Project No: 312040

Flood Risk Assessment and Drainage Strategy: Leaford Solar Farm

Prepared for:

Renewable Energy Systems Ltd

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Contents Amendment Recordz

This report has been issued and amended as follows:

Revision	Description	Date	Signed
1.0	First Issue	19 September 2023	D Hughes
2.0	Updates to site boundary and additional detail following client discussions	24 November 2023	D Hughes
3.0	Updates following client comments	07 December 2023	D Hughes
4.0	Updates following client comments	15 December 2023	D Hughes
5.0	Updates following client comments	10 January 2024	D Hughes

Acknowledgement

This report has been prepared for the sole and exclusive use of Renewable Energy Systems Ltd (RES) in accordance with the scope of work presented in Mabbett & Associates Ltd (Mabbett) Letter Agreement (312040/LA/SB/pb Rev 5.0), dated 30 January 2023. This report is based on information and data collected by Mabbett. Should any of the information be incorrect, incomplete, or subject to change, Mabbett may wish to revise the report accordingly.

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Section 1.0: Introduction

1.1 Project Understanding

Mabbett & Associates Ltd (Mabbett) has been commissioned by Renewable Energy Systems Ltd (RES) to undertake a Flood Risk Assessment (FRA) and Drainage Strategy (DS) for proposed solar photovoltaic (PV) development on land to the northeast of Fulford, between Stallington and Saverley Green, Staffordshire, known as the Site, hereon.

This report is intended to assess the potential risk of flooding to the Site from all sources, the impact of the proposed development on flood risk elsewhere (if any) and suggest flood mitigation measures that could be incorporated into the design (if required).

This report has been prepared in accordance with the following guidance documents:

- National Planning Policy Framework (NPPF) (2021) ;
- National Planning Practice Guidance (NPPG) (2014) ;
- CIRIA Guidance: The SuDS Manual (C753) (2017) ; and
- Stoke-on-Trent City Council Planning Policy (including the Strategic Level 1 Flood Risk Assessment Final Report, dated January 2020)

Section 2.0: Site Location and Development Proposals

Site Area (approx.):	69.2ha	National Grid Reference:	395630 338810

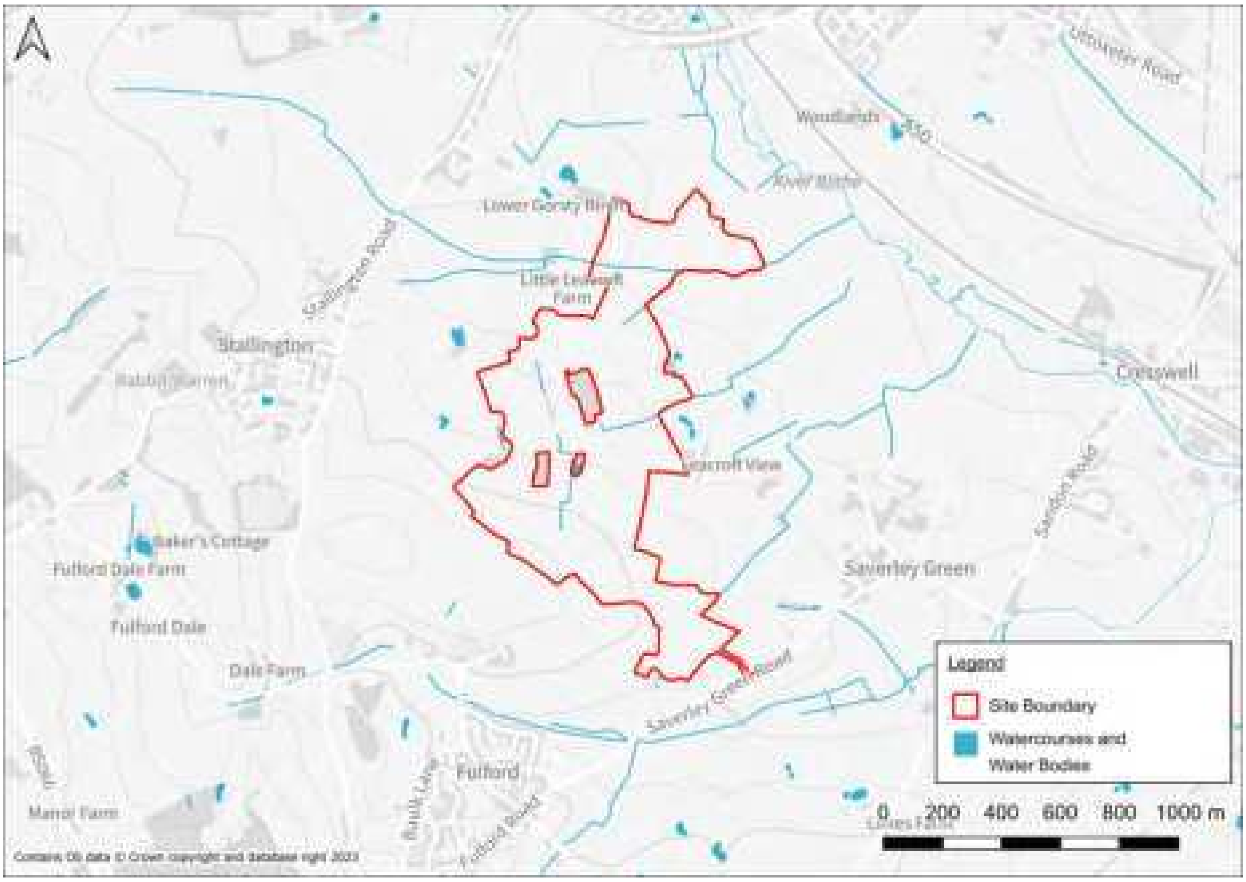

Figure 1: Site location

Site Location:	The Site is located on land to the northeast of Fulford, between Stallington and Saverley Green, Staffordshire.
Existing Site Conditions:	The Site comprises entirely of agricultural land and woodland.
Topography:	Topographic survey undertaken by Infomap Surveys and Mapping Ltd in June 2023 shows the site generally slopes down from a high of 207.93m AOD in the southwest to 163.75m AOD in the north. The topographic survey is provided in Appendix A.
Hydrology:	The River Blithe is an EA main river situated approximately 270m northeast of the site. An unnamed tributary of the River Blithe flows eastwards through the north of the site towards its confluence with the River Blithe approximately 340m east of the site. A series of smaller, unnamed drains are also present across the site. The significant watercourses in the vicinity of the Site are shown in Figure 2.

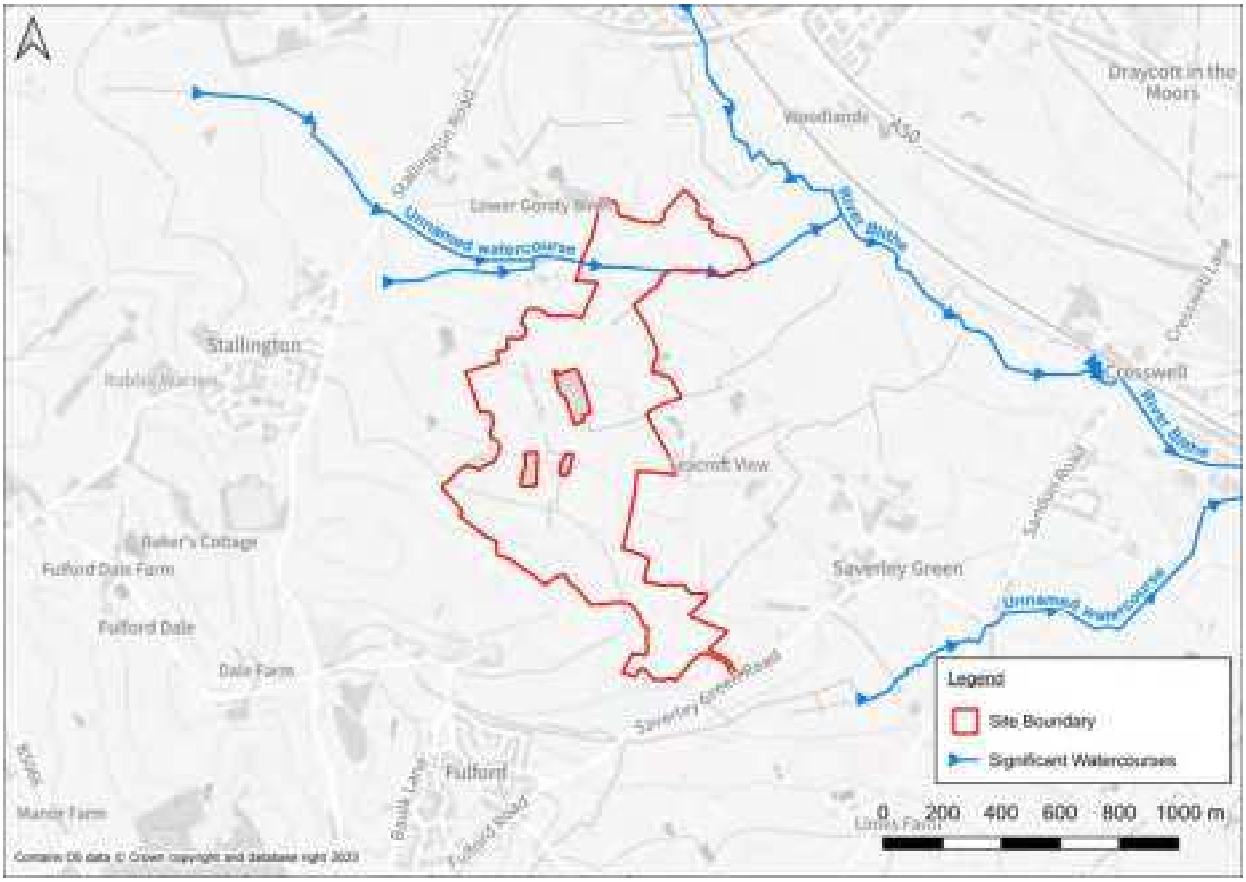

Figure 2: Nearby watercourses

Geology:	The Cranfield University 'Soilscapes' map accessed in June 2023 indicates that the site is underlain by "*slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils*" and "*loamy soils with naturally high groundwater*". This data is available at a 1:250,000 scale and as such may not be accurate on a site-specific basis. The British Geological Survey (BGS) online map (1:50,000 scale) indicates that approximately two thirds of the Site is underlain by Till, Devensian – Diamicton, with a further 15% underlain by River Terrace Deposits, Sand and Gravel. The remainder of the Site is reported not to have significant superficial deposits. This data is available at a 1:50,000 scale and as such may not be accurate on a site-specific basis. A historical borehole record on Site (Ref: SJ93NE8, NGR 395990 338430, to the south of the site, dated 1971) indicates that silty clay deposits extend to depths of at least 5.45m below ground level (bgl) and that groundwater was not encountered. The underlying Bedrock Deposit underneath 82% of the site is Tarporley Siltstone Formation - Siltstone, Mudstone and Sandstone, with the remaining 18% underlain by Mercia Mudstone Group - Mudstone. This data is available at a 1:50,000 scale and as such may not be accurate on a site-specific basis. Extracts from the Soilscapes data are presented in Figure 3. Extracts of the BGS superficial deposits and bedrock datasets are presented in Figure 4 and Figure 5 respectively.

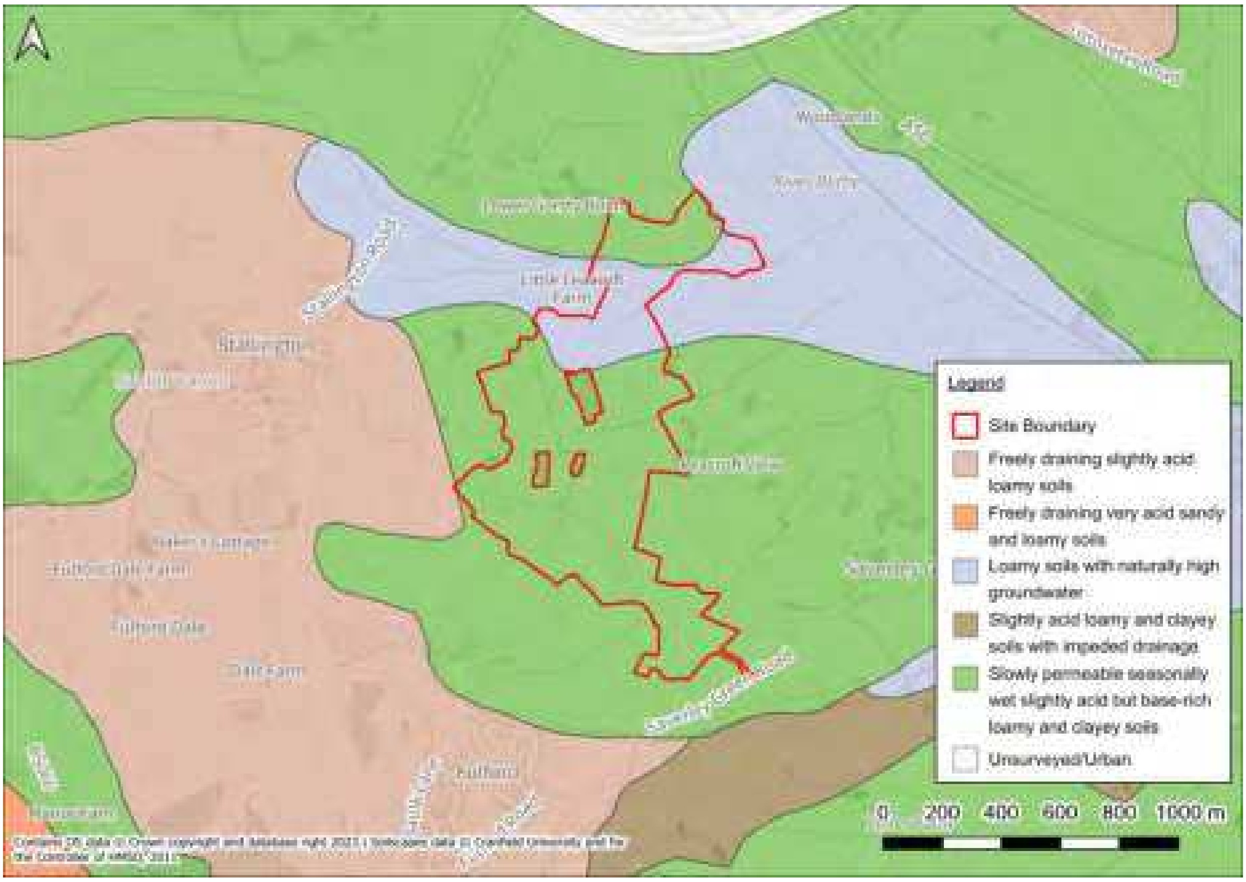

Figure 3: Soilscapes map extract

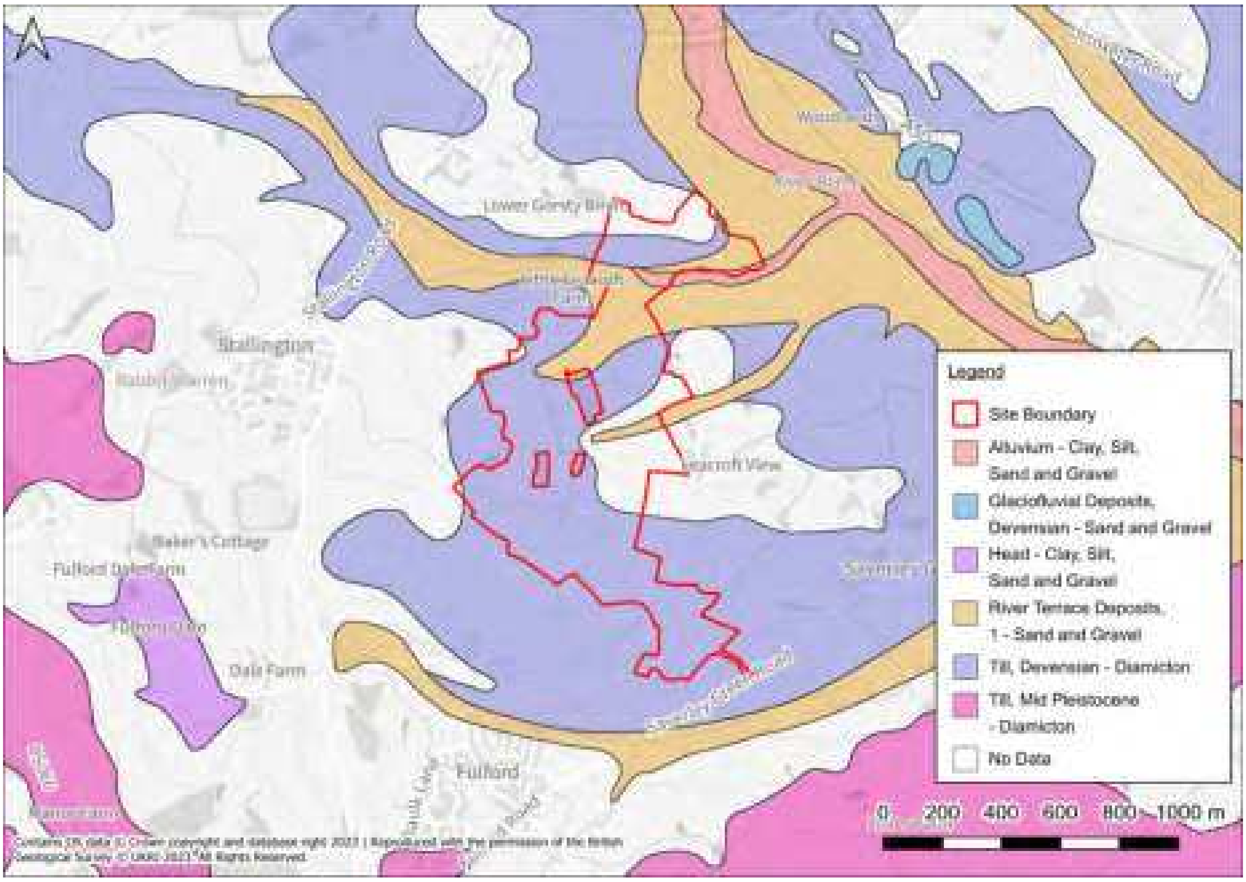

Figure 4: BGS superficial deposits map extract

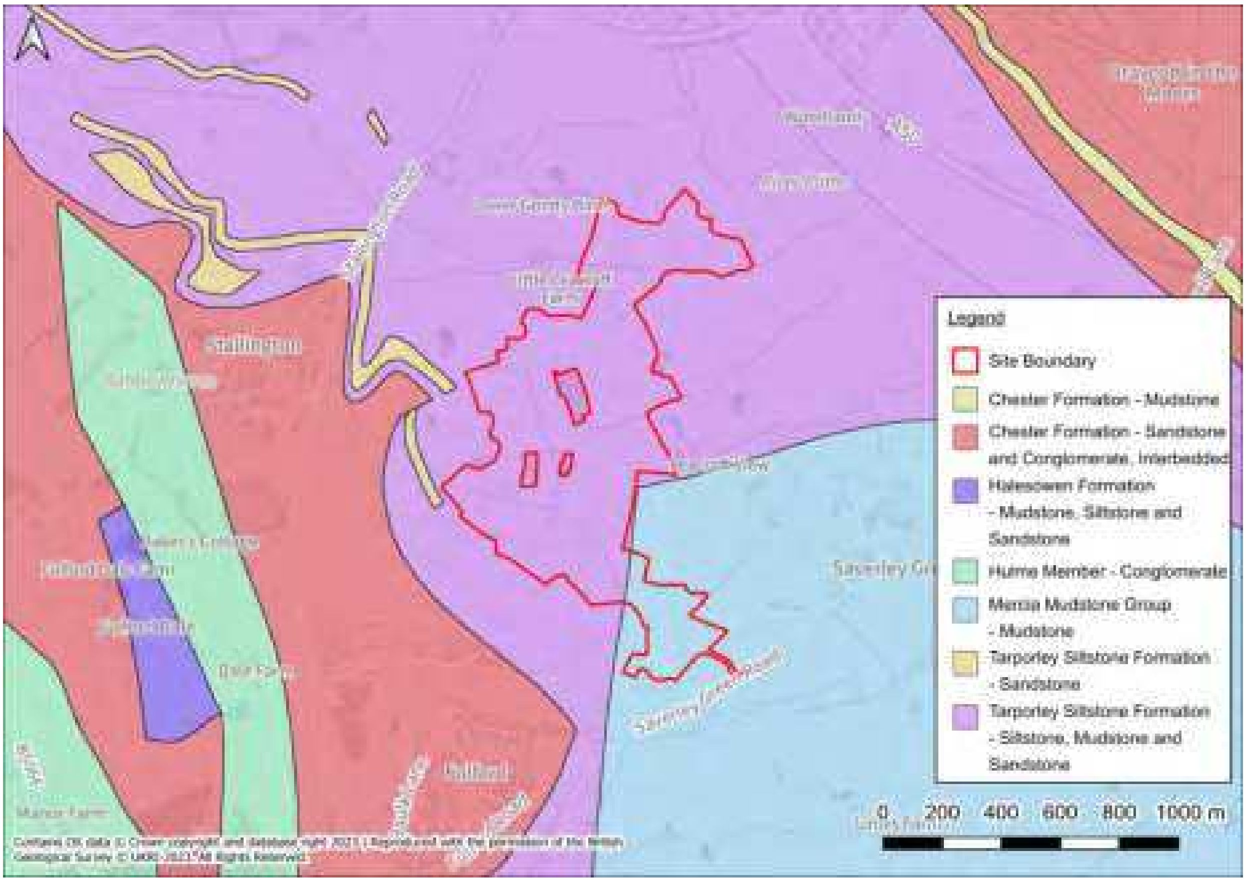

Figure 5: BGS bedrock map extract

<table>
<tr>
<td>Development Proposals:</td>
<td>The proposed development comprises the construction and operation of a ground-mounted solar farm with a maximum generation capacity of 30MW and the associated infrastructure, which is expected to include the following components:

Solar PV modules mounted on to frames to form arrays;
Transformer/inverter units;
Battery storage containers;
Substation;
Fencing and security measures;
Access tracks;
Onsite cabling;
Ancillary site works; and
Landscaping and biodiversity enhancement measures.

A proposed development plan is included in Appendix B.</td>
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Section 3.0: Relevant Planning Policy and Guidance

3.1 Introduction

The aim of this section of the report is to discuss the main aspects of the local and national planning policies that are relevant to any proposed development on the site and relevant guidance and legislation.

3.2 Assessment of Flood Risk

The flood risk from fluvial (Main Rivers) and coastal flooding is assessed through the use of the EA Flood Maps (flood risk from rivers or the sea). This map defines three zones of different flood risk, the third of which is subdivided into two categories:

- Zone 1 "Low probability of flooding" – This zone comprises land assessed as having a less than 1 in 1,000 annual probability of river or sea flooding (<0.1%);
- Zone 2 "Medium probability of flooding" – This zone comprises land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% – 0.1%), or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% – 0.1%) in any year;
- Zone 3a "High probability of flooding" – This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year; and
- Zone 3b "Functional floodplain" – A sub-part of Zone 3, this zone comprises land where water has to flow or be stored in times of flood. This zone is not normally included within the national Flood Map for Planning and is calculated where necessary using detailed hydraulic modelling.

3.3 National Planning Policy Framework

Flood risk in England is normally considered through the planning process in the NPPF (2023), produced by Ministry of Housing, Communities and Local Government.

The principal aim of the NPPF assessment of flood risk is that:

"Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere".

The NPPF requires a FRA to be produced where development sites are:

- Greater than one hectare in size;
- All proposals for new development (including minor development and change of use) in Flood Zones 2 and 3;
- Or in an area within Flood Zone 1 which has critical drainage problems (as notified to the local planning authority by the EA); and
- Where proposed development or a change of use to a more vulnerable class may be subject to other sources of flooding.

The NPPF requires that developers consider not just the flood risk to the development but also the impact that the development might have on flood risk elsewhere. As well as Main Rivers and the sea, it is also necessary to consider flood risk from other sources, including surface water, groundwater, Ordinary Watercourses, artificial drainage systems, canals and reservoirs.

Sequential Test
A key part of the NPPF is that a proposed development must first pass a “Sequential Test” to demonstrate that the overall development proposal is appropriate in terms of flood risk. It ensures that a sequential approach is followed to guide new development to areas with the lowest probability of flooding.

Exception Test
The Exception Test determines whether the benefits of the proposed development will outweigh the potential flood risk.

Vulnerability Classification
The proposed development is considered “essential infrastructure” in accordance with “Table 2” of the NPPG: Flood Risk and Coastal Change, an extract of which is provided in Table 1 below.

Table 1: Flood Risk Vulnerability Classification (from Table 2 of online Planning Practice Guidance)

Flood Zones	Flood Risk Vulnerability Classification				
	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water-Compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a	Exception Test required	✗	Exception Test required	✓	✓
Zone 3b	Exception Test required	✗	✗	✗	✓

✓ development is permitted
✗ development is not permitted

Table 2 of the NPPG states that essential infrastructure developments are considered appropriate within Flood Zone 1. The development therefore passes the flood risk Sequential Test, and the Exception Test does not need to be applied.

3.4 Local Policy

The South Staffordshire Local Plan (Green Belt and Open Countryside Supplementary Planning Document), dated April 2014, aims to retain the character of the traditional agricultural landscape whilst promoting sustainable development as a core strategy.

The Stafford Borough Council Local Plan 2020-2040 Infrastructure Delivery Plan (Preferred Options Stage) states that:

“The Preferred Options also contains a separate renewable energy policy (Policy 40) which identifies areas in which proposals for wind turbines and solar photovoltaic generation will be supported in principle, as long as they meet all the policy requirements.”

Section 4.0: Flood Risk from All Sources

4.1 Rivers and the Sea

An extract of the EA Flood Map for Planning (FMfP) is provided in Figure 6.

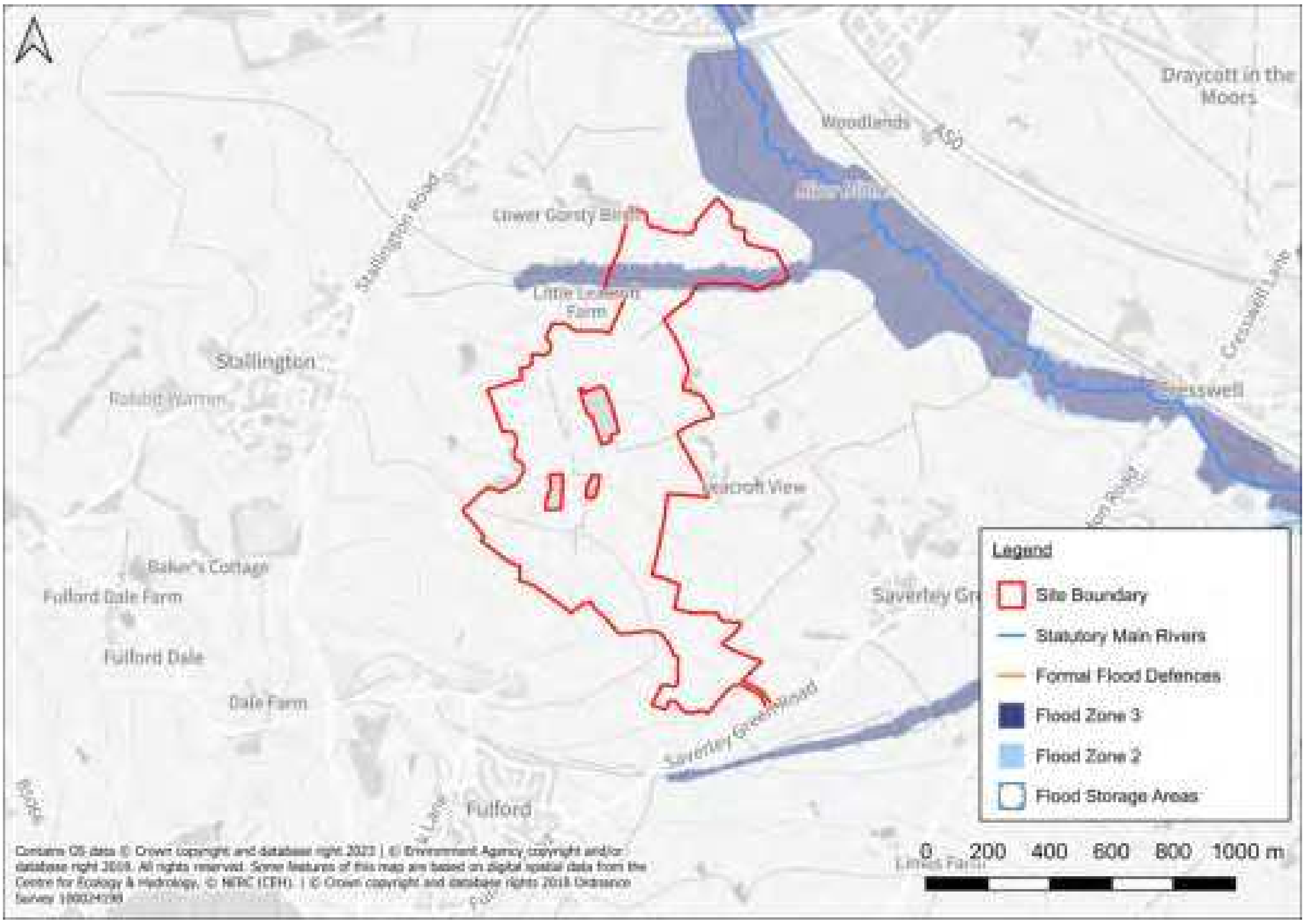


Figure 6: EA Flood Map for Planning (data accessed July 2023)

4.1.1 Fluvial

Fluvial flooding could occur if the unnamed tributary of the River Blithe overtopped its banks during or following an extreme rainfall event. Both local topographic survey levels and the EA FMfP suggest any overtopping water would follow the local topography and the general route of the watercourse towards the east.

Much of the Site is in Flood Zone 1, an area considered to be at very low risk of fluvial flooding from significant watercourses. Areas in the immediate vicinity of the existing open watercourses are shown in Flood Zone 3 and are therefore considered to be at high risk of fluvial flooding. The unnamed watercourse is not an EA designated main river. The associated flood zones are understood to be the product of a national scale modelling exercise using JFlow software or similar and therefore the EA surface water flood maps may offer a more appropriate assessment of flood risk to the site from this watercourse in this instance. The EA surface water maps are discussed in section 4.2.

There are no records of fluvial flooding at or near to the Site.

Much of the Site is therefore considered to be at very low risk of fluvial flooding, except for land immediately adjacent to the watercourse where flood risk should be determined by the EA surface water flood maps.

4.1.2 Coastal

The Site is situated at a minimum of 163.75m AOD and is significantly above sea level.

The Site is therefore not considered to be risk of coastal flooding.

4.2 Surface Water (Pluvial)

Pluvial flooding may occur when rainwater does not drain away through any drainage systems present or soak into the ground. This is generally associated with heavy rainfall but also can result from overland flow and ponding in depressions.

The EA Flood Map for Surface Water indicates there is a very low likelihood of pluvial flooding across much of the site, with higher risk shown along the route of the unnamed watercourse to the north and in the vicinity of an existing pond feature in the centre of the site. Small local depressions across the site are shown to be at low risk of pluvial flooding. An extract of the EA Flood Map for Surface Water is provided in Figure 7.

The EA Flood Map for Surface Water can also used to highlight potential fluvial risk from smaller watercourses either not represented or poorly represented by the EA FMfP. No significant additional flow routes are shown, suggesting the fluvial risk from smaller watercourses is also low.

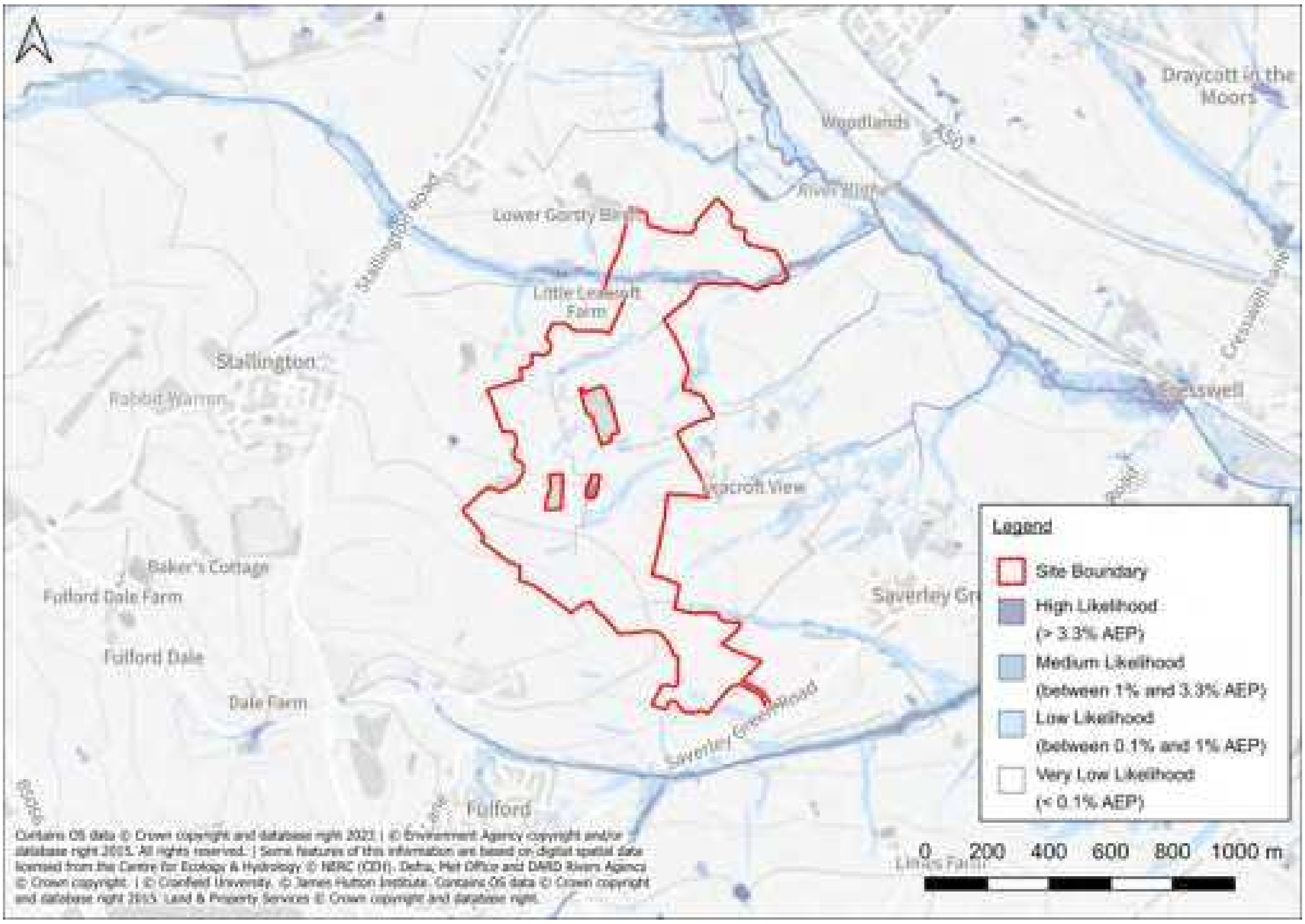


Figure 7: EA Flood Map for Surface Water (data accessed July 2023)

Solar panels can be considered water-compatible up to depths of around 1m, therefore it should be possible to install panels within areas highlighted to be at risk of flooding. Comparison of the EA surface water flood extent (low likelihood) with underlying topographic survey where available and EA LiDAR DTM data elsewhere (outside the site boundary, 1m resolution, dated 2022), produces a map of flood depths through the site, shown in Figure 8. This flood depth map shows depths outside an 8m easement from the banks of the unnamed watercourse remain below 1m, suggesting solar panels can be installed up to the 8m buffer, derived from EA Guidance Documentation[1]. In addition to this, a 10m buffer has been implemented in design in order to adhere to the 8m buffer and more for caution

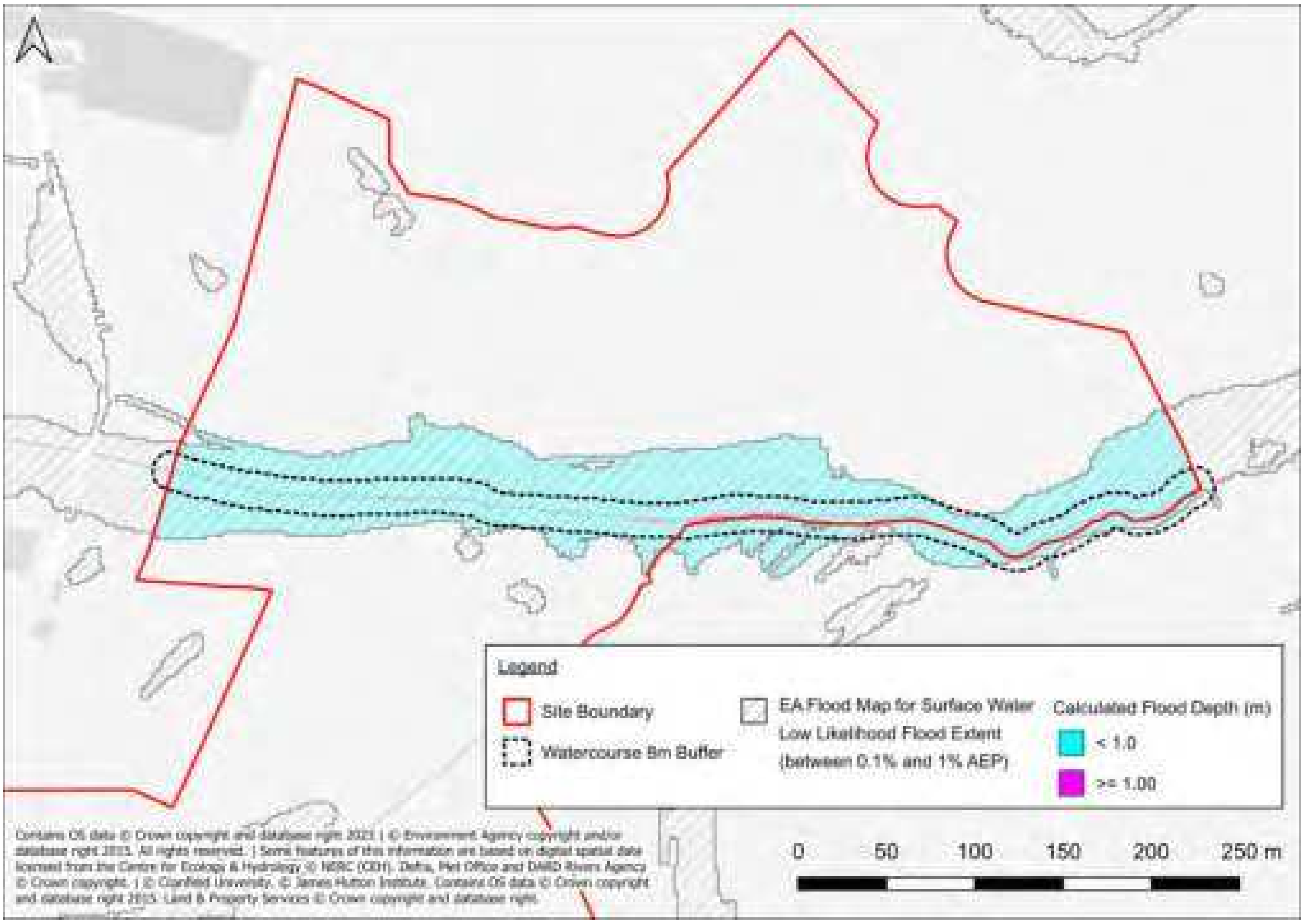


Figure 8: Flood depths

The Site is therefore considered to be at low risk of pluvial flooding from rainfall, subject to associated drainage systems designed in line with current EA guidance.

There are no records of pluvial flooding at or near to the Site.

[1] https://www.gov.uk/guidance/flood-risk-activities-environmental-permits

4.3 Surface Water (Drainage Network)

Flooding from sewers can occur when a sewer is overwhelmed by heavy rainfall, becomes blocked, is damaged, or is of inadequate capacity. Flooding is mostly applicable to combined and surface water sewers.

A Severn Trent Water combined sewer pipe (unknown size, material, inverts, condition) passes through the north of the site. In the unlikely event of a surface water flood occurring on Site from this pipe, it is likely that flooding would follow similar routes to those suggested by the surface water flood maps and be shallow in nature. The impact to the potential development is likely to be negligible. The exact location of surface water sewers on Site should be confirmed prior to construction.

There have been no records of flooding from overwhelmed sewers on Site.

The Site is therefore considered to be at low risk of surface water flooding in the event of drainage network issues.

4.4 Infrastructure Failure

There is no significant infrastructure such as canals or reservoirs nearby. The Site is therefore not considered to be at risk of flooding from infrastructure failure.

4.5 Groundwater

Groundwater flooding occurs when the water table rises above the ground surface. Prolonged heavy rainfall soaks into the ground and can cause the ground to become saturated. This results in rising groundwater levels which leads to flooding above ground.

The superficial deposits are shown to consist of clay, silt and sand. The onsite borehole record (Ref: SJ93NE8, dated 1971) stated that groundwater was not encountered at the maximum depth of 5.45m bgl. There are no records of groundwater flooding at or near to the Site.

The Site is therefore considered to be at low risk of groundwater flooding.

4.6 Flood Risk Summary

Table 2: Summary of potential flood risk at the site

Source of Flooding	Considered Level of Risk	Further Comments
Fluvial	Low (high in places)	The surface water maps offer a more appropriate assessment of flood risk to the site.
Coastal	None	-
Surface Water (Pluvial)	Low (high in places)	Flood depths adjacent to the unnamed watercourse outside an 8m easement from the banks remain below 1m, suggesting solar panels can be installed up to the easement.
Surface Water (Drainage Network)	Low	The exact location of surface water sewers on Site should be confirmed prior to construction.
Infrastructure Failure	None	-
Groundwater	Low	No groundwater encountered in 1971 boreholes at a depth of 5.45m bgl.

It can be concluded that fluvial flooding from the unnamed tributary of the River Blithe is the main potential source of flood risk to the site, though the surface water maps offer a more appropriate assessment of flood risk in this instance. Comparison of the low likelihood surface water flood extent and the underlying DTM data suggests that flood depths remain below 1m outside an 8m easement[2] from the banks of the unnamed watercourse. As a water-compatible development, solar panels can be installed up to the easement.

4.7 Evacuation Routes

The development must ensure safe access and egress is provided during a flood event so that site users can be safely evacuated without any undue risk to life. As a solar PV development, the Site will be unmanned except during times of maintenance. In the unlikely event of a flood coinciding with planned maintenance, site users should not evacuate into flood water unless instructed to do so by emergency services.

4.8 Offsite Impact on Flood Risk

Flood risk to the Site is low to very low from all sources. In the unlikely event of a flood at the Site, the solar panels will be mounted on raised frames and therefore raised above surrounding ground level allowing flood water to flow freely underneath. Therefore, there will be negligible loss of floodplain volume as a result of the proposed development.

[2] https://www.gov.uk/guidance/flood-risk-activities-environmental-permits

Section 5.0: Drainage Strategy

5.1 Introduction

The Site currently comprises undeveloped land which is not formally drained and is therefore considered to be drained naturally.

The proposed development will introduce approximately 10,230m² of hardstanding in the form of battery energy storage (BESS) areas and the substation and AC-AC storage, assuming permeable paving is to be used for access tracks across the site. The proposed hardstanding will therefore account for approximately 1.5% of the total site area.

The individual BESS sites cover approximately 600m² each, or less than 0.1% of the site area. Therefore, they will have negligible impact on the existing runoff rates, volumes, or flow routes.

The proposed substation positioned to the north of the development covers an area of 4,700m².

5.2 Drainage Hierarchy

The recommended surface water drainage hierarchy (Paragraph 080 of the NPPG: Flood Risk and Coastal Change) is to utilise soakaway systems or infiltration as the preferred option, followed by discharging to an appropriate watercourse. If this is not feasible, the final option is to discharge to an existing public sewer.

<u>Surface Water Discharge to Soakaway</u>
The first consideration for the disposal of surface water is infiltration (soakaways and permeable surfaces). As described above the Site is underlain by superficial deposits of Till, Devensian – Diamicton. The relatively impermeable nature of the superficial deposits will likely result in a soakaway to not be an appropriate means of disposing surface water from the proposed development.

It can be concluded that soakaways may not be suitable for the discharge of surface water runoff. Infiltration tests should be undertaken in accordance with the BRE365 specification to determine the suitability of soakaways. Soakaways should be located a minimum of 5m from habitable dwellings.

<u>Surface Water Discharge to Watercourse</u>
Where soakaways are not suitable a connection to watercourse is the next consideration. As well as the unnamed tributary of the River Blithe to the north of the site, there are some smaller open drains through the site. Discharge to these watercourses, limited to the greenfield runoff rate, appears to be feasible via gravity.

<u>Surface Water Discharge to Sewer</u>
Where disposal of surface water to watercourse is not possible, a connection to the public sewer system is the final consideration.

5.3 Surface Water Drainage

The existing greenfield runoff rates have been estimated using the Revitalised Flood Hydrograph Model (ReFH2) method for the full site, and for the proposed substation area only, provided as Table 3 below:

Table 3 - Summary of greenfield release rates, ReFH2 method

Return Period (Years)	Runoff Rate – Whole Site (l/s)	Runoff Rate – Substation (l/s)
1 in 1	233	1.8
1 in 2	262	**2.1**
1 in 30	548	4.7
1 in 100	718	6.1

A greenfield runoff rate of 2.1l/s has been used for the proposed substation site to ensure the drainage system is self-cleansing.

5.4 Attenuation Storage

Hardstanding at each of the BESS sites will have a negligible impact on runoff given the relatively minor area of each site, and that each site is surrounded entirely by greenfield land. Therefore, the BESS sites will have negligible impact on the existing runoff rates, volumes, or flow routes and no localised storage is required.

Attenuation storage will be required at the site of the substation. Storage estimates have been provided using Causeway Flow and are included in Appendix C. An estimated storage volume of 284m³ will be required for the 1 in 100 year plus 25% CC event. The storage estimates are based on a limited discharge rate of 2.1l/s, an impermeable drainage area of the 4,700m^2 and hydro brake flow control.

The attenuation volumes are provided for indicative purposes only and should be verified at the detailed design stage.

5.5 Sustainable Drainage Systems

Attenuation storage should be provided in the form of Sustainable Drainage Systems (SuDS) where practical. The following SuDS options have been considered:

<u>Soakaways</u>
As described above, the use of soakaways is not considered to be feasible due to the underlying superficial deposits on site.

<u>Swales, Detention Basins and Ponds</u>
The site will remain greenfield and will therefore continue to discharge to soils and overland flow as existing, though the presence of the solar panels means there will be limited space to accommodate above ground storage features such as ponds and basins. However, sufficient space is available on Site to utilise a swale as an above ground attenuation feature.

<u>Rainwater Harvesting</u>
The attenuation benefits provided through the use of rainwater harvesting are considered to be limited and would only be realised when the tanks were not full. However, rainwater harvesting techniques could be incorporated within the final design.

<u>Porous/Permeable Surfacing</u>
The proposed solar panels are raised on minimal frames which do not introduce hardstanding and therefore the area of hardstanding proposed as part of the development is negligible as it covers 4.4% of the site area, however the use of permeable surfacing should be considered where necessary at the detailed design stage to prevent any localised issues.

5.6 Preferred Drainage Scheme

5.6.1 Surface Water – Solar Panels

There are no significant changes in land cover or land use planned by the scheme design, for example permeable grassland to impermeable surfaces. The nature of the proposals consists of solar panel modules which are raised off the ground, therefore not reducing existing permeable areas. The solar array will involve the placement of impermeable surfaces associated with the solar panels. However, it is generally accepted that runoff from the solar panels will fall to the ground below where it will naturally infiltrate. It is possible that runoff from the solar panels will be concentrated along the drop line. This could lead to an increase in ponding of water and increased runoff from the site below the solar panel module. However, as the site is to remain grass beneath the solar panel modules, this will assist in controlling surface water runoff and maintaining a relatively natural infiltration capacity. It is considered that well maintained and established vegetation will dissipate the runoff along the drop line and allow water to runoff or infiltrate mimicking the pre-development scenario.

It is considered that the solar panel modules themselves will not increase runoff, with any risk of erosion mitigated by having well maintained and established vegetation below the drip line. However, it may be beneficial to install a localised form of SuDS to control any runoff.

Surface water runoff from hardstanding areas associated with the substation will discharge to the unnamed watercourse passing through the north of the site at a rate of 2.1l/s. Surface water runoff up to the 1 in 100 year plus 25% climate change allowance event will be attenuated on site. An estimated total attenuation volume of 284m³ will be required to achieve the discharge rate. The proposed surface water drainage scheme will ensure no increase in runoff over the lifetime of the development.

5.7 Surface Water Treatment

In accordance with the CIRIA C753 publication 'The SuDS Manual' (2015), the runoff from solar panels and low traffic roads has a 'low' pollution hazard level. Table 4 below shows the pollution hazard indices for each land use.

Table 4: Pollution Hazard Indices

Land Use	Pollution Hazard Level	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Residential Roofs	Very Low	0.2*	0.2	0.05
Other Roofs (typically commercial/industrial roofs)	Low	0.5	0.2**	0.4
Low Traffic Roads	Low	0.5	0.4	0.4
Moderately Trafficked Roads	Medium	0.7	0.6	0.7
Sites with heavy pollution	High	0.8	0.8	0.9

Table extract taken from the CIRIA C753 publication 'The SuDS Manual' – Table 26.2

* Indices values range from 0-1.

** up to 0.8 where there is potential for metals to leach from the roof

Where practical, runoff from solar panels and access tracks will be directed to swales. Table 5 below demonstrates that swales and permeable pavement provides sufficient treatment.

Table 5: SuDS Mitigation Indices

	Mitigation Indices		
Type of SuDS	**Total Suspended Solids (TSS)**	**Metals**	**Hydrocarbons**
Permeable Pavement	**0.7**	**0.6**	**0.7**
Swale	**0.5**	**0.6**	**0.6**
Detention basin	**0.5**	**0.5**	**0.6**
Pond	**0.7**	**0.7**	**0.5**

Table extract taken from the CIRIA C753 publication 'The SuDS Manual' – Table 26.3

It can be concluded that the inclusion of a swale will provide sufficient treatment prior to being discharged to the watercourse, River Blithe, to the northeast of the site.

As part of the associated site works, a temporary construction access track which will include a temporary construction compound will be incorporated. Should permanent tracks be necessary, permeable surfacing such as reinforced grass, crushed stone or gravel should be used to allow surface water to infiltrate into the ground, in order to mimic the existing runoff conditions.

In accordance with the CIRIA C753 publication 'The SuDS Manual' (2015), the runoff from solar panels has a 'low' pollution hazard level. Table 4 shows the pollution hazard indices for the land use.

Table 4: Pollution Hazard Indices

Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydrocarbons
Other roofs (typically commercial/industrial roofs)	Low	0.2	0.2	0.05

Table extract taken from the CIRIA C753 publication 'The SuDS Manual' – Table 26.2

The Simple Index Tool (SIA) indicates that for the solar panels a single level of SUDS would suffice, see Table 5 below. Surface water arising from the solar panels would be subject to treatment by way of a swale prior to being discharged to the watercourse, River Blithe, to the northeast of the site.

Table 5: SUDS Mitigation Indices

Type of SUDS	Total suspended solids (TSS)	Metals	Hydrocarbons
Swale	0.5	0.6	0.6

Table extract taken from the CIRIA C753 publication 'The SuDS Manual' – Table 26.3

5.7.1 Surface Water – Access Track

As part of the associated site works, a temporary construction access track which will include a temporary construction compound will be incorporated. Should permanent tracks be necessary, permeable surfacing such as reinforced grass, crushed stone or gravel should be used to allow surface water to infiltrate into the ground, in order to mimic the existing runoff conditions.

In accordance with the CIRIA C753 publication 'The SuDS Manual' (2015), the runoff from the access track has a 'low' pollution hazard level. Table 6 below shows the pollution hazard indices for the land use.

Table 6: Pollution Hazard Indices

Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydrocarbons
Individual property driveways, residential car parks, low traffic roads (e.g. cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change (e.g. schools, offices) i.e. <300 traffic movements/day	Low	0.5	0.4	0.4

Table extract taken from the CIRIA C753 publication 'The SuDS Manual' – Table 26.2

The SIA indicates that for the access track a single level of SUDS would suffice, see Table 7 below. Surface water arising from the access track would be subject to treatment by way of a swale or permeable pavement prior to being discharged to the watercourse, River Blithe, to the northeast of the site.

Table 7: SUDS Mitigation Indices

Type of SUDS	Total suspended solids (TSS)	Metals	Hydrocarbons
Swale	0.5	0.6	0.6
Permeable pavement	0.7	0.6	0.7

Table extract taken from the CIRIA C753 publication 'The SuDS Manual' – Table 26.3

Section 6.0: Conclusions and Recommendations

6.1 Conclusions

The risk of flooding from all sources has been assessed and the main potential source of flooding to the site is from the unnamed tributary of the River Blithe. The tributary is not an EA designated main river and the EA surface water maps offer a more appropriate assessment of fluvial flood risk to the site in this instance. Comparison of the low likelihood surface water flood extent and the underlying DTM data suggests that flood depths remain below 1m outside an 8m easement from the banks of the unnamed watercourse. As a water-compatible development, solar panels can be installed up to the easement.

It is considered that the solar panel modules themselves will not increase runoff, with any risk of erosion mitigated by having well maintained and established vegetation below the drip line. However, it may be beneficial to install a localised form of SuDS to control any runoff.

Hardstanding at each of the BESS sites will have a negligible impact on runoff given the relatively minor area of each site, and that each site is surrounded entirely by greenfield land. Therefore, the BESS sites will have negligible impact on the existing runoff rates, volumes, or flow routes and no localised storage is required.

Surface water runoff from hardstanding areas associated with the substation will discharge to the unnamed watercourse passing through the north of the site at a rate of 2.1l/s. Surface water runoff up to the 1 in 100 year plus 25% climate change allowance event will be attenuated on site. An estimated total attenuation volume of 284m³ will be required to achieve the discharge rate. The proposed surface water drainage scheme will ensure no increase in runoff over the lifetime of the development.

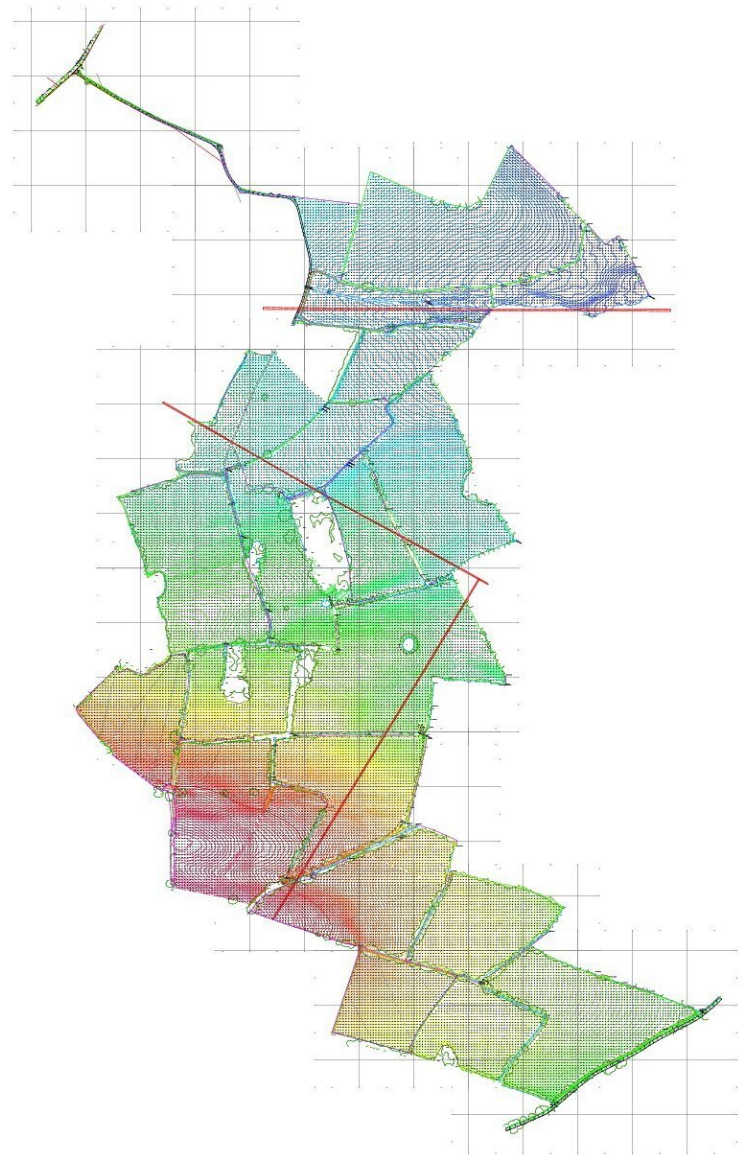
6.2 Recommendations

This FRA and DS should be submitted to the EA and Staffordshire County Council in support of the planning application.

Section 7.0: Disclaimer

The content of this assessment is for internal use only and should not be distributed to third parties unless under the expressed authority of our client. The designs, recommendations and outline proposals shall remain the property of Mabbett & Associates Ltd and shall not be plagiarised in any form without authority to do so. The comments and recommendations stipulated are solely those expressed by Mabbett & Associates Ltd, and both parties understand that the comments and recommendations expressed are not binding. Mabbett & Associates Ltd confirms that reasonable skill, care, and diligence have been applied and that any design element has been carried out using verifiable and approved reference documentation. No responsibility shall be assumed by Mabbett & Associates Ltd for system failure as a result of incorrect installation work by contractors assigned by the client or incorrect or inappropriate implementation of Mabbett & Associates Ltd.'s recommendations.

Appendix A: Topographic Survey



Wall	Soffit Level
Ditch	Invert Level
Kerb	Road Gully
Track Edge	Spot level
Top of Bank	Manhole
Bottom of Bank	Pole Stay
Breakline	Road Sign
Road Channel	Spot Level
Centre Line	Bollard
Concrete	BT Cover
Change Surface	Electricity Pole
Gate	Lamp Post
Wire Fence - 1m	Post
Timber Fence - 1m	Telecom Pole
Hedge	Tree with Bole
Hedge	Drinking Trough
Vegetation	Water Tap
Tree Canopy	
O/H Cable Electricity	
O/H Cable Telecom	

VEGETATION HEIGHT ABOVE GROUND SHADING KEY

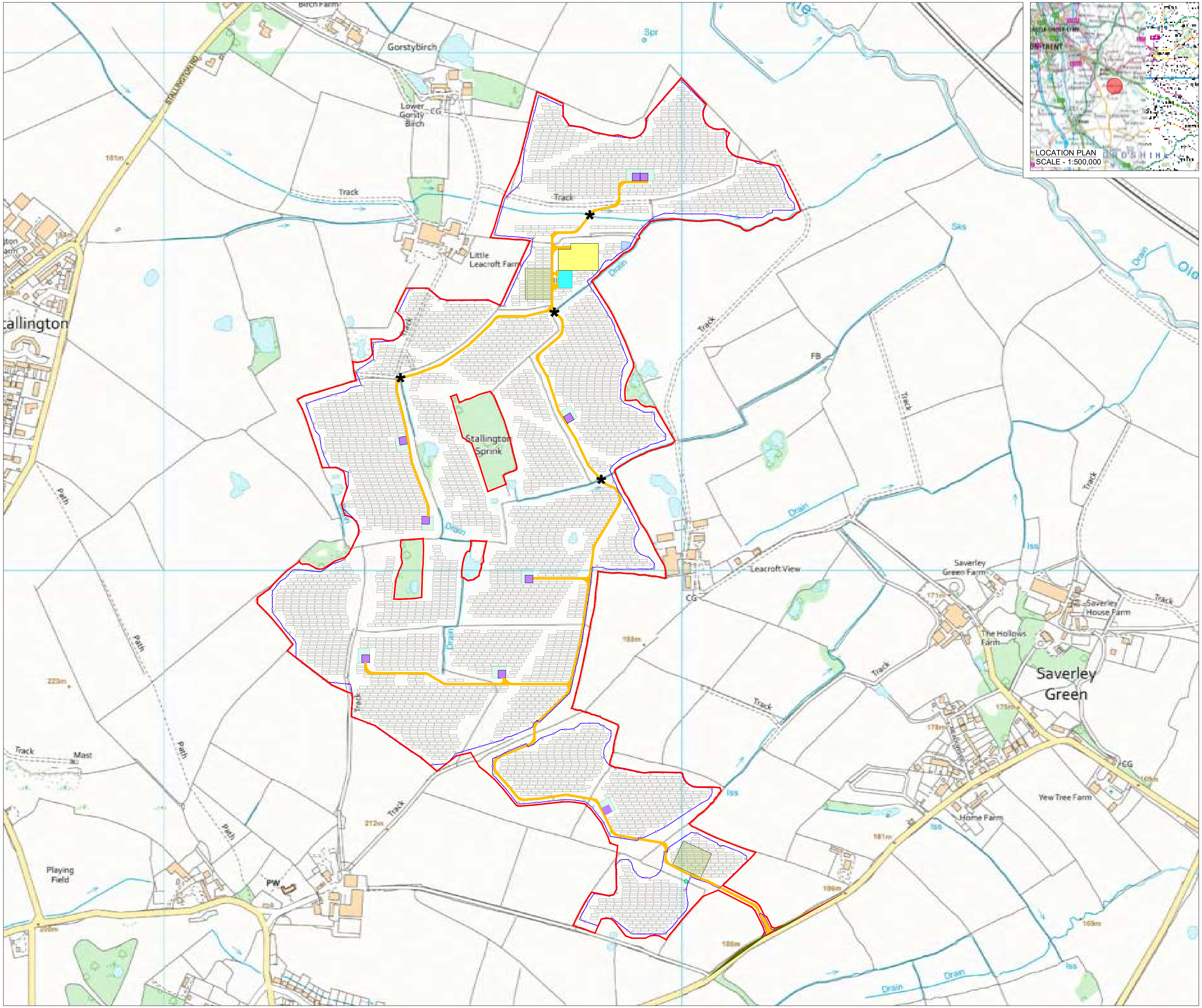
SURVEYED BY GPS TO OSNG. LEVEL DATUM OSGM15

200 100 0 250 500 750 1000 1250m

Scale: 1/5000 at A1; 1/10000 at A3

Client	Project	
Mabbett Consultants Mabbett House 11 Sandyford Place Glasgow G3 7NB	FULFORD SOLAR FARM TOPOGRAPHICAL SURVEY	INFOMAP CHARTERED SURVEYORS RICS Seymours House Sunnyside Road North Weston-super-Mare North Somerset BS23 3PZ Tel: 01934 644060 /fax 01934 644060 E-mail: mail@infomapsurveys.co.uk Website: www.infomapsurveys.co.uk
Surveyed: F.C.	Apprd: R.J.FLEW	DRAWING REFERENCE
Date: 13.09.2023	File Ref: 1841	ISM/FULFORD SOLAR FARM TOPOGRAPHICAL SURVEY
Scale: 1/5000 at A1; 1/10000 at A3	Datum: OSTN15/OSGM15	OVERALL PLAN

Appendix B: Proposed Development Plan



KEY:

- SITE BOUNDARY (*OUTSIDE OF LINE DENOTES BOUNDARY*)
- PROPOSED ACCESS TRACK
- INDICATIVE SOLAR PV ARRAY
- INVERTER & BATTERY STORAGE AREA
- HARDSTAND
- SUBSTATION COMPOUND
- AC-AC STORAGE COMPOUND
- TEMPORARY CONSTRUCTION COMPOUND
- FENCE LINE
- GATE (FENCE)
- WATERCOURSE CROSSING
- CCTV
- SITE ENTRANCE - VISIBILITY SPLAY
- PROPOSED ATTENUATION POND
- SPARES CONTAINERS
- NEW HEDGEROW GAP FOR ACCESS

ISSUE	DRAWN	CHKD	APPD	DATE	REVISION NOTES
4	FG	JM	WB	2023-11-22	Indicative solar PV array update
3	FG	MK	WB	2023-11-16	Infrastructure layout update
2	FG	MK	CC	2023-10-23	Site boundary update
1	FG	MK	CC	2023-10-19	First Issue

PURPOSE: PERMITTING	COORDINATES: OSGB 1936
SCALE: 1:7,000 @A3	DATUM: N/A
LAYOUT DRAWING: N/A	T-LAYOUT NO: N/A

PROJECT TITLE

LEAFORD SOLAR

DRAWING TITLE

FIGURE 4
INFRASTRUCTURE LAYOUT

RES DRAWING NUMBER: 05004-RES-LAY-DR-PT-004

REV: 4

BEAUFORT COURT,
EGG FARM LANE,
KINGS LANGLEY,
HERTS WD4 8LR. UK
TEL +44 (0) 1923 299200
WWW.RES-GROUP.COM

Appendix C – Storage Calculations

Design Settings

Rainfall Methodology	FEH-22	Minimum Velocity (m/s)	1.00
Return Period (years)	100	Connection Type	Level Soffits
Additional Flow (%)	0	Minimum Backdrop Height (m)	0.200
CV	0.750	Preferred Cover Depth (m)	1.200
Time of Entry (mins)	5.00	Include Intermediate Ground	✓
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	✓
Maximum Rainfall (mm/hr)	50.0		

Nodes

Name	Area (ha)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
Storage	0.470	100.000	1200	0.000	0.000	2.000

Simulation Settings

Rainfall Methodology	FEH-22	Analysis Speed	Normal	Additional Storage (m^3/ha)	20.0
Summer CV	0.750	Skip Steady State	x	Check Discharge Rate(s)	x
Winter CV	0.840	Drain Down Time (mins)	240	Check Discharge Volume	x

Storm Durations

15	30	60	120	180	240	360	480	600	720	960	1440

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
100	25	0	0

Node Storage Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	97.500	Product Number	CTL-SHE-0064-1800-1000-1800
Design Depth (m)	1.000	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	1.8	Min Node Diameter (mm)	1200

Node Storage Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	98.000
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m^2)	Inf Area (m^2)	Depth (m)	Area (m^2)	Inf Area (m^2)	Depth (m)	Area (m^2)	Inf Area (m^2)
0.000	319.8	0.0	1.000	319.8	0.0	1.001	0.0	0.0

Results for 100 year +25% CC Critical Storm Duration. Lowest mass balance: 95.09%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m^3)	Flood (m^3)	Status
720 minute winter	Storage	705	98.871	0.871	20.8	283.7405	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	Outflow (l/s)	Discharge Vol (m^3)
720 minute winter	Storage	Hydro-Brake®	2.1	103.5