Appendix B.1

Flood Consequence Assessment

BODELWYDDAN SOLAR & ENERGY STORAGE

Bodelwyddan, LL22 9SD

FLOOD CONSEQUENCE ASSESSMENT

Project No	24-310-60
Revision No	02
Issue date	03/09/25

Transport Planning | Flood Risk & Hydrology | Infrastructure & Drainage

Control Sheet

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1 EXECUTIVE SUMMARY

1.1.1 Bodelwyddan Solar and Energy Storage Limited are seeking permission for the following Proposed Development at land to the northwest and southeast of Bodelwyddan, North Wales:

Construction, operation and decommissioning of a proposed solar photovoltaic (PV) electricity generating system and battery energy storage system (BESS), associated solar arrays, inverters, transformers, substations and ancillary buildings, accesses, internal access tracks, landscaping and biodiversity, fencing/CCTV, cabling and associated ancillary development

1.1.2 The Proposed Development will have an operational lifespan of 40 years, after which it will be fully decommissioned and this would be secured via a planning condition.

1.1.3 The Site is approximately 183.77ha and comprises a Solar Site (168.95ha), BESS Site (6.51ha) and Cable Corridor (8.29ha) which links the two sites. The Solar and BESS sites are a mix of pastoral and arable agricultural land.

1.1.4 The Solar Site will contain the solar arrays, inverters, switchroom and associated infrastructure and the BESS Site will contain the BESS units, inverters, substation/transformer and associated infrastructure. The cable(s) within the Cable Corridor will be a buried service and flood resistant, and therefore it is not considered further in this document.

1.1.5 This document considers the flood risk to the site and the potential impact of the proposals on downstream flood risk in accordance with Technical Advice Note 15 – Development, Flooding and Coastal Erosion, published in March 2025. The risk of flooding has been considered over the development's proposed lifetime in accordance with paragraph 10.29 of Technical Advice Note 15 Development, flooding and coastal erosion (TAN15).Large parts of the Solar Site are in Flood Zones 2 and 3 as a result of predicted fluvial and tidal flooding in an undefended scenario. The principal sources of flood risk are the Afon Gele and Bodoryn Cut to the north which form part of an extensive drainage network for the surrounding low-lying land and the Afon Clwyd to the east and the sea and Clwyd Estuary.

1.1.6 The latest model data was provided by NRW October 2024. NRW subsequently provided a copy of the Point of Ayr to Pensarn model in March 2025 which considers tidal flooding.

1.1.7 The Afon Gele and Bodoryn Cut form part of an extensive drainage system which drains the low-lying land within which the Solar Site lies. Ultimately this system drains to the Afon Clwyd via the Afon Gele Outfall which comprises two outfalls and two overflow outlets with sluices to prevent tidal ingress. At the end of the century a 1 in 100 year flood results in limited flooding of the site. A 1 in 1,000 year event at the end of the century is predicted to result in flooding to depths of up to 0.6m but generally below 0.3m. This risk will be mitigated by raising solar arrays and containerised infrastructure above the predicted flood level.

1.1.8 The Afon Clwyd is flanked by embankments which protect the Solar Site from flooding up to and including a 1 in 100 year event in 2115. However, during a future 1 in 1,000 year event extensive flooding of the solar generation area to the south of the A547 is predicted, with depths of up to 1.2m predicted. Solar panels will be tracker-type and raised above the predicted flood level as will containerised infrastructure where practicable. However, due to engineering and landscape and visual related constraints some of these units will be at risk of flooding during a future 1 in 1,000 year flood. The risk will be minimised as far as practicable through the layout design and contingency planning which will allow solar generation to be brought back on line rapidly in unlikely situation that flooding of this magnitude is experienced over the development's 40 year lifetime.

1.1.9 Extensive coastal defences protect the Solar Site from tidal flooding up to and including a 1 in 200 year event in 2067. During a defended 1 in 1,000 year event in 2067, flooding is predicted to land north of the A547. Depths are typically below 0.3m and no more than 0.7m. No flooding is predicted in the 1 in 200 year event for 2067.

1.1.10 Breach modelling was completed for the 1 in 200 year event in the year 2070 (slightly beyond the development lifetime). Although breach flooding is considered a design event by paragraph 10.26 of TAN15, it remains a very unlikely scenario. The model predicts there would be extensive flooding of the Solar Site but this flooding would remain no greater than 1.2m depth. Mitigation is proposed to minimise the impact on solar generation during such an event.

1.1.11 The site would be remotely operated and therefore no access would be required during flood conditions. Consequently, in the event of a flood warning being issued, access would be postponed until the warning has passed. Given the breach modelling work is based on a breach coinciding with the peak of a 1 in 200 year flood, it is likely that warnings would be in place with or without a breach.

1.1.12 The transition to a solar farm would have benefits in terms of soil erosion, runoff and leaching of contaminants through removal of pesticide and herbicide use.

1.1.13 Runoff from the panels would drain to ground with no additional mitigation required.

1.1.14 Access tracks, and temporary construction compounds would be formed from permeable materials with no additional mitigation required.

1.1.15 Isolated containerised infrastructure (including the PCS and the switchroom) would be sited on granular bases. The dimensions of these bases would be sized to be sufficient to contain the 1 in 100 year, 12-hour duration +40% rainfall event.

1.1.16 The BESS area is proposed in a location at low risk of flooding and set on a granular subbase. The subbase would be lined and under normal circumstances would release it at QBar greenfield rates to the nearby watercourse network. The BESS drainage system would have the ability to be isolated in the very unlikely event of fire. It would provide sufficient capacity to contain at least six hours of fire suppression water.

1.1.17 Infiltration has been discounted on account of the impermeable geology and soils.

1.1.18 The above proposals and mitigation would meet the requirements of the latest release of TAN15. Specifically, the vast majority of the site would remain operational even during a breach event coinciding with a future 1 in 200 year tidal flood. Furthermore, the remote operation would mean that lives would not be at risk. These are key aspects of the tolerable conditions test.

2 INTRODUCTION

2.1 Background

2.1.1 Calibro Consultants has been appointed by *Bodelwyddan Solar and Energy Storage Limited* to undertake a Flood Consequence Assessment (FCA) to accompany a planning application for Proposed Development at land to the northwest and southeast of Bodelwyddan, North Wales:

2.1.2 Construction, operation and decommissioning of a proposed solar photovoltaic (PV) electricity generating system and battery energy storage system (BESS), associated solar arrays, inverters, transformers, substations and ancillary buildings, accesses, internal access tracks, landscaping and biodiversity, fencing/CCTV, cabling and associated ancillary development

2.1.3 The Proposed Development will have an operational lifespan of 40 years, after which it will be fully decommissioned, and this would be secured via a planning condition

2.2 Policy Requirements

2.2.1 The general approach of Planning Policy Wales is to direct development away from areas at risk of flooding.

2.2.2 'Technical Advice Note 15 – Development, Flooding and Coastal Erosion' (TAN15), published in March 2025, provides a framework for assessing flooding associated with proposed development. This includes the definition of the Flood Map for Planning Flood Zones 1 ,2 and 3 and Defended Zones, which form the starting point for any assessment.

2.2.3 An overarching principle of TAN15 is to restrict new development in Zone 3, subject to the limited exceptions, and to ensure that decision makers have taken flood risk matters into consideration in all other zones. However, paragraph 10.3 states that

proposals that address national security or energy security needs, mitigate the impacts of climate change, that are necessary to protect and promote public health may also, by exception, be appropriate provided that their locational need is clear and the potential consequences from flooding have been considered and found to be acceptable.

2.2.4 An FCA must be produced for any proposed development shown to be within Flood Zone 2 or 3 defined by being at risk from a 1 in 1,000 year (0.1% annual exceedance probability) event as shown on the NRW Flood Map for Planning.

2.2.5 TAN15 states that the prime objective of an FCA is to develop a full appreciation of:

- "The risk and consequences of flooding on the development; and

- The risk and consequences (i.e. the overall impacts) of the development on flood risk elsewhere." (para. 6.4)

2.2.6 TAN15 requires that

"The assessment must allow for a range of potential flooding scenarios up to and including that flood having a probability of 0.1% in any year. An allowance for climate change must be made in line with current Welsh Government guidance, published alongside this TAN". (para. 6.5).

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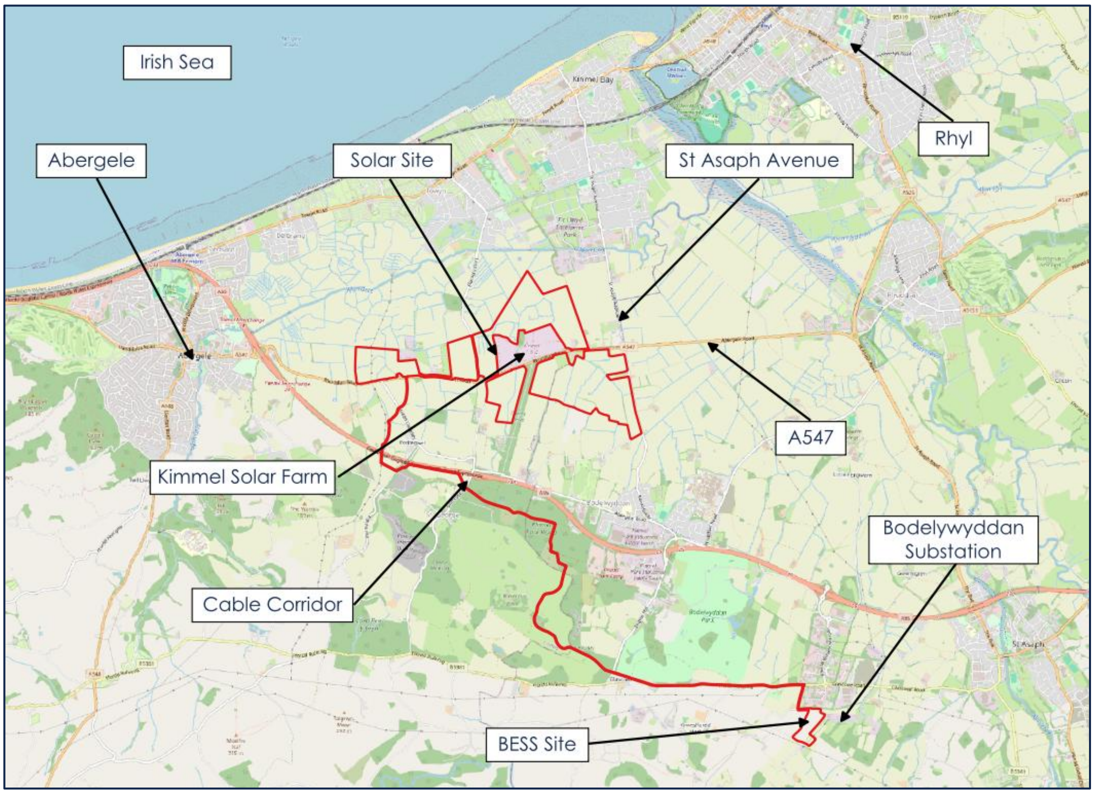
3 EXISTING SITE AND HYDROLOGY CHARACTERISTICS

3.1 Site Description

3.1.1 The location of the proposed development in shown in Figure 3-1 Figure 3-1.

Figure 3-1 Site Location



3.1.2 The site, including the associated infrastructure and cable route, covers approximately 183.77ha, and is currently used for agriculture as part of several pastoral and arable agricultural holdings.

3.1.3 The Site is broadly divided into two areas: the northern parcel (Solar Site) which will contain solar arrays, PCS, switchroom and associated infrastructure, and: the southern parcel (BESS Site) which will contain the BESS units, inverters, substation/transformer and associated infrastructure.

3.1.4 The Solar Site is approximately 168.95ha. It surrounds the existing Kinmel solar farm and the A547 runs through it. The approximate co-ordinates at the centre of this area is 298330, 377480 and the nearest postcode LL22 9SD. It is located approximately 1km to the northwest of Bodelwyddan at its nearest point and approximately 2km from the Irish Sea. The Solar Site comprises 6 parcels as shown in **Error! Reference source not found.**. Solar generation is proposed Parcels 1 – 5. Ecological mitigation and enhancement is proposed in Parcel 6.

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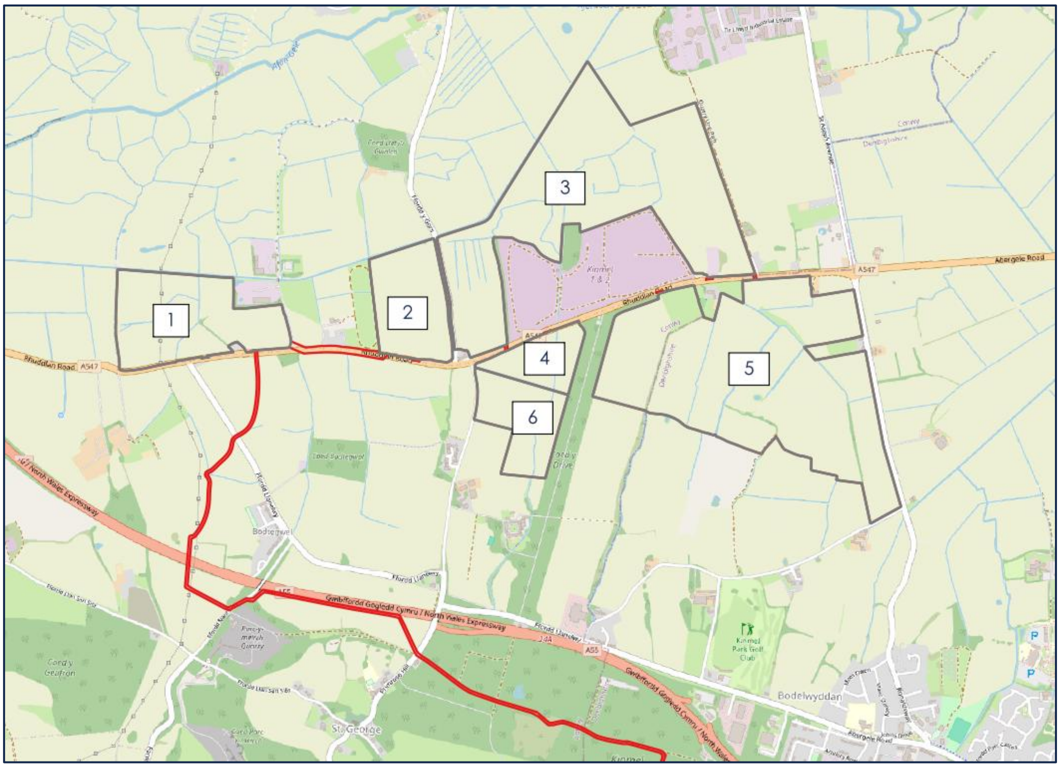
Figure 3-2 Solar Ste Parcels



3.1.5 The BESS Site is located approximately 3.5km to the southeast of the Solar Site and covers approximately 6.51ha. It lies adjacent to the existing Bodelwyddan Substation, which would form the point of connection for the scheme.

3.1.6 The Cable Corridor connects the two areas. This will be a buried service following existing highways and roads wherever possible, which will be flood resistant and not have a material impact on flood risk or drainage and consequently it is not considered further in this document.

3.2 Topography

3.2.1 The northern parcel is predominantly low-lying land which generally slopes gently to the north. The majority of the parcel sits at 4.0mAOD and 4.5mAOD. The maximum and minimum ground levels, excluding channels are approximately 3.4mAOD and 7.1mAOD respectively.

3.2.2 As shown in Figure 3-3, land at the far southern parts of the solar generation area parcels slopes up to levels over 6mAOD.

3.2.3 The southern parcel is located on high ground between 42 and 58mAOD. It falls to the northeast at a gradient of approximately 1 in 30.

Figure 3-3 Solar Site Topography

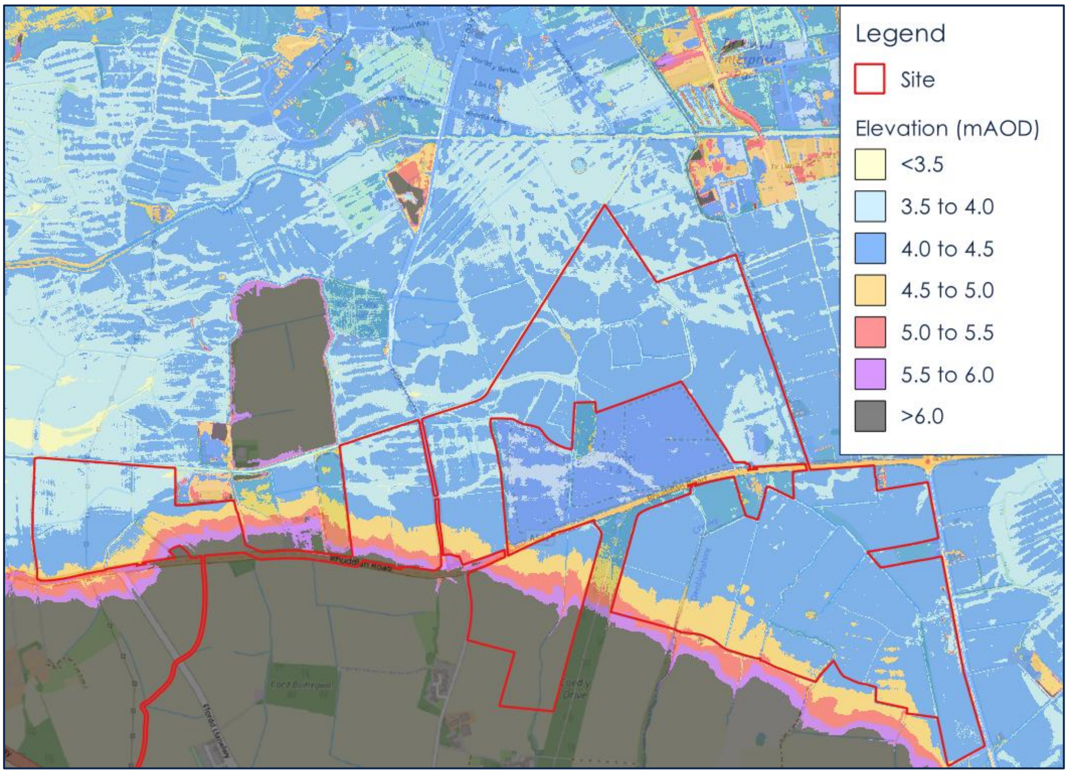
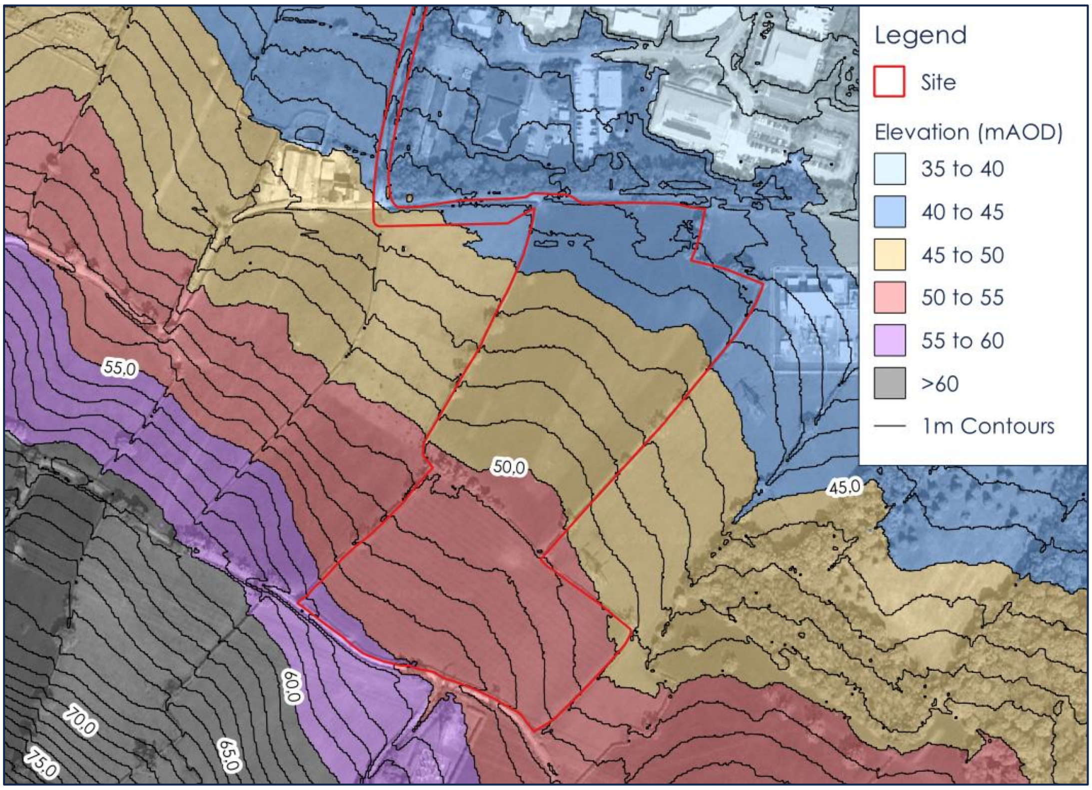


Figure 3-4 BESS Site Topography



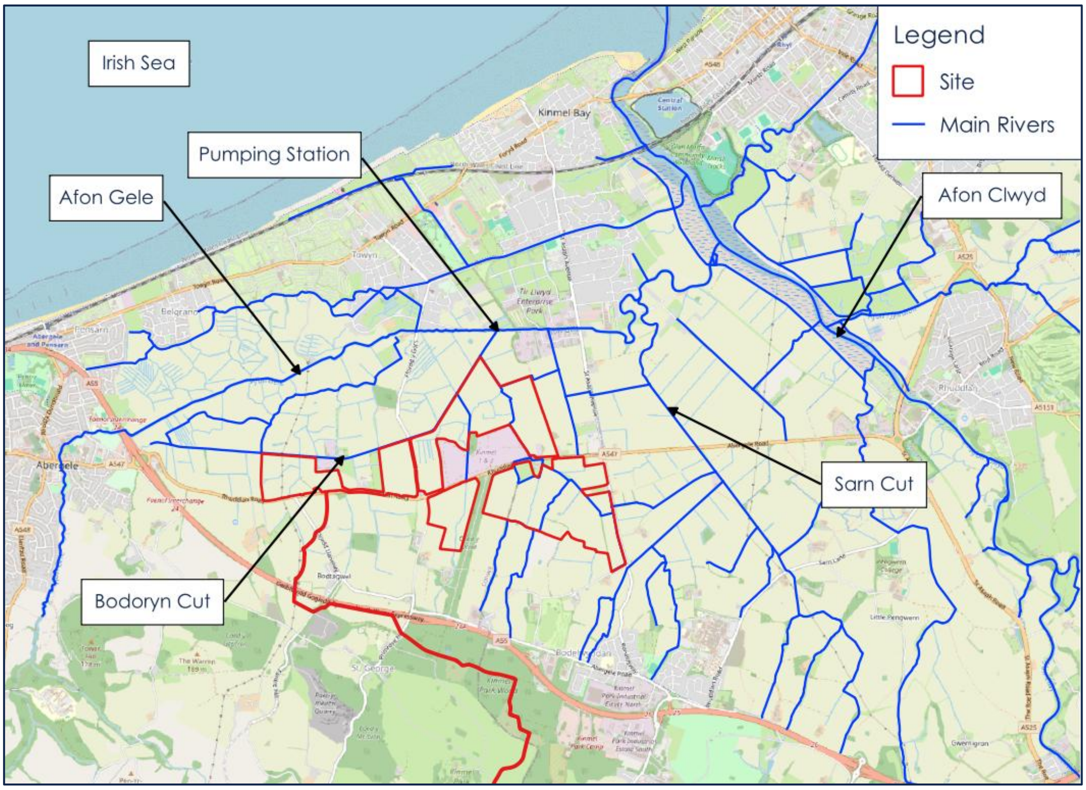
3.3 Hydrology

3.3.1 The northern edge of the site is approximately 2km from the Irish Sea. The entire site falls within the Afon Gele Water Framework Directive Catchment. It is designated as being 'Heavily Modified' with an overall waterbody classification of 'Moderate'. The Afon Gele catchment is part of the wider Clwyd Flood Risk Management Catchment.

3.3.2 The principal catchments which have been considered as part of the study are the Afon Gele and the Afon Clwyd. The Main Rivers and principal watercourses are shown in Figure 3-5. NRW has advised that "all the main rivers in the proposed parcel of land for the solar array are subject to regular maintenance activities (annual) by NRW".

3.3.3 The Afon Clwyd is a large river approximately 2.5km west of the northern parcel. It is tidally influenced and flanked by large embankments.

Figure 3-5 Solar Site Watercourses



3.3.4 The Afon Gele rises on high ground to the west of the site where it drains a steep upland catchment before flowing through Abergele. Beyond Abergele it passes under the A55 and flows broadly eastward to the north of the site. The Afon Gele Flood Risk Study, Overview of Flood Risk Report (NRW, 2024) states that:

"Downstream of the A55, the Gele has been heavily modified over time. In this area it would once have discharged into the sea at Pensarn but now has been directed to flow eastwards towards the Clwyd estuary through what would once have been tidal floodplain. Much of it is embanked as part of an extensive man-made drainage system to convert the land to farmland (mainly grazing). Flooding in this area from the overtopping of sections of embankment is frequent."

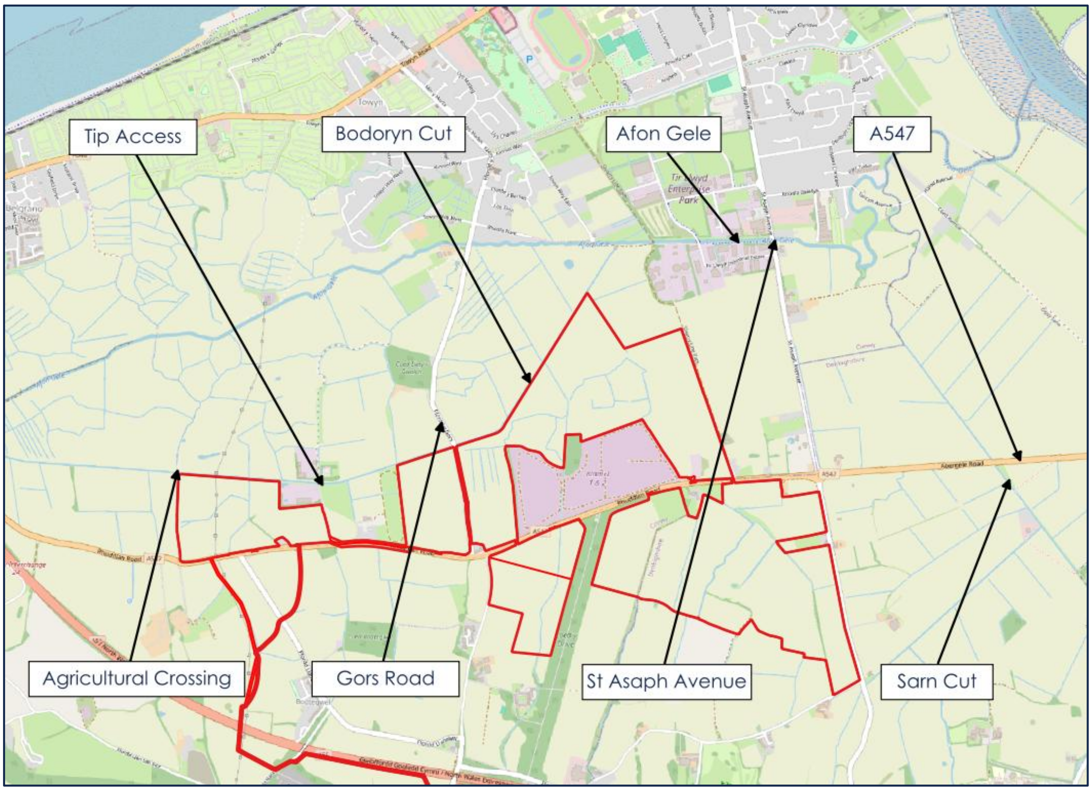
3.3.5 The Afon Gele discharges to the Clwyd Estuary via the Gele Outfall which comprises two 1.5m diameter pipes and two overflow outlets.with sluices to prevent tidal ingress.

3.3.6 The Bodoryn Cut passes alongside the northern edge of the site and discharges into the Afon Gele at a rate of 0.55m^3/s via a pumping station approximately 250m north of the north eastern edge of the most northerly part of the site. The Sarn Cut flows broadly in a northwesterly direction approximately 700m west of the northern parcel.

3.3.7 Key structures in the Afon Gele catchment are shown in Figure 3-6. Details of these structures as recorded in the Afon Gele Model Users Report are as follows:

- The agricultural access is a masonry arch bridge 4.52m wide and 2.0m high.
- The tip access is a clear span concrete bridge 5.59m wide by 2.0m high
- The Gors Road crossing over the Bodoryn Cut is a single arch opening 2.97m wide and 1.4m high.
- The Gors Road crossing over the Afon Gele is a clear span concrete bridge 4.4m wide by 2.0m high.
- The A547 crossing over the Sarn Cut is a clear span structure 4.46m wide by 2.0m high.

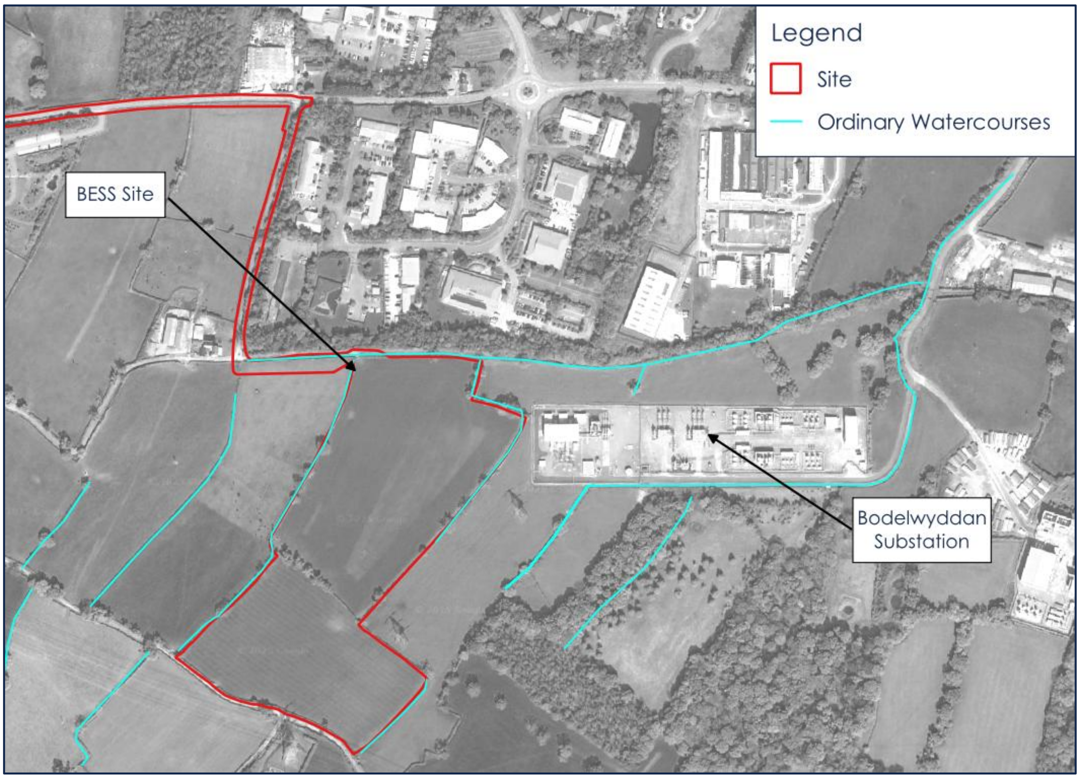
Figure 3-6 Bodoryn Cut, Sarn Cut and Afon Gele Key Structures



3.3.8 Within the Afon Gele catchment there are numerous unnamed Main Rivers and ordinary watercourses which from part of the extensive land drainage network.

3.3.9 There are no Main Rivers in the vicinity of the southern parcel. Ordnance Survey Mastermap records a small watercourse around the southern edge. There are field ditches on the eastern and western edges of the southern parcel. A review of LiDAR data suggests that there are numerous field drains within the vicinity of the site as shown in Figure 3-8. A small drain is also recorded passing through the western part of the Bodelwyddan Substation. It is presumed that this was diverted as part of the development.

Figure 3-7 BESS Site Watercourses



3.3.10 Main Rivers are shown on Drawing 24-310-60-001 in Appendix A.

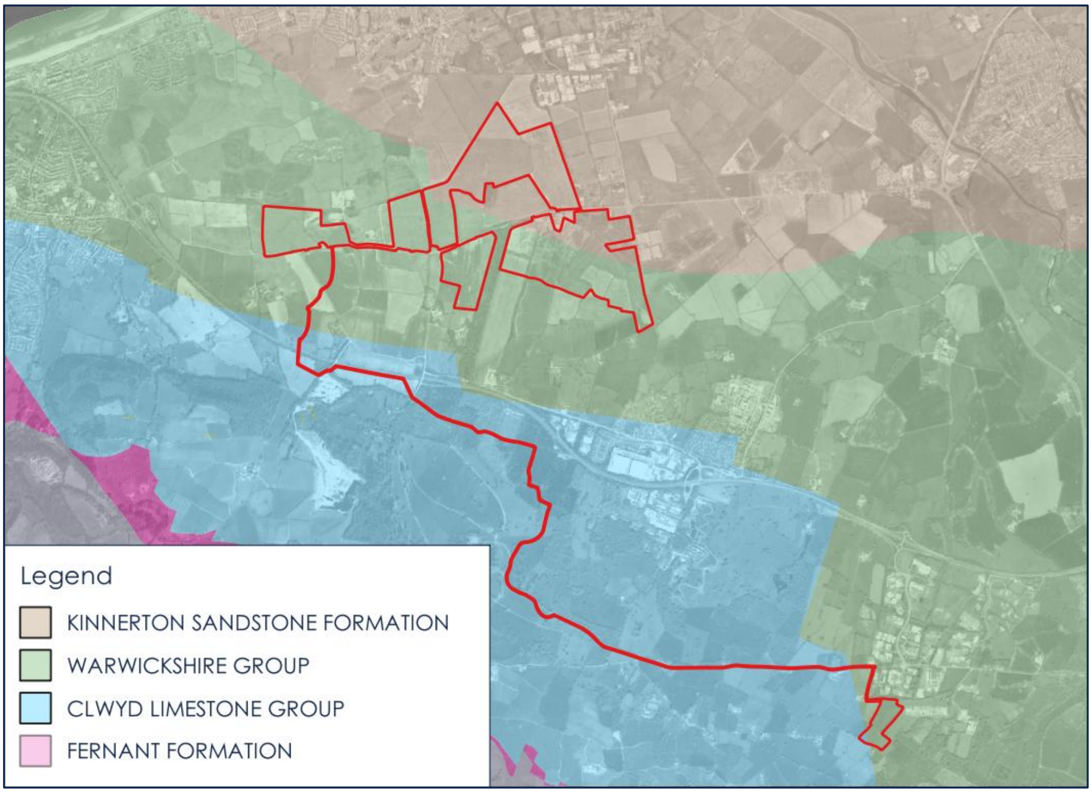
3.4 Geology and Soils

3.4.1 Geological data held by the British Geological Survey (BGS) shows that the site is underlain by a variety of bedrock types:

- Kinnerton sandstone formation – sandstone
- Warwickshire group - mudstone, siltstone and sandstone
- Clwyd limestone group - limestone
- Fernant formation - mudstone, siltstone and sandstone.

3.4.2 The BGS Bedrock information is presented in Figure 3-9.

Figure 3-8 BGS Bedrock Geology



3.4.3 BGS records Tidal Flats superficial deposits in the northern part of the site comprising Clay, Silt and Sand. In the south, which includes some higher ground in the northern parcels the superficial deposits are recorded as being 'Till, Devensian – Diamicton'. The extent of superficial deposits is presented in**Error! Not a valid bookmark self-reference.**Figure 3-9.

3.4.4 The BGS Hydrogeology dataset records land in the northeast as being underlain by a 'Highly productive aquifer' with 'Significant intergranular flow'. The rest of the land is recorded to be underlain by a 'Moderately productive aquifer' noting that 'Flow is virtually all through fractures and other discontinuities'. The BGS Hydrogeology dataset is presented in Figure 3-10.

Figure 3-9 BGS Superficial Geology

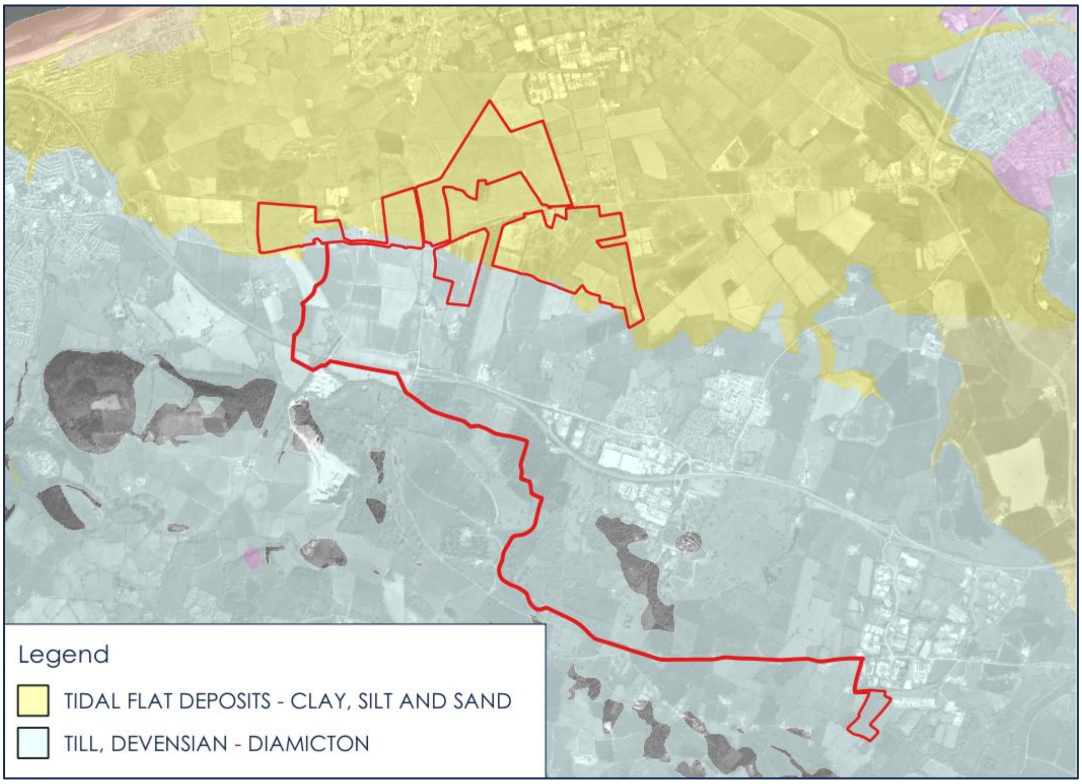
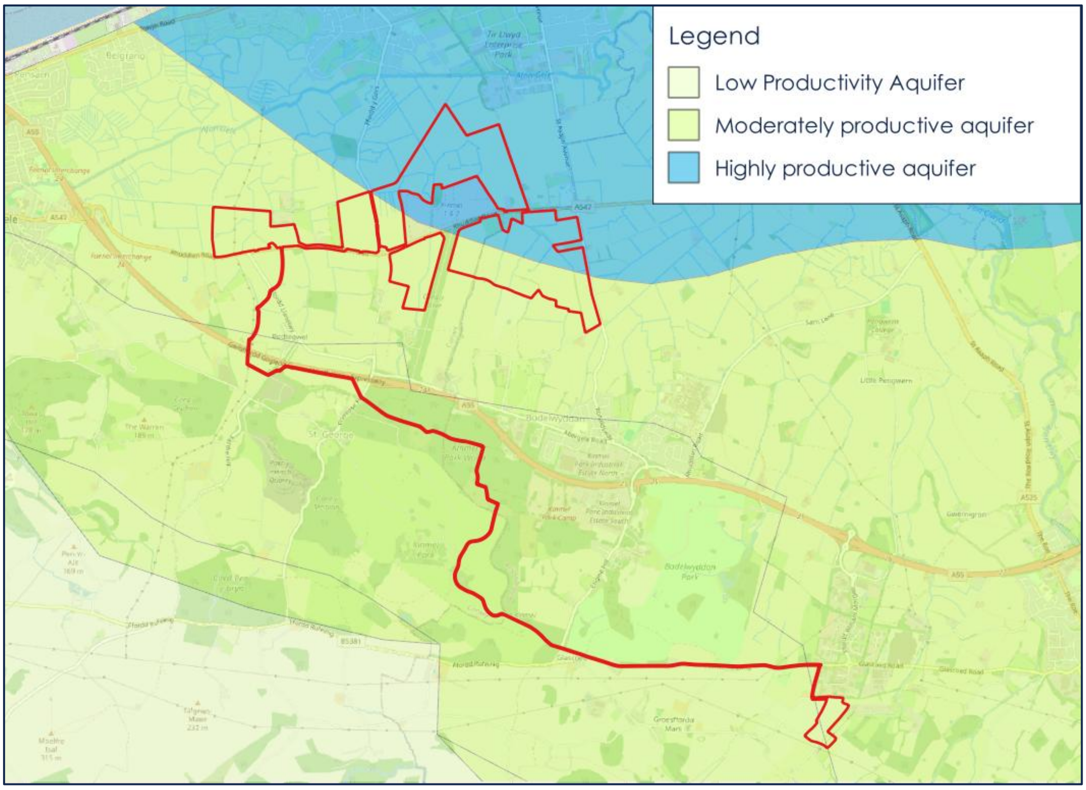
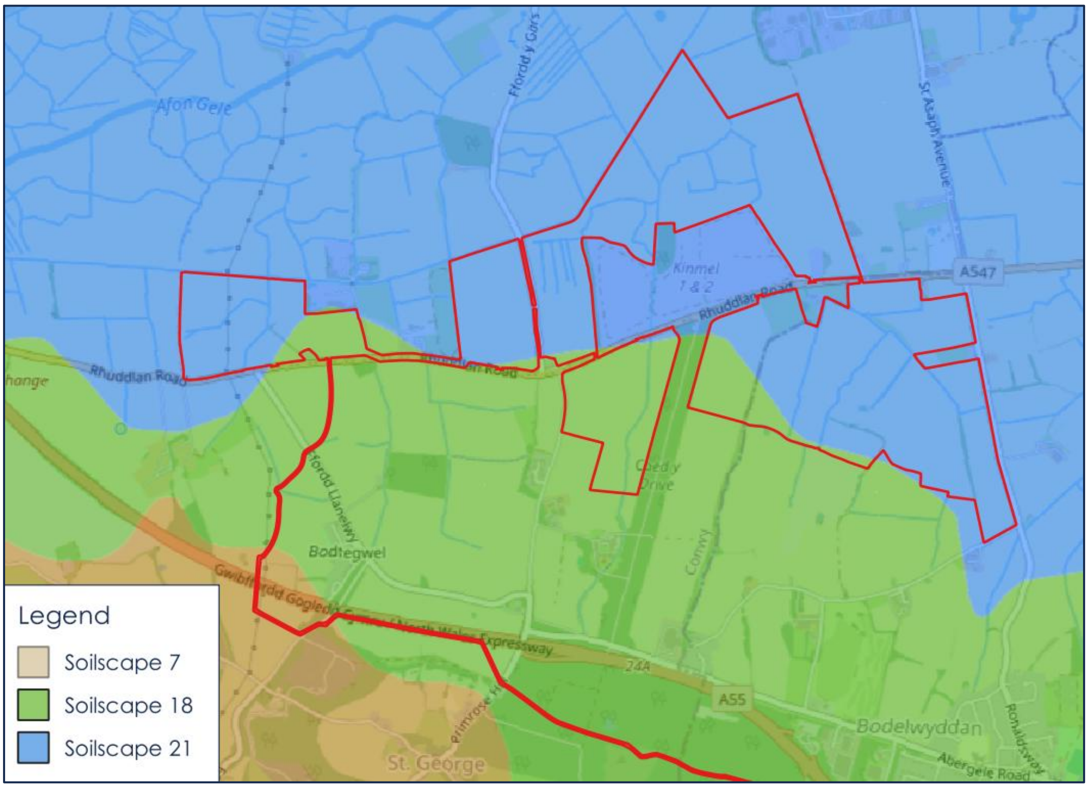


Figure 3-10 BGS Hydrogeology



3.4.5 Soilscapes mapping records the soil type in vast majority of the northern parcel to be 'Loamy and clayey soils of coastal flats with naturally high groundwater' (Soilscape 21). Within the westernmost parcel and the two parcels south of the A547 there are some areas with Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils' with 'impeded drainage' (Soilscape 18). In these areas ground elevations exceed approximately 5.0mAOD. Soilscapes data for the northern parcel is presented in Figure 3-11.

Figure 3-11 Soilscapes Classifications



3.4.6 Soilscapes records the soil type in the southern parcel to be entirely Soilscape 18, 'Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils' with 'impeded drainage'.

3.5 Existing Site Use

3.5.1 The site is currently used for mixed agriculture including arable crops, grazing and land used for hay production. The arable uses result in long periods of time where there is limited or no ground cover. The arable production also relies on the use of fertilizers and pesticides which are a potential source of pollution. Aerial imagery (Figure 3-12 through to Figure 3-15) shows significant parts of the site to have limited vegetation cover.

Figure 3-12 Google Earth Imagery Solar Site April 2015 -

Figure 3-13 Google Earth Imagery Solar Site March 2025

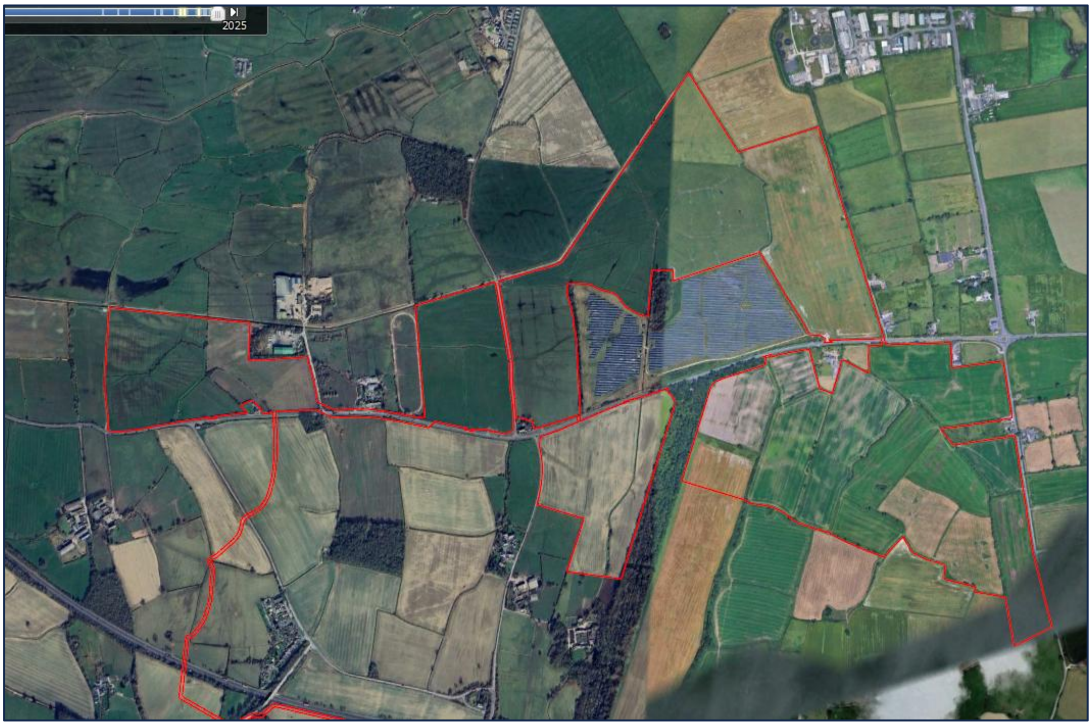


Figure 3-14 Google Earth Imagery BESS Site December 2006

Figure 3-15 Google Earth Imagery BESS Site January 2020

4 FLOOD RISK

4.1 Introduction

4.1.1 In accordance with TAN15, this FCA considers the risk posed to the site from all sources:

a) Tidal Flooding – from the sea;

b) Fluvial Flooding – from rivers and streams;

c) Surface Water Flooding – from intense rainfall events;

d) Groundwater flooding – from elevated groundwater levels or springs;

e) Flooding from sewers – from existing sewer systems; and

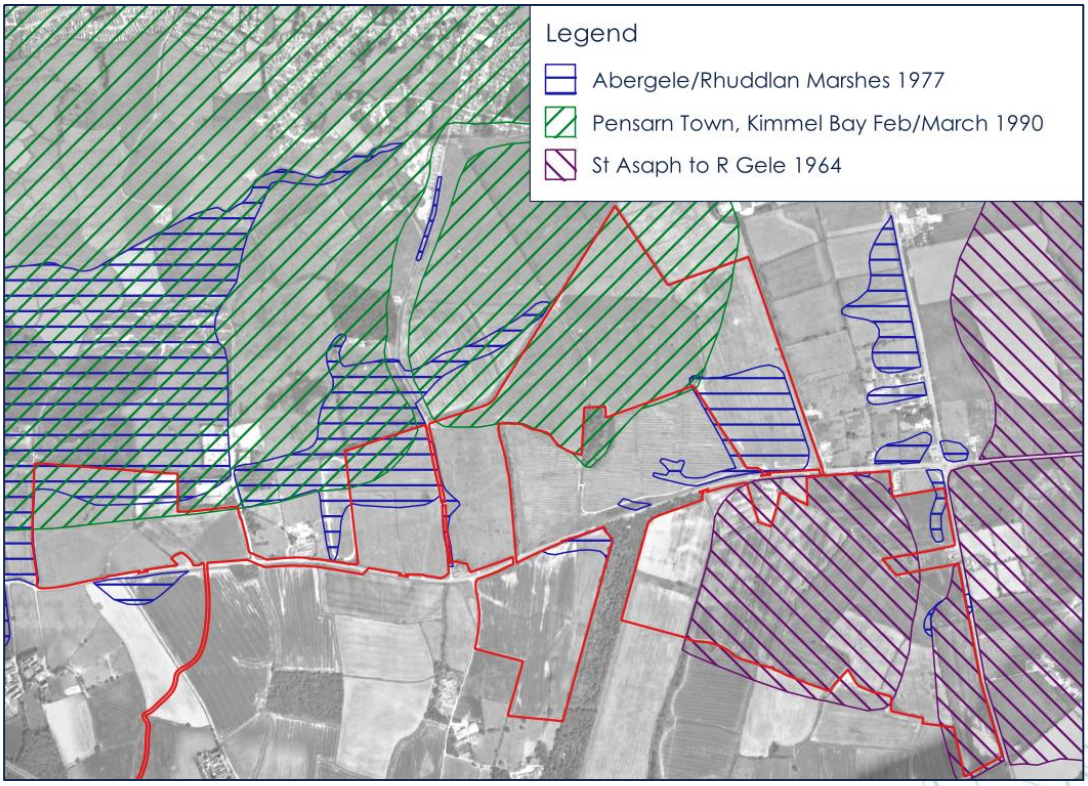
f) Artificial sources – from reservoirs, canals etc.

4.1.2 The policy implications and mitigation are discussed in Section 5.

4.2 Flood History

4.2.1 The NRW Historic Flood Map dataset contains three flood events that affected the southern parcel as shown in Figure 4-1. No further details are provided within the dataset. No record of the events were found in Chronology of British Hydrological Events.

Figure 4-1 Historic Flood Map



4.2.2 The Denbighshire Council Strategic Flood Consequences Assessment (SFCA) notes that the 1990 event was caused by coastal flooding. An internet search reveals that the event was understood to be as a result of defence overtopping during a storm surge event.

4.2.3 No further details of the remaining events were found. It is presumed that the 1964 event was caused by flood waters overtopping the banks of the Afon Clwyd. The 1977 event affected a much smaller area than the other two events and may have been caused by heavy rainfall coinciding with tidelocking or a failure of parts of the local drainage network.

4.2.4 The Afon Gele Flood Risk Study report includes the following information regarding flooding of Abergele.

"The town of Abergele last flooded in July 1971 before the current flood defences in the town had been constructed. The flooding from 1971 was in part due to a car being washed into the Afon Gele and getting stuck at the Bridge Street bridge in the town centre. A video record of the flooding from this event can be found on-line: Watch Abergele Floods - July 1971 online - BFI Player

The current Abergele defences, constructed between 1971 and 2012, have never overtopped."

4.2.5 There are no extents in the Historic Flood Map. It is not known whether such flooding affected land in the vicinity of the site but it is unlikely that the blockage in Abergele resulted in an increase in flooding in this area.

4.3 Flood Map for Planning Flood Zones

4.3.1 The NRW Flood Map for Planning Flood Zones underpin the approach to managing flood risk through spatial planning. The definition of the zones in TAN 15 is reproduced in

4.3.2 Table 4-1.

Table 4-1 Flood Zones Classification

Zone	Flooding from rivers	Flooding from the sea	Flooding from surface water and small watercourses
1	Less than 1 in 1,000 (0.1%) (plus climate change) chance of flooding in a given year		
2	Less than 1 in 100 (1%)but greater 1 in 1,000 (0.1%) (plus climate change) chance of flooding in a given year, including climate change	Less than 2 in 100 (0.5%)but greater 1 in 1,000 (0.1%) (plus climate change) chance of flooding in a given year, including climate change	Less than 1 in 100 (1%)but greater 1 in 1,000 (0.1%) (plus climate change) chance of flooding in a given year, including climate change
3	A greater than 1 in 100 (1%) chance of flooding in a given year including climate change.	A greater than 1 in 200 (0.5%) chance of flooding in a given year including climate change.	A greater than 1 in 100 (1%) chance of flooding in a given year including climate change.
TAN15 Defended Zones	Areas where flood risk management infrastructure provides a minimum standard of protection against flooding from rivers of 1:100 (plus climate change and freeboard).	Areas where flood risk management infrastructure provides a minimum standard of protection against flooding from the sea of 1:200 (plus climate change and freeboard).	Not applicable

Rivers and the Sea

4.3.3 The Flood Map for Planning Flood Zones for Rivers and the Sea the site are presented in

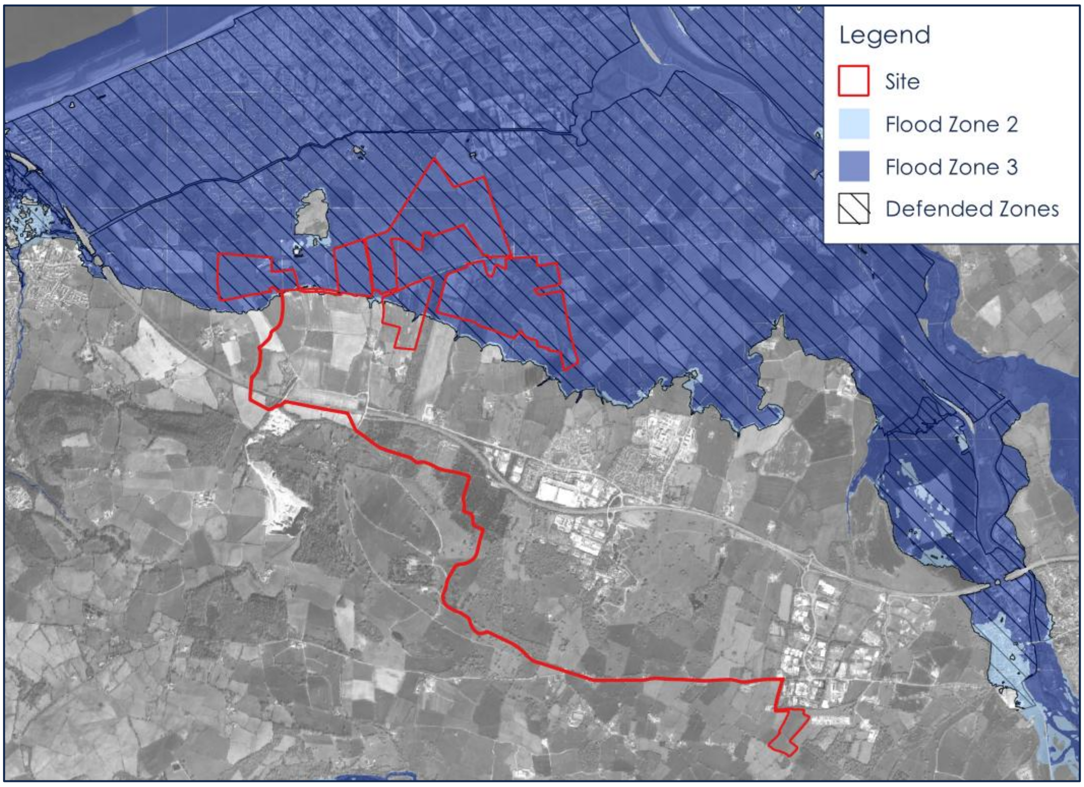
4.3.4 Figure 4-2.

4.3.5 The overwhelming majority of the northern parcel falls within Flood Zone 3. There is a limited area of land at the southern edge adjacent to the A547 which is classified as Flood Zone 2. A very small proportion of the site is designated as Flood Zone 1. This is land which is above approximately 6.7mAOD.

4.3.6 The southern parcel is designated as being entirely within Flood Zone 1.

4.3.7 The land in Flood Zones 2 & 3 is also classified as falling in a Defended Zone. The data in the defends against (defend_ag) field is 'sea' signifying that it is defended against tidal flooding. Flood Risk from various sources is discussed in the following sections.

Figure 4-2 Flood Zones Rivers and Sea and Defended Zones



4.4 Climate Change

Paragraph 10.28 of TAN15 states that a 100 year lifetime should be assumed for dwellings and "75 years is considered a reasonable rule of thumb" for other types of development. However, it also states it is reasonable to consider climate change over the development's lifetime.

"The Flood Map for Planning contains 100-year climate change scenarios. Where new developments will have shorter lifetimes, it is reasonable that the flood consequences assessment focusses on potential risks during the development's expected lifetime." (TAN15 Paragraph 10.29).

4.4.1 The planning application is seeking consent for a development and decommissioning with a 40 year operational lifetime. It is therefore unnecessary to consider climate change impacts beyond this timeframe.

Sea Level Rise

4.4.2 One of the impacts of a changing climate is sea levels are predicted to rise significantly over the next century. As the watercourses are tidally influenced this is relevant for both fluvial and tidal flooding.

4.4.3 The *Adapting to Climate Change: Guidance for Flood and Coastal Erosion Risk Management Authorities in Wales*[1] provides allowances for sea level relative to a 1981-2000 baseline by local authority area. For Denbighshire the sea level rise estimates for 2100 are 0.75m for the 70th percentile and 0.95m for the 95th percentile. For 2120 they increase to 0.98m and 1.29m respectively.

4.4.4 Within Annex 2 it is advised that sea-level rise can be taken from the quoted values in Table 4 or otherwise site-specific values can be obtained directly from the UKCP18 interface. It also states that the 70th percentile (higher central) should be used as a 'design allowance' and the 95th percentile (upper end) should be used in 'sensitivity planning'.

4.4.5 To understand the impact on sea level rise Coastal Flood Boundary data was downloaded from the UKCIP18 for nodes _1126, _1134, for the RCP8.5 scenario.

4.4.6 According to the Coastal Flood Boundary dataset, sea level rise to 2070 is predicted to be 0.36m less than in 2100 in the C2 scenario and 0.48m less than in 2100 in the C3 scenario. It is understood that the C3 and C4 scenarios correspond to the 70th and 95th percentile referenced in NRW guidance.

4.4.7 The location of the CFB nodes is shown in Figure 4-3 peak tidal water levels for key events are presented in

[1] https://www.gov.wales/sites/default/files/publications/2022-11/guidance-for-flood-and-coastal-erosion-risk-management-authorities-in-wales_0.pdf

Table 4-2.

Figure 4-3 Coastal Flood Boundary Nodes

Table 4-2 1 in 200 year event Peak Tidal Water Levels (mAOD)

Scenario	_1126	_1132	_1148
2020	5.45	5.53	5.82
2020_C2	5.46	5.54	5.83
2020_C3	5.48	5.56	5.85
2070	5.77	5.85	6.14
2070_C2	5.82	5.90	6.19
2070_C3	5.96	6.04	6.33
2100	6.05	6.13	6.42
2100_C2	6.14	6.22	6.52
2100_C3	6.41	6.49	6.79

River Flows

4.4.8 Fluvial flooding river flow allowances presented in the *Adapting to Climate Change - Guidance for Flood and Coastal Erosion Risk Management Authorities in Wales*[2] and the *Flood Consequence Assessment: Climate change allowances*[3] documents for West Wales are reproduced in Table 4-3.

Table 4-3 Total Potential Increase in Fluvial Flows for West Wales

Scenario	2020s (2015 to 2039)	2050s (2040 to 2069)	2080s (2070 to 2115)
Upper (90th)	25%	40%	75%
Central (50th)	10%	20%	30%

4.4.9 As the development has a lifetime of 40 years the estimates for the 2050s are appropriate.

Surface Water

Rainfall intensity allowances presented in the *Adapting to Climate Change - Guidance for Flood and Coastal Erosion Risk Management Authorities in Wales* document are reproduced in

[2] https://www.gov.wales/sites/default/files/publications/2022-11/guidance-for-flood-and-coastal-erosion-risk-management-authorities-in-wales_0.pdf
[3] https://www.gov.wales/sites/default/files/publications/2018-11/flood-consequence-assessments.pdf

4.4.10 Table 4-4.

Table 4-4 Total Potential Increase in Rainfall

Scenario	2020s (2015 to 2039)	2050s (2040 to 2069)	2080s (2070 to 2115)
Upper (90th)	10%	20%	40%
Central (50th)	5%	10%	20%

4.4.11 As surface water flooding is less significant than tidal and fluvial flooding for the northern parcel and not a significant risk to development in the southern parcel, the difference between flood risk in 2050s and 2080s is not considered to be significant.

4.5 Defences

4.5.1 The site is protected from flooding from the sea by significant coastal defences. The site also benefits from earth embankments along the Afon Clywd. There are also earth embankments alongside the Afon Gele. The other significant flood risk management assets in the vicinity of the site are the Afon Gele Outfall and the Bodoryn Cut Pumping Station.

4.5.2 The location of defences, culverts and trash screens as contained with NRW datasets is presented in Drawing 24-310-60-002. Key structures in the Afon Gele catchment are shown in Figure 3-6. The impact of failure of key assets is discussed under the blockage and breach subheadingsin the fluvial and tidal flood risk sections.

4.6 Tidal Flood Risk

4.6.1 Tidal flood risk is the most significant risk to the land north of the A547 site. In order to assess the site risk, data from the Point of Ayr to Pensarn study was retrieved from NRW, comprising the following reports and associated model data:

- Point of Ayr to Pensarn Tidal Flood Risk Analysis (2017)
- Point of Ayr to Pensarn Model Development Report (2017)
- Point of Ayr Model Updates (2023)

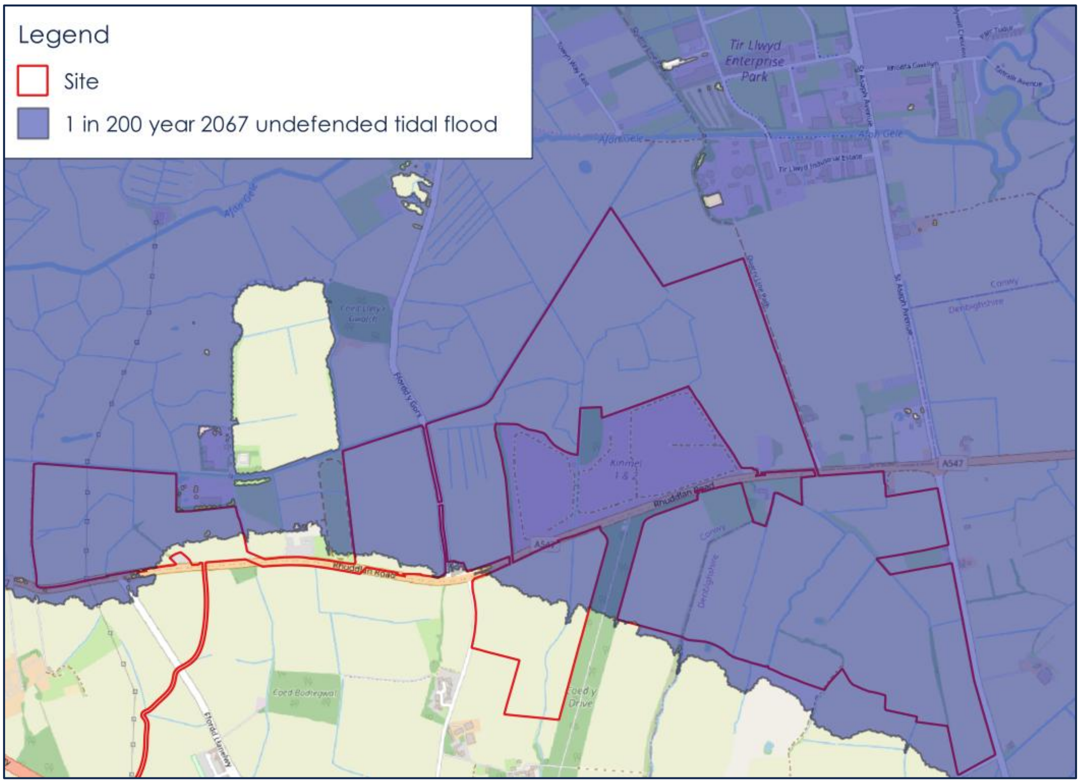
4.6.2 A review of the results reveals that the extent of Flood Zones 2 and 3 in the northern parcel match the 2117 undefended outputs for the 200 year and 1,000 year events respectively as shown in Figure 4-4.

Figure 4-4 Tidal Flood Zones and Modelled Events – Solar Site

Undefended Risk

4.6.3 The Point of Ayr outputs included undefended tidal flood outlines for 2067 which are presented in Figure 4-5. Flooding affects the majority of the northern parcel and is not significantly smaller than the 2117 outlines used to define Flood Zones. 1 in 1,000 year extents for 2067 were not included in the dataset.

Figure 4-5 Undefended 1 in 200 year tidal flood in 2067 – Solar Site



Defended Risk

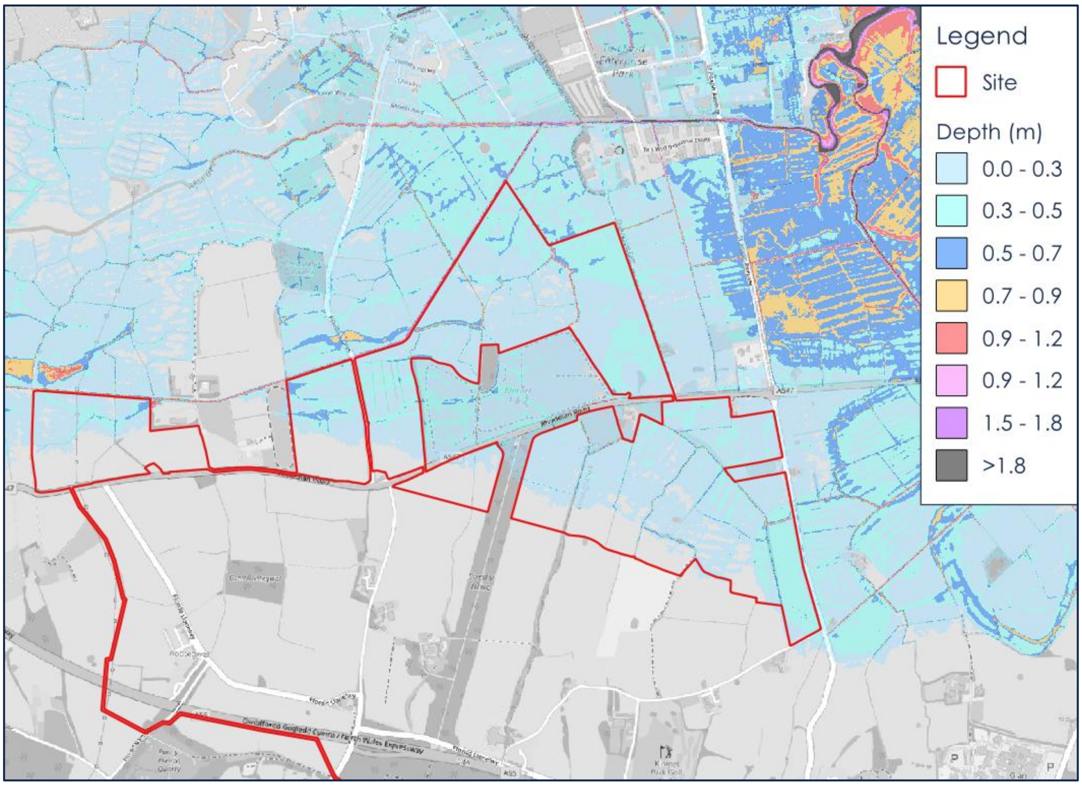
4.6.4 The risk of flooding with defences in place represents the most likely flooding scenario for a given probability event.

4.6.5 The data provided by NRW included maximum depth outputs for the 1 in 200 and 1 in 1,000 year events in 2067 in the defended scenario. During the 1 in 200 year event no flooding of the site is predicted.

4.6.6 During the 1 in 1,000 year event relatively shallow flooding is predicted over large parts of the northern part of the northern parcel (Figure 4-6). The depths are also shown on Drawing 24-310-60-105 in Appendix A.

4.6.7 During this event most of the flooded area is predicted to have depths of below 0.3m and almost the entire site is predicted to have depths of less than 0.5m. Land where depths exceed 0.5m are areas of low-lying land and generally coincident with areas shown to be at risk of surface water flooding. With the exception of watercourses themselves the maximum predicted depth is 0.7m. Elsewhere depths are generally below 0.6m.

Figure 4-6 Defended 1 in 1,000 year in 2067 tidal flood



Breach Risk

4.6.8 The Point of Ayr to Pensarn modelling study included simulations of five distinct beach scenarios. The breach that produces the worst-case flooding on the site is breach of the Afon Gele outfall.

4.6.9 This structure is a tidal outfall which prevents tidal ingress into the Afon Gele catchment. The structure is approximately 15m wide and sits within the tidal flood defence embankments which themselves are about 2m high. The simulations remove the structure and adjacent banks entirely to a total width of 50m. This is the standard approach but is an unrealistic scenario. Breach outputs were produced for the 1 in 200 year event for the 2097 and 2115 scenario.

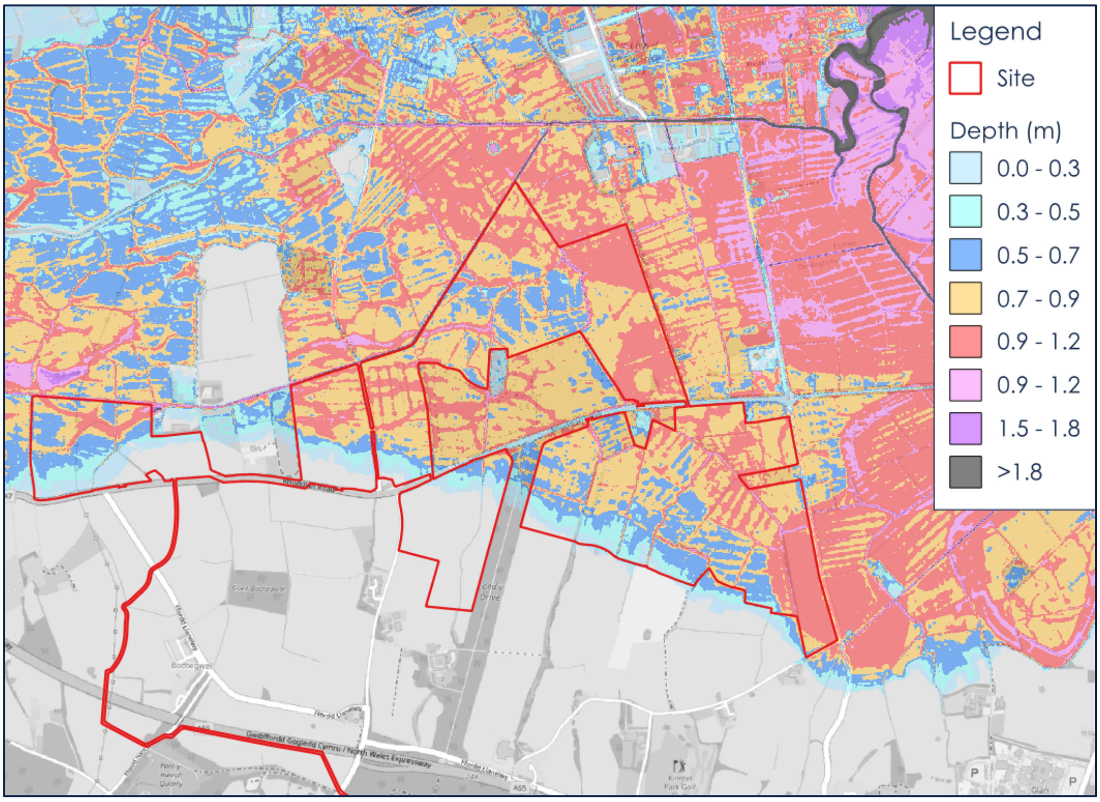
4.6.10 As the proposed development lifetime is for 40 years breach simulations were carried out for 2070, beyond the lifetime of the scheme to ensure a conservative assessment. The model was acquired under licence from NRW and modified to represent predicted sea-level rise to 2070. This comprised changing the tidal boundaries for the model so the peak values matched the values extracted from the CFB dataset presented in

Table 4-2. This resulted in a reduction of approximately 0.3m for the 1 in 200 year 70th percentile and approximately 0.4m for the 1 in 200 year 95th percentile.

4.6.11 The model also includes overtopping volumes derived using the SWAN model. For the sake of expediency, the overtopping data from the existing model from the 2097 scenario were adopted. The overtopping does not have a significant impact on flood levels on the site and it is therefore not necessary to derive equivalent inputs for 2070, which would be smaller and if anything reduce the severity of flooding on site.

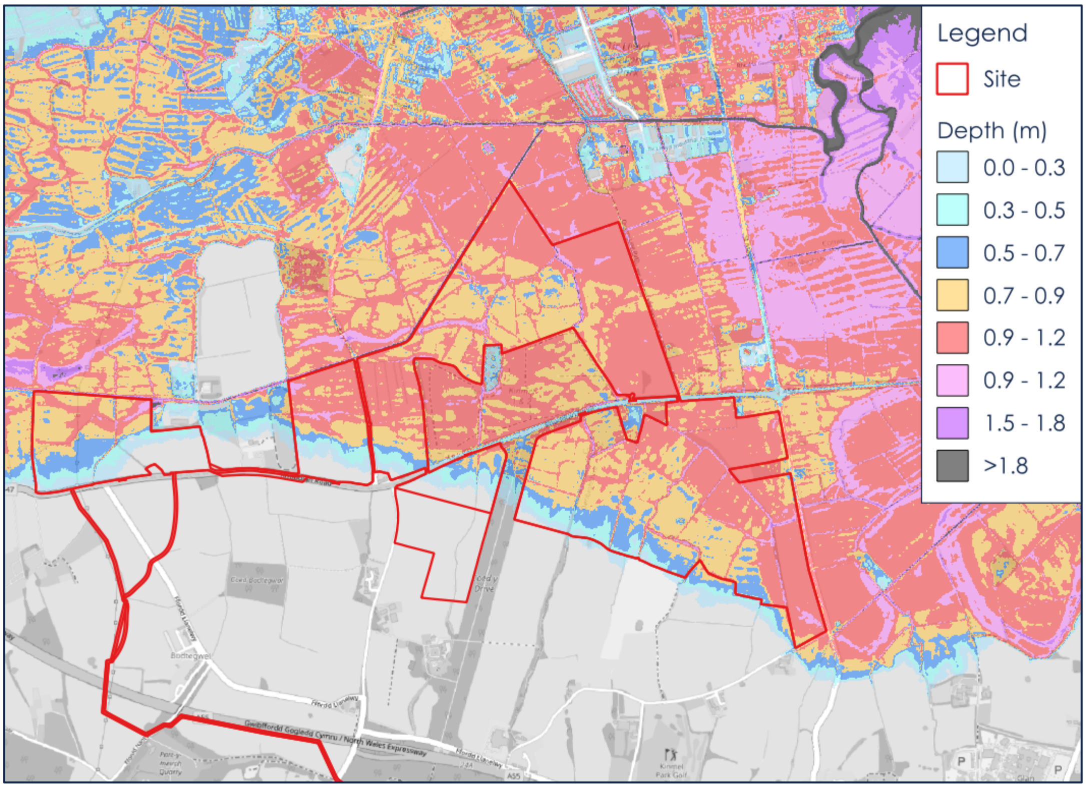
4.6.12 The results of the 2070 70th percentile 1 in 200 year Gele Outfall breach are presented in Figure 4-7 and Drawing 24-310-60-100 in Appendix A. The breach results in extensive flooding of the northern parcel. With the exception of watercourses, the maximum depth is 1.25m in the northeastern corner of the westernmost field. Elsewhere depths are below 1.1m. The southern parcel is unaffected.

Figure 4-7 1 in 200 year 70th Percentile Gele Outfall Breach, Year 2070 Flood Depths



4.6.13 The results of the 2070 95th percentile 1 in 200 year Gele Outfall breach are presented in Figure 4-8 and Drawing 24-310-60-101. Flood levels are approximately 0.1m higher but depths generally remain below 1.2m.

Figure 4-8 2070 95th Percentile Gele Outfall Breach 1 in 200 year Flood Depths



4.7 Fluvial Flood Risk

4.7.1 The Rivers Flood Zones define the parts of the site to be in Flood Zones 2 and 3, based on the undefended risk during the future 1 in 100 and 1 in 1,000 year events (Figure 4-9). Land to the south of the A547 is predominantly within Flood Zone 3. Land to the north of the A547 is predominantly within Flood Zone 2. The southern parcel is in River Flood Zone 1 (Figure 4-10) and is not discussed further in this section.

4.7.2 In order to assess the risk of fluvial flooding to the site the latest model reports and outputs were requested from NRW. NRW provided outputs for the following models:

- St Asaph - Various Studies (2018-2021)
- Afon Gele Flood Risk Study (2024)
- Afon Gele Model Users Report (2024)
- Ffynon-y-Dol Model Flood Risk Study (2023)

Figure 4-9 Fluvial Flood Zones – Solar Site

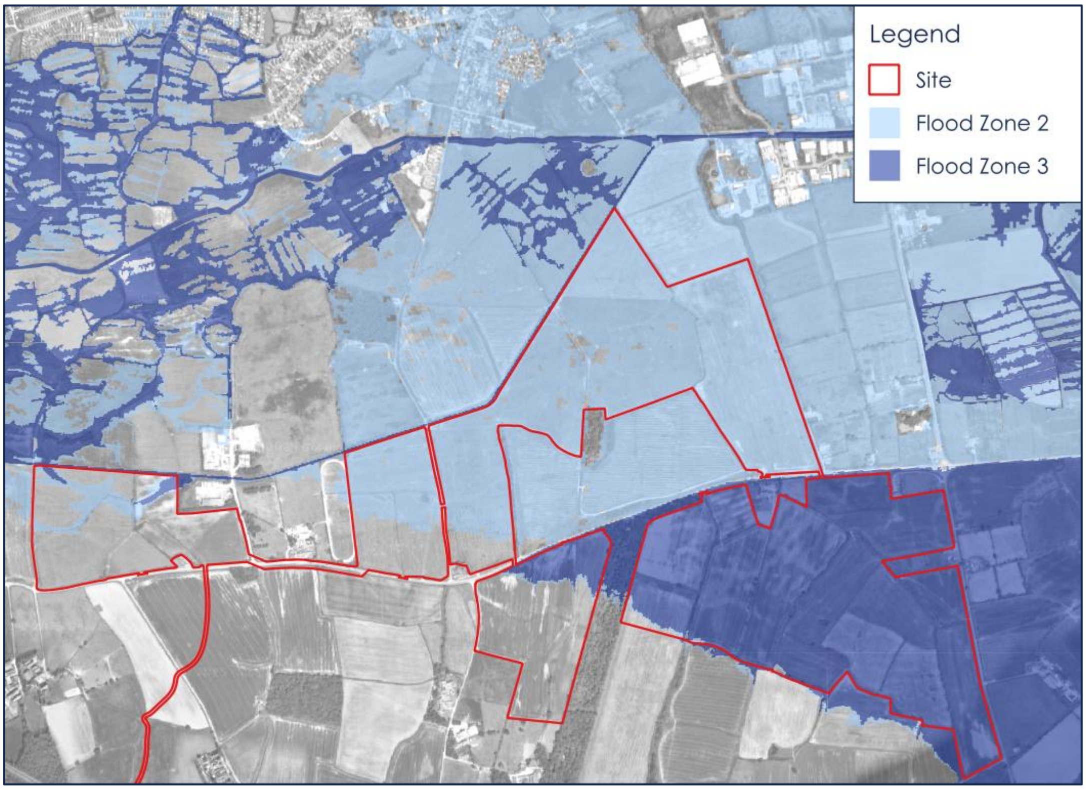
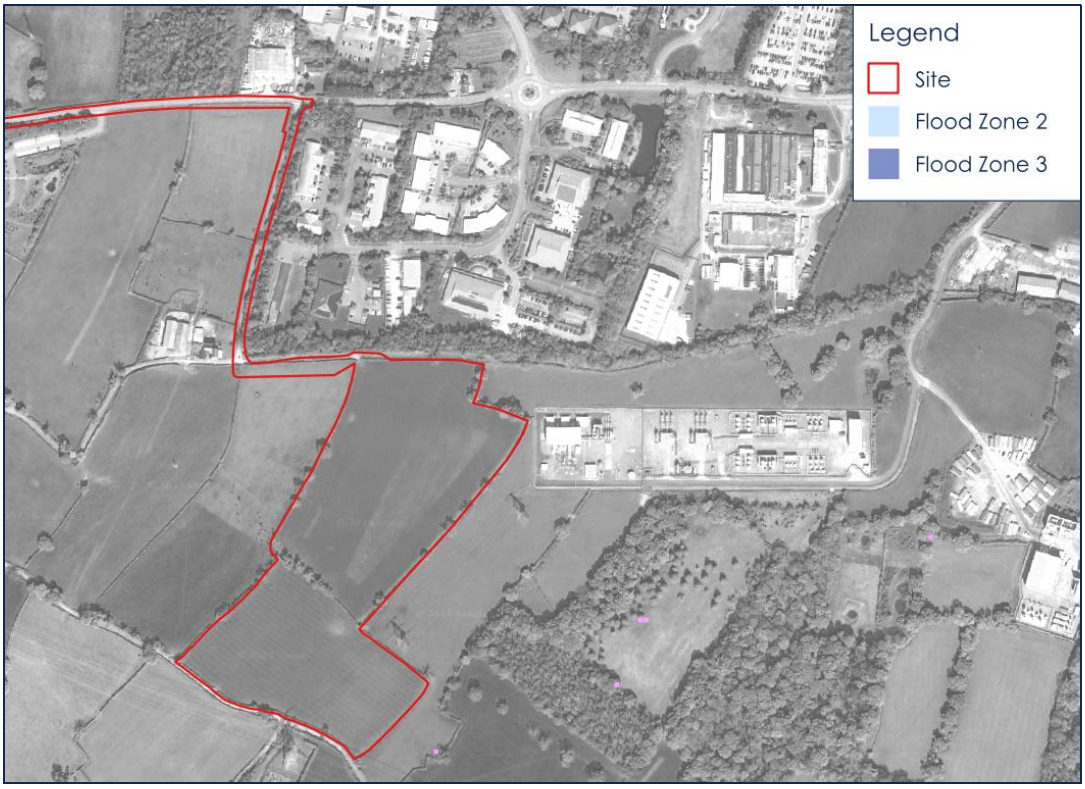


Figure 4-10 Fluvial Flood Zones – BESS Site



St Asaph Model

4.7.4 The St Asaph Model data package included the following reports**Error! Reference source not found.**:

- St Asaph Flood Risk Management Scheme - Hydraulic Modelling Report (2018).
- St Asaph update for FRAW (2020).
- St Asaph FMfP Climate Change Report (2021).

4.7.5 The model simulates flooding from the Afon Elwy and the Afon Clwyd. The St Asaph update for FRAW (2020) states that:

"After discussions within the Flood Risk Analysis team, the decision was made to cut the model at the A547 and rely on the Gele and Ffynnon Y Ddol models to represent the area".

4.7.6 The St Asaph FMfP Climate Change Report states that the climate change has been accounted for by increasing flood flows by 30%. This is equivalent to the latest climate change guidance for the central estimate for the 2080s (2070-2115).

4.7.7 Sea level rise has been accounted for by increasing tidal levels by 0.9m which was *"taken from Table 4 of the Adapting to Climate Change Guidance, based on the 70th percentile mean sea level rise by 2120 for the Denbighshire local authority area"*. It is presumed that the divergence from the 0.98m value in the latest guidance is because the base data is taken from beyond 2000. 2120 is far beyond the design life of the scheme and consequently these flood levels will overestimate flooding at the site at the end of its lifetime.

4.7.8 To the south of the A547, the undefended future 1 in 1,000 year and 1 in 1,000 year outputs are coincident with the extent of Rivers Flood Zones 2 & 3, respectively. The model does not extend beyond the A547. The risk from the Afon Gele is discussed in the following section.

4.7.9 The St Asaph model outputs do not predict flooding to the site in a 1 in 100 year +30% climate change flood when accounting for defences (Figure 4-11). Although the model does not extend beyond the A547, in reality, some water would flow into the local drainage network. Given the shallow depths predicted in the vicinity of the site it is expected that water would drain via the Sarn Cut to the Afon Gele to the north and not affect the site.

4.7.10 During a defended future 1 in 1,000 year +30% flood levels to the west of the site are approximately 0.7m higher and the model predicts widespread flooding to land to the south of the A547. Depths on the site are generally below 0.9m and the maximum depth beyond the watercourses is 1.1m (Figure 4-12 and Drawing 24-310-60-103 in Appendix A). The model level data indicates that flood water would overtop the A547 from approximately 400m to the east of the development all the way to the junction with the A525 approximately 2.5km to the east of the development. In the west the road is predicted to flood to depths of up to 0.4m.

Figure 4-11 St Asaph Model – Defended 1 in 100 year +30% Flood Depth

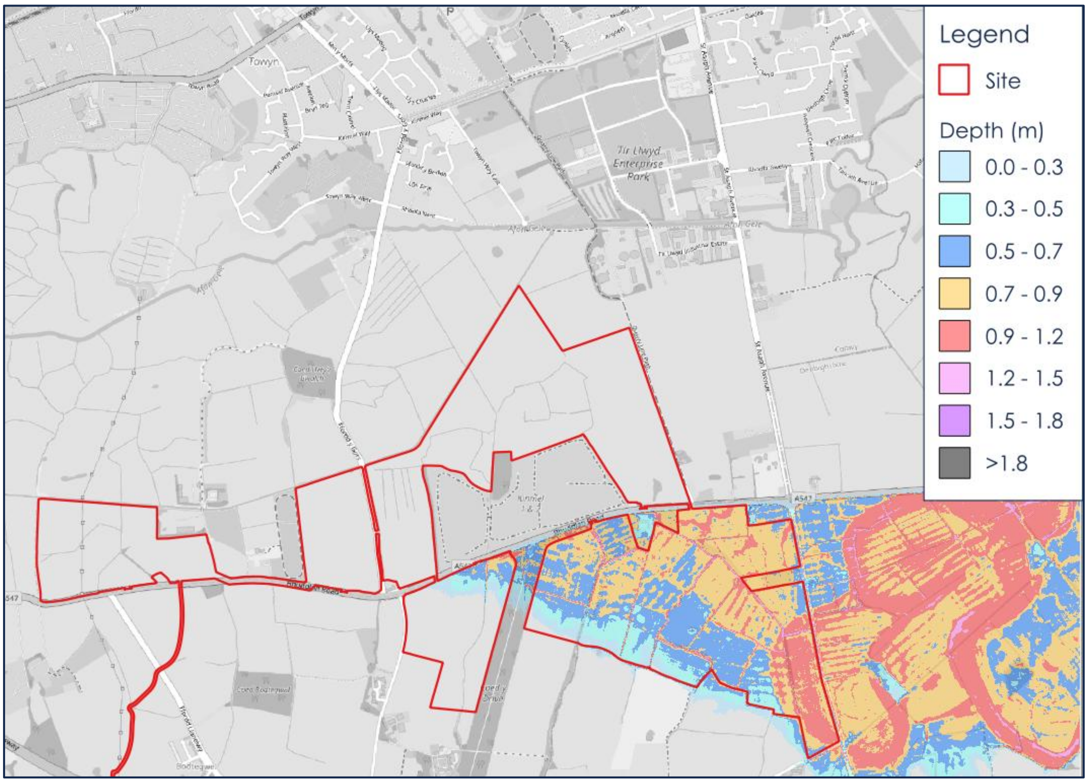
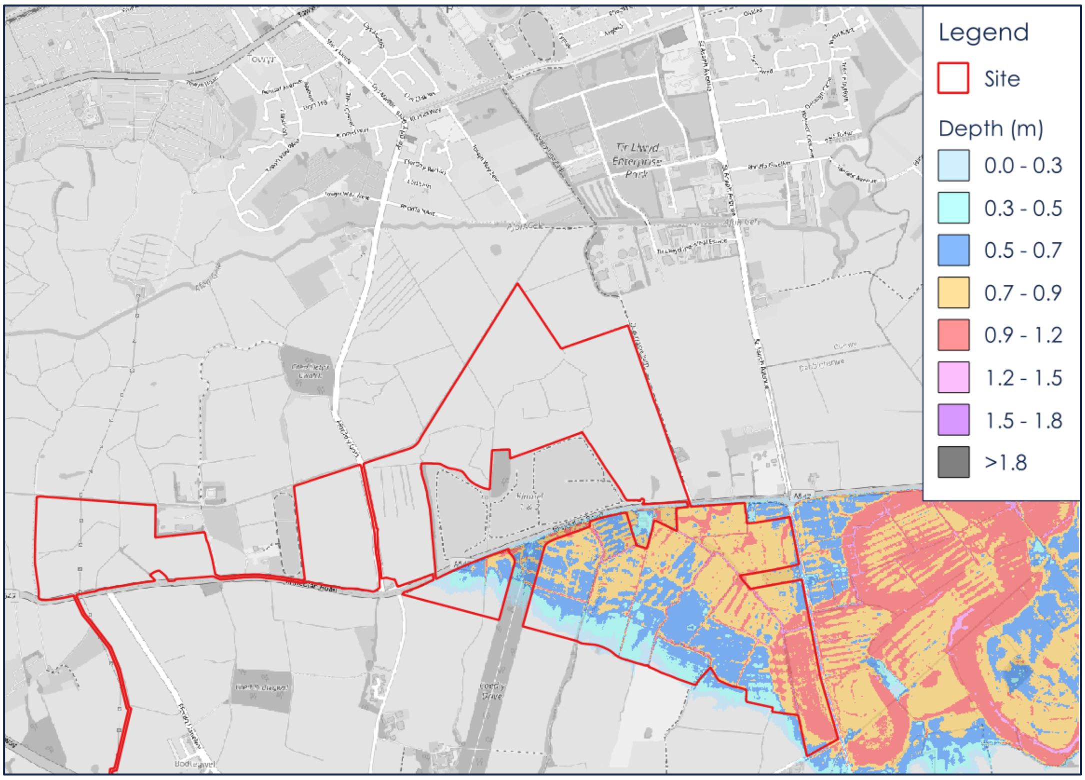


Figure 4-12 St Asaph Model – Defended 1 in 1,000 year +30% Flood Depth



4.7.11 It is not unreasonable to assume widespread flooding of land to the south of the A547 would occur. However, it is considered unlikely that flooding of the site would be worse than the predicted tidal future 1,000 year event. In order for significant flood waters to flood land in the vicinity of the northern part of the site, water would first have to overtop the A547 and then subsequently reach a level high enough to overtop St Asaph Avenue. Before this occurs a huge area of land would need to flood as it does in the modelled tidal scenario.

Blockage or Breach

4.7.12 There are no blockage or breach simulations to represent these flooding mechanisms. It is considered unlikely that the failure of a section of embankment on the River Clwyd would result in worse flooding than predicted during the future tidal flood with a breach of the Afon Gele.

Afon Gele Model

4.7.13 The Afon Gele model assesses flood risk from the Afon Gele, the Bodoryn Cut and the Sarn Cut as show in the 'Figure 1-1 – Study Area and main features' of the Afon Gele Flood Risk Study Overview of Flood Risk Report (reproduced in Figure 4-13).

Figure 4-13 Afon Gele Study Area

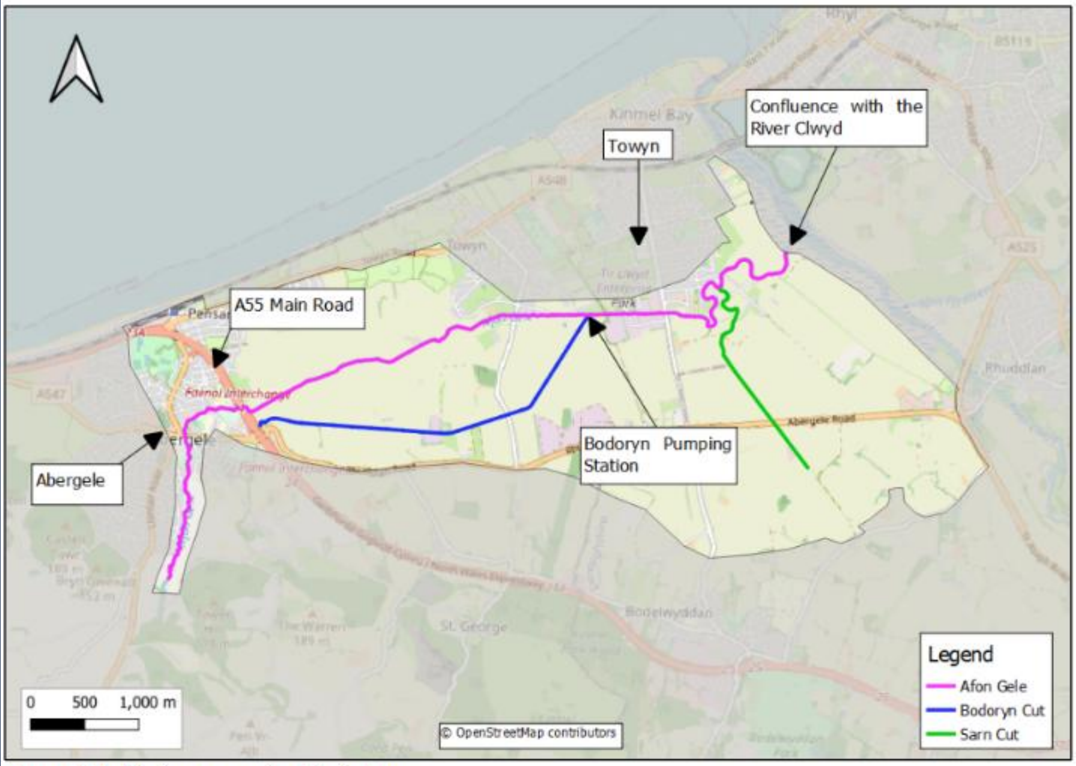


Figure 1-1: Study area and main features

4.7.14 The Afon Gele Model data package included the following reports**Error! Reference source not found.**:

- Afon Gele Flood Risk Study Overview of Flood Risk Report (2024)
- Afon Gele Model Users Report (2024)
- Afon Gele Flood Estimation Calculation Record (2022)

4.7.15 Climate change was accounted for by increasing flows by 30% and tidal levels by 0.91m to account for sea level rise "over the next 100 years" equivalent to the parameters used in the St Asaph study for a future date of 2120. The Afon Gele discharges to the Clwyd Estuary and therefore gets tidelocked in certain conditions. The proposed development lifetime is 40 years and consequently the model will overestimate flooding at the end of the development's lifetime.

4.7.16 There are embankments alongside the Afon Gele but as note in the *Afon Gele Flood Risk Study Overview of Flood Risk Report*.

"Much of it is embanked as part of an extensive man-made drainage system to convert the land to farmland (mainly grazing). Flooding in this area from the overtopping of sections of embankment is frequent."

4.7.17 Consequently, the defences are unlikely to afford significant flood risk benefits to the site. The data package did not include any undefended outputs.

The defended 1 in 100 +30% flood depths are presented in

4.7.18 Figure 4-14 and Drawing 24-310-60-102. The majority of the site is unaffected. There is some flooding north of the A547 from the Afon Gele Bodoryn Cut. Depths do not exceed 0.3m except where there are watercourses and low-lying land in the west. The maximum depth is 0.6m in the northeastern corner of the westernmost parcel. Flood waters from the Sarn Cut do not reach the site.

4.7.19 The defended 1 in 1,000 +30% flood depths are presented in Figure 4-15 and Drawing 24-310-60-104 in Appendix A. Flood levels are approximately 0.1m higher and depths for the majority of the site remain below 0.3m. Low-lying land in the westernmost parcel floods to depths of up to 0.7m. No flooding is predicted to the site south of the A547.

Blockage or Breach

4.7.20 The modelling included simulations of 25%, 50% and 80% blockages of three structures. The worst-case scenario is a 80% blockage of the Faenol Avenue Culvert (location shown on Drawing 24-310-60-002 in Appendix A). In the 1 in 100 year +30% event this scenario results in flood levels on the site increasing by approximately 0.1m. The predicted depths are shown in Figure 4-15.

Figure 4-14 Afon Gele Defended 1 in 100 year +30% Depths

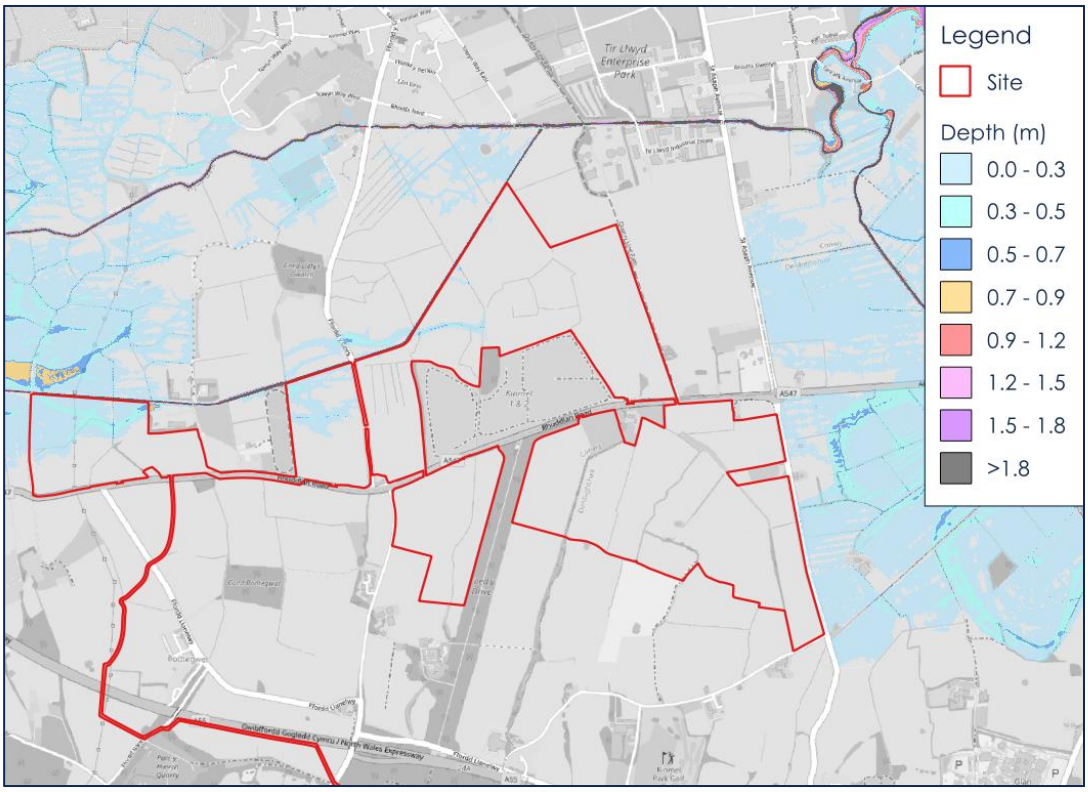
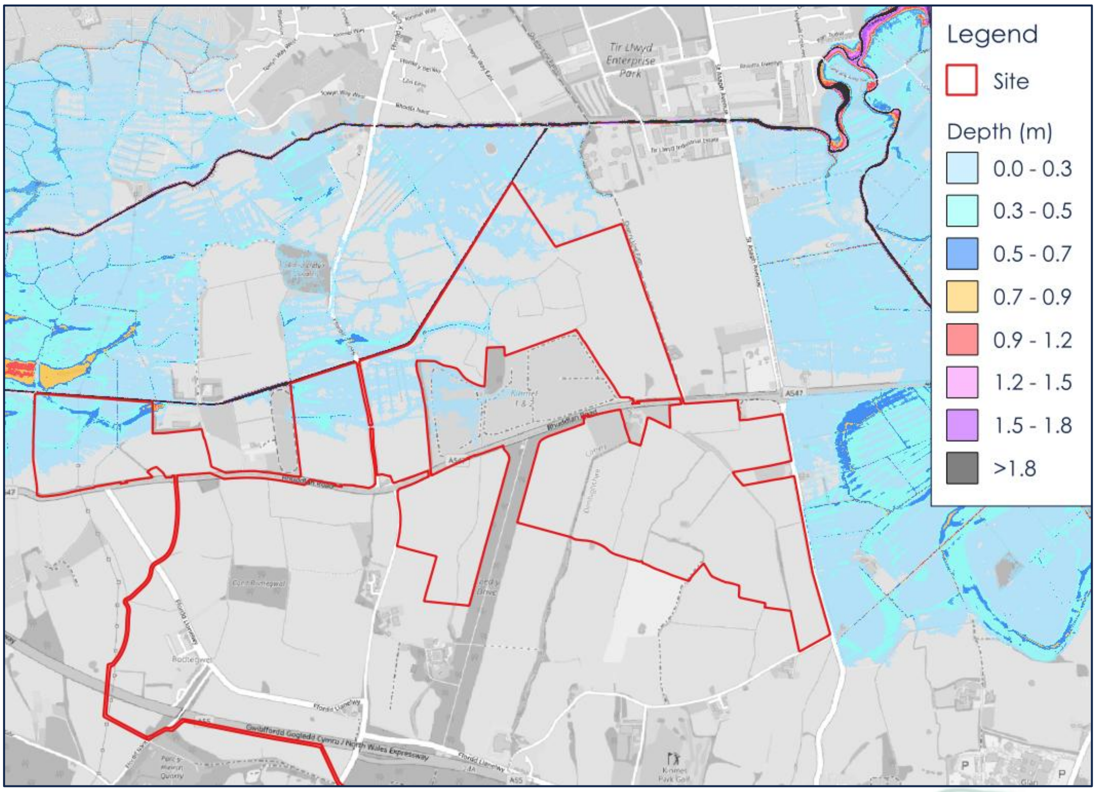


Figure 4-15 Afon 80% Blockage of Faenol Avenue Culvert 1 in 100 year +30% Depths



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4.7.21 There are other structures in the vicinity of the site which could present a risk of flooding should they become blocked. These structures area shown in Figure 3-6. Blockage of these structures have not been simulated as part of the modelling study.

4.7.22 The most upstream culvert on the Bodoryn Cut is the agricultural access. Upstream of this access LiDAR records the right (southern) bank to be 0.2-0.6m higher than the left (northern) bank. In the event of a blockage water would preferentially flow to the north away from the site which would tend to reduce flooding on site.

4.7.23 Downstream of this location, structures on the Bodoryn Cut are larger and sources of debris are limited so blockage is unlikely. The smallest of these structures is the Gors Lane crossing over the Bodoryn Cut, which is an arch opening 2.97m wide and 1.4m high. Nonetheless the upstream catchment is agricultural with very few trees so debris loading during a flood event is likely to be limited.

4.7.24 During a blockage, additional water is expected to preferentially overtop the right bank and flood the parcel upstream of Gors Lane. However, in the simulated future 1 in 1,000 year event the water level in the fields immediately to the north and south of the Bodoryn Cut is 4.12mAOD and overtops Gors Lane approximately 250m north of Bodoryn Cut. It is expected that during a blockage the water level would not rise significantly above this, in the order of 0.1m. During the simulated future 1 in 100 year plus climate change event depths in the field upstream of Gors Lane are less than 0.3m so peak depths are unlikely to exceed 0.5m.

4.7.25 Blockage of structures on the Afon Gele are unlikely to occur given surrounding land use is agricultural with limited trees and flows from the urban areas of Abergele have to pass through numerous smaller structures (A55 road culvert, Forrd y Morfa culvert, Faenol Culvert) before reaching this area. Should a blockage occur it is unlikely to have a significant effect on flooding on the site given the extensive flooding present in the simulated future 1 in 1,000 year flood.

4.7.26 Blockage of structures on the Sarn Cut is also unlikely given the agricultural nature of the catchment. Blockage of the A547 road culvert would result in water levels increasing upstream, but given St Asaph Avenue is raised above the simulated 1 in 1,000 year flood level and there is a vast area of flooding in this event any flooding of the site in such an event is expected to be minor.

4.7.27 In summary, the risk of flooding from blockage is unlikely to be severe and in any case is unlikely to exceed predicted flooding during the tidal defended event for land to the south of the A547 or the fluvial defended event for the land to the north of the A647 and therefore the mitigation put in place to manage these events would also effectively manage the risk of flooding from the Afon Gele, Bodoryn Cut and Sarn Cut should there be a breach of defences or blockage of cuvlerts.

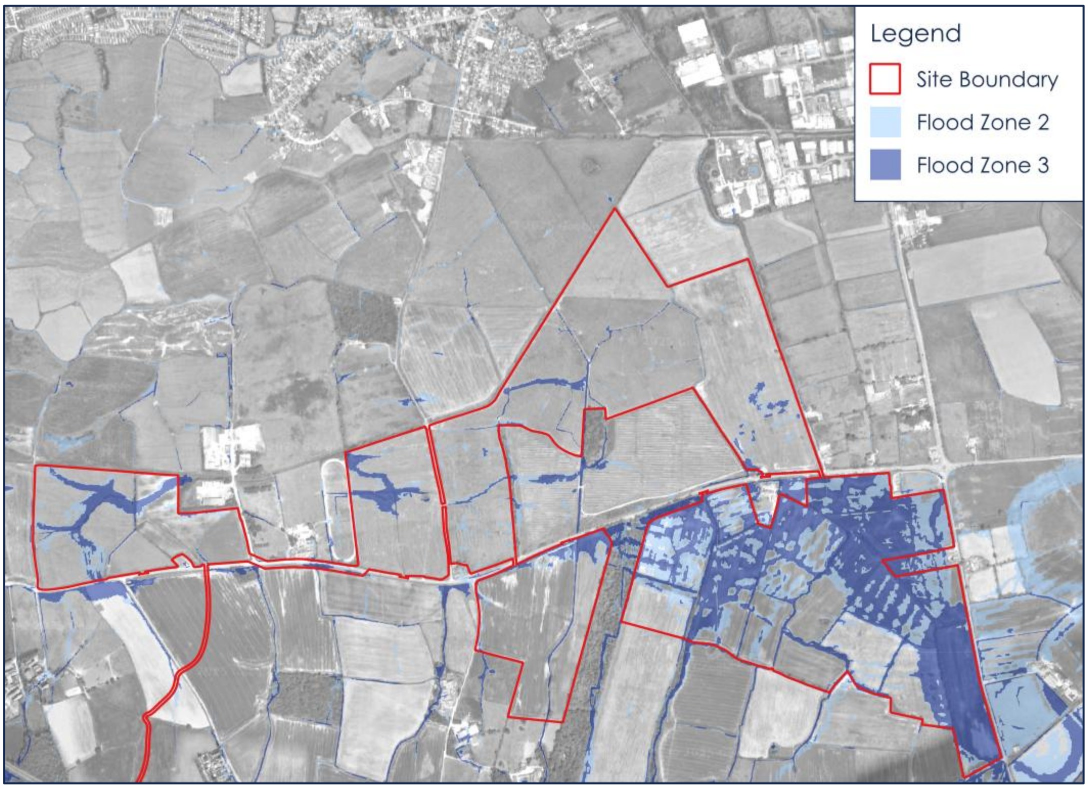
Ffynon-y-Dol Model

Ffynon-y-Dol Model simulates flooding associated with the Ffynon-y-Dol, Pensarn Drain and Holland Drive Drain. These are located to the north of the Afon Gele and flooding from these watercourses does not affect the site.

Small Watercourses and Surface Water

4.7.28 The Small Watercourses and Surface Water Flood Zones for the north site are shown in Figure 4-16 & Figure 4-17. The data attributes indicate the source is from pluvial mapping from 2018 and consequently represents the risk from heavy rainfall.

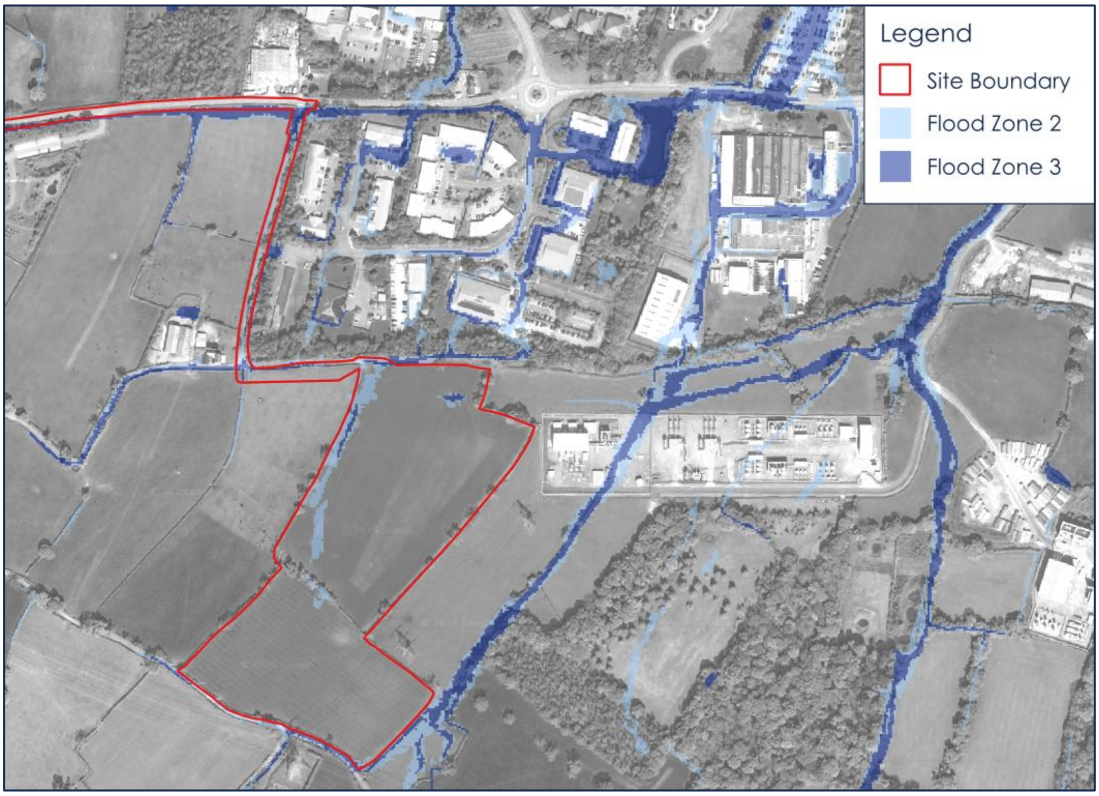
Figure 4-16 Flood Zones Small Watercourses and Surface Water – Solar Site



4.7.29 Large parts of the northern parcel are classified as Flood Zone 2 and Flood Zone 3. To the north of the A547 these areas coincide with low-lying ground. This area is served by an extensive network of watercourses which discharge via the Bodoryn Pumping Station. Due to the high-level modelling methodology, the capacity of this network is likely to be significantly underestimated and the resultant flooding overestimated.

4.7.30 To the south of the A547 flooding is more widespread. It appears that water is trapped in these areas by the A547 to the north and St Asaph Avenue to the east, both of which are raised above surrounding ground levels. In reality, the drains in this area are part of an extensive network. It appears that these drain to the Sarn Cut via culvert/s under St Asaph Avenue.

Figure 4-17 Flood Zones Small Watercourses and Surface Water – BESS Site



4.7.31 Surface water from higher ground to the north is shown to flow in a easterly direction along the minor road on the site's southern boundary indicating that flooding on the site is caused by rain falling on the site itself. This would be managed as part of the development's drainage infrastructure.

4.8 Groundwater Flooding

4.8.1 The site ground conditions are not considered to be conducive to groundwater emergence. Although there are water bearing rocks under the southern parcel the Afon Gele catchment is drained by an extensive network of drains and consequently groundwater levels are unlikely to rise significantly above ground levels.

4.8.2 At this stage, the risk of flooding from groundwater is therefore assessed as being **Very Low**. Mitigation put in place to manage fluvial and tidal flooding will effectively mitigate this risk.

4.9 Flooding from Sewers

4.9.1 Given the rural setting of the site, it is unlikely there are any significant sewers located within the vicinity of the site to generate sewer flooding. Therefore, the risk of sewer flooding to the site is considered to be **Negligible**.

4.10 Flooding from Artificial Sources

4.10.1 None of the site is shown to be at risk on the NRW Flood and Coastal Erosion Risk Maps[4]. Flood risk from reservoirs is not considered further. No other artificial sources of flooding have been identified.

4.10.2 The development is considered to be at **Negligible** risk of flooding from reservoirs, canals and artificial sources.

4.11 Flood Risk Summary

Actual Risk

4.11.1 The southern parcel is not considered to be at significant risk of flooding from any source.

4.11.2 The principal sources of flood risk for the northern parcel are fluvial and tidal flooding. The northern parcel benefits from significant coastal and fluvial defences and consequently is not at risk during a future 1 in 200 year tidal event or a future 1 in 100 year flood from the Afon Clwyd. Parts of the northern parcel are at risk of flooding during a future 1 in 1,000 year flood from the Afon Gele. Peak depths during this event are 0.6m which is not a significant impediment to solar development.

4.11.3 During an extreme, future 1 in 1,000 year tidal flood land to the north of the A547 is shown to be at risk of flooding to depths of generally below 0.5m. There are limited areas where depths are in the 0.5m to 0.7m range, this is not an issue for solar arrays.

4.11.4 During an extreme, future 1 in 1,000 fluvial event significant flooding from the Afon Clwyd is predicted to affect the southern part of the northern parcel. A large proportion of this area is affected to depths of over 0.5m and maximum depths are 1.1m. Solar arrays can be designed to mitigate this but due to landscape and visual constraints some enabling infrastructure may be affected by such an event.

4.11.5 The northern parcel is shown to be at risk of surface water flooding. This area is served by an extensive drainage system which is not represented by the surface water flood map. Flooding is likely to be confined to depression within the site or otherwise shallow and in any case not worse than the predicted fluvial or tidal flooding.

Risk from Defence Failure and Blockage

4.11.6 The northern parcel is at risk of failure of defences. The simulation of a catastrophic loss of the Gele Outfall structure and adjoining banks during the peak of a future 1 in 200 year tidal flood predicts significant tidal flooding of the site. This is an extremely unlikely scenario. Flooding is almost entirely below 1.2m during the future 1 in 200 year breach event even when accounting for the 95th percentile prediction for sea level rise to the end of the development's lifetime.

[4] https://flood-risk-maps.naturalresources.wales/?locale=en

4.11.7 The risk of flooding in the event of blockage of structures on the Afon Gele, Bodoryn Cut and Sarn Cut has been assessed with respect to the nature of the catchment and size of structures. Although blockage would result in an increase in water levels in some areas, the effect is unlikely to be large and measures put in place to manage the risk of flooding from the Clwyd and from the sea should be sufficient to manage these risks.

4.11.8 There are no model outputs which considered the failure of defences on the Afon Clwyd during a fluvial event but is considered unlikely that such scenarios would result in more significant flooding than the breach considered as part of the tidal modelling.

4.12 Safe Access and Egress

4.12.1 The solar farm will be controlled remotely and only visited occasionally for maintenance operations. Consequently, there will be no requirement for site access or egress during times of flood.

4.12.2 The entire site falls within the 'Clwyd Left Bank' Flood Warning Area. Site operatives should sign up to the Flood Warning and Flood Alerts service. They should also sign up for notifications of extreme weather from NRW, the Met Office, the BBC and local news services.

4.12.3 If flooding is expected any planned site visits would be postponed.

4.12.4 The flood conditions described in this report presume extreme flooding either occurs with the defences in place or that extreme flooding coincides with a breach or failure in the defences. Extreme flooding, particularly tidal which presents the most significant risk to the site, typically require stormy or inclement weather systems to coincide with spring high tides. Both high tides and low pressure weather systems are normally well forecast.

4.12.5 The above means it is reasonable to presume that the site would be closed, with visitations postponed, for the duration of a design flood event. Consequently, regardless of whether a breach occurs or not, the site would be free from operatives for the duration of a flood event.

5 PROPOSED DEVELOPMENT AND POLICY IMPLICATIONS

5.1 Proposed Development

5.1.1 The main components of the Proposed Development are:

- Rows of solar photovoltaic (‘PV’) panels and mounting systems;
- Solar Power Conversion System (‘PCS) i.e. inverters and transformers
- Switchroom building(s)
- BESS equipment comprising battery units, PCS and associated infrastructure;
- Substation and transformer compound and associated equipment;
- Underground electrical cable route corridor;
- Internal access tracks;
- Perimeter fencing, gates, CCTV cameras and other ancillary infrastructure including fire suppression systems / water storage tanks;
- Landscape planting and ecological enhancements;
- Drainage; and
- Temporary construction compounds

5.1.2 In order to facilitate ongoing NRW maintenance activities, there would be no built development within 5m of the top of bank of an Ordinary Watercourse and 8m from top of bank of a Main River or toe of formal flood defence structure.

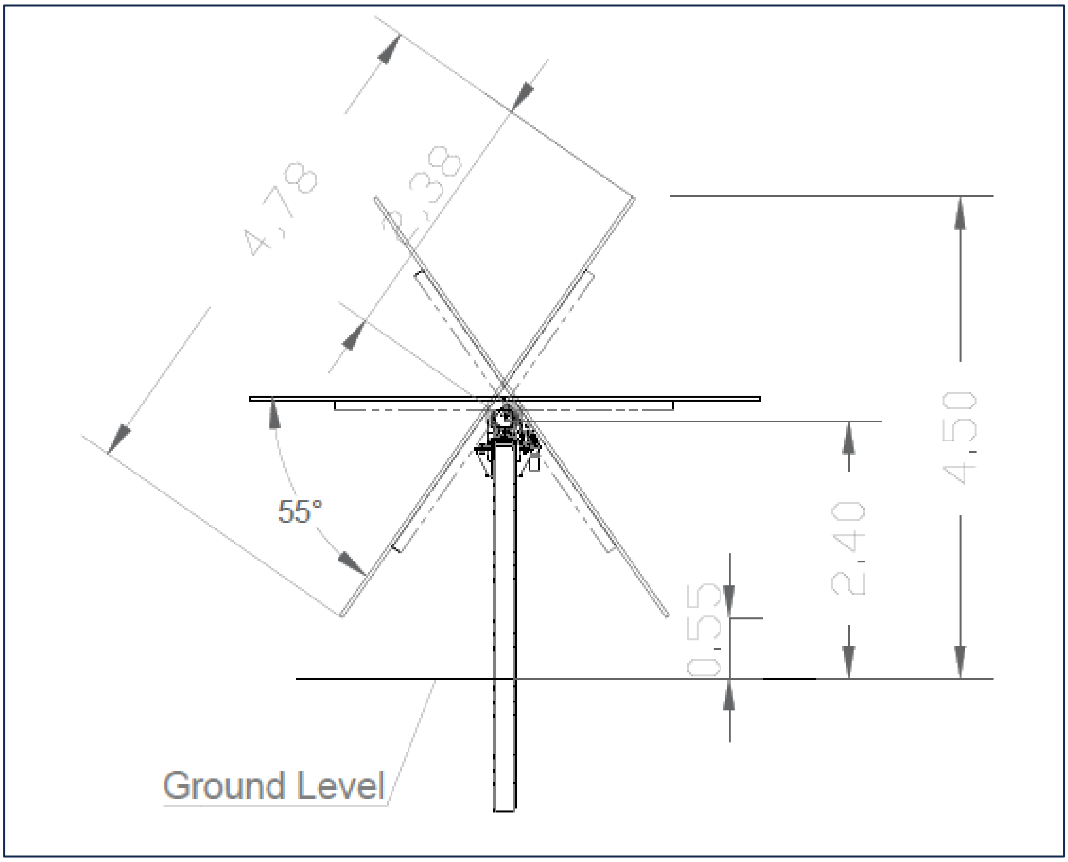
5.1.3 Solar panels will be tracker panels which tilt and rotate to maximise solar energy generation. The typical arrangement for these panels is shown in

5.1.4 Figure 5-1. The lowest edge of the panels will either at least 0.55m above ground when in full declination. Their default position is to be stowed (laid horizontal). In this configuration sensitive equipment will be approximately 2.4m above ground levels.

5.1.5 Within the Solar Site, there will be containerised Power Conversions Systems (PCS) distributed throughout t. These will be raised up to 0.5m above ground levels to mitigate flood risk. A 33kv sub-distribution switchroom will be located in east part of Parcel 1 north of the A547.

5.1.6 The substation and Battery Energy Storge System will be located at the BESS Site.

Figure 5-1 Tracker Panel Arrangement



5.1.7

5.1.8 Access tracks will be constructed with permeable granular material. Where practicable, these access tracks will utilise or improve existing watercourse crossings.

5.1.9 The site layout and landscape masterplan plan are included in elsewhere in the planning submission.

5.2 Flood Risk Mitigation

5.2.1 The only infrastructure proposed in areas at risk of flooding are solar panel arrays and PCS. The 33kv switchroom located in eastern part of parcel has been located outside the areas at risk.

5.2.2 The panel heights will be set so that when resting flat (the default position) they would be above the predicted defended 1 in 1,000 year fluvial and tidal flood levels as well as the breach flood depths.

5.2.3 The breach location assessed in this report and associated modelling work is located approximately 2km from the site and consequently the site is unlikely to suffer from rapid inundation in the extremely unlikely event of a breach coinciding with the peak of a future 1 in 200 year tidal flood.

5.2.4 Supporting containerised infrastructure distributed throughout the solar generation area will be set up to 0.5m above ground level where necessary for flood risk reasons. This is sufficient to mitigate flooding from future defended 1 in 1,000 year tidal flood and future 1 in 100 year fluvial flood from the Afon Clwyd and Afon Gele.

5.2.5 However, due to operation reasons, it is likely that some PCS will need to be placed in areas where flood depths during the future 1 in 1,000 year flood will exceed 0.5m.

5.2.6 During a breach event more containerised infrastructure would be below the flood level. However, the probability of a 1 in 200 year flood occurring during a 40 year window is 19% and the probability that 50m section of defences disappears during the peak of this event is very small (furthermore in most of those 40 years sea level would be much lower than predicted in the simulation). In combination this scenario is incredibly unlikely and therefore not likely to have a material impact in the site's energy production.

5.2.7 Furthermore, given the site would not be occupied during a future 1 in 200 year tidal flood coinciding with a breach, the only likely risk is damage to, our outing of, PCS. These could be isolated in advance of an event to reduce the impact of them being damaged. Finally, it should be noted that the risk that PCS failure results in loss of generation rests with the operator.

5.2.8 Nonetheless, to mitigate the breach scenario, it is proposed for the inverter PCS containers to be as flood resilient or resistant as possible. For example, units could be made to be watertight or raise the internal equipment to be as high as possible and ideally above the flood level. The specific type, material and formation of the PCS containers is subject to a procurement process. Flood resistance or resilience would be a factored into the procurement process.

5.2.9 The predicted flood velocities in the most extreme events are typically low and will not pose a risk to the proposed infrastructure.

5.2.10 During a future (2067) 1 in 1,000 year tidal flood, the Point of Ayr to Pensarn model predicts flood velocities to be below 0.15m/s (with the exception of ditches). The velocities are presented in Drawing 24-310-60-106 in Appendix A.

5.2.11 During a future (2100) 1 in 1,000 year fluvial flood, the St Asaph model predicts flood velocities to be below 0.45m/s (with the exception of ditches). Where PCS are proposed the velocities do not exceed 0.3m/s. The velocities are presented in Drawing 24-310-60-107 in Appendix A.

5.2.12 During a future (2070 95th Percentile) 1 in 200 year breach event the Point of Ayre to Pensarn model predicts flood velocities to be below 0.45m/s (with the exception of ditches and adjacent low-lying areas). Where PCS are proposed the velocities are generally below 0.30m/s do not exceed 0.45m/s. The velocities are presented in Drawing 24-310-60-108 in Appendix A.

The battery energy storage system and substation are located in the southern parcel is not considered to be at a significant risk from any source of flooding. Rain falling on the site itself will be managed effectively by the site's surface water drainage strategy.

5.3 Flood Zones

5.3.1 The majority of the northern parcel is located within defended Flood Zone 3, with the most significant risk being that of tidal flooding.

5.3.2 TAN 15 has a general presumption against development in Flood Zone 3 and states that development in Flood Zone 3:

"will only be appropriate if they are essential to the Development Plan Strategy to regenerate an existing settlement or achieve key economic or environmental objectives. Any redevelopment proposal must be consistent with the acceptability considerations in section 11. …….. Proposals that address national security or energy security needs, mitigate the impacts of climate change, that are necessary to protect and promote public health may also, by exception, be appropriate provided that their locational need is clear and the potential consequences from flooding have been considered and found to be acceptable" Para 10.23.

5.3.3 The proposal will deliver significant climate and energy benefits, generating up to 110MW of renewable electricity and storing an equivalent amount within the BESS element. This will also support grid stability by storing surplus renewable energy and discharging it when demand is high. The proposal will therefore improve the UK's energy security and will assist with mitigating the impacts of climate change as set out in national energy and climate change legislation, in accordance with TAN15.

5.3.4 Grid capacity is a key constraint for renewable projects nationally. This site's proximity to the Bodelwyddan substation, which is due for extension by National Grid, offers a rare, viable connection point. It represents the most suitable land available for a project of this scale.

5.3.5 Flood risk has been thoroughly assessed through a Flood Consequence Assessment and supporting drainage strategy, in accordance with TAN15.

5.4 Development Vulnerability

5.4.1 Figure 4 of TAN15 sets out the definition of three development categories. 'Renewable energy generation (excluding hydro generation)' is listed in the 'Less Vulnerable Development' category.

5.4.2 However, paragraph 9.4 states:

"Water compatible developments include developments which are required to be located near water by virtue of their nature, and developments which are resilient to the effects of occasional flooding".

5.4.3 Solar farms have a proven track record of operating in areas at risk and through appropriate design and mitigation measures can be resilient to the effects of occasional flooding.

5.4.4 Paragraph 9.3 states:

"Less vulnerable development is development where the ability of occupants to decide if risks and consequences are acceptable is greater than that in the highly vulnerable category."

5.4.5 The proposed development will be remotely operated and therefore will not have 'occupants'.

5.4.6 Paragraph 9.5 states:

"The list in Figure 4 is not exhaustive therefore decision makers should apply professional judgement when considering development categories not explicitly listed based on the risks posed to lives and livelihoods in the event of a flood. However, the list is the basis for the type of development captured by the Notification Direction."

5.4.7 As the site will be remotely operated, there should be no risk to life. There should be significant advance warning of any flood event for the sea or the Afon Clwyd and site flood levels would rise slowly given the large area of low-lying land within which the areas at risk sit. Through appropriate site design there will be no damage to the proposed infrastructure in all but the most extreme events and impacts on livelihoods would be insignificant.

5.5 Acceptability of flood consequences

Acceptability Criteria

5.5.1 Under the heading 'Acceptability criteria for flooding consequences' Paragraph 11.3 of TAN15 states:

"Whether a development should proceed or not will depend upon whether the consequences of flooding can be safely managed, including its effects on flood risk elsewhere"

5.5.2 With the proposed mitigation measures in place the consequences of flooding of land where the development is proposed can be safely managed.

5.5.3 The key considerations listed in Paragraphs 11.4 and 11.5 are reproduced below:

1. No increase in flooding elsewhere
2. Occupiers aware of flood risk
3. Escape/evacuation routes present
4. Flood emergency plans and procedures agreed an in place

5. Flood resistant and resilient design
6. Acceptable Consequences for type of use
7. Minimal risk to life
8. Minimal disruption to people living and working in the area
9. Minimal potential damage to property
10. Minimal impact of the proposed development on flood risk generally
11. Minimal disruption to the sustainable management of natural resources.

5.5.4 With regard to points 1, 8 and 10, the proposed development will, as far as practicable, be raised above the flood level. The solar array supports, which are typically 'C section' steel or aluminium piles are narrow in profile and would have a negligible impact on flood risk elsewhere.

5.5.5 With regard to points 2-4, there will be no site occupiers. There site will have a Flood Emergency Management Plan in place which will include escape/evacuation routes but the working presumption would be that the site would be clear of operatives well in advance of a significant event (breach or otherwise). Therefore, the proposals would also satisfy point 7.

5.5.6 With regard points 5 and 9, water-sensitive solar infrastructure in areas at risk of flooding will, where practicable, be raised above the predicted future 1 in 1,000 year defended flood level. The array supports and plinths/pads for containerised infrastructure are inherently flood resilient.

5.5.7 The water sensitive parts of the arrays will be raised comfortably above the future 1 in 1,000 year and the breach event.

5.5.8 Due to landscape constraints and engineering feasibility, it may not be possible to raise supporting containerised infrastructure above the future defended 1 in 1,000 year fluvial flood level or future 1 in 200 year the breach event flood level. To raise the PCSs above the future (2070 95th Percentile) 1 in 200 year breach flood level the majority of them would need to be raised to approximately 1m or higher.

5.5.9 Where this is the case, some PCS may be at risk of flooding during the future 1 in 1,000 year fluvial event (but not the future 1 in 100 year) or breach event. This infrastructure will be flood resistant or resilient where practicable and subject to a procurement process. The risk that PCS fail and output is temporarily impacted, rests with the operator.

5.5.10 With regard to point 6, acceptable consequences for the type of use are discussed below under the subheadings 'Frequency thresholds' and 'Tolerable conditions: managing consequences in an extreme flood event'.

5.5.11 With regard to point 11, the development proposals are not considered to be likely to disrupt the sustainable management of natural resources, although the document does not elaborate on what the key considerations are. The development will maintain an offset to watercourses to allow access for maintenance.

Frequency Thresholds

5.5.12 For 'Less vulnerable' and 'Water compatible development that may be occupied by people', TAN15 states that development must be flood free during a future 1 in 100 year fluvial flood and a future 1 in 200 year tidal flood. Model data provided by NRW predicts that at the end of the development's lifetime the site will not flood during a 1 in 200 year tidal flood and a 1 in 100 year fluvial flood from the Afon Clwyd.

5.5.13 There will be some flooding to the northern parcels during a future 1 in 100 year flood from the Afon Gele. Depths in the affected areas are generally predicted to be less than 0.3m and entirely below 0.6m. The only proposed infrastructure in these areas would be solar panels and associated water sensitive infrastructure which would be raised above the predicted flood level.

5.5.14 It is presumed that the intention of TAN15 is not to prevent solar panels being placed in areas which are subject to infrequent, shallow flooding from rivers and that the proposals are acceptable with regards to the frequency threshold requirements.

Tolerable conditions: managing consequences in an extreme flood event

5.5.15 Paragraph 11.9 of TAN15 states:

"The flood free thresholds outlined above relate to very serious but not the most extreme flood events (with the exception of thresholds for emergency services). During extreme flood events there is recognition that it may not be possible to keep all development flood-free. In these circumstances it is imperative that flooding does not endanger life, therefore it needs to be demonstrated that conditions within the development during an extreme event will be tolerable."

5.5.16 As noted in Paragraph 11.11 of TAN15, high velocities and/or depths of floodwater pose a potential risk to life and the primary purpose of the tolerable conditions is to ensure that flooding during extreme events does not endanger life. Paragraph 11.12 advises that each site must be considered individually and Paragraph 11.15 states:

"The planning authority should consider all potential and likely users of any proposed development when assessing whether the development can be considered to provide a safe environment during an extreme flood event. If a safe environment cannot be provided, the planning application should be refused."

5.5.17 Flooding from the Afon Gele would only exceed the tolerable threshold depth of 0.6m in limited parts of the site. Fluvial flooding from the Afon Clwyd and tidal flooding during a future 1 in 1,000 year flood would be preceded by significant advance warning. Given the large flood cell within which the southern parcels sit, flood waters would rise slowly after overtopping the Afon Clwyd embankments or tidal defences.

5.5.18 The site will be operated remotely and only occasional visits would be necessary for inspection and routine maintenance, which would be cancelled if there was a risk of flooding. Consequently, flooding of the site would not 'endanger life' and it is not considered necessary that the development provides a 'safe environment'. On this basis it is concluded that the development is acceptable in terms of tolerable conditions.

6 SURFACE WATER DRAINAGE

6.1 Hydrological Impact of the Proposals

6.1.1 The proposed development is for a solar farm and ancillary infrastructure at the Solar Site across an area of 168.95ha and a BESS, substation/transformer and ancillary infrastructure at the BESS Site across an area of 6,51am and consequently, the main part of the Site as a whole will be taken up by solar panels. Rows of solar panels will be approximately 6.5m wide and separated by gaps of 4-5m. The solar arrays themselves have thermal expansion gaps (Figure 6-1).

Figure 6-1 Typical Solar Panel Arrangement (showing expansion gaps)

6.1.2 The concentration of runoff from the solar panels will be spatially localised, with water draining from the panels between the expansion gaps. Once rainfall has exceeded the interception capacity of vegetation it will initially take up any available depression storage and soil moisture deficit before moving laterally through the soil and percolating downwards. This movement will be governed by soil pore pressure until the soil is saturated.

6.1.3 If the incident rainfall exceeds the rate of soakage into the ground it will move laterally above the soil and soak into areas which are within the 'rain shadow' of the panels. Consequently, the impact of the panels on runoff is considered to be negligible.

6.1.4 Across the site the cessation of intensive agricultural activities, particularly arable farming, will have beneficial effects. The ability of soil to accept rainfall is dependent on good aggregate stability and pore structure. Soil structure depends on a healthy soil ecosystem. Key components of a healthy soil ecosystem which improve soil structure are discussed in the 'Soil Structure and Infiltration Fact Sheet', by the Agriculture and Horticulture Development Board (AHDB). These include:

- Tunnels created by earthworms and roots of plants.
- Fungal hyphae (root-like structures).
- Polysaccharides produced by bacteria and fungi which act as biological glues.

6.1.5 Farming the land can negatively impact soil structure through the application of pesticides and only allowing the growth of a limited number of plants with poor diversity of root structure. In addition to impairing the ability of the soil to maintain a good structure, farming causes compaction which can significantly damage the soil structure. Compaction is caused by the movement of machinery and grazing animals, particularly when the soil is wet, which is expected to be fairly frequent given the Soilscapes classification of the soils as having naturally high groundwater in the low-lying land in the southeast and impeded drainage elsewhere.

"Farming has a profound influence on the natural ability of soil to accept rainfall. Working, travelling across and keeping livestock on the land in wet conditions can seriously degrade soils by reducing soil porosity."

Source: Soils and Natural Flood Management (East Devon Catchment Partnership)

6.1.6 This compaction causes a corresponding decrease in depression storage, absorption, infiltration and an increase in runoff rates, soil erosion, pollution and flooding downstream:

"When soils become compacted, they are more likely to become waterlogged and experience surface ponding that leads to run-off and flooding. This increases nutrient losses to watercourses causing pollution and reducing nutrient levels in soil."

Source: The state of the environment: soil (Environment Agency, 2019)

6.1.7 According to several sources:

"Runoff from compacted soils is 50-60% higher than on aerated healthy soils".

Source: Lowland Natural Flood Management Measures – a practical guide for farmers (Dales to Vales River Network)

6.1.8 Clearly, the magnitude of impact will depend on the mineral content of the native soil, the land use and aggregate stability, the degree of compaction and the intensity and duration of rainfall. Nonetheless, it is indicative of the severity of impact compaction can have on runoff rates.

6.1.9 Work carried out on soils in Devon and Cornwall by the National Soil Resources Institute of Cranfield University states:

"At Boscastle, the study found that grassland with a strongly developed stable soil structure with fine granular soil aggregates only generated 2% runoff under 36mm/hr rainfall. Grassland with weakly developed soil structure with coarse, dense aggregates and low porosity had 60% runoff. This soil became saturated at the surface generating overland flow after 20 minutes of rainfall. Similar results were found in experiments at Ottery St Mary where compacted grassland generated 88% runoff under 50mm/hr rainfall."

Source: Soils and Natural Flood Management (East Devon Catchment Partnership)

6.1.10 In the case of Boscastle, the rate of runoff from grassland was 30 fold higher where the soil structure was poor. An intensity of 36mm/hr for 15 minutes is approximately equivalent to a 1 in 2 year storm.

6.1.11 In addition to compaction, surface crusts, known as capping, can form on unprotected soils preventing the downward movement of water and promoting runoff.

"Capping can be a particular problem where soils have a large amount of fine sand and silt, and a low content of clay and organic matter. When these soils are exposed to the battering action of rainfall an impermeable surface cap can form which can generate overland flow of rainwater.

Source: Soils and Natural Flood Management (East Devon Catchment Partnership)

6.1.12 The change of use to a solar farm will allow the establishment of a healthy soil ecosystem, an increase in organic matter content, and associated improvements in soil structure, especially in areas which were formally ploughed and left to bare earth following harvest, and those areas where overgrazing and trafficking has caused compaction and erosion. The solar panels will also protect the ground from intense rainfall whilst vegetation is becoming established and should reduce the formation surface crusts in certain soil types.

6.1.13 The proposals also include the enhancement of existing hedgerows, and the creation of new hedgerows and blocks of woodland. An ecological mitigation and enhancement area of approximately 9ha is also proposed (in Parcel 6 at the Solar Site) which includes additional valuable wetland habitat, in the form of scrapes, an enhanced ditch and a series of permanent ponds.

6.1.14 These changes will result in a reduction in runoff rates and volumes. The reduction in the application of herbicides and fertilisers will also result in a reduction in soil erosion and improvement in runoff quality. Figure 6-2 illustrates the difference between good soil structure and compacted soil structure.

Figure 6-2 Illustrative Comparison of Poor and Good Soil Structure

Figure 2.3. Good soil structure (left) and compacted soil structure (right): Very little surface runoff is able to infiltrate into the subsoil layers due to the surface crust and compacted soil layers while vegetation is deprived of oxygen due to the compression of pores that normally transport air and water.

Source: Natural Flood Management Handbook, Scottish Environmental Protection Agency.

6.1.15 Figure 6-3 to Figure 6-5 show the contrast between arable land and solar farmland adjacent to one another in Gloucestershire taken on May 22nd 2020 after relatively dry weather for the preceding two months. The arable land was noticeably harder underfoot and exhibited surface crust and significant cracks from shrinkage. Where the panels are located the ground was not as severely cracked and vegetation was lush, indicating better soil structure and moisture retention.

calibro

Figure 6-3 Arable Land Adjacent to a Solar Farm, Gloucestershire (May 2020)

Figure 6-4 Close Up of Arable Ground, Gloucestershire (May 2020)

Figure 6-5 Close Up of Solar Farm Ground, Gloucestershire (May 2020)

6.2 Climate Change

6.2.1 The development is proposed for a temporary period of 40 years and therefore will be operating up to circa 2069, should consent be granted. In accordance with Table 2 of NRW's Flood Consequence Assessments: Climate Change guidance, this would put the development in the in the 2050s epoch.

6.2.2 In accordance with the above guidance, the Site falls in a large (over 5km²), rural catchment in the West Wales River Basin District.

6.2.3 NRW's Flood Consequences Assessments: Climate Change guidance states that rainfall allowances should be applied when considering surface water flooding and drainage assessments.

6.2.4 As a result of the above, the relevant rainfall uplift for the proposals is 20%. Therefore, the design rainfall event is the 1 in 100 year +20%.

6.3 Drainage Strategy

6.3.1 In accordance with Standard S1 of Welsh Government's Statutory Standards for Sustainable Drainage Systems, drainage systems should follow the below hierarchy in terms of runoff destination.

Priority 1 - Water Collection

6.3.2 The Site would be remotely operated and only visited occasionally for routine maintenance. In addition, washing water or irrigation water will be limited. However, it is likely that the site welfare units would include water reuse for example to assist with toilet flushing or general cleaning.

Priority 2 - To the Ground

6.3.3 The dispersed containerised infrastructure in the solar generation area would encourage rainfall to ground, mimicking existing conditions.

6.3.4 As demonstrated in Section 3.4, the soils beneath the BESS and substation areas are recorded as having impeded drainage characteristics, meaning that infiltration is likely to be unviable.

Priority 3 - Surface Water Body

6.3.5 The next option in the SuDS hierarchy is to discharge surface water runoff into a nearby surface water body at greenfield runoff rates. As evidenced in Section 3.3 and shown in Figure 3-7, there are a number of field ditches located near the BESS site. It is therefore proposed to discharge surface water runoff to one of the nearby ditches.

6.4 Drainage Strategy Components

6.4.1 Containerised infrastructure in the Solar Site would have a small footprint and be dispersed across the area. They would also be constructed on gravel bases. Therefore, the most appropriate method of disposing runoff from them would be to direct runoff to their gravel bases and subsequently to the ground, mimicking the existing site.

6.4.2 In the BESS Site there will be a larger area of hardstanding. However, there is a need to balance the hardstanding areas with proposed cable routes and existing constraints like an existing gas pipe.

6.4.3 For example, the auxiliary transformers are likely to be surrounded by significant cabling, which would constrain the use of swales or subterranean pipes. Consequently, it is proposed to drain these to ground via gravel trench surrounds as per the containerised infrastructure in the Solar Site.

6.4.4 The substation itself would be almost entirely surfaced with permeable materials. Consequently, it would drain to ground as per the existing site with no further mitigation required.

6.4.5 Similarly, access tracks will be constructed using permeable materials and consequently would allow rainfall to percolate to the ground locally, mimicking the existing site. Therefore, no further mitigation is proposed.

6.4.6 The control room measures approximately 276m^2 and consequently it would be served by a positive drainage system.

6.4.7 The BESS area is of sufficient area and concentration of hardstanding to warrant a drainage strategy with positive drainage.

6.4.8 The BESS area itself is in three discrete parts. Due to the topography of the site, the western two parts are on land that slopes west. The eastern component is on land that slopes east.

6.4.9 Consequently, at this stage, the drainage is proposed to follow the natural topography with the western parts draining to the west and eastern part to the east. This may be revised following the levels strategy and cut and fill analysis.

6.4.10 The BESS west areas have a combined area of 6,170m^2 (0.617ha) and the east has an area of 760m^2 (0.076ha).

6.4.11 The drainage arrangements are shown in Appendix B.

6.5 Greenfield Runoff Rates

6.5.1 In order to limit proposed flows from the BESS areas and control room as close to greenfield rates as possible, greenfield runoff rates for the contribution areas have been calculated using the FEH Statistical Method, the results of which are shown in Table 6-1, with calculations provided in Appendix C.

Table 6-1 Greenfield Runoff

Rainfall Event	BESS West Runoff (l/s)	BESS East Runoff (l/s)	Control Room Runoff (l/s)
QBar	1.9	0.2	0.1
1 in 30 year	3.5	0.4	0.2
1 in 100 year	4.2	0.5	0.2

6.6 Drainage Strategy - BESS Areas

6.6.1 The BESS comprises the largest land take of the proposals and is therefore the largest area of relatively concentrated hardstanding.

6.6.2 For reasons of fire management (explained below), it is proposed to utilise the gravel bases beneath the BESS units areas to attenuate rain falling on the units and the gravel base. It is proposed to discharge water stored in the gravel bases to the nearby watercourses via a filter drain with hydrobrake penstock chambers which can be closed to create a sealed system in the event of a fire.

6.6.3 The gravel bases have been designed to have sufficient capacity to store a design rainfall event (1 in 100 year +20%). The contribution area for the calculations includes the gravel base areas as well as the BESS containers, to ensure rain falling on the gravel base is accounted for.

6.6.4 Given the configuration of the BESS area, the hydrobrake penstock chamber serving the BESS West area would flow to the control room area and subsequently to the adjacent field ditch. Therefore, in order to limit runoff entering the ditch, it is proposed to limit discharge from the BESS west area to 0.9l/s, which would be facilitated by a 52mm hydrobrake, the smallest aperture when considering blockage risk in accordance with Sewerage Sector Guidance Appendix C.

6.6.5 Microdrainage source control calculations indicate that approximately 623m^3 of volume is required in the gravel bases during the design, critical duration, event.

6.6.6 The proposed BESS west gravel base area would measure approximately 0.62ha ha and have a depth of at least 0.4m at its downstream end, base slope of 1:300 and porosity of 0.3. Microdrainage calculations show that such bases would only fill to a maximum of 0.39m, providing some additional capacity for an exceedance event.

6.6.7 The BESS east would discharge to the east and a different field ditch. In order to comply with Sewerage Sector Guidance, a 51mm aperture orifice would be used, which would restrict flows to 1.2l/s.

6.6.8 Microdrainage source control calculations show that approximately 50m^3 of volume is required in the gravel bases during the design, critical duration, event.

6.6.9 The proposed BESS east gravel base area would measure a depth of at least 1m at its downstream end to manage fire suppression water (described below), base slope of 1:300 and porosity of 0.3. Microdrainage calculations show that such bases would only fill to a maximum of 0.22m, providing significant additional capacity for an exceedance event.

6.6.10 The control room would discharge to the existing field ditch to the west, with the precise location subject to the existing gas pipe and trees. As with the BESS east, the discharge rate is dictated by the hydrobrake orifice size and compliance with Sewerage Sector Guidance. Therefore, the reference discharge rate from the control room would be 0.9l/s.

6.6.11 Microdrainage source control calculations show that approximately 13.4m^3 of volume is required in the gravel bases during the design, critical duration, event.

6.6.12 The proposed gravel base area would measure a depth of at least 0.4m at its downstream end, base slope of 1:300 and porosity of 0.3. Microdrainage calculations show that such bases would only fill to a maximum of 0.21m, providing significant additional capacity for an exceedance event.

6.6.13 The above is demonstrated in the drainage strategy drawing provided in Appendix B and Microdrainage calculations provided in Appendix C.

6.7 BESS Fire Management

Background

6.7.1 Although extremely unlikely, BESS units can ignite. Ignition is most commonly caused by thermal runaway, which occurs when BESS units overheat. This can be exacerbated in a few ways, including proximity to BESS units already alight.

6.7.2 Significant mitigation is included within the BESS units (i.e. monitoring systems which includes both remote and on-site emergency stop mechanisms, automated cooling and a fire suppression system in addition to active ventilation, and the submitted Outline battery safety management plan, reported elsewhere in the planning documents, and BESS safety technology is rapidly improving. This significantly reduces the chances for ignition to occur and includes methods to limit the chance for overheating due to proximity. For example, many BESS units can be manufactured to contain a fire within the container or cabinet.

6.7.3 In the extremely unlikely event a unit does ignite the fire service may choose to use water spraying as part of the method of suppression, particularly to keep adjacent units cool and reduce the chance for them to ignite.

6.7.4 The latest, draft, National Fire Chiefs Council (NFCC) guidance recommends that fog spraying or similar should be sufficient to manage the thermal runaway of adjacent units. Fog nozzles have various flow rates but for the purposes of this assessment, they are presumed to have a rate of 650l/min.

Mitigation

6.7.5 The BESS units themselves would be water resistant, meaning that discharged chemicals would most likely remain contained within the unit ready to be cleaned when the fire is extinguished.

6.7.6 However, it is proposed that the gravel bases underlying the units would be limestone-based and wrapped in an impermeable liner and served by a network of perforated pipes.

6.7.7 The perforated pipes would flow to a single point of discharge in the network, which would be facilitated by a penstock chamber.

6.7.8 The penstock chamber would remain open during normal conditions, to allow the passage of rainfall receiving watercourses. However, during a fire event, the penstocks would be shut, creating a sealed system beneath the BESS units.

6.7.9 Once the system is sealed, water in the penstock can be tested for contaminants. If they are identified, water can be pumped out and disposed of appropriately. When contamination is at safe levels, the penstock can be released to resume the normal flow regime.

6.7.10 As shown in the drainage strategy, the BESS west area would have an area of approximately 6,170m^2. Presuming the sealed gravel base would be at least 0.4m deep with a porosity of 0.3 would result in a capacity of at least 740m^3, sufficient for more than 12 hours of fog spraying with a pump rate of zero.

6.7.11 The BESS east would have an area of 760m^2 and depth of 1m, consequently providing 228m^3 of storage, sufficient to contain approximately six hours of fog spraying.

6.7.12 The gravel bases would be specified to be limestone-based. This is because the calcium carbonate content in limestone is known to be effective at neutralising HF, particularly when diluted[5].

6.7.13 The proposed drainage strategy, including the fire management procedures, is included in Appendix B.

6.8 Design for Exceedance

6.8.1 It is recommended the proposed infrastructure would be raised on plinths or pads which would prevent flood damage in an exceedance event.

6.8.2 As shown above, the storage capacity of the drainage features would exceed the volume of runoff in a design event, providing some additional capacity for an exceedance event.

6.8.3 In the unlikely event the capacity of the drainage features were exceeded, water would slowly dissipate to the overland onto surrounding grassed areas, where it would absorb into the ground as per the existing site.

6.9 Water Quality

6.9.1 The SuDS Manual (CIRIA C753) states that the design of surface water drainage should consider minimising contaminants in surface water runoff discharged from the Site. The level of treatment required depends on the proposed land use, according to the pollution hazard indices. To provide adequate treatment, the SuDS mitigation

6.9.2 Indices for the development must be equal to, or exceed, the pollution hazard indices.

6.9.3 Using a precautionary approach to runoff water quality, the closest land use in the SuDS Manual to the containers is ‘other roofs’. Surface water runoff from ‘other roofs’

[5] https://prod-edam.honeywell.com/content/dam/honeywell-edam/pmt/oneam/en-us/hydrofluoric-acid/honeywell-bases-for-neutralization-of-HF-v2.pdf?download=false

are considered by Table 26.2 of the SuDS Manual to present a Low hazard to water quality, respectively (see Table 6-2).

6.9.4 Table 26.4 of the SuDS Manual provides SuDS mitigation indices for various SuDS methods discharging to the ground, as summarised in Table 6-2. This shows that the nearest equivalent to the gravel storage and auxiliary transformer trenches would be infiltration trenches, these would provide sufficient mitigation of the likely pollutants expected.

Table 6-2 Water Quality Indices (Groundwater, as per C753 The SuDS Manual)

		Pollution Hazard Level	Total suspended solids	Metals	Hydro-carbons
Land Use	Other roofs	Low	0.3	0.2	0.05
SuDS Mitigation Indices	Infiltration trenches	-	0.4	0.4	0.4

6.9.5 Table 26.3 of the SuDS Manual provides SuDS mitigation indices for discharges to surface waters. This shows that the proposed BESS area gravel base and perforated pipe network and the proposed filter drain in the substation compound would provide sufficient mitigation of the likely pollutants expected. Additionally, the proposed ditch would provide further mitigation against the likely pollutants expected. Table 6-3 summarises Table 26.3 of the SuDS Manual.

Table 6-3 Water Quality Indices (Surface Water, as per C753 The SuDS Manual)

		Pollution Hazard Level	Total suspended solids	Metals	Hydro-carbons
Land Use	Other roofs	Low	0.3	0.2	0.05
SuDS Mitigation Indices	Filter drains	-	0.4	0.4	0.4
	Swale	-	0.5	0.6	0.6

6.10 Maintenance Regime

6.10.1 Maintenance of SuDS features is essential for the operation of the surface water drainage system.

6.10.2 The proposed maintenance schedule, based on information from the SuDS Manual, is outlined as Table 6-4. It is envisaged the site operator would have responsibility for the maintenance activities.

Table 6-4 Proposed Drainage System Maintenance Plan

Maintenance Schedule	Action	Frequency
Subbase storage	Remove litter and debris from subbase storage	As required
	Inspect filter drain surface, inlet/outlet pipework and control systems for blockages, clogging, standing water and structural damage	Monthly
	Inspect inlets and perforated pipework for silt accumulation and establish appropriate silt removal frequencies	Six monthly, or as required
	Inspect for evidence of poor operation and/or weed growth – if required take remedial action	Every three months, 48 hours after large storms in the first six months
	Replacement of gravel	As required
	Jetting perforated pipe	As required
	Replacement of geotextile wrap	As required
	Required Action	Typical Frequency
Pipework, manholes, flow control chambers, catch pits and silt traps	Stabilise adjacent areas	As required
	Remove litter and debris	As required
	Clear any poor performing structures.	As required
	Inspect all structures for poor operation	Three monthly, 48 hours after large storms in first six months
	Monitor inspection chambers. Inspect silt accumulation rates and determine silt clearance frequencies	Annually

6.11 Construction Management

6.11.1 The majority of the infrastructure on the site will be the panels themselves. Constructing the panels would not require earthworks sufficient to cause a significant change in landform. As a result, the ridge and furrow network should largely remain as existing. Furthermore, the panel stanchions will have a limited footprint.

6.11.2 Suspected land drains have been mapped within the Geophysical Survey Report. Stanchion piling should avoid these drains if possible so as to limit the severance or disruption of existing drains. Where this is not possible, the drains should be replaced to ensure the hydrological connectivity remain as close to existing as is possible.

6.11.3 As a result, there would likely be negligible impact on the hydrological connectivity between the site and the local watercourse network.

6.11.4 During the construction of the solar farm there is potential for limited soil compaction and erosion through vehicular movements. It is recommended that these effects are duly considered as part of a Construction Environmental Management Plan.

6.11.5 It is recommended that following measures are considered:

- Construct, and utilise, access tracks early in the construction phase;
- Use of low tyre pressure machinery to reduce compaction;
- A delivery and construction schedule that minimises repeat journeys;
- Temporary measures such as sediment traps using geotextiles, straw and temporary bunding.

6.11.6 Where the soil has been disturbed as part of the construction it is recommended that the soil is adequately prepared for seeding. Tillage (mechanical loosening) to an appropriate depth, may be advisable where the soil is compacted. A native seed mix should be used which allows for rapid establishments of ground cover. The seed mix should, where possible, include plants with a diversity of root structures. It is also recommended that consideration is given to including species that are particularly effective at breaking up compacted soil (where necessary) and increasing soil organic matter content.

7 SUMMARY AND CONCLUSIONS

7.1.1 Bodelwyddan Solar and Energy Storage Limited are seeking permission for the construction, operation and decommissioning of a proposed solar photovoltaic (PV) electricity generating system and battery energy storage system (BESS) with associated infrastructurenear Bodelwyddan, Wales. The proposed development will have an operational lifetime of 40 years. The site is approximately 183.77ha of mixed (pastoral and arable) agricultural land. The site comprises a Solar Ste which will contain solar arrays and supporting infrastructure and a BESS Site which will contain a Battery Energy Storage System and a substation and a cable corridor.

7.1.2 The BESS Site is not considered to be at significant risk from any form of flooding. Some of the land is predicted to be at risk of surface water flooding but a review of the data concludes that this is from water arising on the site itself, which would be effectively managed by the development's drainage system.

7.1.3 Large parts of the Solar Site are in Flood Zones 2 and 3 as a result of predicted fluvial and tidal flooding in an undefended scenario. The principal sources of flood risk are fluvial flooding from the Afon Clwyd to the east and tidal flooding from the Clwyd Estuary. There is also a less significant risk of flooding from the Afon Gele and Bodoryn Cut to the north which form part of an extensive drainage network for the surrounding low-lying land.

7.1.4 The Afon Clwyd is flanked by embankments which protect the site from flooding up to and including a 1 in 100 year event in 2115. During a future (2115) 1 in 1,000 year event extensive flooding of the solar generation area to the south of the A547 is predicted, with depths of up to 1.2m predicted.

7.1.5 Extensive coastal defences protect the site from tidal flooding up to and including a 1 in 200 year event in 2067. During a defended 1 in 1,000 year event in 2067, flooding is predicted to land north of the A547. Depths are typically below 0.3m and no more than 0.7m. No flooding is predicted in the 1 in 200 year event for 2067.

7.1.6 Breach modelling was completed for the 1 in 200 year flood in the year 2070 (beyond the development's proposed lifetime). This is an extremely unlikely scenario but predicts flooding would remain below 1.2m depth.

7.1.7 The Afon Gele and Bodoryn Cut pose limited risk to the site. At the end of the century (well beyond the development lifetime) a 1 in 100 year flood results in minor flooding of the site. A 1 in 1,000 year event at the end of the century is predicted to result in flooding to depths of up to 0.6m but generally below 0.3m.

7.1.8 The risk of flooding will be mitigated by ensuring solar arrays are above the maximum flood levels when in a stowed horizontal position (the default position). The Power Conversion Systems (PCS) distributed throughout the Solar Site will be sequentially located in areas at the lowest risk of flooding and raised up to 0.5m above ground level.

7.1.9 Due to landscape and visual constraints it is not possible to raise these units further so some of them will be at risk during future 1 in 1,000 year events and should there be a breach of the Afon Gele outfalls that coincides with a 1 in 200 year flood. This risk will be minimised as far as practicable through flood resilient and resistant designs, wherever possible and subject to a procurement process. The predicted velocities where PCS are proposed during the most extreme events would not exceed 0.30m/s which is not considered to present a risk to the infrastructure.

7.1.10 The site would be remotely operated and therefore no access would be required during flood conditions, with or without a breach in the defences. Consequently, in the event of a flood warning being issued, access would be postponed until the warning has passed.

7.1.11 The transition to a solar farm would have benefits in terms of soil erosion, runoff and leaching of contaminants through removal of pesticide and herbicide use.

7.1.12 Runoff from the panels would drain to ground with no additional mitigation required.

7.1.13 Access tracks, and temporary construction compounds would be formed from permeable materials with no additional mitigation required.

7.1.14 Isolated containerised infrastructure in the solar generation area would be sited on granular bases, which would act as the recipient for runoff from the small containers, allowing it to percolate to the ground.

7.1.15 The BESS area is proposed in a location at low risk of flooding and set on a granular base. The base would be lined and under normal circumstances would release it at QBar greenfield rates to the nearby watercourse network. The BESS drainage system would have the ability to be isolated in the very unlikely event of fire. It would provide sufficient capacity to contain at least six hours of fire suppression water.

7.1.16 The substation would be formed from permeable materials with no mitigation required.

7.1.17 The auxiliary transformers would be surrounded by significant pipework which would constrain the use of swales or pipes. Therefore, runoff from these would be directed to infiltration trenches.

7.1.18 The control room would utilise its gravel base to attenuate rainfall, allowing it to slowly drain to the nearby watercourse as close to greenfield rates as possible.

7.1.19 The above proposals and mitigation would meet the requirements of the latest release of TAN15. Specifically, the vast majority of the site would remain operation even during a breach event coinciding with a future 1 in 200 year flood. Furthermore, the remote operation would mean that lives would not be at risk. These are key aspects of the tolerable conditions test.

APPENDICES

APPENDIX A

Drawings

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APPENDIX B

Drainage Strategy

APPENDIX C

Drainage Calculations

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