7 HYDROLOGY, WATER QUALITY AND FLOOD RISK

7.1 This chapter has been compiled by Yellow Sub Geo, by Chartered hydrologists and geologists each with over twenty years' experience in Environmental Impact Assessment of infrastructure and renewable energy projects.

SYNOPSIS

7.2 The Site is currently used for intensive dairy farming and associated cultivation of forage crops including maize. The conversion of the Site to one of a solar park with associated low-intensity grazing grassland represents the opportunity to deliver a moderate beneficial effect to the water quality of the reens and ditches on site. This in turn will have a beneficial effect on the Gwent Levels Redwick Llandevenny SSSI features in the vicinity of the site.

7.3 The conversion of the site from intensive agriculture to one of solar farm with accompanying low-intensity grazing represent a small beneficial effect on the Site's capacity to hold and store rainfall. This is because the current farming practices involve the use of heavy agricultural equipment that compact soil and lessen infiltration and because the current cultivation of forage crops leaves the soil bare in winter months. Neither will be the case under a solar park system.

7.4 The developer has committed to use of best practice in environmental controls during the construction period, as documented in the appended Outline Construction Environmental Management Plan. The Construction Environmental Management Plan (CEMP) appended to this ES at Appendix 2.2 sets out a number of protocols that shall be employed and adhered to during the construction of the solar park in order to manage and mitigate any impacts to the water environment. Effects on the water environment will therefore be controlled at a negligible level during the construction phase.

7.5 The solar park design has been compiled in order to build into the design inherent mitigation against any future impacts on the water environment.

7.6 No significant effects have been identified associated with the interaction of the proposed solar park development and the hydrology, water quality and flood risk. No further mitigation is therefore considered necessary over and above those inherent to the construction methods and design.

ASSESSMENT SCOPING AND PROJECT EVOLUTION

7.7 Tidal flooding was scoped out of the EIA at scoping stage, subject to provision of a Flood Consequence Assessment (FCA) in support of the planning application. An FCA has been compiled which assesses the consequences of development on all forms of flooding. This assesses the risk of

flooding from all sources as low with the exception of tidal/ coastal. The reader is directed to the separate FCA document for further details on tidal/ coastal flooding.

7.8 During the scoping of the EIA, water quality was highlighted as being of concern to both NRW and NCC (See Scoping Direction at Appendix 3.2). NRW highlighted that the ES should address any potential impact on the reens during development, de-commissioning and operational phases of the proposal. NRW commented that "*the proposal may have a likely impact on water quality and quantity during construction, and this should be fully assessed by the ES. The ES should also include assessment of the impact of the proposal on fields with grips …. and reen maintenance*".

7.9 NRW advised that "the Caldicot and Wentlooge Levels Internal Drainage District (IDD) is sensitive in terms of water level management (i.e. flood risk from the reens), increased surface water run-off, silt deposition, watercourse and soil erosion and soil compaction. As the project is likely to have significant effects on the IDD, based on the information provided, certain matters should be scoped into the ES:

- Estimated Greenfield run-off of the site and potential for the project to change this
- Assessment of the project resulting in ground compaction and the potential for ground swell affecting the reen bed height resulting in adverse effects on levels and flow direction
- Access for NRW planned maintenance of the reens and ditches when operational and impacts on access and maintenance during the construction stage
- Associated overhead and underground electricity cabling impacts on NRW maintenance."

7.10 Additionally, the Inspectorate endorsed NCC comments that if land raising is proposed, the impact of flood water displacement and run-off effects should be taken into account. These aspects have been incorporated into the scope of this assessment.

7.11 The combined concerns of NRW and NCC associated with the issue of greenfield run-off and flood water displacement and run-off are driven by the concern that the proposed development might exacerbate flooding effects or cause detriment to the flood resilience of the area. This issue is assessed herein under the general heading of "flood risk and drainage".

7.12 The issued raised by NRW concerning the interaction of the development and associated cabling with the maintenance of the reen system are addressed herein under the general heading of water quality, although it is understood that the reen maintenance programme has both land drainage and water quality drivers.

7.13 Consultation with NCC has continued during the compilation of this Environmental Statement. In a meeting of 11th July 2019, NCC queried whether the site drainage included any grip systems. They also provided comments on the likely required approach to Flood Consequence Assessment (which is outside of the scope of this EIA, but is addressed in the FCA appending the planning application). A commentary on the current drainage baseline is provided in Paragraphs 7.52 to 7.59.

7.14 A consultation meeting was also held with Monmouthshire County Council, but no issues were raised around water.

7.15 Consultation with NRW has been ongoing through the drafting of this ES. This has predominantly been associated with the issue of tidal flooding, outside the scope of this ES. In addition, the comments provided by NRW in response to the nearby Gwent Farmers solar scheme application have been studied and incorporated into the drafting of this ES document.

7.16 NRW and Welsh Government datasets have been accessed in the compiling of this chapter.

7.17 At scoping stage, it was envisaged that consultation would be undertaken with the relevant authority in order to ascertain the degree to which agri-environment and environmental stewardship schemes might currently affect the water environment on the site. However, following consultation of the Glastir dataset via the Lle.gov.wales mapping portal, it is apparent that the farm is not part of any agri-environment scheme and so this has not been relevant.

ASSESSMENT METHODOLOGY

Assessing water quality

Guidance and best practice

7.18 The methodology and approach used in this chapter has been drafted in accordance with guidance provided in the ICE Environmental Impact Assessment Handbook; a practical guide for planners, developers and communities.[1] The reens on site fall within the catchment of the River Severn. The *Severn river basin district River basin management plan*[2] and associated documents published by the Environment Agency and NRW provided context as to the current water quality status and water quality objectives. Against this wider backdrop, NRW have published a Briefing Note entitled *NRW Advice on Water Quality Standards to be used for Impact Assessment of the M4 Relief Road on the Gwent Levels Ditch System*[3]. This document was produced as part of NRW's response to the planning application for the M4 Corridor around Newport (M4 CaN), but is deemed by NRW to have relevance to all major projects on the Levels.

7.19 The Scottish Environmental Protection Agency (SEPA), in conjunction with NRW, have released a series of Guidance for Pollution Prevention (GPP) documents. There is a programme of release for

[1] ICE 2020. Environmental Impact Assessment Handbook; a practical guide for planners, developers and communities (Third Edition). ICE publishing.
[2] EA 2015. Severn river basin district River basin management plan Updated: December 2015
[3] NRW 2016. Advice on Water Quality Standards to be used for Impact Assessment of the M4 Relief Road on the Gwent Levels Ditch System

these documents, replacing the previous Pollution Prevention Guidance documents (PPGs). Where no GPP exists, PPGs remain current. Amongst these documents, those pertaining to the interaction of the proposed development and water resources include "GPP 5: Works and maintenance in or near water" and "PPG 6: Working at construction and demolition sites".

7.20 Other relevant guidance documents released by Welsh Government a "Code of practice for using plant protection products".

Defining the baseline

7.21 Water quality conditions within the reens on the site is largely dependent upon the land management practices on the Site and on surrounding land. Whilst there is connectivity across the network of reens through the wider Caldicot Levels, water within the reens on the site is classed ecologically as eutrophic standing water. This is indicative of the near-static nature of water flow within the reens on site. As such, impacts to water quality within the reens is considered likely to be localised. A study area of the site plus a 30 m buffer has been used. This aligns with the study area for assessment of effects on aquatic ecology.

7.22 In order to inform the baseline assessment of water quality, the following has been undertaken;

- *a farm impact interview, collating information from the farmer on current farming practices;*
- *review of literature sources to ascertain the expected run-off and leaching of sediment; fertilisers/ pesticides/ herbicides/ fungicides associated with the current farming practices;*
- *a reen condition assessment;*
- *a review of current and historic NRW favourability assessment of the SSSI Units that cover the site; and*
- *a search for NRW data on the water quality for the reens on the site.*

Assessing flood risk and drainage

Guidance and best practice

7.23 *Welsh Government Planning Policy Wales Technical Advice Note 15: Development and Flood Risk Technical Advice Note 15* (TAN15) sets out the required methodology and standards for flood risk and consequence assessment in Wales. The area of the site is shown by the Natural Resources Wales Development Advice Map to be within Flood Zone C1, as defined by TAN15. Zone C is described as being *"based on Environment Agency extreme flood outline, equal to or greater than 0.1% risk of flooding in any single year (i.e. 1 in 100)"* and Zone C1 as *"areas of the floodplain which are developed and served by significant infrastructure, including flood defences"*.

7.24 The key risk driver for flooding within the Gwent Levels is that of tidal or coastal flooding caused by either overtopping or breaching of the sea wall and associated defences. A Flood Consequences Assessment has been undertaken to assess the tidal/ coastal flooding risk and mitigation designed into the proposed design. The assessment of effects from tidal and coastal flood risk is scoped out

of the EIA as the mitigation designed into the solar park as a result of the FCA will avoid the potential for significant effects related to flooding. Without such built-in mitigation, the project would not gain consent.

7.25 In accordance with the concerns of NRW and NCC, the issue of flood risk and drainage is addressed within this document as far as the interaction of the development and the internal drainage district operations are concerned.

Defining the baseline

7.26 Greenfield runoff is the estimated runoff from the site in its original condition. Whilst the original condition of the levels was a tidal marsh, the effects of flood fences and drainage via the reen network have been taken into account to estimate a greenfield runoff rate for pastureland. Greenfield runoff from the 105 Ha site has been estimated using the IH124 methodology on the HR Wallingford online tool[4]. This is used to represent the baseline drainage condition on the site.

7.27 There are numerous features of the current land management practices that likely increase current runoff to greater than greenfield rates. Information on land management has been collated by means of interview with the farmer, site walkover and review of available datasets on Welsh Government, NRW and aerial photography databases.

Assessing the impacts and effects of the development

7.28 The following criteria have been defined for use in assessing the sensitivity of receptors, the magnitude of anticipated impact to receptors caused by the development and the resulting magnitude of effect that is created.

7.29 The following table provides the framework for defining the sensitivity of receptors:

[4] https://www.uksuds.com/drainage-calculation-tools/greenfield-runoff-rate-estimation

Table 7-1 Classification of sensitivity

Classification	Definition
High	The receptor has little ability to absorb change without fundamentally altering its present character, is of high environmental value, or of international importance.
Medium	The receptor has moderate capacity to absorb change without significantly altering its present character, has some environmental value, or is of regional or national importance.
Low	The receptor has high capacity to absorb change without significantly altering its present character, has low environmental value, or is of local importance.

7.30 The potential impacts of the project are identified and classified according to their magnitude of change. These impacts are either positive or negative. The categories of the magnitude of change are defined below.

Table 7-2 Classification of magnitude of impact

Classification	Definition
Large	There would be fundamental changes to the water quality, hydrology or dependent ecosystem (e.g. an ecosystem no longer functions or the function/s improve due to a change in water quality).
Medium	There would be material but non-fundamental changes to the water quality, hydrology or dependent ecosystem. (e.g. a water body suffers a detrimental change/ loss or benefits from a change, but remains largely in-tact and functioning).
Small	There would be detectable but non-material changes to the water quality, hydrology or dependent ecosystem. (e.g. minor changes/ very local water quality detriment, but the ecosystem remains largely as was).
Negligible	There would be no perceptible changes.

7.31 Combining the magnitude of impact with the sensitivity of the impacted receptor, the significance of the potential effect will then categorised according to the matrix presented below.

Table 7-3 Matrix for assessment of significance of effects

		Magnitude of Impact			
		Large	**Medium**	**Small**	**Negligible**
Sensitivity	**High**	Major	Moderate or Major	Minor or Moderate	Minor
	Medium	Moderate or Major	Moderate	Minor	Negligible or Minor
	Low	Minor or Moderate	Minor	Negligible or Minor	Negligible

7.32 Effects of Minor or above are considered to be potentially significant effects. Negligible or Minor and Negligible effects are considered to not be significant.

BASELINE

7.33 The site, comprising agricultural fields, extends to approximately 105.3 Ha and is part of the wider Gwent Levels. The Gwent Levels are a distinctive topographic zone comprising of a low-lying, flat and expansive coastal plain extending up to the Severn Estuary. Its elevation is typically between 5 - 6m AOD and generally below 10m AOD. The site is therefore essentially flat. The vast majority of the Gwent Levels lie below Mean High Tide. They are afforded protection against inundation from the sea by tidal defences (typically embankments).

Current water quality conditions

Site drainage and watercourses

7.34 The fields on the site are bordered by drainage channels (called reens) or agricultural ditches, situated adjacent to or in between hedgerows. The farmland is drained by the reen system, within which water flows slowly towards the Severn Estuary. The reen system drains to the Severn Estuary via tide-locked outfalls. These outfalls are dammed (penned) at a higher level during the summer months to maintain water levels, and penned at a lower level to allow them to drain more freely in winter to alleviate the effects of high rainfall. The system discharges to the Severn Estuary by means of tide-locked gates.

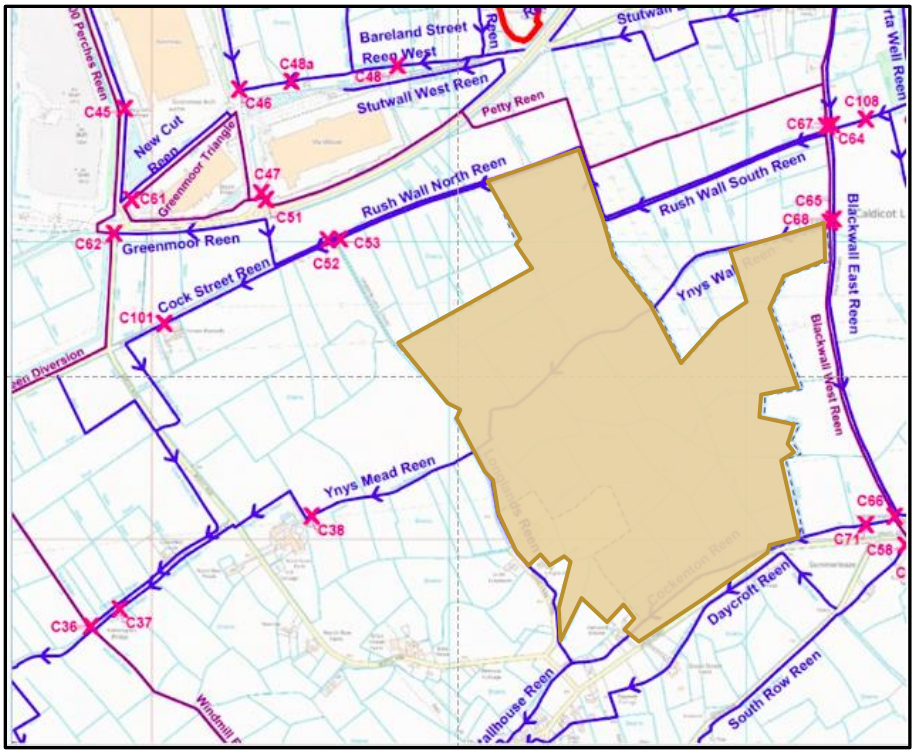

Figure 7-1 The reen system on the Site, with NRW maintained main reens highlighted in dark blue

7.35 The main reens on the site or adjacent to the site are the Ynys Mead Reen, Cockenton Reen, Longlands Reen, Blackwall West Reen and Rush Wall South Reen as shown in **Error! Reference source not found.**. These are cleared annually by Natural Resources Wales (NRW) who therefore require access to these reens at all times in order to carry out this maintenance. The farm maintains the other reens on the site, mainly to remove vegetation (such as hedge trimmings).

7.36 The reen system on site provides the main underpinning of the Gwent Levels Redwick & Llandevenny Site of Special Scientific Interest (SSSI). The citation for this SSSI states that "*The Gwent Levels reens are rich in plant species and communities, many of which are rare or absent in other Levels systems. This is due to the variety of reen types and their management regimes and the timing of the management which results in a staggered programme across the Levels.*".

7.37 The Site Management Statement for the SSSI states that "*like most of lowland Britain, in the last 50 years there has been a steady rise in the agricultural improvement of the grassland through under-drainage, ploughing, regular re-seeding and the use of artificial fertiliser. Large areas have also been converted to arable production and intensive dairy farming. All these changes have led to ditches being filled in, summer water levels being lowered and more pollution entering the ditches. …. as water is kept in the system over summer, any pollution which enters the ditches at that time will remain until the boards are removed and the system is flushed by the winter rains. Pollution can come from many different sources such as agricultural practices, residential and industrial developments and fly tipping*."

Current land management practices

7.38 The site is currently used as an intensive dairy farm, with cattle typically kept indoor and the land used to grow silage, haylage and fodder. Figure 7-2 provides an aerial photograph of the Site providing an indication of the current land management practices, with approximately 50% of the site being given over to maize production.

7.39 An interview with the farmer undertaken on 21st November 2019 confirmed that all of the fields have a grip system installed, comprising a clay or plastic pipe approximately 50 to 150 mm diameter laid approximately 600 mm beneath ground surface with a gravel surround. The farmer also confirmed that fertilisers are used on the farm, both in the form of manure and artificial products. The farmer was unable to supply specific quantities, but the following provides information on typical required rates of fertilisation for forage maize:

- 100kgN/ha for nitrogen (University of Reading, 2014[5]).

[5] University of Reading, 2014. Growing and feeding forage maize – a Review. Research Partnership: Grasslands, Forage and Soil, Work Package 3b: Alternative forages. Report prepared for AHDB Dairy February, 2014

- Approximately 50-60 kg/ha of phosphate fertilizer would be typical for most UK soils (Pain (1978)[6], Phipps and Wilkinson (1985)[7] and PDA (2008)[8]).
- The University of Reading (2014) report that 30t/ha crop of maize removes 130kg/ha K2O and a 50t/ha crop removes up to 220kg/ha K2O which must be returned to the soil through fertilisers.

7.40 The degree to which fertilisers added are taken up by the crops and the degree to which they are washed out from the soil by runoff will depend upon many factors, including the timing and manner of application, the degree to which the volume of nutrients added are matched to plant demand and the prevailing weather and soil conditions at point of application. Notwithstanding this, it is reasonable to assume that at least some of the added nutrients are leached and enter the reen system.

[6] Pain, B. F. (1978). Nutritional Requirements of Forage Maize. Forage Maize Production and Utilisation. B. F. Pain, R. H. Phipps, J. M. Wilkinson and R. E. Gunn. London, Agricultural Research Council: 87-116.
[7] Phipps, R. H. and M. Wilkinson (1985). Maize Silage. Great Britain, Chalcombe Publications
[8] PDA. (2008). "Forage Maize Fertiliser Requirements." https://www.pda.org.uk/wp/wp-content/uploads/2015/12/PDA-lf17.pdf

Figure 7-2 Aerial photograph of the Site indicating the current land management practices. Bare soil associated with maize production covers approximately 50% of the site

7.41 Pesticide use for forage maize is typically dominated by use of herbicides to manage competing weeds early in the growth stages of the maize (Syngenta, 2019[9]). As a result the herbicide is typically added when the soil is relatively bare and most prone to runoff in periods of heavy rainfall. It is reasonable to assume that some of any herbicide added will enter the reen system via leaching and/ or runoff.

7.42 The Glastir datasets available from NRW via the Lle.gov[10] website indicate that the Site does not currently receive support through the agri-environment scheme.

[9] Syngenta, 2019. Syngenta Maize Portfolio, Early weed control to drive maize yields. Syngenta UK Ltd.
[10] http://lle.gov.wales/home

7.43 Water quality of the reens was visually assessed during a site walkover on 30th October 2019. Several of the ditches were dry at the time of walkover, whilst others could not be inspected due to hedgerow growth on both sides of the reen. The NRW maintained main reens were accessible to assess, as were a proportion of those managed by the farmer. Some former ditches have been infilled in parts of the site to create larger fields.

7.44 As part of the consultation response to the scoping exercise, NRW have confirmed that they "*have carried out surveys of the field ditches in recent years. For a field block unit to pass the performance indicators (PIs) it must have no more than 50% ditches categorised as shaded or dry*". On this basis, the NRW maintained reens could be classed as passing, whereas the vast majority of the ditches maintained by the farmer do not.

Reen water quality

7.45 The water quality within the reen system of the Gwent Levels is considered to reflect the low flow and significant organic loading associated with the setting. During the summer months, natural organic degradation results in significant nutrient enrichment. The high productivity and low/ absent flow also result in low levels of dissolved oxygen and elevated Biological Oxygen Demand (BOD) compared to other rivers.

7.46 In response to these unique characteristics, NRW have published a series of Water Quality Standards for the reens of the Gwent Levels (NRW 2016)[11]. These were published in response to the now abandoned plans to construct the M4 relief road across land to the north-west of the site, but the NRW document states that, following adoption of the document (in December 2016) by the NRW Water Management Group, the "*standards [are] to be used in connection with the M4 CaN and also in relation to other development proposals of any scale likely to impact the water quality of the Gwent Levels SSSI. Adoption of these standards will enable NRW officers working within the Gwent Levels to provide consistent and evidence-based advice. There would still be an expectation that developers/ applicants provide baseline water quality data relevant to their proposed development and that this would then need to be considered in relation to the principle of no deterioration.*"

Work undertaken on behalf of the Welsh Government during the Environmental Impact Assessment of the M4 Corridor around Newport scheme included the monitoring of water quality within the reens of the Caldicot Levels (Atkins, 2016)[12]. One of the monitoring points, SW509, was immediately adjacent to the Site's north-western boundary, as shown in

7.47 Figure 7-2.

[11] NRW 2016. Briefing note: NRW Advice on Water Quality Standards to be used for Impact Assessment of the M4 Relief Road on the Gwent Levels Ditch System. Updated December 2016.
[12] M4 Corridor around Newport Environmental Statement Volume 3: Appendix 16.2 Baseline Water Environment Report. Report Ref. M4CaN-DJV-EWE-ZG_GEN-RP-EN-0003. March 2016

7.48 Table 7-4 provides a comparison of the reen water quality data gathered on behalf of the Welsh Government with the NRW Water Standards for the Gwent Levels.

Table 7-4 Water quality data for sample point SW509/ Caldicot Levels (from Atkins 2016)

Determinand	Unit	NRW Gwent Levels Standards	Concentration range	Exceedances?
pH	pH unit	6 – 9	8.3 – 8.9	No
Conductivity	µS cm^{-1}	1000	277 – 1164*	Yes, marginal
Chloride	mg/l	300	31 – 34	No
Water clarity	Secchi depth/ mg/l	Secchi disc visible at reen bed/ 20	2 – 714*	Yes, significant
Biological oxygen demand	mg/l	6.5	1 – 33*	Yes
Total ammonia as N	mg/l	1.1	0.11 – 1.2	Yes, marginal
Ortho-phosphate	µg/l	90	31.3 – 4200*	Yes, significant
Total oxidised Nitrogen as N	mg/l	2	0.123 – 9.43*	Yes
Sulphate	mg/l	300	3.6 – 114*	No
Zinc (bioavailable)	µg/l	10.9	1.6 – 3	No
Copper (bioavailable)	µg/l	1	<LoD#	No
Lead	µg/l	1.3	<LoD#	No
Cadmium	µg/l	0.15	<LoD#	No
Nickel	µg/l	4	1.1 – 1.2	No
Polycyclic aromatic hydrocarbons (PAHs)	µg/l	$1.7x10^{-4}$	<LoD#	No
Oil and grease	mg/l	None visible/ 1	<LoD#	No
Pesticides and other hazardous priority substances identified under WFD	Various	WFD standard applies	Not tested	Not tested

* Not tested for at SW509. Concentration range taken from Caldicot Levels dataset, Atkins 2016.

Results reported as below laboratory test method limit of detection by Atkins 2016.

7.49 The water quality within the reens is largely dependent upon the agricultural land practices on the Site. As can be seen, the current reen water quality exceeds the required standards for conductivity, BOD, total oxidized nitrogen and total ammonia on at least some occasions, and significantly exceeds for water clarity and ortho-phosphate. This reflects the current intensive agriculture practices on the Site and on much of the surrounding land, including intensive dairy production (combining indoor cattle with intensive fodder crop production) and the use of pesticides, fertilisers and herbicides. These can be assumed to leach into the reen system to some degree. Annual ploughing is also likely contributing a silt load to the reens in periods of heavy winter rainfall.

7.50 The critical receptor with respect to the water environment is the quality of the water within the reens on the site. These reens are protected as SSSI and support a range of aquatic flora and fauna. Notwithstanding this, those ditches/ reens currently maintained by the farmer are largely overshadowed by hedgerows and in some cases dry. Water quality, as monitored immediately off-site to the north-west, falls significantly short of NRW standards.

7.51 The reens and ditches are assigned a medium sensitivity for the purposes of environmental impact assessment.

Current flood risk and drainage

7.52 Greenfield runoff from the 105 Ha site has been estimated using the IH124 methodology on the HR Wallingford online tool[13]. The results are shown below in Table 7-5, with details provided in Appendix 7.1

Table 7-5 Greenfield runoff rates (calculated using HR Wallingford online tool

Greenfield runoff rates	Default	Edited
Q_{BAR} (l/s)	353.23	353.23
1 in 1 year (l/s)	310.84	310.84
1 in 30 year (l/s)	628.74	628.74
1 in 100 year (l/s)	770.03	770.03
1 in 200 year (l/s)	868.93	868.93

7.53 However, greenfield runoff is an estimate of runoff from the site in a natural condition. Land use, including agricultural use, changes the natural runoff, so the baseline conditions at the site will already include a modification to greenfield runoff.

7.54 Of particular note are the following land management aspects, currently being employed on the site:

- Use of heavy agricultural machinery can compact soils, reducing infiltration and increasing runoff.
- Growing maize for animal feed results in bare soils during winter months, increasing winter runoff.
- Installation of grip drainage has increased the rate at which soils shed water to the reen system.

7.55 The actual current run-off rates are therefore considered likely to exceed the modelled greenfield runoff rates.

7.56 The reen system is a managed network, under the control of the internal drainage district team at NRW. During wet winter months, the penning level (the level at which water can overtop to the Severn Estuary via tide-locked gates) is reduced, enabling the drainage of the levels. During the summer the penning levels are increased, holding water within the reen system to counteract the dry climate of the Levels.

7.57 In light of the current greenfield runoff considerations and the fact that the reen system is a managed system, the sensitivity of the greenfield runoff at the site is considered "medium" i.e. the site has moderate capacity to absorb change without significantly altering its present character.

[13] https://www.uksuds.com/drainage-calculation-tools/greenfield-runoff-rate-estimation

7.58 Ground compaction can occur from high loading of the soil surface, particularly for long-term loading arising from (for example) building foundations and deposition of stockpiles. The high water content and peat deposits of the Levels can result in localised subsidence and ground swell around such high loading areas as material is squashed and/ or displaced, and this could cause variation in reen levels and hence drainage within the level, although this could be rectified by dredging if it did occur.

7.59 The sensitivity of the site to compaction and ground swell is considered "medium" i.e. the site has only moderate capacity to absorb change without significantly altering its present character.

How will the baseline evolve in the future?

7.60 The continued use of the site for intensive dairy farming will likely prevent any improvement to current water quality and will likely cause further deterioration of it. This is due to the continued leaching of agricultural chemicals and run-off of silt from ploughed fields.

7.61 Current land management practices lead to bare soil in winter periods and compaction of soils under agricultural vehicles during crop management. Continuation of these practices will likely exacerbate the effects of increased duration and intensity of rainfall events (as are expected from climate change modelling) and limit the ability of the reen system to maintain current drainage.

AVOIDING EFFECTS THROUGH DESIGN

Designing construction phase works to avoid impacts

7.62 The critical receptor with respect to water quality and runoff is the water within the reens and ditches, which is the key underpinning feature of the Gwent Levels – Redwick to Llandevenny SSSI. The scoping responses from NRW and NCC have been used, together with professional judgement experience, to guide the proposed construction design and methodology.

7.63 In order to ensure that the construction works are designed and implemented with due respect to the important landscape in which they are to be carried out, an Outline Construction Environmental Management Plan (CEMP) has been compiled for the development. The purpose of this document is to provide a series of outline considerations and measures that will be implemented during the construction phase of the solar park project in order to suitably control and mitigate the environmental impact of the project.

7.64 The CEMP document sets out the commitments made by the developer, BSR Energy, to suitably limit environmental impact of construction through the development of the solar park. It has been written in order to demonstrate that the project can be delivered in such a way as to minimise environmental impact during the construction phase to acceptable levels. It is intended that the outline document will be used as part of the tender pack issued to inform procurement of a Main Contractor for the works in due course.

7.65 It will be the responsibility of the Main Contractor to build upon this Outline CEMP and provide a Detailed CEMP as part of their contractual requirements on the project. This Detailed CEMP will provide detailed information as to how the Main Contractor and their sub-contractors shall design and implement the outline principles set out within this Outline CEMP.

7.66 The planned solar park construction requires work to be undertaken in the vicinity of the Main Reens and ditches on site. These works present two key hazards to the surface water environment:

- Pollution from fuels, oils and other chemicals that are being used and/ or stored on site entering the watercourses following spills, leaks or accidental releases.
- Impact from sediment/ silt created by exposed soils being eroded by rainfall, flowing into the watercourses

7.67 In order to control these hazards, the CEMP includes the following key aspects:

Employing proper controls to manage hazardous substances

7.68 The CEMP stipulates that the site shall be run in accordance with best practice with respect to environmental controls, including adherence to the principles and practices set out in CIRIA 741[14], CIRIA 532[15]. This includes;

- strict storage and refuelling protocols, ensuring a safe distance between storage and use of hazardous substances and the watercourses;
- the requirement of pollution prevention measures such as drip trays, bunds, spill kits etc.;
- the design and implementation of an Environmental Emergency Protocol or similar, defining the actions and chain of reporting required of all site personnel in the event on an environmental incident.

Giving the reens and ditches respect and space

7.69 In accordance with NRW requirements, the Main Reens require a greater standoff for works and structures of 12.5 metres (m) in order that access can be gained by NRW at times of maintenance and other activities. Ditches require a 7 m standoff. All watercourses on site are to be afforded a high level of protection, as they are a key feature of the Gwent Levels Redwick Llandevenny SSSI.

7.70 In order to ensure that these standoffs are implemented, the CEMP stipulates that a works stand-off from watercourses shall be maintained during the construction phase, with no works undertaken within 12.5 m of a Main Reen and 7 m of a ditch. The turf in these stand-off areas shall be

[14] CIRIA 2015. Environmental good practice on site guide (fourth edition). CIRIA Report C741, CIRIA London
[15] CIRIA 2001. Control of water from construction sites: Guidance for consultants and contractors. CIRIA Report C532. CIRIA London.

maintained in-tact and undisturbed throughout the construction phase, thus forming a vegetated filter strip, providing protection to the watercourses from silt and run-off.

7.71 These vegetated filter strips shall be protected during the works by use of silt fencing, barrier fencing, soil berm or similar to clearly demarcate the stand-off areas and to provide a barrier to movement of plant and migration of silt as required.

7.72 As the site is largely flat lying, generation of run-off is considered likely to be minimal. However, as a precautionary measure additional considerations and measures are also stipulated by the CEMP in order to minimize the potential for generation of silt-laden or otherwise contaminated run-off, and to sever any pathways between the construction works site and the watercourses, including the following:

- Phasing of works, particularly phasing of any required turf and topsoil strip, such that as little bare soil is exposed at any one time.
- Sealing of all soils in storage areas (stockpiles) using an excavator bucket at the end of each shift, to minimise the potential for sediment to be washed off during a rainfall event.
- Formation of all stockpiles outside of the 12.5 m/ 7 m works stand-off zones adjacent to reens/ ditches.
- Where long-term storage of soil is planned, vegetation on stockpiles shall be allowed to naturally regenerate and/ or be seeded to facilitate a cover of vegetation.
- If required, a combination of ditches, berms and sediment traps can be employed in order to control the direction and to slow the flow of rainwater runoff.
- Collection of rainwater gathered on areas of bare soil within the construction in pond/ lagoon areas for it to drain to ground. Where volumes and infiltration rates prevent this, water will be allowed to drain to the watercourses only if it is suitably free of visual evidence of silt or other contamination.
- Where water is visibly turbid (silt-laden) or impacted by contaminants, it shall be treated prior to discharge using one or a combination of; a proprietary water treatment system (e.g. silt-buster); hay bale and/ or sedimat weirs or mats or similar; temporary grips and/ or; proprietary silt filtration devices (e.g. Naylor's SmartFilter).
- The weather forecast will be monitored daily throughout the project, in order to predict periods of likely heavy rainfall. Where heavy rainfall is predicted works may need to be suspended. Ahead of a period of forecasted heavy rain, the Site Management Team shall inspect the works to assess areas susceptible to sediment run-off and take additional precautions as necessary. Such precautions may include additional sediment trap weirs, or covering of stockpiles, for example.
- Chisel-ploughing of the site surface upon completion of construction works, in order to provide improved soil infiltration and counter any compaction of soil surface that may have occurred during the construction works.

7.73 All proposed trackway crossings are to use existing agricultural access points and as such no new crossings are proposed. At each trackway crossing point measures shall be put in place prior to the start of works in that area. Such measures shall be designed by the Main Contractor or sub-contractors and shall include options such as;

- use of silt fencing on either side of the trackway across the top of the crossing;
- use of silt control measures within the watercourse, such as bales, booms, sedimats or other measures to control any spread of silt should it enter the watercourse;
- use of edge-protection berms to prevent migration of silt sideways from trackway into watercourse, etc.

7.74 New cable connection routes that require a crossing of a reen or ditch are to be directionally drilled. The launch pit and receiving pit and associated compounds are to be created outside of the 12.5 m/ 7 m stand-off zones. The design for directionally drilled cable routes shall ensure sufficient depth is attained as to be outside of the required depth of future reen/ ditch casting or other reen/ ditch maintenance activities.

Designing a development that improves the future baseline

7.75 The project has been designed such that the land surrounding and beneath the solar panels will be returned to grassland grazing. Upon completion of the construction phase, fields that currently are used to produce forage maize (approximately 50% of the land based on recent aerial photography) will become vegetated year-round. The sward within the solar park boundary will be allowed to grow and will not be cropped or harvested. As a result, there will not be periods of bare soil.

7.76 Unlike under the current land management scenario, during the operational phase of the development, the fields will not be accessed by heavy plant or machinery, thus reducing compaction effects on the soil.

7.77 As with the construction phase, all structures and works will be set back from reens and ditches by 12.5 m and 7 m respectively, providing the required maintenance corridor.

7.78 All trackways will be constructed to be permeable (i.e. unsealed), and as such will maintain infiltration capacity similar to the bare soil cover under the current scenario. The proportion of land given over to trackways is significantly smaller than that currently left as bare soil thus this represents a significant betterment.

7.79 Where concrete pads are required (under the substation for example), a gravel-filled drainage trench shall be constructed around the structure, thus providing soakaway capacity equivalent to the infiltration capacity lost beneath the structure.

7.80 Where trackways are required to cross reens and ditches, they will do so over existing crossing points and so no new trackway crossing will be required.

7.81 Where cabling routes cross reens and ditches, detailed methodology is be agreed with and signed off by NRW prior to works commencing to ensure that future casting and maintenance operations are not affected.

7.82 The risk of ground settlement and/ or heave will be avoided in the proposed scheme by the following measures:

- All roads and structures will be outside of the 12.5 m/ 7 m protection zone to reens/ ditches.
- The access road will be constructed on a mat of geogrid to spread the loading of traffic.
- The substation and inverter stations will be placed on platforms supported by piles. These will transfer load through the depth of soil to competent bedrock and not place a loading on the ground surface.
- The solar panels themselves are light and supported on piles.

ASSESSING THE EFFECTS OF THE DEVELOPMENT

What are the important receptors?

7.83 The critical receptors are the reens and ditches that are present on site. The aquatic environment that these provide is the cornerstone of the Gwent Levels Redwick Llandevenny SSSI. This aquatic environment is adjudged to be able to absorb some change, but to already be partially impacted by the current land management practices on Site and on much of the surrounding farmland. These receptors are summarised in Table 7-6 below.

Table 7-6 Important receptors

Receptor	**Status**	**Valuation**	Sensitivity (see **Table 7-1**)
Gwent Levels SSSI - Redwick And Llandevenny	Wildlife and Countryside Act 1981	National (United Kingdom)	Medium
Reens	Environment (Wales) Act 2016, Section 7 Local biodiversity action plan priority habitat	County (Newport)	Medium
Ditches	Environment (Wales) Act 2016, Section 7 Local biodiversity action plan priority habitat	Local	Medium
Internal drainage district reens and ditches as land drainage apparatus	Internal Drainage District of Caldicot Levels	Local	Medium

What are the impacts of development going to be?

Construction phase

7.84 The construction of the solar park has the potential to cause impacts on the water environment, if unchecked by proper environmental controls. These impacts could take the form of;

- pollution from fuels, oils and other chemicals that are being used and/ or stored on site entering the watercourses following spills, leaks or accidental releases and;
- impact from sediment/ silt created by exposed soils being eroded by rainfall, flowing into the watercourses

7.85 However, the developer is committed to implementing the construction phase works in accordance with the Outline CEMP (Appendix 2.2). These in-built mitigation measures are considered sufficient to reduce the potential magnitude of these impacts to negligible.

7.86 The construction phase will involve the use of heavy machinery and plant within the agricultural fields on site. Whilst this will represent an intensive period of trafficking on the soil, it is not considered that this is any greater in magnitude than would occur from use of heavy agricultural plant and machinery in a typical growing season for forage maize or silage. The potential magnitude of this impact is therefore considered to be negligible.

7.87 The proposed construction method for the panel panels uses driven steel tube piles to form the foundation of the panels, founding within the clays of the tidal flat deposits. These are not considered to significantly alter the hydrogeology of the shallow soils and will unlikely affect the grip system significantly. Where impact does occur, it will likely damage the grip drainage and hence improve soil wetness and decrease soil throughflow. This is considered to represent a negligible to small beneficial impact.

Operational phase

7.88 During the operational phase of the development, the intensity of use of the land will be much lower than is currently the case. Whereas the land is currently ploughed and trafficked on an annual basis and much of it (an estimated 50%) is left as bare soil through the winter months, once the solar park is operational the land will be given over to grazing pasture, with little trafficking and no ploughing or bare soil. This change in land management is considered to represent a medium beneficial impact on the water quality in the reens and ditches on site.

7.89 The proposed development has been designed such that the operational maintenance required by NRW for reens and ditches is to be preserved. Cable runs are to be directionally drilled beneath

watercourses to sufficient depth to not compromise the ability to cast and otherwise maintain them into the future. This represents negligible change.

Summary

7.90 Table 7-7 below provides a summary of the predicted impacts on water quality arising from the development:

Table 7-7 Summary of predicted impacts

Ref. No.	Project phase	Impact	Magnitude
C1	Construction	Pollution from fuels, oils and other chemicals	Negligible
C2		Impact from sediment/ silt created by exposed soils	Negligible
C3		Soil compaction from heavy plant/ machinery	Negligible
C4		Alteration to soil drainage (e.g. by foundations)	Negligible to small beneficial
C5		Ground heave or settlement due to construction	Negligible
O1	Operational	Change in land management from intensive dairy and forage production to grazing reducing silt and agrichemical run-off	Medium beneficial
O2		Reduction in soil compaction due to lack of use of heavy plant and machinery reducing silt runoff	Medium beneficial
O3		Impact on NRW or landowner ability to maintain and cast reens and ditches	Negligible
O4		Slowing of run-off rates due to removal of intensive agriculture, lack of bare soil in winter, lack of compaction under heavy machinery	Small beneficial

What are the effects on receptors of these impacts?

7.91 Table 7-8 below combines the sensitivity of receptors and the predicted magnitude of impact to define the predicted significance of effect, in accordance with the matrix in Table 7-3.

Table 7-8 Predicted significance of effects

Ref. No.	Impact	Impact magnitude	Receptor	Receptor sensitivity	Significance of effect
Construction phase					
C1	Pollution from fuels, oils and other chemicals	Negligible	Gwent Levels SSSI - Redwick And Llandevenny reens and ditches	Medium	Negligible or minor adverse
C2	Impact from sediment/ silt created by exposed soils	Negligible			Negligible or minor adverse

C3	Soil compaction from heavy plant/ machinery	Negligible			Negligible or minor adverse
C4	Alteration to soil drainage (e.g. by foundations)	Negligible to small beneficial			Minor beneficial
C5	Ground heave or settlement due to construction	Negligible	Internal drainage district reens and ditches as land drainage apparatus	Medium	Negligible
Operational phase					
O1	Change in land management from intensive dairy and forage production to grazing	Medium beneficial	Gwent Levels SSSI - Redwick And Llandevenny reens and ditches	Medium	Moderate beneficial
O2	Reduction in soil compaction due to lack of use of heavy plant and machinery	Medium beneficial			Moderate beneficial
O3	Impact on NRW or landowner ability to maintain and cast reens and ditches	Negligible			Negligible
O4	Slowing of run-off rates due to removal of intensive agriculture, lack of bare soil in winter, lack of compaction under heavy machinery	Small beneficial	Internal drainage district reens and ditches as land drainage apparatus	Medium	Minor beneficial

Are there potential cumulative, secondary or in-combination effects?

7.92 The assessment undertaken above is cognisant of the interaction of hydrology and water quality with ecology on the site and hence no further in-combination assessment is considered necessary. Equally, no secondary effects are considered likely.

7.93 The predicted effects on surface water will be of only local extent and hence a cumulative effect with other schemes is not considered likely. Notwithstanding this, potentially significant effects associated with this development have been taken forward and compared with the effects assessed in the respective environmental assessment for each of the projects scoped in to the cumulative assessment (See Table 3-2). The results of this exercise are summarised in Table 7-9.

7.94 Those effects taken forward for this cumulative assessment are;

- Construction Phase C4 – Alteration to soil drainage (Minor Beneficial)

- Operational Phase O1 – Change in land management from intensive dairy and forage production to grazing (Moderate Beneficial)
- Operational Phase O2 – Reduction in soil compaction due to lack of use of heavy plant and machinery (Moderate Beneficial)
- Operational Phase O4 – Slowing of run-off rates due to removal of intensive agriculture, lack of bare soil in winter, lack of compaction under heavy machinery (Minor Beneficial)

Table 7-9 Cumulative impact assessment

Project	Effect	Assessed significance		Cumulative effect?
		Rush Wall	Other scheme	
Gwent Farmers' Community Solar Scheme	C4 Alteration to soil drainage	Minor Beneficial	Not assessed	Minor Beneficial
	O1 De-intensification of land management	Moderate Beneficial	Beneficial	Moderate Beneficial
	O2 Reduction in soil compaction	Moderate Beneficial	Beneficial	Moderate Beneficial
	O4 Slowing of run-off rates	Minor Beneficial	Beneficial	Minor Beneficial
Single wind turbine on land off Rush Wall Lane, Redwick, Caldicot, NP26 3DX	C4 Alteration to soil drainage	Minor Beneficial	Not directly assessed. Project footprint is small (0.13 ha). Small loss of permeable land beneath turbine and switchgear bases. Contribution to cumulative effect small.	Minor Beneficial
	O1 De-intensification of land management	Moderate Beneficial		Moderate Beneficial
	O2 Reduction in soil compaction	Moderate Beneficial		Moderate Beneficial
	O4 Slowing of run-off rates	Minor Beneficial		Minor Beneficial
Single wind turbine on Land To The North Of Little Longlands, Longlands Lane, Magor, Caldicot	C4 Alteration to soil drainage	Minor Beneficial	Negligible	Minor Beneficial
	O1 De-intensification of land management	Moderate Beneficial	Not assessed Small project footprint. Contribution to cumulative effect small.	Moderate Beneficial
	O2 Reduction in soil compaction	Moderate Beneficial	Not assessed. Small project footprint. Contribution to cumulative effect small.	Moderate Beneficial
	O4 Slowing of run-off rates	Minor Beneficial	Negligible	Minor Beneficial
1.6km rail formation - Land Adjacent And North Of Branch Railway Line, Seven Stiles Avenue, Newport	C4 Alteration to soil drainage	Minor Beneficial	Development sits in separate water catchment and outside of Gwent Levels SSSIs so considered too distant to contribute cumulative effect with Rush Wall solar park.	
	O1 De-intensification of land management	Moderate Beneficial		
	O2 Reduction in soil compaction	Moderate Beneficial		
	O4 Slowing of run-off rates	Minor Beneficial		

Table 7-9 Cumulative Impact Assessment (Continued)

Project	Effect	Assessed significance		Cumulative effect?
		Rush Wall	Other scheme	
Free Range Egg Production Unit – Land at Castle Farm, Bishton Road, Bishton, Newport, NP18 2DZ	C4 Alteration to soil drainage	Minor Beneficial	Development sits in separate water catchment and outside of Gwent Levels SSSIs so considered too distant to contribute cumulative effect with Rush Wall solar park.	
	O1 De-intensification of land management	Moderate Beneficial		
	O2 Reduction in soil compaction	Moderate Beneficial		
	O4 Slowing of run-off rates	Minor Beneficial		
Land at Vinegar Hill - Hybrid app for 155 dwellings	C4 Alteration to soil drainage	Minor Beneficial	Development 1.3 km from site and outside of Gwent Levels SSSIs and so considered too distant to contribute cumulative effect with Rush Wall solar park.	
	O1 De-intensification of land management	Moderate Beneficial		
	O2 Reduction in soil compaction	Moderate Beneficial		
	O4 Slowing of run-off rates	Minor Beneficial		
Land at Rockfield Farm - Outline consent for 266 house and approx. 5575m^2 of employment space	C4 Alteration to soil drainage	Minor Beneficial	Development 1.9 km from site and outside of Gwent Levels SSSIs and so considered too distant to contribute cumulative effect with Rush Wall solar park.	
	O1 De-intensification of land management	Moderate Beneficial		
	O2 Reduction in soil compaction	Moderate Beneficial		
	O4 Slowing of run-off rates	Minor Beneficial		
Land at Rockfield Farm partial RM for the above site - 144 dwellings	C4 Alteration to soil drainage	Minor Beneficial	Development 1.9 km from site and outside of Gwent Levels SSSIs and so considered too distant to contribute cumulative effect with Rush Wall solar park.	
	O1 De-intensification of land management	Moderate Beneficial		
	O2 Reduction in soil compaction	Moderate Beneficial		
	O4 Slowing of run-off rates	Minor Beneficial		
Land at Ifton Manor Rogiet - 12 dwellings	C4 Alteration to soil drainage	Minor Beneficial	Development 4.7 km from site and outside of Gwent Levels SSSIs and so considered too distant to contribute cumulative effect with Rush Wall solar park.	
	O1 De-intensification of land management	Moderate Beneficial		
	O2 Reduction in soil compaction	Moderate Beneficial		
	O4 Slowing of run-off rates	Minor Beneficial		
Magor Brewery. Erection of sixteen fermentation	C4 Alteration to soil drainage	Minor Beneficial	Development 1.0 km from site and outside of Gwent Levels SSSIs and so considered too distant to contribute cumulative effect with Rush Wall solar park.	
	O1 De-intensification of land management	Moderate Beneficial		
	O2 Reduction in soil compaction	Moderate Beneficial		

vessels, enclosed supporting structure and associated works.	O4 Slowing of run-off rates	Minor Beneficial	
Magor Motorway Services Installation of ground mounted photovoltaic solar arrays to provide circa 5 MW generation capacity with associated infrastructure.	C4 Alteration to soil drainage	Minor Beneficial	Development 1.4 km from site and outside of Gwent Levels SSSIs and so considered too distant to contribute cumulative effect with Rush Wall solar park.
	O1 De-intensification of land management	Moderate Beneficial	
	O2 Reduction in soil compaction	Moderate Beneficial	
	O4 Slowing of run-off rates	Minor Beneficial	