



Frodsham Solar

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Appendix 5-3: Climate Resilience Assessment

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1 Introduction

This appendix has been written in support of **ES Vol 1 Chapter 5: Climate Change [EN010153/DR/6.1]**. This appendix details the extent the Proposed Development is vulnerable to, and how it will be resilient to, the effects of climate change.

The resilience to climate change has been assessed for the following vulnerable receptors:

- Operational equipment (solar photovoltaics (PV) modules, battery energy storage system (BESS), power conditioning unit (PCU), power conversion system (PCS), substation and cabling);
- Vehicular access to Site;
- On-site workers;
- Members of the public accessing the new permissive paths within the Site; and
- Habitats created as part of the Proposed Development.

This has considered the following projected changes to climate as identified in **ES Vol 2 Appendix 5-2: Climate Baseline Report [EN010153/DR/6.2]**:

- Increased winter precipitation;
- Decreased summer precipitation;
- Increase in temperatures;
- Increased frequency and magnitude of storms;
- Changes in cloud cover; and
- Sea level rise.

The methodology is set out in **ES Vol 1 Chapter 5: Climate Change [EN010153/DR/6.1]**.

2 Increased winter precipitation

As set out in **ES Vol 2 Appendix 5-2: Climate Baseline Report [EN010153/DR/6.2]**, the UKCP18 predictions are that there will be a move to wetter winters. As a central estimate it is predicted that mean precipitation during winter will increase by 16% by 2060-2079 from existing levels. This predicted increase in precipitation will increase the potential for flooding.

The Flood Risk Assessment and Drainage Strategy (FRA and Drainage Strategy) provided in **ES Vol 2 Appendix 9-1: Flood Risk Assessment and Drainage Strategy [EN010153/DR/6.2]** provides full details of the flood risk within the Order Limits and includes consideration of the potential for flooding from fluvial, tidal, surface water, sewer, groundwater and artificial sources. This also includes consideration of the effects of climate change. For full details of the flood risk reference should be made to **ES Vol 2 Appendix 9-1: Flood Risk Assessment and Drainage Strategy [EN010153/DR/6.2]**. In summary this shows that:

- The Site is located in an area which benefits from flood defences. However, fluvial flooding could occur if the River Weaver or Manchester Ship Canal overtop their defences during or following an extreme rainfall event. Coastal / tidal flooding from the River Mersey could occur from overtopping of the defences during an extreme tidal event. However, there are no historic records of these events occurring at or near to the site.
- The modelling of fluvial flooding from the River Weaver with the 1% Annual Exceedance Probability (AEP) plus a climate change allowance of 30% and failure of the flood defences (very worst-case), shows that the eastern extent of the Site is at risk of residual flooding, but the western extent of the site is flood free.
- The risk of the flooding from the Manchester Ship Canal is very low.
- The risk of tidal flooding has been modelled including an allowance for climate change including and excluding the flood defences (which is unlikely to occur, as this would entail a complete failure of both the River Mersey flood defences and the River Weaver flood defences occurring simultaneously). This shows that the eastern extent of the Site is at risk from tidal flooding, which is exacerbated should the flood defences fail. However, the western extent of the Site is flood free during all scenarios.
- For the majority of the site the risk from surface water flooding is very low. However, there are some isolated pockets shown to be at high, medium and low risk. These areas are associated with surface water ponding within topographical low points on site. The proposed solar arrays will be elevated above ground on supporting structures, with no inverters or equipment susceptible to flood damage located within these areas.
- The risk of sewer flooding is very low.
- The risk of groundwater flooding is low.
- The risk of reservoir flooding is extremely unlikely to happen.

2.1 Operational equipment (solar PV modules, BESS, PCS, PCU, substation and cabling)

Flooding within the Order Limits has the potential to result in the damage of equipment resulting in a loss of electricity generation. The extent of flooding will determine the level of damage which could be caused.

2.1.1 Sensitivity

The sensitivity of the operational equipment to flooding is deemed to be medium for the following reasons:

- The value of the receptor is high as the operational equipment have a high monetary value.
- The vulnerability is considered to be moderate as the parts of the Site are within Flood Zone 3 and flooding may be exacerbated as a result of climate change.
- The susceptibility is deemed to be low as the following effective mitigation measures are in place to allow the Proposed Development to withstand the projected increases in rainfall and associated flooding events:
 - The proposed solar arrays will be situated on ram mounted posts, with the base of the panels a minimum of 600 mm above the 0.5% AEP upper end climate change (year 2075) defended River Mersey tidal flood event. The bottom edge of the panels will therefore be situated at 6.52 m AOD in the eastern extent of the Site within the area covered by Flood Zone 3.
 - All equipment susceptible to flood damage i.e. inverters, would also be situated at a minimum of at 6.24 m AOD in the eastern extent of the Site and 6.1 m AOD in the centre of the Site.
 - The proposed substation and BESS compound are sequentially located in the higher western extent of the Site and are flood free in all considered events.
 - As the proposed solar arrays will be elevated above the ground on steel frames and above flood levels, flood flows will be allowed to move freely beneath the panels and there will be no loss of flood storage and no impediment to flood flows as a result of the development. Across the wider Site, the steel frames and inverters are negligible in terms of footprint.
 - Access roads will be formed by removing topsoil, organic soils, and filling with engineer fill. The access roads stone surface will be marginally higher than the surrounding ground, however no ground raising is proposed to facilitate the access roads. The access roads will therefore have negligible impact on flood risk.
 - The Power Conversion Units (PCUs), and Power Conversion Systems (PCSs) will be installed on concrete pile foundations.

2.1.2 Magnitude

The overall magnitude of impact is small for the following reasons:

- The probability of increased rainfall is high as a result of climate change (and this is projected to occur in both the central and high estimate), but the probability of increased flooding at the Site is low because drainage has been incorporated into the design, the main electrical equipment will be situated at a minimum height to avoid flood damage.
- The consequence of serious flooding would be damage to electrical equipment and the cessation of disruption to the export of electricity from the Proposed Development until the flooding subsides and the equipment has been repaired. As noted above the critical components of electrical infrastructure i.e. substation, control room, BESS etc, as well as a significant proportion of the generating capacity of the solar PV panels, would be located well above the most extreme flood levels. As such in an extreme flood event the Proposed Development would still have the ability to generate and export power to the grid, as well as provide grid balancing services within the BESS.

2.1.3 Significance

As a result, it is considered that the predicted increase in precipitation leading to the increased potential for flooding would be of slight significance to the operational equipment.

2.2 Vehicular access

Flooding within the wider area has the potential to result in the disruption of access to the Proposed Development. The extent of flooding will determine the level of disruption caused. However, the Proposed Development could continue to operate if the equipment is not damaged, and flooding is limited to the wider area.

2.2.1 Sensitivity

The sensitivity of the vehicular access to the Site to increased precipitation is deemed to be medium for the following reasons:

- The value of the receptor is high as the vehicular access is required for full-time and maintenance workers to enter and leave the Site.
- The vulnerability is considered to be moderate because the local access routes for workers may be at risk of flooding. The risk of flooding is likely to increase throughout the lifetime of the Proposed Development.
- The susceptibility is deemed to be low as it is possible to operate the facility remotely during periods when there is an extreme flood event possible. Additionally, a Framework Flood Warning & Evacuation Plan (ES Vol 2 Appendix 9-5: [EN010153/DR/6.2]) has been prepared that sets out measures for evacuating on-site workers within the Site.

2.2.2 Magnitude

The overall magnitude of impact is small for the following reasons:

- The probability of increased rainfall is high, and this is projected to occur in both the central and high estimate, but the probability of increased flooding to vehicular access routes is low as the access route to the Site would remain flood free in all but the most extreme modelled flood events, and then the access would only be flooded in small sections to less than 100mm.
- The consequence of flooding on vehicular access is the workers' commutes will be disrupted, but the plant could still operate. Additionally, during the operational phase there are less workers required on-site. Maintenance works could be re-arranged if necessary.

2.2.3 Significance

As a result, it is considered that the predicted increase in precipitation leading to the increased potential for access route flooding would be of slight significance.

2.3 On-site workers

Increased rainfall linked to climate change can impact on-site workers by resulting in dangerous working conditions. However, there are mitigation measures built into the design and Risk Assessment Method Statements (RAMS) will be used during operational Phase of the Proposed Development. Staff will be equipped with the correct PPE (that is also appropriate for the weather), trained in on-site health and safety. Workers would not be able to or be expected to work in areas

of the Site that are flooded. Therefore, there are no likely significant impacts. Additionally, a Framework Flood Warning & Evacuation Plan (ES Vol 2 Appendix 9-5: [EN010153/DR/6.2]) has been prepared that sets out measures for evacuating on-site workers within the Site.

2.4 Members of the public accessing the new permissive paths within the Site

Increased rainfall linked to climate change can result in dangerous conditions which has the potential to impact members of the public accessing the new permissive paths within the Site.

2.4.1 Sensitivity

The sensitivity of members of the public accessing the new within the Site to flooding is deemed to be medium for the following reasons:

- The value of human life is high.
- The vulnerability of members of the new permissive paths within the Site is considered to be moderate because the permissive may be at risk of flooding. The risk of flooding is likely to increase throughout the lifetime of the Proposed Development.
- The susceptibility is deemed to be low.
 - Additionally, members of the public will be alerted of flooding events via several official channels which would discourage them from going on a walk through the Site:
 - The UK Government issues emergency alerts sent directly to mobile phones for life-threatening situations including flooding events.
 - Flood warnings are shared through the BBC, ITV, and local radio stations.
 - The Environment Agency, local councils, and emergency services post updates on their website and social media.
 - National Highways, Network Rail, and airports issue travel warnings for disruptions.

2.4.2 Magnitude

The overall magnitude of impact is small for the following reasons:

- The probability of increased rainfall is high as a result of climate change (and this is projected to occur in both the central and high estimate), but the probability of the flooding events affecting members of the public using the new permissive paths within the Site is low because members of the public will be discouraged from going on walks in poor weather conditions.
- The consequence of serious flooding would be danger to human life. However, weather warnings via the official channels will ensure members of the public are safe.

2.4.3 Significance

As a result, it is considered that the predicted increase in precipitation leading to the increased potential for flooding would be of slight significance to members of the public using the new permissive paths within the Site.

2.5 Habitats

The habitats proposed include open water habitats and reedbeds, native species hedgerows, trees and semi-improved grasslands. Flooding within the Order Limits has the potential to result in the damage to and loss of habitat created as part of the Proposed Development. The extent of flooding and to what habitats will determine the level of damage which could be caused.

2.5.1 Sensitivity

The sensitivity of habitats to flooding is deemed to be medium for the following reasons:

- The value of habitats is medium.
- The vulnerability of the habitats is considered to be moderate as they are dependent upon rainfall but are able to tolerate a range of conditions and parts of the Site flooding may be exacerbated as a result of climate change.
- The susceptibility is deemed to be low as the habitat creation areas have been designed allowing for the flood risk across the Site and have the ability to withstand increased rainfall and flooding events. For instance:
 - new semi-improved grassland will be laid under solar PV modules where the flood risk is lower;
 - new species rich wet grassland will be laid in the Non-Breeding Bird Mitigation Area (NBBMA) and around the field edges this area has a higher probability of flooding but given the nature of the habitats these would not be negatively affected by flood events;
 - open water and reedbed mosaic will be enhanced along the Manchester Ship Canal where risk of flooding is higher but given the nature of the habitats these would not be negatively affected by flood events.

2.5.2 Magnitude

The overall magnitude of impact is small for the following reasons:

- The probability of increased rainfall is high as a result of climate change (and this is projected to occur in both the central and high estimate), but the probability of increased flooding at the Site is low because drainage has been incorporated into the design and planting will take place (as described above) to encourage the infiltration of water into the ground.
- The consequence of serious flooding would be damage to and loss of habitats. However, the habitat creation areas have been designed taking into account the flood risk across the site and more susceptible habitats are located away from flood areas, which habitats which are more able to withstand flood events located in the flood zone.

2.5.3 Significance

As a result, it is considered that the predicted increase in precipitation leading to the increased potential for flooding would be of slight significance to habitats.

3 Decreased summer precipitation

As set out in **ES Vol 2 Appendix 5-2: Climate Baseline Report [EN010153/DR/6.2]**, the UKCP18 predictions are that there will be a move to drier summers. As a central estimate it is predicted that mean precipitation during summer will decrease by 23% by 2060-2079 from existing levels. This predicted decrease in precipitation could increase the risk of drought. This could lead to water shortages.

The water supplier for the area is United Utilities. United Utilities' Business Plan 2025-2030¹ has outlined a number of measures to ensure a reliable supply including investing £975 million in a programme to build a more resilient network; fixing leaks and replacing 950 km of old pipes and mains; and working with local authorities to separate rainwater from their systems.

3.1 Operational equipment

The Proposed Development does not need a water supply to operate. However, water is used for cleaning the solar PV modules and for firefighting purposes. Fire water tank(s) would be provided which reduces the reliance on a fixed supply, these would be located within 100 m of the BESS units.

3.1.1 Sensitivity

The sensitivity of the operational equipment to a water shortage as a result of decreased summer precipitation is deemed to be low for the following reasons:

- The value of the receptor is high as the operational equipment have a high monetary value.
- The vulnerability is low as water is not required for the Proposed Development to operate but the solar PV modules will work less efficiently when they are not cleaned.
- The susceptibility would be low as
 - United Utilities has effective mitigation measures in place to ensure a reliable supply.
 - Fire water storage tanks will be provided to reduce the reliance on a fixed supply.

3.1.2 Magnitude

The overall magnitude of impact is small for the following reasons:

- The probability of decreased summer precipitation is high, but due to the mitigation measures committed to by United Utilities, the probability of reduced water supply is low. In addition, on-site fire water storage tanks are incorporated into the design to ensure that they meet the need.
- The consequence would be that the solar PV modules would work less efficiently until they are next cleaned.

3.1.3 Significance

As a result, it has been considered that decreased summer rainfall leading to the increased potential for drought and lack of water supply would be of negligible significance to the operational equipment.

¹ United Utilities. (2023). *Our Business Plan Summary 2025-2030*. Available at: <https://pr24.unitedutilities.com/> [Last Accessed 20 October 2024].

3.2 Vehicular access

The projected decrease in precipitation and increased risk of water shortages is not expected to affect vehicular access to the Site.

3.3 On-site workers

The projected decrease in precipitation and increased risk of water shortages is not expected to affect on-site workers. The measures set out by the water supplier would ensure that a supply for welfare facilities is secured and this allows for the effects of climate change.

3.4 Members of the public accessing the new permissive paths within the Site

The projected decrease in precipitation and increased risk of water shortages as a result of climate change is not expected to affect the members of public accessing permissive paths within the Site. Water shortages can be dangerous to members of the public by increasing the risk of dehydration. However, it is not expected that the members of the public would be at the Proposed Development for extended periods as they would be walking through the Site on the new permissive paths and should be prepared for the weather conditions. Therefore, there are no likely significant impacts.

3.5 Habitats

Drought at the Proposed Development has the potential to result in the damage to and loss of habitat. The extent of drought will determine the level of damage which could be caused. The habitats proposed include wetlands and grasslands which may be susceptible to drought.

Sensitivity

The sensitivity of habitats to drought is deemed to be medium for the following reasons:

- The value of habitats is medium.
- The vulnerability is considered to be moderate as the habitats have the ability to withstand some amount of drought especially given the increased rainfall projected to occur during winter.
- The susceptibility would be moderate as the habitats are dependent on rainfall, but are able to tolerate a range of conditions. In addition, the management of the habitat creation areas will be modified to align with changes in climate if necessary.

3.5.1 Magnitude

The overall magnitude of impact is small for the following reasons:

- The probability of drought is high as a result of climate change.
- The consequence of drought would be damage to and loss of habitats. However, the habitats have been chosen to enhance the local area and would be managed throughout the lifetime of the Proposed Development and adapt to the challenges faced by increased probability of drought.

3.5.2 Significance

As a result, it is considered that the predicted decrease in summer precipitation leading to the drought would be of slight significance to habitats.

4 Increase in temperatures

As set out in **ES Vol 2 Appendix 5-2: Climate Baseline Report [EN010153/DR/6.2]**, the UKCP18 predictions are that there will be an increase in temperature across the UK. Probabilistic projections show that there is likely to be more waring in summer than winter. The projected change in mean temperature (as a central estimate) is an overall increase of 2.5°C, with an increase of 3.1°C in summer by 2060-2079 from existing levels.

4.1 Operational equipment

The predicted increase in mean summer temperatures has the potential to cause materials to be heated up to higher temperatures than currently which cause damage to equipment and reduce the efficiency of the solar cells and the BESS.

4.1.1 Sensitivity

The sensitivity of the operational equipment to increased temperatures is deemed to be low for the following reasons:

- The value of the receptor is high as the operational equipment have a high monetary value.
- The vulnerability is moderate as the materials can be affected by extremes in temperature.
- The susceptibility is low as the materials to be used are tolerant for a range of temperatures well within the project temperatures for the UK. Although the equipment has not yet been chosen, the equipment is likely to have specifications like below:
 - The BESS will likely have a temperature controlled forced air cooling system which will be used to stabilise temperature and humidity to maintain a stable minimum temperature optimising performance. The BESS will likely be designed to operate safely between -30°C and 50°C.
 - The operating temperature for the candidate solar PV modules is between -40°C and 85°C.
 - The solar PV substructure is likely to be made of galvanised steel with piles driven into the ground. Galvanized steel mounting support can withstand very large range of ~-50°C to 100°C.
 - The operating temperature for PCU is likely to be between -30°C and 60°C.
 - The operating temperature for PCS is likely to be between -25°C and 45°C.
 - The installation temperature for cables is likely to be between 0°C and 80°C and the operating temperature is between -15°C and 90°C.

4.1.2 Magnitude

As such the overall magnitude of impact is small for the following reasons:

- The probability of increased temperatures is high, but the probability of temperatures high enough to damage the operational equipment is low.
- The consequence is the operational equipment may undergo damage but only at very high temperatures (outside the likely temperatures in the UK), but this would be repairable at the operators cost and impacts would be short term.

4.1.3 Significance

As a result, it has been considered that the predicted increase in temperatures would be of negligible significance to the operational equipment.

4.2 Vehicular access

The predicted decrease in temperatures due to climate is not expected to impact vehicular access at the Site.

4.3 On-site workers

Projected increases in temperatures can impact on-site workers by resulting in dangerous working conditions. However, there are mitigation measures built into the design built into the design and RAMS are used during operation of the Proposed Development. Staff will be equipped with the correct PPE (that is also appropriate for the weather), trained in on-site health and safety and informed about protecting themselves from the dehydration and the sun. In addition, air-conditioning will be provided in indoor areas where staff could be expected to be present.

4.3.1 Sensitivity

The sensitivity of the on-site workers to increased temperatures is deemed to be medium for the following reasons:

- The value of human life is high.
- The vulnerability is considered to be moderate as it is likely that temperatures will increase on-site, and workers have the potential to be affected by this.
- The susceptibility is deemed to be low, as mitigation measures would be in place such as access to appropriate PPE, education and appropriate ventilation. However, on-site workers may still be impacted by the increase in temperatures, but they would be exposed to these in their everyday life too.

4.3.2 Magnitude

The overall magnitude of impact is small for the following reasons:

- The probability of increased temperatures is high. However, this will apply to the ambient air which on-site workers would be exposed to in their everyday life, and will not be specific to the Site. The probability of regular negative impact to the on-site workers from high temperatures is low.
- The consequence of increased temperatures causing heat stroke would result in staff absences. However, high heat occasions would only occur in summer and for a few days at a time and appropriate measures to mitigate the effects will be in place.

4.3.3 Significance

As a result, it has been considered that the predicted increased temperatures leading to the increased potential for uncomfortable working conditions for the on-site workers would be of slight significance.

4.4 Members of the public accessing the new permissive paths within the Site

The projected increase in summer temperatures as a result of climate change is not expected to affect the members of public accessing the new permissive paths within the Site. Increased summer temperatures can be dangerous to members of the public increasing the risk of heat-related illnesses such as heat exhaustion and heatstroke. However, it is not expected that the members of the public would be at the Proposed Development for extended periods as they would be walking through the Site on the new permissive paths, and they should be prepared for the weather conditions. Therefore, there are no likely significant impacts.

4.5 Habitats

Increased temperatures would lead to increased levels of evaporation and a shortage of water. The effect of increased temperatures on habitats would be the same as decreased summer precipitation as outlined in section 3.

5 Increased frequency and magnitude of storms

As set out in **ES Vol 2 Appendix 5-2: Climate Baseline Report [EN010153/DR/6.2]**, there is a large uncertainty in projected changes in wind and air circulation across the UK. However, projections indicated there will be an increase in frequency and magnitude of storms. The predicted increase in extreme events could increase precipitation rates and high wind speeds. The effects as a result of the predicted increase in precipitation has been covered in section 2.0. This section will focus on the effect of wind gusts. The UKCP18 projections predict that wind speeds will increase, but do not quantify what the increase will be.

5.1 Operational equipment

Gusts in wind could cause structural damage to the operational equipment and damage to the wind turbines which are co-located on the Site. The projected increased frequency of these events can result in damage to operational equipment.

5.1.1 Sensitivity

The sensitivity of the operational equipment to increased frequency and magnitude of wind and storms is deemed to be medium for the following reasons:

- The value of the receptor is high as the operational equipment has a high monetary value.
- The vulnerability is moderate. The area is likely to experience higher wind speeds, but the equipment is able to tolerate a range of conditions. Additionally, increased wind speeds could cause branches and other objects to fall and damage the operational equipment.
- The susceptibility is moderate.
 - The containerised electrical infrastructure will have the ability to withstand extreme wind speeds.
 - standard solar PV modules can withstand a wind load of approx. 2400 pa.
 - The turbines on Frodsham Wind have the ability to withstand the extreme wind speeds.

5.1.2 Magnitude

The overall magnitude of impact is small for the following reasons:

- The probability of increases in extreme events is high, however, the probability of the solar PV modules and associated infrastructure being damaged is low as the equipment will be designed to withstand strong winds and the Frodsham Wind Farm turbines and foundations have been designed including safety factors to prevent topple over in very high winds.
- Turbines T15 to T20 of Frodsham Wind Farm are located within the Site, the operational equipment may undergo a severe damage if adjacent wind turbines fall. This probability of this occurring is low as they have been designed to take anticipated wind loading.
- The operational equipment may undergo damage if debris is to fall on it. The damaged solar PV modules would work at a lower efficiency until they are replaced, and the electrical equipment could potentially be temporarily out of action depending on the size of the object.

5.1.3 Significance

As a result, it has been considered that the predicted increase in extreme events leading to the potential increase in wind damage would be of slight significance to the operational equipment.

5.2 Vehicular access

The predicted increase in rain caused by storms and extreme events is covered in section 3.1. Surges in wind may have an impact on the vehicular access to the Site where they cause branches to be blown off or trees to be blown over, resulting in a road blockage.

5.2.1 Sensitivity

The sensitivity of the vehicular access to the Site to road blockages caused by fallen trees is assessed to be medium for the following reasons:

- The value of the receptor is high as the vehicular access is required for full-time and maintenance workers to enter and leave the Site.
- The vulnerability is moderate, as it is possible that part of the vehicular access route could be blacked by trees and branches that have fallen as a result of higher wind speeds.
- The susceptibility is deemed to be low as there are effective mitigation measures in place to clear any blockages.

5.2.2 Magnitude

The overall magnitude of impact is small for the following reasons:

- The probability of increased extreme events is high, but the probability of this impacting the vehicular access routes is medium, as the Local Highways Authority / National Highways are responsible for clearing blockages on strategic roads quickly and any onsite roads can be cleared when conditions are suitable. Any blockages of roads on-site would be cleared by the operator.
- The consequence of blockages to access routes and the workers' commutes will be disrupted but the plant could still operate if infrastructure was not damaged.

5.2.3 Significance

As a result, it is considered that the predicted increase in extreme events as a result of changes to climate would be of slight significance to the vehicular access to the Site.

5.3 On-site workers

Increased wind speeds can increase the risk to hazards such as equipment, and debris being shifted by wind gusts, coming loose and falling on workers. Regular inspections and preventative maintenance will reduce the risk to on-site workers. The projected increased frequency of these events can result a greater potential for damage to occur.

5.3.1 Sensitivity

The sensitivity of the on-site workers to increased safety risks from wind gusts is deemed to be medium for the following reasons:

- The value of human life is high.

- The vulnerability is considered to be moderate as it is likely that wind gusts will increase, and workers on-site may be affected by this.
- The susceptibility is deemed to be low, as the on-site workers have access to appropriate PPE and education. Preventative maintenance and regular inspections (of both the solar PV infrastructure and neighbouring wind turbines) and RAMS will be in place to ensure on-site worker safety.

5.3.2 Magnitude

The overall magnitude of impact is small for the following reasons:

- The probability of increased extreme events is high, however the probability of this impacting on-site workers is low due to the imbedded mitigation measures.
- The consequence of increased gusts is injury to or death of workers.

5.3.3 Significance

As a result, it has been considered that the predicted increase in extreme events leading to increased risk to on-site workers from wind gusts would be of slight significance.

5.4 Members of the public accessing the new permissive paths within the Site

Increased frequency and magnitude of storms linked to climate change has the potential to result in dangerous condition which can impact members of the public accessing the new permissive paths within the Site.

5.4.1 Sensitivity

The sensitivity of members of the public accessing the new permissive paths within the Site to increased frequency and magnitude of storms is deemed to be medium for the following reasons:

- The value of human life is high.
- The vulnerability of members of the public accessing the new permissive paths within the Site is considered to be moderate as it is likely that wind gusts will increase, and members of the public using the new permissive paths within the Site may be affected by this.
- The susceptibility is deemed to be low as members of the public will be alerted of severe weather warnings via several official channels which would discourage them from going on a walk or a hike:
 - Met Office Weather Warnings are issued in yellow, amber, or red categories based on severity, covering wind, rain, snow, and thunderstorms.
 - The UK Government issues emergency alerts sent directly to mobile phones for life-threatening situations including severe storms events.
 - Warnings are shared through the BBC, ITV, and local radio stations.
 - The Met Office, Environment Agency, local councils, and emergency services post updates on their website and social media.
 - National Highways, Network Rail, and airports issue travel warnings for disruptions.

5.4.2 Magnitude

The overall magnitude of impact is small for the following reasons:

- The probability of increased frequency and magnitude of storms is high as a result of climate change (and this is projected to occur in both the central and high estimate), but the probability of increased frequency and magnitude of storms affecting members of the public at the Site is low because members of the public will be discouraged from going on walks in poor weather conditions and should be prepared for the weather conditions.
- The consequence of serious flooding would be danger to human life. However, weather warning via the official channels will ensure members of the public are safe.

5.4.3 Significance

As a result, it is considered that the predicted increase in frequency and magnitude of storms would be of slight significance to members of the public accessing new permissive paths within the Site.

5.5 Habitats

Habitats are unlikely to be affected by increased frequency and magnitude of wind and storms. The planting plan has considered habitats that are native and once established will be able to withstand storm events. Ongoing management of the habitats will ensure that any damage to habitats is investigated and appropriate action is taken.

6 Changes in cloud cover

Just as clouds affect climate, changes in the climate affect clouds. This relationship is known as cloud-climate feedback and it a challenging research area in climate science. Climate scientists predict that as Earth's climate warms, there will also be fewer clouds to cool it down. This would result in an increase in solar radiation and result in increased temperatures.

6.1 Operational equipment

Whilst increased solar radiation would result in more energy generation from the Proposed Development, there would also be an associated increase in temperature which has the potential to damage operational equipment.

6.1.1 Sensitivity

The sensitivity of the operational equipment to changes to increases in solar radiation and temperature as a result of changes to cloud cover is deemed to be medium for the following reasons:

- The value of the receptor is high as the operational equipment has a high monetary value.
- The vulnerability is low as the materials have the potential to be affected by extremes in temperatures, but increased solar radiation would result in more energy generation from the Proposed Development.
- The susceptibility is low as the operational equipment will have the ability to withstand increases in solar radiation. Although the equipment has not yet been chosen, the equipment is likely to have specifications like below:
 - Whilst BESS are susceptible to overheating which can lead to degraded performance, shortened lifetime and fire risk. A temperature controlled forced air cooling system will be used to stabilise temperature and humidity to maintain a stable minimum temperature optimising performance. A candidate BESS is designed to operate safely between -30°C and 50°C.
 - The operating temperature for the candidate solar PV modules is between -40°C and 85°C. It is unlikely that temperatures in the UK would exceed this range.
 - The solar PV substructure will be made of galvanised steel with piles driven into the ground. Galvanized steel mounting support can withstand very large range of ~-50°C to 100°C.
 - The operating temperature for the candidate PCU is between -30°C and 60°C. It is unlikely that temperatures in the UK would exceed this range.
 - The operating temperature for the candidate PCS is between -25°C and 45°C. It is unlikely that temperatures in the UK would exceed this range.
 - The installation temperature for the candidate cables is between 0°C and 80°C and the operating temperature is between -15°C and 90°C. It is unlikely that temperatures in the UK would exceed this range.

6.1.2 Magnitude

The overall magnitude of impact is small for the following reasons:

- The probability of reduced cloud cover is medium.

- The consequence of reduced cloud cover is that solar PV modules will generate more electricity as they will be exposed to more sunlight and the resultant increase in temperature is unlikely to have significant impacts on the operational equipment.

6.1.3 Significance

As a result, it has been considered that the predicted changes in cloud cover would be of slight significance to the operational equipment.

6.2 Vehicular access

The projected changes in cloud cover are not expected to impact vehicular access to the Site.

6.3 On-site workers

Projected changes in cloud cover can impact on-site workers by resulting in dangerous working conditions. However, staff will be equipped with the correct PPE (that is also appropriate for the weather), trained in on-site health and safety and informed about protecting themselves from the dehydration and the sun. The risk to on-site workers is similar to that associated with the projected increase in temperatures as set out in section 4.3.

6.4 Members of the public accessing the new permissive paths within the Site

The projected changes in cloud cover as a result of climate change is not expected to affect the members of public accessing the new permissive paths within the Site. Reduction in cloud cover can be dangerous to members of the public by increasing UV radiation exposure and increasing temperatures which in turn increases the risk of heat-related illnesses such as heat exhaustion and heatstroke. However, it is not expected that the members of the public would be at the Proposed Development for extended periods as they would be walking through the Site on the new permissive paths and would be prepared for the weather conditions. Therefore, there are no likely significant impacts.

6.5 Habitats

The projected changes in cloud cover are not expected to affect the habitats created as part of the Proposed Development.

7 Sea level rise

Sea level rise will increase the chance of flooding from the sea. The FRA and Drainage Strategy provided in **ES Vol 2 Appendix 9-1: Flood Risk Assessment and Drainage Strategy [EN010153/DR/6.2]** considers the risk of tidal flooding within the Order Limits including and excluding the flood defences (which is unlikely to occur, as this would entail a complete failure of both the River Mersey flood defences and the River Weaver flood defences occurring simultaneously). This shows that the eastern extent of the Site is at risk from tidal flooding, which is exacerbated should the flood defences fail. However, the western extent of the Site is flood free during all scenarios.

The effect of the predicted increase in flooding due to sea level rise as a result of climate change has been covered in section 2.

8 Summary

The resilience to the effects of climate change has been summarised in **Table 5-7** in **ES Vol 1 Chapter 5: Climate Change [EN010153/DR/6.1]**.

The overall resilience of the Proposed Development to the effects of climate change has been assessed to be negligible to slight. Therefore, it is considered that the Proposed Development is resilient to the effects of climate change.

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