3 Design Evolution and Alternatives

3.1 Introduction

3.1.1 This chapter provides a description of the site selection process and design strategies that were adopted in arriving at the final layout of the proposed development, as described in Chapter 2: Proposed Development Description of this Environmental Impact Assessment (EIA) Report. The final layout of the proposed development is shown in Figure 1.3.

3.1.2 It describes the site selection process, outlines the key constraints, reviews the considered alternatives and details the design evolution adopted that allowed the applicant to arrive at the final layout of the proposed development.

3.1.3 This chapter draws on issues considered in more detail in the relevant technical chapters (Chapters 5 to 13). However, it does not pre-empt the conclusions of the later chapters. Instead, it explains how potential environmental effects which have emerged early in the EIA and through the studies by the EIA team have informed the layout design of the proposed development.

3.2 Current Land Use and Site Context

3.2.1 The site is currently used predominately for sheep and cattle grazing with small areas of commercial forestry. It covers an area of approximately 1,020ha and includes hills locally known as Collin Haggs, Healy Hill and Bloch Hill.

3.2.2 The B7068 is located immediately north of the site while the C63A sits the south of the site. The C70A bisects the site into western and eastern halves and connects the B7068 to the C63A.

3.2.3 There are residential properties located within the site boundary, Bloch Farm and Bigholms. There are a number of residential properties to the north, adjacent to the B7068 and to the south, adjacent to the C63A and C70A. Langholm is the nearest settlement, approximately 5.5km[1] to the north-east. Properties located within the site boundary have an interest in the proposed development.

3.2.4 There are a number of wind farms within 45km of the proposed development (Figure 5.8). Operational and consented wind farms include Solwaybank, Minsca, Ewe Hill, Crossdykes, Craig, Beck Burn, Hallburn and Little Hartfell Wind Farms all within 15km of the site.

3.3 Policy Considerations

3.3.1 Scottish Planning Policy (SPP) 2014[2] is the key national level document considered. SPP requires planning authorities to define a spatial framework identifying those areas that are likely to be most appropriate for onshore wind farms. The spatial frameworks must be based on the following criteria:

- Group 1: Areas where wind farms will not be acceptable (National Parks and National Scenic Areas);
- Group 2: Areas of Significant Protection (National and international designations, other nationally important mapped environment interests including areas of wild land) and a 2km community separation distance for consideration of visual impact; and
- Group 3: Areas with potential for wind farm development.

3.3.2 At a local level, the key Dumfries and Galloway Council (DGC) policy is provided within the following documents:

- Dumfries and Galloway Local Development Plan 2 2019 (DGLDP2)[3];
- Dumfries and Galloway Wind Energy Development Supplementary Guidance 2020a[4] (WED Supplementary Guidance); and
- Dumfries and Galloway Wind Farm Landscape Capacity Study 2020b (DGWFLCS)[5].

3.3.3 Policy IN2 of DGLDP2 refers to the Council's Spatial Framework for wind energy developments. The Spatial Framework is in accordance with the criteria set out in the overarching Scottish Planning Policy and a Spatial Framework Map is provided as Map 8 of the Local Development Plan 2. The Spatial Framework Map categorises suitability for wind energy development as;

[1] This distance is given to the approximate centre point of the site boundary.

[2] Scottish Government (2014). Scottish Planning Policy. June 2014. Available at: https://www.gov.scot/publications/scottish-planning-policy/

[3] Dumfries and Galloway Council (2019). Local Development Plan 2. October 2019. Available at: https://www.dumgal.gov.uk/media/21885/Adopted-Local-Development-Plan-2/pdf/Adopted_LDP2_OCTOBER_2019_web_version.pdf?m=637060550180970000

[4] Dumfries and Galloway Council (2020a) Wind Energy Development Supplementary Guidance https://www.dumgal.gov.uk/media/22639/Wind-Energy-Development-Development-Management-Considerations/pdf/Wind_Energy_SG_Final_PDF_February_2020_Version.pdf?m=637184984806630000

[5] Dumfries and Galloway Council (2020b). Part 1 Wind Energy Development: Development Management Considerations. Appendix C Dumfries & Galloway Landscape Capacity Study. Available at: https://www.dumgal.gov.uk/media/22640/Part-1-Wind-Energy-Development-Development-Management-Considerations-Appendix-C-DGWFLCS/pdf/Wind_Energy_Appendix_C_Landscape_SG_LDP2_Adopted.pdf?m=637184996412100000

- Group 1 – Areas where wind energy development will not be acceptable;
- Group 2 – Areas of Significant Protection, where consideration is required to demonstrate that any significant effects on the qualities of these areas can be substantially overcome by siting, design or other mitigation, and;
- Group 3 - Areas with potential for wind farm development, where wind energy developments are likely to be acceptable, subject to detailed consideration against identified policy criteria.

3.3.4 The proposed development is located primarily in a Group 3 Area (with potential for wind energy development), with the remainder of the site considered to be in a Group 2 Area (areas for significant protection). It is understood that the site falls partly within Group 2 Areas due to mapped areas of Class 1 carbon rich soil, deep peat and priority peatland. In the determination of applications, Policy IN2 makes it clear that the Spatial Framework Map provides strategic guidance only.

3.3.5 In the 2020 Local Development Plan 2, WED Supplementary Guidance, the site is categorised as "High" and High-Medium" Sensitivity for large typology turbines. The site was not assessed for very large typology turbines.

3.3.6 SPP provides support for wind development in principle and encourages local authorities to guide developments towards appropriate locations. Paragraph 154 states that planning authorities *"should support the development of a diverse range of electricity generation from renewable energy technologies - including the expansion of renewable energy generation capacity"*. Paragraph 155 also states that *"development plans should seek to ensure an area's full potential for electricity and heat from renewable sources is achieved, in line with national climate change targets."*

3.3.7 In response to these policy requirements DGC has undertaken a landscape capacity study to identify those landscapes which, in principle, have the capacity to accommodate wind turbines. The WED Supplementary Guidance (adopted 2020) and its associated DGWFLCS, forms part of the DGLDP2, adopted October 2019). Policy IN1 (Renewable Energy) and Policy IN2 (Wind Energy) provide further detail with regards to the development management considerations identified within the policies. They provide some guidance with respect to siting and design of wind energy proposals and also the assessment of landscape, visual, cumulative and residential visual amenity effects.

3.3.8 Maps within Appendix B to the WED Supplementary Guidance identify the sensitivity of the landscape to various wind turbine typologies and are informed by the DGWFLCS.

3.3.9 The DGWFLCS provides an assessment of landscape 'sensitivity' for each landscape character type (LCT) identified within Dumfries and Galloway. The site is located predominantly within LCT 175: Foothills - Dumfries & Galloway, with the south-eastern part of the site falling within LCT 172: Upland Fringe - Dumfries & Galloway. The Foothills landscape type is identified as being of high 'sensitivity' to large (up to 150m) typology wind turbines but of low landscape value, with the Upland Fringe identified as being of high 'sensitivity' to large (up to 150m) typology wind turbines but of high-medium landscape value where the Regional Scenic Area is located.

3.3.10 It is noted that the local authority landscape capacity study and peatland mapping are undertaken at regional / national scales and thus subject to limitation as they cannot achieve the same level of definition and granularity as a site-specific impact assessment undertaken for an EIA. In particular, on-site peat surveys based on high resolution probing provides a much higher resolution mapping of peat, which allows for any deep peat areas to then be avoided as far as possible. Further detail on baseline peat data is provided in Chapter 10: Hydrology, Hydrogeology, Geology and Soils.

3.3.11 The principles of the EIA process require that site selection and project design be iterative and constraint-led, to ensure that potential environmental impacts as a result of the proposed development are avoided or minimised, as far as reasonably possible. Schedule 4 (2) of the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 (the 'EIA Regulations'), requires the consideration of reasonable alternatives in terms of site location and characteristics of the proposed development. Regulation 40 (2)(c) of the EIA Regulations requires that an EIA report should include (in respect of alternatives studied by an applicant): "*The main alternatives studied by the applicant and the main reasons for his choice taking into account the effects on the environment".* Alternative layouts are discussed further in Section 3.6 and 3.7 below.

3.3.12 This EIA Report does not make any judgements regarding the acceptability of the proposed development. A separate Planning Statement is provided which presents an appraisal of the proposed development with reference to the energy and planning policy framework and relevant material planning considerations.

3.4 Site Selection Considerations

3.4.1 The applicant maintains a sophisticated Geographic Information System (GIS) model for site selection which seeks to mirror planning, environmental, technical and commercial constraints. The GIS model is updated regularly when new data becomes available or when other factors change. Where available and appropriate, the GIS model incorporates published advice from statutory consultees. The applicants use of the GIS model enables objective and consistent treatment of the whole country to assist with site selection.

3.4.2 The GIS model is based upon a combination of generalised and graded suitability layers covering environmental, economic and technical aspects, known as 'key layers'. All key layers are assessed using a 0% – 100% suitability scale, represented by a 0 – 1 score, where 0 represents unsuitable and 1 represents 100% suitability.

3.4.3 The key layers included in the GIS model are as follows:

- wind speed;
- proximity to housing;
- natural and built heritage constraints; and
- slope constraint.

3.4.4 In addition, for each site, a visual sweep of the following 'informative layers' is carried out:

- national and local planning policy / development plans / spatial frameworks (as discussed above in Section 3.3);
- MOD tactical training areas;
- electromagnetic links and utilities;
- proximity to other wind farm sites (pre-planning, consented and operational); and
- other information gleaned from maps or knowledge of the area such as masts, undesignated parks, tourist attractions, etc).

3.4.5 These informative layers are included in the GIS model for information, but not scored and combined into the results.

3.4.6 The applicant undertook an analysis of its GIS model and after having scored with medium to excellent preferability on all inputs, the combination of the scored layers results in a good score for the site.

3.5 Key Issues and Constraints

3.5.1 Once the site was identified, key issues and constraints for consideration in the design process were established through a combination of desk-based research, extensive field survey and consultation (through the EIA scoping process). The design process considered the following key issues and constraints:

- landscape designations and visual amenity;
- archaeological and cultural heritage assets;
- sensitive fauna;
- sensitive habitats;
- watercourses, private water supplies and sensitive surface water features;
- topography and ground conditions;
- public road accessibility;
- recreational and tourist routes;
- proximity of residential properties;
- aviation and defence constraints; and
- presence of utilities.

3.5.2 Information in respect of the survey work to identify various key issues and constraints and how they have contributed to the layout design has been investigated in greater detail in the technical chapters of this EIA Report (Chapters 5 to 13).

3.5.3 The key issues and constraints gleamed from the assessments within the technical chapters has allowed for the careful placement of the proposed development within the site. This allowed the applicant to facilitate effective mitigation, with potentially significant effects avoided or minimised as far as reasonably practicable through the design process. A summary of the potential effects addressed through the design process and the issues remaining following the selection of the final design is provided in Table 3.1.

Table 3.1 – Summary of Mitigation by Design.

Issue	Environmental Constraint / Potential Effect	Mitigation by Design	Issues Remaining
Landscape and Visual	The following key landscape and visual sensitivities were identified in the vicinity of the site: • potential effects on local landscape character and regional and local landscape designations including Langholm Hills RSA; • potential effects on visual receptor groups including local roads, residents and core paths between the A7, A6071 and A74(M), and on Langholm, local core paths and hills. • potential visibility from nearby dwellings, settlements and transport routes as noted above; • changes in the experience of recreational users on the long distance and local walking paths including those up to the Malcolm Monument near Langholm; • potential effects on the night time environment arising from the lighting of wind turbines. • potential cumulative effects in combination with Faw Side and Teviot Wind Farms on the Langholm Hills RSA. • potential effects on the night time environment combination with Faw Side and Teviot Wind Farms on the Langholm Hills RSA.	The final layout of the proposed development has adopted the following design measures: • the proposed development has been designed to be read harmoniously in the context of the nearby operational and consented wind farms. It has also been designed to take account of the adjacent Solwaybank Wind Farm and so fits in with the existing pattern of consented and proposed wind energy development in the local area; • wind turbine tip heights have been reduced for 6 wind turbines to 200m and 5 wind turbines to 180m. • wind turbines on Bloch Hill have been set lower on the hillside to reduce visual impact on views from Langholm and settlements to the east and south-east of the site. • wind turbines set back over 1,050m from the closest third party residential properties; • agreement of a reduced aviation lighting scheme with the CAA, which removes the requirement for tower lighting, and requires only T1, T2, T5, T6, T7, T8, T10, T13, T14, T15, T17, T18, T20 and T21 to be lit with medium intensity 2000 candela steady red light (with a second back up light). The 2000 candela lights can be dimmed to 10% of peak intensity when the lowest visibility as measured at suitable points around the wind farm by visibility measuring devices exceeds 5km. Throughout the design evolution of the proposed development, a key driver has been the consideration of potential landscape and visual effects on receptors including how the proposed development would relate to the existing landscape character as well as existing wind farms in the landscape. Care has been taken to evaluate the scale and number of proposed wind turbines cumulatively with existing wind farms in the area, in particular with the operational site of Solwaybank Wind Farm directly to the west and Ewe Hill Wind Farm 3km to the north of the site. The landscape and visual effects potentially caused by the proposed development have been considered extensively from key receptors during the layout design of the proposed development.	The landscape and visual effects of the proposed development are addressed further in Chapter 5: Landscape and Visual Impact Assessment, and in Technical Appendix 13.1.

Issue	Environmental Constraint / Potential Effect	Mitigation by Design	Issues Remaining
Archaeology and Cultural Heritage	The following key archaeological and cultural heritage sensitivities were identified in the vicinity of the site: • potential direct effects on cultural heritage assets within the site boundary. • potential effects on the settings of designated heritage assets in the wider landscape. • cumulative effects on the settings of designated heritage assets in the wider landscape.	Non-designated heritage assets were identified within the site, which mainly relate to agricultural settlement and land division, and probably date to the post-medieval period. These features have been avoided with the inclusion of a 0.5km buffer to Bloch Farm Scheduled Monument and appropriate buffers for other non-designated assets. 11 wind turbines have reduced in height compared to the scoping layout, as well as the number of wind turbines reducing from 22 to 21. In particular: • T19, T20 & T21 on Bloch Hill were reduced from 230m to 180m to mitigate their visibility from Langholm and scheduled monuments to the north; • T5 and T7 located within the main views from Bloch Farm (SM4690) to the east and west down Wauchope Water were reduced from 230m to 200m; and • T1 and T2 were also reduced in height from 230m to 180m to help the mitigation of impacts on Scots Dike to the south and heritage assets to the north.	The archaeological and cultural heritage effects of the proposed development are addressed further in Chapter 6: Archaeology and Cultural Heritage.
	Within the site there is one designated asset; • Scheduled Monument, Bloch Farm enclosure, (SM690), an Iron Age defensive enclosure.	The proposed development has been designed to be located at least 800m from the asset. The applicant has also committed to improving access to and providing information boards for Bloch Farm enclosure.	
Ecology	The following key ecological sensitivities were identified in the vicinity of the site: • potential effects on sensitive habitats through habitat loss, fragmentation and degradation, including peat forming habitats. • potential effects on protected species e.g. mammals, fish, etc.; • cumulative effects as arising from the addition of the proposed development in combination with other relevant projects; and • potential effects on statutory sites within 5km designated for ecological interests	The proposed development has been designed to reduce the potential for ecological effects by avoiding more sensitive ecological interest features including: • avoidance of areas of deeper peat - this has reduced the habitat loss of more sensitive higher quality habitats such as blanket bog; • avoidance of watercourses – these have been buffered by 50m, apart from locations where access tracks unavoidably need to cross watercourses. • avoidance of bat preferred habitat features – buffers of 108m (for 200m tall wind turbines) and 87m (for 180m tall wind turbines) have been maintained between wind turbine blade tips and the nearest woodland edge, as set out in current NatureScot guidance (NatureScot et al. 2021); and • Avoidance of badger setts – all setts found during the baseline surveys have been avoided by a minimum 100m buffer.	The ecological effects of the proposed development are addressed further in Chapter 7: Ecology.

Issue	Environmental Constraint / Potential Effect	Mitigation by Design	Issues Remaining
Ornithology	The following key ornithological sensitivities were identified in the vicinity of the site: • short-term reduction in breeding or wintering bird populations due to construction disturbance (affecting breeding or foraging behaviour and potentially resulting in a reduction in productivity or survival); • long-term reduction in breeding or wintering bird populations due to the loss/fragmentation of habitat critical for nesting or foraging; • long-term reduction in breeding or wintering bird populations due to collision mortality; • cumulative effects with other projects or activities that are constructed during the same period, and/or with projects or activities which pose either a potential collision risk or loss of habitat by displacement; and • potential effects on statutory sites within 20 km designated for ornithological interests.	The proposed development has been designed to avoided more sensitive ornithological habitats. Neither cumulative disturbance nor cumulative collision risk would represent an adverse effect on the integrity of the SPAs assessed. No significant ornithological effects are expected as a result of the proposed development either during construction or operation. Nonetheless, best practice mitigation during construction would be followed through the appointment of an ECoW and the production of a CEMP, a Breeding Bird Protection Plan and a Habitat Management Plan.	The ornithological effects of the proposed development are addressed further in Chapter 8: Ornithology. In addition, an outline Breeding Bird Protection Plan and outline Habitat Management Plans are available in Technical Appendices 8.6 and 7.6 respectively.
Peat and Soils	• Potential impacts of excavated peaty soils. • Potential impacts of sliding of peatlands. • Potential effects on peatland habitats through habitat loss, fragmentation and degradation.	The proposed development has been designed to avoided areas of deeper peat reducing the habitat loss of more sensitive higher quality habitats such as blanket bog wherever possible. Where access tracks cannot avoid areas of deeper peat the use of floating access track construction has been adopted to minimise impact. The proposed development has been designed to avoid any areas of ground which may be subject to peat slide risk where possible. The ground condition factors that were considered in the design of the proposed development were: • identification of peat depths in excess of 0.0m – to minimise incursion, protect from physical damage, minimise excavation and transportation of peat, reduce potential for peat instability and minimise potential soil carbon loss; • identification of slope angles greater than 4˚- to minimise soil loss and potential instability; and • avoidance of areas where initial peat stability concern was identified where possible – to avoid areas with possible instability issues and associated indirect effects on surface water. Proposals for peatland restoration have been included in the outline Habitat Management Plan, seeking to restore areas of degraded peatland habitats.	The potential effects on peat and soils due to the proposed development are addressed further in Chapter 9: Hydrology, Hydrogeology, Geology and Soils and Technical Appendix 9.2: Peat Management Plan, and Technical Appendix 9.3: Peat Slide Risk Assessment.

Issue	Environmental Constraint / Potential Effect	Mitigation by Design	Issues Remaining
Hydrology	The following key hydrological sensitivities were identified in the vicinity of the site: • potential effects on designated sites due to potential changes in surface and/or groundwater quality and quantity; • potential effects on the catchments due to changes in surface and/or groundwater quality and quantity; • potential localised increase in flood risk due to watercourse crossings; • potential effects on GWDTE through changes to site hydrogeology; • potential effects on Public or Private Water Supply (PWS) abstractions due to potential changes in surface and/or groundwater quality and quantity; and • potential for peat slide risk.	The proposed development has been designed to reduce the potential for hydrological effects by avoiding more sensitive ecological interest features including: • avoidance of watercourses – these have been buffered by 50m, apart from locations where access tracks unavoidably need to cross watercourses; • minimising the number of watercourse crossings through the layout design process, with the locations of watercourse crossings selected to avoid damage; • avoidance of private water supply catchments – these have been buffered by at least 700m to the nearest wind turbine locations. • avoidance of high dependency GWDTES - areas with potential to be Groundwater Dependent Terrestrial Ecosystems (GWDTEs) were also examined. They were found to be limited in extent across the site and mainly confined to the upland moorland areas and adjacent to watercourses. Areas of high potential for GWDTEs have been avoided by site infrastructure across the site. The proposed development incorporates good practice drainage design during construction and operation adopting a sustainable drainage system (SuDS) approach to control the rate, volume and quality of runoff from the proposed development.	The hydrology and hydrogeology effects of the proposed development are addressed further in Chapter 9: Hydrology, Hydrogeology, Geology and Soils. In addition, an outline Pollution Prevention Plan is available in Technical Appendix 2.3.
Topography	The following key topographical sensitivities were identified in the vicinity of the site: • potential for peat slide risk; • potential for deep cut / fill slopes around infrastructure; and • potential for safety risks to personnel during construction and operation of the proposed development.	The proposed development has been designed to reduce the potential for topographical effects by avoiding: • areas of the site where the topography is greater than 12% slope gradient for wind turbine and adjacent crane hardstand positioning; • positioning the crane hardstand downslope of the proposed wind turbine location where other site constraints allow it; • positioning the access track, adjacent to the crane hardstand at wind turbine locations, downhill to the crane hardstand when aligning parallel to the contours where other site constraints allow it; • aligning access tracks perpendicularly to slope gradients greater than 14%; • areas where slope stability was identified as an area of high peat slide risk have been avoided at all turbine locations, with the exception of T1 where additional engineering mitigation may be required.	The Peat Slide Risk Assessment in Technical Appendix 9.3 undertakes a thorough review of risk at each of the infrastructure locations and provides additional mitigation where required.
Traffic and Transport	The following key transport sensitivities were identified in the vicinity of the site: • Severance; • Driver Delay; • Pedestrian Delay and Amenity; • Fear and Intimidation; and • Accidents and Safety.	The proposed development has been designed to reduce the potential for transport effects by avoiding positioning wind turbines within the public roads buffer of 253m (tip height + 10%).	The traffic and transport effects of the proposed development are addressed further in Chapter 10: Traffic and Transport. It is proposed that a Construction Traffic Management Plan (CTMP), Transport Management Plan and Path Management Plan are prepared post-consent to further mitigate any effects of the proposed development.
Noise	Potential effects at nearby properties due to operational and construction noise with potential for cumulative impact.	The proposed development has been designed to reduce the potential for noise effects by avoiding locating wind turbines within 1.050m of residential properties or 750m of financially involved properties.	The noise effects of the proposed development are addressed further in Chapter 11: Noise and Vibration.

Issue	Environmental Constraint / Potential Effect	Mitigation by Design	Issues Remaining
Shadow Flicker	Potential effects of shadow flicker on residential receptors.	The proposed development includes a shadow flicker assessment to assess the impact. A shadow flicker module will be installed in the turbines that would shut down turbines during times when wind and climactic conditions are such that shadow flicker could occur. The assessment concludes that with the installation of a shadow flicker management system that all assessed properties would not experience significant residual effects.	The shadow flicker effects of the proposed development are addressed further in Chapter 13: Aviation, Radar and Other Issues.
Utilities	Potential effects on existing utilities within the site.	The proposed development has been designed taking into consideration the location of the following existing utilities: • National Grid Gas Pipeline – A gas pipeline runs through the western part of the site adjacent to an existing track from Callisterhall to Barnglieshead. The following buffers were applied for wind turbines: 1.5 * hub height + 5m (192.5m at the north side of the gas pipeline, 162.5m at the south side of the gas pipeline). • Zayo Fibre Optic Cable – A fibre optic cable runs parallel to the gas pipeline. The following buffers were applied for wind turbines: tip height + 10% (220m at the north side of the cable, 198m at the south side of the cable). • SPEN 33kV OHL – An overhead line runs across the north of the site. A buffer of 40m has been applied for wind tirbines following discussions with SPEN to underground the cable. Where the overhead line is to remain in place a 450m buffer has been applied. • Scottish Water Pipeline – A water pipeline runs adjacent to the C70A bisecting the proposed development. A buffer of 220m (tip height + 10%) was applied for wind turbines.	Utility crossings have been minimised as far as practicable. Where utility crossings are required appropriate utility protection will be designed.

3.6 Design Principles and Alternatives

3.6.1 The principles of the EIA process require that site selection and layout design be iterative and constraint-led, to ensure that potential environmental impacts as a result of the proposed development are avoided or minimised, as far as reasonably possible.

3.6.2 Schedule 4 (2) of the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 (the 'EIA Regulations'), requires the consideration of reasonable alternatives in terms of site location and characteristics of the proposed development. Regulation 40 (2)(c) of the EIA Regulations requires that an EIA report should include (in respect of alternatives studied by an applicant): "*The main alternatives studied by the applicant and the main reasons for his choice taking into account the effects on the environment*".

3.6.3 This section will review the principles of the layout design and alternatives options for the proposed development.

Design Principles

3.6.4 As part of the iterative approach adopted by the applicant, a number of design principles have been incorporated into the proposed development as standard practice, including the following:

- consideration to the underlying landscape and its scale;
- consideration to operational, consented and proposed wind turbines neighbouring the site;
- consideration to the size and scale of the proposed development appropriate to the location and proximity to residential properties;
- sensitive siting of the proposed infrastructure incorporating appropriate buffer distances from environmental and archaeological receptors to avoid or reduce effects;
- maximising the re-use of existing tracks as much as possible to access proposed wind turbine locations;
- optimising the alignment of new access tracks and hardstands taking due consideration to the topography of the site, to minimise cut and fill, minimise the impact on sensitive peatland habitats and reduce landscape and visual effects;
- adoption of floating access tracks to minimise disturbance of peat where appropriate;
- minimising watercourse crossings and encroachment on watercourse buffers;
- consideration to inclusion of borrow pit search areas to minimise the volume of the stone required to be imported to the site;
- using the latest wind turbine technology, consisting of more efficient and larger turbines where these can be reasonably accommodated within the landscape, as supported by the Onshore Wind Policy Statement (OWPS); and
- maximising the potential energy yield of the site through the employment of co-located technology in optimal locations (wind and battery storage).

Alternative Sites

3.6.5 The applicant uses a range of criteria to select sites for the development of renewable energy projects. As part of the growth plans for the development of renewable energy projects, the applicant is continually assessing potential sites. The pipeline of potential sites is commercially sensitive and are not considered to be alternative sites to the proposed development. Alternative sites are therefore not considered further in the EIA Report.

Do Nothing

3.6.6 The "do nothing" scenario is a hypothetical alternative conventionally considered in the EIA Report as a basis for comparing the development proposal under consideration. This scenario is considered to represent the current baseline situation as described in the individual chapters of this EIA Report.

3.6.7 In the absence of the proposed development, it is anticipated that the site would continue to be managed as a combination of grazing livestock and commercial forestry. These land uses would continue on the site whether or not the proposed development proceeds.

Infrastructure & Technologies

3.6.8 Onshore wind continues to be the lowest cost of new renewable energy generation and the site has been predominantly selected for its potential to generate electricity from wind turbines.

3.6.9 Advances in wind turbine technology mean that larger, more efficient wind turbines are now being deployed and it is recognised that wind turbines will continue to increase in tip height and rotor diameter in order to maximise the generation of electricity. To ensure optimal capture of wind energy and associated generation of electricity, spacing between wind turbines increases with wind turbine size usually leading to fewer, more productive wind turbines across any given site.

3.6.10 Larger wind turbines are needed if onshore wind development is to continue making a contribution to both the UK and Scottish Government's renewable energy targets, particularly the recent announcement commitment to net zero CO_2 emissions by 2045 (Scottish Government, 2019).

3.6.11 The necessity for larger wind turbines is also recognised in paragraph 23 of the Scottish Government Onshore Wind Policy Statement (OWPS, 2017), which states that the Scottish Government *"acknowledge that onshore wind technology and equipment manufacturers in the market are moving towards larger and more powerful (i.e. higher capacity) turbines and that these by necessity will mean taller towers and blade tip heights"*. Paragraph 25 of the OWPS continues that the Scottish Government "*fully supports the delivery of large wind turbines in landscapes judged to be capable of accommodating them with significant adverse impacts.*"

3.6.12 The use of larger but fewer wind turbines across any given site allows for greater efficiencies with respect to the civil infrastructure required per wind turbine and hence per megawatt produced. A site with large wind turbines requires fewer wind turbine foundations, crane hardstands and lengths of access track in comparison to the same site that adopted a greater number of smaller wind turbines.

3.6.13 Furthermore, the supply of smaller wind turbines across Europe is already reducing, due to lack of demand. Manufacturers are recognising the world market is shifting to larger machines with development work focussing on larger turbines to maximise the generation of electricity. The onshore wind industry has experienced a reduction in supply of smaller wind turbines due to lack of demand from mainland Europe, where the tendency is to install wind turbines with tip heights of 180m – 250m to blade tip. Therefore, it is highly unlikely that a range of smaller turbines (e.g. 150m to blade tip) would be available at competitive prices by the time the proposed development is ready to be constructed, should it be consented.

3.6.14 For these reasons, the final selection of the wind turbine tip height of between 180m - 230m was considered to represent the best balance of tall wind turbines and design in the landscape. These considerations and the final selection of wind turbine height are described in Section 3.7 of this chapter.

3.6.15 There is a national requirement to balance the peaks and troughs associated with electricity supply and demand to avoid strains on transmission and distribution networks and to keep the electricity system stable. A battery energy storage system (BESS) is therefore proposed as part of the proposed development to support the flexible operation of the national grid and decarbonisation of electricity supply.

3.6.16 The BESS would store electrical energy through the use of batteries, contained alongside inverters (to convert the direct current (DC) from the batteries to alternating current (AC), suitable for exporting to the grid), within a self-contained building adjacent to the substation compound to allow easy connection to the grid and minimise energy losses.

3.7 Design Evolution

3.7.1 With consideration to the key issues and constraints, up-to-date wind turbine technology and the design principles set out above, the final layout of the proposed development was the result of several iterations as outlined below:

- the scoping stage;
- the design stage; and
- the refinement stage.

Scoping Stage

3.7.2 The 'scoping layout' for the proposed development was included in the Scoping Report as a useful focus for discussions with consultees and interested parties. This layout comprised 22 wind turbines of up to 230m to blade tip. This was based largely on future wind turbine availability, technical acceptability, and operational efficiencies (as outlined in Section 3.5). However it was informed by preliminary landscape and visual analysis and high-level site constraints gathered from available desktop data sources.

3.7.3 In addition, consideration to the adjacent wind turbines in Solwaybank Wind Farm, was incorporated into the layout design to ensure energetic losses caused by the neighbouring wind turbines was minimised. In doing so, the proposed development would, in turn, not overly compromise the operation of Solwaybank Wind Farm.

3.7.4 The 'scoping layout' is presented on Figure 3.1.

Design Stage

3.7.5 Following consideration of consultee responses, included in the Scoping Opinion, and the completion of initial on-site surveys, allowing the site constraints to be more accurately defined, an informed layout design was undertaken to produce a 'design chill layout'.

3.7.6 Upon completion of the initial on-site surveys it became apparent that one wind turbine would need to be removed from the layout due to its location in an area of deep peat. It could not be relocated without the removal of an adjacent wind turbine.

3.7.7 While wind turbine location is a key consideration, refinement of the layout needs to take consideration of the locations of required infrastructure surrounding the wind turbines. As such some wind turbine locations are dictated by environmental constraints pertaining not only to the wind turbine but also the adjacent crane hardstand and access track. The applicant's civil engineers reviewed the 'design chill layout' taking due consideration of the required infrastructure surrounding wind turbines and after adopting the design principles set out in Section 3.6, made changes to the 'design chill layout' for further technical analysis.

3.7.8 LDA design carried out a secondary landscape and visual analysis. This analysis took into account views from key viewpoints around the site. In particular, the visibility of wind turbine blade tips above Bloch Hill from the conservation area of Langholm was a key consideration. This resulted in wind turbines being moved down the south-west face of the Bloch Hill to reduce their visibility from Langholm, and to reduce wind turbine tip heights for six wind turbines to 200m to blade tip and five wind turbines to 180m to blade tip.

3.7.9 The applicant has developed a sophisticated turbine layout optimisation tool. This tool essentially iteratively repositions wind turbines across the site, with due cognisance of the site constraints, with the aim to maximise capture of wind energy and associated generation of electricity.

3.7.10 Following the secondary landscape and visual analysis, the applicant's technical analysts fixed wind turbine heights and locations as suggested above by LDA Design and then ran the layout optimisation tool for the remaining ten wind turbines to produce the 'design chill layout'.

3.7.11 The suitability of the locations of the proposed development infrastructure were then confirmed following on-site surveys carried out by the applicant's civil engineers.

3.7.12 The 'design chill layout' is presented on Figure 3.1 consisting of ten wind turbines of up to 230m to blade tip, six wind turbines of up to 200m to blade tip and five wind turbines of up to 180m to blade tip.

Refinement Stage

3.7.13 Following and review and applicant approval of the 'design chill layout', secondary on-site surveys were carried out allowing the site constraints to be fully defined. This would enable the applicant to complete the layout design and produce a 'design freeze layout'.

3.7.14 Upon reviewing the fully defined site constraints and a second run of the layout optimisation tool the applicant's technical analysts proposed minor movements to three wind turbines (namely wind turbines 2, 9 (previously named 21) & 20 (previously named 10)) to optimise the layout of the proposed development.

3.7.15 LDA design carried out a tertiary landscape and visual analysis reviewing the key viewpoints around the site as previously assessed. Given the minimal changes between the 'design chill layout' and 'design freeze layout' no further changes were proposed with respect to landscape and visual effects.

3.7.16 The 'design freeze layout' is presented on Figure 3.1 and in more detail on Figure 1.3 consisting of ten wind turbines of up to 230m to blade tip, six wind turbines of up to 200m to blade tip and five wind turbines of up to 180m to blade tip.

Micrositing

3.7.17 In order to address any localised environmental sensitivities, unexpected ground conditions or technical issues that are found during detailed intrusive site investigations and construction, it is proposed that 100m micrositing allowance around the wind turbine locations all other infrastructure is allowed. The technical assessments (presented in Chapters 5 to 13) have considered the potential for micrositing.

3.7.18 During construction, the need for any micrositing would be assessed and agreed with the on-site Environmental Clerk of Works (ECoW).

3.8 Summary

3.8.1 The proposed development was the result of extensive iterative design work, to sensitively locate the wind turbines and the infrastructure required to facilitate construction and operation of the wind turbines.

3.8.2 In summary, the final layout of the proposed development presented achieves the following:

- minimises impact on the underlying landscape and is largely in accordance with DGWFLCS and DGLDP2;
- visually accommodates operational, consented and proposed wind turbines neighbouring the site;
- minimises the proximity to and visibility from residential properties as well as the settlements surrounding the site as far as possible;
- sensitively locates infrastructure incorporating appropriate buffer distances from environmental and archaeological receptors to avoid or minimise effects;

- optimises the alignment of new access tracks and hardstands to minimise cut and fill, minimise the impact on sensitive peatland habitats and reduce landscape and visual effects;
- adopts floating access tracks to further minimise disturbance of peatland;
- minimises watercourse crossings and protects watercourses from the potential impacts of constructing the proposed development;
- Includes three borrow pit search areas to minimise the volume of the stone required to be imported to the site;
- adopts of the latest wind turbine technology;
- maximises the potential for electricity generation through the adoption of wind turbines and energy storage technologies; and
- can be constructed and operated safely.

3.8.3 The final layout of the proposed development overlain with the site constraints as described above has been present in Figure 3.2. The potential effects of the resulting layout are addressed throughout Chapters 5 to 13 of the EIA Report.