planning of the construction are listed in the table below and will be planned in the CEMP.

Table 8.4: Mitigation

Ref	Measure to avoid, reduce or manage any adverse effects and/or to deliver beneficial effects	How measure would be secured		
		By Design	By S.106	By Condition
1	Swale/filter trench installation	X		
2	Silt mobilisation	X		

3	Oil pollution	X		
4	Debris contamination	X		
5	Contractor to prepare CEMP			X
6	CEMP to be approved			X

4.6 CUMULATIVE AND IN-COMBINATION EFFECTS

4.6.1 The consequence of the development will be an improvement in the flow characteristics in the receiving watercourses – i.e. more uniform flows, less risk of silt pollution as occurs during harvesting etc.

4.6.2 There are no known cumulative effects during the operational phase.

4.7 SUMMARY

Introduction

4.7.1 This assessment considers the effect of the proposed development of the solar farm on the receiving water body.

4.7.2 The proposed solar farm is in a rural location and occupies about 104.61Ha of arable farmland and is entirely greenfield.

Baseline Conditions

4.7.3 The site is entirely greenfield with existing watercourses located to the west and southern parts of the site, as well as existing ditches throughout the development.

4.1.1 The site is located within Flood Zone 1, with a small area within Flood Zone 3 to the far west of the site adjacent to the existing Winter Beck watercourse.

Likely Significant Effects

4.7.4 The likely significant effects of the completed solar farm are beneficial and include a reduction in the risk of silt runoff, improved (i.e. more uniform) flow characteristics in the receiving watercourses and improved runoff quality.

4.7.5 The risk of silt runoff is high during construction, when the vegetation and soils can be damaged by traffic resulting in the potential for silt runoff. This is exacerbated if works are undertaken during wet weather.

Mitigation and Enhancement

4.7.6 The Contractor will be required to prepare a CEMP which will be reviewed and approved.

4.7.7 The CEMP must include measure to prepare for and implement, which will reduce the risk of silt and waste entering the receiving watercourses during construction and until the vegetation has established.

4.7.8 Preparation, seeding and protection to encourage early vegetation will be included in the contract.

4.7.9 These measures will protect the receiving watercourses from being adversely affected by the works, and on completion will result in improved conditions in the receiving watercourses.

Conclusion

4.7.10 The consequence of the development, with the mitigation measures incorporated to reduce silt and debris mobilisation during the construction and until the vegetation has established, will be to deliver improved conditions in the receiving watercourses, and improved conditions for the designated sites.

4.7.11 The proposed swales and/or filter trenches adjacent to internal access roads on site will slow surface water flows and improve water quality on site.

4.7.12 The completed solar farm will become a haven for wildlife and enhance biodiversity in the area and downstream, as has been demonstrated on other solar farms delivering major beneficial improvements.

Table 8.5: Summary of Effects, Mitigation and Residual Effects.

Receptor / Receiving Environment	Description of Effect	Nature of Effect	Sensitivity Value	Magnitude of Effect	Geographical Importance	Significance of Effects	Mitigation / Enhancement Measures	Residual Effects
Construction								
Soil	Erosion	Pollution of watercourse	Not applicable	Not applicable	Local	Moderate	CEMP Preparation	Minor Adverse
Watercourse	Silt conveyance	Pollution of Watercourse	Not applicable	Not applicable	Local	Moderate	CEMP Preparation	Minor Adverse
Watercourse	Swale/ filter trench installation	Flow characteristics improved	Not applicable	Not applicable	Local	Moderate	CEMP Preparation	Minor Adverse
Operation								
Soil	Erosion	Pollution of watercourse	Not Applicable	Not Applicable	Local	Minor	Maintenance of vegetation	Negligible Adverse
Watercourse	Silt conveyance	Pollution of watercourse	Not Applicable	Not Applicable	Local	Minor	Maintenance of vegetation	Negligible Adverse
Watercourse	Swale/ filter trench installation	Flow characteristics improved	Not Applicable	Not Applicable	Local	Minor	Maintenance of vegetation	Moderate Beneficial
Watercourse	More uniform flow	Improved habitat	Not Applicable	Not Applicable	Local	Minor	Maintenance of vegetation	Moderate Beneficial
Cumulative and In-combination								
Not applicable								