Technical Appendix 2.1: Outline Construction Environmental Management Plan (OCEMP)

Intended for
M74 West Ltd

Date
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Project Number
1620015684

M74 WEST RENEWABLE ENERGY PARK
OUTLINE CONSTRUCTION ENVIRONMENTAL MANAGEMENT PLAN – DRAFT TEMPLATE FOR PLANNING

RAMBOLL

Confidential

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1. INTRODUCTION

This document provides a framework for a Construction Environmental Management Plan (CEMP). This outline CEMP (OCEMP) has been prepared as part of the Environment Impact Assessment (EIA) process for the Proposed Development and this document forms a Technical Appendix to the Environmental Impact Assessment Report (EIAR) submitted as part of the application for consent for the Proposed Development.

A CEMP will describe the environmental management and construction methods to be employed during the construction of the Proposed Development. This draft outline document will be updated with detailed information and finalised prior to commencement of construction, in consultation with the relevant authorities and taking account of the approved plans and planning conditions.

The contractor(s) appointed to construct the Proposed Development will prepare detailed method statements which will be incorporated into the final CEMP.

The requirement to produce a CEMP will form part of the contract for the construction works for the Proposed Development. The management measures, method statements and referenced good practice guidance and legislation will form the basis of the detailed design to be prepared by the Contractor.

The CEMP will provide:

- a schedule of all construction stage mitigation measures required to address likely significant effects identified in the EIAR;
- a schedule of all additional construction and decommissioning stage good practice management measures included as part of the proposed construction work, in line with industry good practice guidance;
- a schedule of roles and responsibilities for delivering the requirements of the CEMP, including a statement of responsibility to 'stop the job/ activity' if in potential breach of a mitigation or legislation occurs;
- a method statement for monitoring, auditing, and templates for reporting and communication of environmental management performance on-site and with the Applicant, planning authority and other relevant parties;
- construction stage environmental management measures, based on both compliance with relevant regulations and relevant good practice including but not limited to:
  - The Water Environment (Controlled Activities) (Scotland) Regulations 2011[1,2] and the requirement for Construction Site Licence[3] (and Pollution Prevention Plan);
  - Forestry Commission (2017). UK Forestry Standard: The Government's approach to sustainable forestry, 4th Edition. Forestry Commission, Edinburgh[4];
  - NatureScot (2019) Good Practice During Wind Farm Construction, A joint publication by Scottish Renewables, NatureScot, SEPA, Forestry Commission Scotland and Historic Environment Scotland, Marine Scotland Science, 4th Edition[5];
  - Netregs, Guidance for Pollution Prevention (GPP)[6];
  - CIRIA Publications including CIRIA C768 (Guidance on the construction of SuDS), CIRIA C753 (The SuDS Manual)[7]; and
  - NatureScot (2015) Constructed Tracks in the Scottish Uplands, 2nd Edition[8]; and
- a template for the production of detailed and task/ site specific plans for on-site components of the construction work.

It is anticipated that specific mitigation plans and additional management measures will be required to address archaeology, ecology (protected habitats and species), surface water management and pollution prevention, watercourse crossings, waste, access arrangements, soil and peat management, construction and decommissioning nuisance (noise, dust), and community liaison.

[1] UK Government. The Water Environment (Controlled Activities) (Scotland) Regulations 2011. Online. Available at: https://www.legislation.gov.uk/ssi/2011/209/contents/made [accessed 08/05/2024]

[2] SEPA, 2022. The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended): A Practical Guide. Online. Available at: https://www.sepa.org.uk/media/dw5de0kh/car-a-practical-guide.pdf [accessed 08/05/2024]

[3] SEPA, 2021. Supporting Guidance WAT-SG-75. Sector Specific Guidance: Water Run-Off from Construction Sites. Online. Available at: https://www.sepa.org.uk/media/340359/wat-sg-75.pdf [accessed 08/05/2024]

[4] Forestry Commission, 2017. The UK Forestry Standard. Online. Available at: https://www.gov.uk/government/publications/the-uk-forestry-standard [accessed 08/05/2024]

[5] NatureScot, 2019. Guidance- Good Practice during Wind Farm Construction. Online. Available at: https://www.nature.scot/guidance-good-practice-during-wind-farm-construction [accessed 08/05/2024]

[6] NetRegs, 2024. Guidance for Pollution Prevention. Online. Available at: https://www.netregs.org.uk/environmental-topics/guidance-for-pollution-prevention-gpp-documents/ [accessed 08/05/2024]

[7] SUSDRAIN, URL: https://www.susdrain.org/resources/ciria-guidance.html [accessed 08/05/2024]

[8] NatureScot, 2015. Constructed tracks in the Scottish Uplands. Online. Available at: https://www.nature.scot/doc/archive/constructed-tracks-scottish-uplands [accessed 08/05/2024]

2. SCHEDULE OF ENVIRONMENTAL COMMITMENTS FROM ENVIRONMENTAL IMPACT ASSESSMENT REPORT (EIAR)

The CEMP will provide a schedule of embedded mitigation, commitments made in the EIAR and good practice measures.

Table 2.1.1: Schedule of Embedded Mitigation and Good Practice Measures

Reference	Commitment
Landscape and Visual Amenity	• Good practice measures during construction to be adopted in the line with the CEMP.
Cultural Heritage	• A professionally qualified Archaeological Contractor would be appointed to act as an Archaeological Clerk of Works (ACoW). • The ACoW would provide advice to the appointed construction Contractor(s) regarding the micro-siting of development components, where there is a possibility of intersecting with identified heritage assets, and to undertake archaeological monitoring of topsoil stripping operations in areas designated and approved by the Council's Archaeological Advisors (West of Scotland Archaeology Service (WoSAS)). • Thirstone Stone Circle to be marked out for avoidance during the construction phase. A buffer of 50 m around the scheduled area would be fenced off and the fence would be left in place for the duration of the construction phase and removed on completion of the Proposed Development. • Archaeological Watching brief(s) will be carried out at the locations of Asset (40) and Asset (41). • Three heritage assets (30, 31 and 33) will be marked out for avoidance during the construction phase. The features will be identified by placing high visibility markers 5 m from the outer limit of the visible remains, facing the working area. Any required micro-siting of the solar panels would be managed to avoid the visible remains and the demarcated areas. The markers will be left in place for the duration of the construction phase and removed on completion of the Proposed Development. • If new, archaeologically significant discoveries are made during archaeological monitoring, and it is not possible to preserve the discovered remains in situ, provision would be made for the excavation, where necessary, of any archaeological deposits encountered. The provision will include the consequent production of written reports on the findings, with post-excavation analysis and publication of the results of the works, where appropriate. • Written guidelines will be issued for use by all construction Contractor(s), outlining the need to avoid causing unnecessary damage to known heritage assets. The guidelines will set out arrangements for calling upon retained professional support if buried archaeological remains of potential archaeological interest (such as building remains, human remains, artefacts, etc.) should be discovered during any construction activities. • The guidelines will make clear the legal responsibilities placed upon those who disturb artefacts or human remains.
Ecology	• A suitability experienced Ecological Clerk of Works (ECoW) will be appointed prior to the commencement of construction to advise the Applicant and the Contractor on all ecological (and ornithological) matters (with the assistance of a suitably qualified /licenced ornithologist if required). The ECoW will be required to be present on-Site during the construction phase and will carry out monitoring of works and briefings with regards to any ecological sensitivities on the Site to the relevant staff of the Contractor(s).

Table 2.1.1: Schedule of Embedded Mitigation and Good Practice Measures

	• A Species Protection Plan (SPP) will be implemented during the construction (and decommissioning) phase. The SPP includes pre-construction surveys and good practice measures during construction. re-construction surveys will be undertaken to check for any new protected species or features in the vicinity of the construction works. The results of the pre-construction surveys will be used to update the outline SPP ahead of construction starting. The SPP will remain a live document to be updated as required and in agreement with the ECoW where changes to the distribution and status of protected species and features are recorded. • Enhancement and restoration of habitats through the delivery of a Biodiversity Enhancement Management Plan (BEMP). The BEMP would aim to achieve significant biodiversity enhancement at the Proposed Development and would include provisions for the protection, maintenance, restoration and/or enhancement of bog habitats locally. • An Outline BEMP has been prepared as part of the EIAR (see Technical Appendix 6.6 (EIAR Volume 4)). The OBEMP is based on a number of identified habitat management areas for each respective habitat management and biodiversity enhancement proposal. These habitat management areas will likely be refined following further specialist surveys and feedback from relevant consultees, and all search areas may not be taken forward for the final BEMP, and other search areas and/or proposals may also be considered; however, the Applicant remains committed to delivering significant biodiversity enhancement at the Proposed Development.
Ornithology	• A Bird Disturbance Management Plan (BDMP) will be prepared and implemented for the Proposed Development which details good practice and species-specific measures to be implemented during construction, decommissioning and, where relevant, during operational maintenance activities. • The following additional species-specific measures are outlined for inclusion within the BDMP to be informed by pre-commencement surveys and which will avoid or further minimise the potential for disturbance to sensitive breeding birds during the construction phase: – Black grouse: no construction and/or operational maintenance works will be undertaken within 750 m of any identified black grouse lek sites before 9am in April and May; – Short-eared owl: no construction works and/or operational maintenance works will be undertaken within 30 m of any active short-eared owl nest.
Hydrology, Hydrogeology and Geology	• The appointed Principal Contractor would compile a Pollution Prevention Plan (PPP) which would include details of construction phase SuDS, construction Site plans and proposed drainage management measures. • The installation of SuDS measures would be supervised by the Environmental Clerk of Works (EnvCoW) during the construction phase of works. • Any requirement for monitoring of water quality within watercourses downstream of the Proposed Development would be agreed with SEPA and procedures for this would be detailed in the CEMP. • Sediment capture methods to be implemented at the Site would be detailed in a Drainage Impact Assessment which would be prepared by the Principal Contractor. • Detailed proposals for the management of surface water runoff at the Site would be submitted to SEPA by the Principal Contractor under a Construction Runoff Licence. • At two locations mitigation through drainage design would ensure that water supply is maintained to downslope habitats. Measures would include:

Table 2.1.1: Schedule of Embedded Mitigation and Good Practice Measures

	– installation of upslope cut off drains to collect surface water runoff from upslope locations and distribute runoff to downslope areas; – installation of cross drains below tracks at regular intervals to ensure the distributed conveyance of runoff across linear features (i.e. the collection and downslope release of runoff should not create new preferential surface water flow paths); – consideration to be given to the installation of floating track and granular, permeable sub-base materials on track at these locations to maintain flows of soil water; and – installation of SuDS measures to ensure the settlement of sediments, prior to distributed release over downslope vegetated areas. • The Principal Contractor will prepare a detailed Peat Management Plan (PMP) prior to the commencement of construction. The PMP would include operational mitigation measures as appropriate.
Traffic and Transport	• A project website, blog or web-based communication tools which may include social media, will be regularly updated to provide the latest information relating to traffic movements associated with vehicles accessing the site. • A Construction Traffic Management Plan (CTMP) would be prepared and implemented. The CTMP will include, but is not limited to, the following measures: – Agreement on Abnormal Indivisible Loads (AIL) route modification and improvements with SLC, TS and other relevant stakeholders; – A Site worker transport and travel arrangement plan, including transport modes to and from the worksite (including pick up and drop off times). – An AIL Transport Management Plan; – Specific training and disciplinary measures to ensure the highest standards are maintained to prevent construction vehicles from carrying mud and debris onto the carriageway. – Establishment of wheel cleaning facilities at the Site entrance. – Normal Site working hours. – Appropriate traffic management measures along the Site access roads to avoid conflict with general traffic, subject to the agreement of the roads authority. Typical measures will include HGV turning and crossing signs and banksman where necessary. – Adoption of a voluntary speed limit of 15 miles per hour (mph) for all construction vehicles along the B7078. – Induction and tool box talk safety briefing. • Before AILs traverse the route, the following tasks will be undertaken: – Ensure any vegetation which may foul the loads is trimmed back to allow passage; – Confirm there are no roadworks or closures that could affect the passage of the loads; – Check no new or diverted underground services on the proposed route are at risk from the abnormal loads; and – Confirm the police are satisfied with the proposed movement strategy. • Any damage to road infrastructure caused directly by construction traffic will be made good, and street furniture that is removed on a temporary basis will be fully reinstated.

Table 2.1.1: Schedule of Embedded Mitigation and Good Practice Measures

	• Any damage caused by traffic associated with the Proposed Development, during the construction period that would be hazardous to public traffic, will be repaired immediately. • There will be a regular road edge review and any debris and mud will be removed from the public carriageway to keep the road clean and safe during the initial months of construction activity, until the construction junction and immediate access track works are complete. • An AIL Transport Management Plan will be prepared to cater for all movements to and from the Proposed Development. This will include: – Procedures for liaising with the emergency services to ensure that police, fire, and ambulance vehicles are not impeded by the loads. This is normally undertaken by informing the emergency services of delivery times and dates and agreeing communication protocols and lay over areas to allow overtaking. – A diary of proposed delivery movements to liaise with local communities to avoid key dates such as popular local events etc. – A protocol for working with local businesses to ensure the construction traffic does not interfere with deliveries or normal business traffic. – Proposals to establish a construction liaison committee to ensure the smooth management of the Proposed Development / public interface with the Applicant, the Contractor, the local community, and if appropriate, the police forming the committee. This committee will form a means of communicating and updating on forthcoming activities and dealing with any potential issues arising. • An Access Management Plan would be prepared which would include, but is not limited to, such measures as: – Where feasible, users of Core Paths and the Wider Network paths will be separated from construction traffic through the use of barriers; – Crossing points will be provided where required, with path users having right of way; – Appropriate Traffic Signs Manual compliant temporary road signage will be provided to assist at crossing points; and, – Advisory speed limit signed will be installed on approaches to areas where path users may interact with construction traffic.
Noise	• Good site practices would be implemented through the CEMP. Section 8 of BS5228-1:2009+A1:2014 recommends a number of simple control measures as summarised below that would be employed onsite: – Keep local residents informed of the proposed working schedule, where appropriate, including the times and duration of any abnormally noisy activity that may cause concern; – Ensure that any extraordinary site work continuing throughout 24 hours of a day (for example, crane operations lifting components onto the tower) would be programmed, when appropriate, so that haulage vehicles would not arrive at or leave the site between 19:00 and 07:00, with the exception of abnormal loads that would be scheduled to avoid significant traffic flows; – Ensure all vehicles and mechanical plant would be fitted with effective exhaust silencers and be subject to programmed maintenance;

Table 2.1.1: Schedule of Embedded Mitigation and Good Practice Measures	
	– Select inherently quiet plant where appropriate - all major compressors would be 'sound reduced' models fitted with properly lined and sealed acoustic covers, which would be kept closed whenever the machines are in use; – Ensure all ancillary pneumatic percussive tools would be fitted with mufflers or silencers of the type recommended by the manufacturers; – Instruct that machines would be shut down between work periods or throttled down to a minimum; – Regularly maintain all equipment used on site, including maintenance related to noise emissions; – Vehicles would be loaded carefully to ensure minimal drop heights so as to minimise noise during this operation; and – Ensure all ancillary plant such as generators and pumps would be positioned so as to cause minimum noise disturbance and if necessary, temporary acoustic screens or enclosures should be provided.
Aviation	• A reduced lighting scheme has been designed and will be submitted to the Civil Aviation Authority for approval. It proposes 2000 candela steady red lights on eight of the 22 turbines but no mid-tower lighting. • In-fill from Glasgow Primary Surveillance Radar (PSR) / use of inherent data processing capacity of Lowther Hill Indra 3D radar to mitigate false plots/reduced sensitivity of NATS En Route Lowther Hill and Cumbernauld PSRs.
Shadow Flicker	• Prior to the erection of the first turbine, a Wind Farm Shadow Flicker Protocol would be submitted to and approved by the Local Planning Authority. The protocol would ser out the steps to be followed should a shadow flicker complaint be received from a receptor within the study area and potential mitigation measures.
Forestry	• Implementation of Biodiversity Enhancement Management Plan; • Compensatory planting to take place; and • If the material is a suitable size to meet the biomass market all material will be removed from Site. If this option is not available at the time of construction a forestry waste plan will be prepared

The CEMP will also maintain a schedule of commitments required by specific planning conditions.

Table 2.1.2: Planning Condition Commitments	
Reference	**Commitment**
TBC	TBC following planning consent

3. COMMUNICATION PROTOCOL

3.1 Roles and Responsibilities

The CEMP will confirm the roles, responsibilities and communication routes for environmental management during the works. This plan will make reference to or incorporate communication protocols for use during an environmental emergency or incident.

An appropriately qualified Environmental/Ecological Clerk of Works (EnvCoW/ECoW)/ Site Environment Manager will be appointed with the responsibility of monitoring compliance the CEMP. The EnvCow/ECoW will be supported by an appropriately experienced and qualified engineering geologist/ geotechnical engineer for the supervision of work in any areas identified as medium to high risk of peat instability.

An appropriately qualified archaeological clerk of works would be appointed to supervise fencing off of archaeological remains and would be responsible for undertaking an archaeological watching brief on ground-breaking works across the site as identified in the CEMP.

3.2 Recording and Reporting

The CEMP will set out the requirements for recording and reporting all aspects of environmental management, for example:

- minutes and attendance record of start-up meeting (on-site meeting prior to commencement of construction works);
- an environmental risk register;
- minutes of weekly meetings covering environmental (ecology, archaeology, hydrology) issues (meetings may be combined with regular construction progress meetings);
- a communication plan;
- records of toolbox talks;
- dust/ noise monitoring records;
- site waste and materials records;
- water quality monitoring records (if required); and
- licensing and consents.

The CEMP would be agreed with South Lanarkshire Council and relevant statutory consultees before adoption.

3.3 Environmental Audits

The CEMP will set out the programme of environmental audits, including audits of sub-contractors to be undertaken by the contractor, on a quarterly basis (as a minimum) and provides an audit report within two weeks of the audit being undertaken.

The contractor will develop a template for completing and reporting audits for the agreement of the employer prior to the commencement of site works.

3.4 Community Liaison

During the construction period, a community liaison group will be set up to disseminate information and take feedback and the project website will be regularly updated to provide the latest information relating to traffic movements associated with vehicles accessing the Site. This will be agreed with South Lanarkshire Council as the Local Roads Authorities.

4. TYPICAL CONSTRUCTION STAGE ENVIRONMENTAL MANAGEMENT MEASURES AND PLANS

This section provides sub-headings for typical detail to be provided in the outline CEMP.

4.1 Contractor Requirements

A Principal Contractor will be appointed and they will ensure that all employees, sub-contractors, suppliers and other visitors to the site are made aware of the content of the CEMP and its applicability to them. Accordingly, environmental specific induction training will be prepared and presented to all categories of personnel working on and visiting the site.

As a minimum, the following information will be provided to all inductees:

- identification of specific environmental risks associated with the work to be undertaken on-site by the inductee;
- summary of the main environmental aspects of concern at the site as identified in the CEMP; and
- Environmental Incident and Emergency Response Procedures (including specific Environmental Communication Plan requirements).

A conveniently sized copy of an Environmental Risk Map or equivalent will be provided to all inductees showing all of the sensitive areas, exclusion zones and designated washout areas. The map will be updated and reissued as required. Any updates to the map will be communicated to all inductees through a tool-box talk given by specialist environmental personnel. Regular tool box talks will be provided during construction to provide ongoing reinforcement and awareness of environmental issues.

4.2 Temporary Lighting

Temporary lighting will be required at the temporary construction compounds for security purposes and to ensure that a safe working environment is provided to construction staff. In addition, temporary lighting could be required to ensure safe working conditions at infrastructure locations during construction.

All temporary lighting installations will be downwards pointing passive infra-red (PIR) activated lighting and all lights will be switched off during daylight hours and outwith working hours.

4.3 Community Communication Plan

Specify proposed communication protocols and project team contacts.

4.4 Archaeological Management Plan

Specify requirement for mitigation and/ or good practices measures agreed with the planning authority and in line with measures specified in the EIAR.

4.5 Wind Farm Felling Plan

A wind farm felling plan would be developed in accordance with best practice measures and sustainable forest design.

4.6 Agricultural Management Plan

An agricultural management plan would be developed to outline how livestock would be managed on-site. The plan would detail how livestock would be managed through agricultural infrastructure e.g. fences and gates, how these would be maintained, and replaced, if required, during construction.

4.7 Ecological Management Plan

Provide an Ecological Management Plan (EMP), to include all measures required to protect ecology at the Site and ensure compliance with relevant nature conservation and wildlife protection legislation.

4.8 Construction Breeding Bird Protection Plan

A construction breeding bird protection plan would be provided to include all measures to protect breeding birds.

4.9 Surface, Groundwater and Water Quality Monitoring Management Plan

Specify and provide design for drainage management measures, to incorporate sustainable drainage systems (SuDS) to attenuate the volume and rate of runoff and maintain water quality.

Specify requirement for monitoring (including visual inspection and sampling) of all drainage measures (SuDS) employed during the construction phase to assess and manage the performance of the drainage system and ensure they are maintained appropriately and remain effective. The performance of the drainage measures will be monitored and recorded.

Specify the monitoring of surface watercourses to be undertaken during the construction phase, if required.

The contractor will obtain the appropriate CAR licence from SEPA prior to the commencement of construction. The Contactor will be responsible for implementing any requirements of the Site Licence and associated Pollution Prevention Plan (PPP), along with PPG/ GPPs and GBRS relevant to the protection of water quality.

4.10 Dust Management Plan

Detail dust management controls and protocols for implementation (e.g. in the event of dry weather).

4.11 Waste Management Plan

Provide details of Site waste management, identifying all waste streams and responsibilities of the contractor.

4.12 Ancillary Excavation Works and Material Storage

Provide details of ancillary excavation works and material storage, identifying responsibilities of the contractor.

4.13 Soil and Peat Management Plan

Provide an updated Peat Management Plan (PMP), to be produced post consent using data acquired through the Site investigation campaign. Specify measures to maintain soil structure and function during temporary storage and reinstatement work.

4.14 Peat Instability Risk Assessment Management Plan

Provide a geotechnical risk register and management plan to manage risks associated with construction in close proximity to areas identified as having peat instability risk.

4.15 Noise Management Plan

Specify hours of work and an outline of proposed restrictions, noise control measures required during construction work.

4.16 Construction Traffic Management Plan

Specify traffic management plan measures agreed with the planning authority.

5. CONSTRUCTION METHOD STATEMENTS

This section provides sub-headings for typical detail to be provided in the outline CEMP.

5.1 Construction Programme

The estimated construction period of the Proposed Development is approximately 18 months.

5.2 Working Hours

The normal working hours would be as follows:

- Monday to Friday 0700-1900;
- Saturday 0700-1300; and
- No working on Sundays or public holidays without prior written approval from South Lanarkshire Council.

No audible works, with the exception of turbine delivery, the completion of turbine erection or emergency work, will take place outside these hours, and any such out-of-hours works would be subject to prior agreement with South Lanarkshire Council. The requirement for out-of-hours work could arise, for example, from delivery and unloading of abnormal loads or health and safety requirements, or to ensure optimal use is made of fair weather windows for the erection of turbine blades and the erection and dismantling of cranes.

5.3 Temporary Construction Compounds, Lighting, Staging Area and Site Fencing

Specify layout in temporary construction compounds.

5.4 Public Access Roads

Specify the improvements proposed along the Site access route and detail in a Traffic Management Plan (TMP) which will also set out any Agreements or Licences required with the relevant statutory authorities and the delivery of abnormal indivisible loads (AIL).

5.5 Site Entrance

Specify requirement for inspection of Site entrance roads and detail requirement/ protocol for providing a road sweeper to remove any mud or debris transferred onto the roads from Site activities if required. Additionally, the Site entrance provides security to the Site.

5.6 Site Access Tracks

Specify construction details for Site tracks, including installation of track drainage, and the locations and use of cut and floating track design.

Specify areas requiring sub-grade drainage measures to maintain groundwater connectivity (based on detailed site investigation at pre-construction phase).

5.7 Watercourse Crossings

Specify design of watercourse crossings in accordance with the Water Environment (Controlled Activities) (Scotland) Regulations 2011 as amended (CAR). Further detail is contained within Table 2.1.1.

Specifications will comply with:

- Flood Estimation Handbook[9] (Statistical Analysis) and ReFH2 - used where appropriate used to determine the design flow;
- CIRIA Culvert design and operation guide (C689);
- Scottish Executive (2002) River Crossings and Migratory Fish: Design Guidance (where appropriate); and
- Other SEPA guidance where appropriate.

Construction Methodology

Specify watercourse crossing construction methodology, including detailed measures to prevent pollution.

5.8 Crane Hardstandings

Specify construction design details for crane hardstandings and construction methods for their installation.

5.9 Turbine Foundations

Specify foundation design (based on site investigation) and construction methods proposed.

5.10 Turbine and Turbine Transformer Erection

Specify construction details for turbine and turbine transformer erection.

5.11 Site Electrical Works

Specify construction details for Site electrical works.

5.12 Cable Trench Design Philosophy

Specify route and design of on-site cables, including methods of installation, watercourse crossing and measures to ensure that cable trenches do not provide a preferential pathway for dewatering peat forming habitats.

5.13 Substation, Control Building, Battery Energy Storage System and Compound

Specify construction details for substation control building, battery energy storage system and compound.

5.14 Solar Array

Specify construction details for the solar panel and inverters.

5.15 Grid Connection

Specify interface with distribution network operator for providing grid connection.

[9] UK Centre for Ecology and Hydrology: Flood Estimation Handbook. Online. Available at: https://www.ceh.ac.uk/our-science/projects/flood-estimation-handbook [last accessed 08/05/2024]

6. DECOMMISSIONING AND RESTORATION PLAN

The expected operational life of the Proposed Development will be 40 years from the date of final commissioning. Towards the end of this period a decision will be made as to whether to refurbish, remove or replace the turbines. If refurbishment or replacement is chosen, then relevant applications would be made.

The CEMP will be updated on completion of the construction work for handover to the Site owner. The CEMP will provide details of all relevant 'as-built' plans/ drawings and technical details which will inform the decommissioning process.

The CEMP will provide a schedule of bill of quantities to summarise the components and constituent materials which form the Proposed Development, and the likely options or methodology envisaged for the decommissioning process.

If a decision was taken to decommission the Proposed Development this will require the removal of all the turbine components, transformers, battery energy storage systems, the substation and associated buildings. In the event of decommissioning, a Decommissioning and Restoration Plan (DRP) will be prepared and will be submitted for approval by the Councils, NatureScot and SEPA no less than 12 months prior to the final decommissioning of the Proposed Development. The detailed DRP will be implemented within 18 months of final decommissioning of the Site, unless otherwise agreed with the Council.

The DRP will set out methods for the following:

- site track and hardstand areas: new site tracks and areas of hardstanding constructed during as part of the Proposed Development will be reinstated, unless otherwise agreed with the landowner and/ or Council;
- turbines: the decommissioning of the wind turbines will follow the reverse of the erection process involving similar lifting plant and equipment;
- turbine foundations: it is widely accepted that there is no appreciable effect on the local environment from buried reinforced concrete structures left in situ due to the inert state of concrete;
- solar panels: the decommissioning of the solar panels will follow the reverse of the erection process involving similar lifting plant and equipment
- energy storage units: energy storage units and associated equipment can be disassembled in reverse order to assembly with the aim of components being recycled;
- cabling works: cables will remain in situ to avoid any effect to the local environment by their removal; and
- substation compounds: will be decommissioned by disconnecting and dismantling all the surface plant. Solid structures such as the building and equipment plinths will be demolished and the foundation will be removed to an agreed depth below ground level. Ducting and cabling that is within the agreed depth to be cleared will be removed. The fence surrounding the compound will be removed and the area covered with topsoil and reseeded, as required.

APPENDIX 1
FIGURES

Consented Planning Drawings (to be updated with 'as-built' drawings on completion)

APPENDIX 2
DRAINAGE DESIGN CONTENTS

It is anticipated that the Drainage Design for the Proposed Development would comprise the following:

1. General Philosophy
2. Hydraulic/ Water Quality Design Criteria
3. Working in the Vicinity of Watercourses
4. Working in the vicinity of Groundwater Dependent Terrestrial Ecosystems (GWDTEs)
5. Management of Silt and Water pollution

5.1. Detailed Drainage Design

5.1.1. Trackside Drainage

5.1.2. Sediment Ponds/ Lagoons

5.1.3. Watercourse

5.1.4. Turbine Foundations

5.1.5. Excavated Soil Management

5.1.6. Concrete Washout Area

5.2. Maintaining Site Hydrology

5.3. Maintenance/ Monitoring of SuDS performance

5.4. Decommissioning of SuDS

Technical Appendix 2.2: Borrow Pit Assessment

Technical Appendix 2.2: Borrow Pit Assessment

1.1 Introduction

1.1.1 To minimise the volume of imported aggregate transported to Site and any consequent environmental impacts, borrow pits are to be located within the application boundary (subject to further geotechnical evaluation) to source aggregate required for track construction, turbine bases, crane pads, compounds and hardstanding areas. This report provides details of the proposed on-site borrow pits for use during the construction of the Proposed Development. Six potential borrow pit locations have been identified. The Proposed Development is described in Chapter 2: Proposed Development (EIR Volume 2) and the proposed borrow pit search areas are shown on Figure 2.2.1 (in this Technical Appendix). Section 1.4 of this report provides specific information about the borrow pit search areas and restoration details. Images of the land observed on search areas are shown in Annex 2.2.1 of this report.

Aims of this Report

1.1.2 This report provides geo-engineering information on the potential for a borrow pit to be opened on the Site. The aim of this assessment is to provide:

- a preliminary indication of the suitability of the bedrock as construction material;
- potential borrow pit locations;
- indicative borrow pit dimensions;
- indicative extraction volumes;
- estimates of overburden volumes borrow pit locations;
- an indication of potential extraction methods;
- recommendations for geotechnical testing; and
- preliminary borrow pit re-instatement and rehabilitation proposals.

1.1.3 This report outlines the methodology used by Ramboll for borrow pit assessment along with the analysis undertaken; conclusions drawn and recommendations for borrow pit design at each location.

Limitations

1.1.4 It should be noted that all borrow pit information provided within this report is indicative only and is based on desk study and Site reconnaissance alone. No intrusive investigation (other than peat probing) has been carried out and consequently the suitability of the rock, suggested extraction methods and volumes are broad estimates and should be treated as such. A detailed ground investigation (such as boreholes and trial pits) will be required to determine the suitability of the rock (extent and quality), potential for groundwater ingress, and to determine geotechnical parameters. Recommendations can then be made with regards to groundwater control, slope stability, extraction methods and finalised detailed design. The search areas have been identified for a borrow pit to allow for any adjustments following the results of the ground investigation. The final dimensions of each borrow pit are likely to be significantly different to the individual search areas (i.e. they will be smaller).

1.1.5 This report represents the findings and opinions of experienced geotechnical consultants based upon the information obtained from a variety of sources as detailed. Ramboll believes the information obtained from third parties is reliable but does not guarantee its authenticity. The information has been accepted *de facto* but professional judgement has been used in its interpretation.

1.2 Methodology

1.2.1 This report comprises a desk-based study and notes compiled from a geo-engineering walkover survey. The desk study consisted of a review of the available geological and hydrogeological data together with additional information relating to the Site including:

- 1:50,000 and 1:25,000 scale Ordnance Survey (OS) topographic mapping;
- OS Elevation Digital Terrain Mapping (DTM) data;
- review of geological mapping for the Site, British Geological Survey (BGS)[1] 1:50,000 scale;
- review of publicly available aerial photography and OS aerial imagery;
- groundwater vulnerability map of Scotland[2];
- BGS 1:625,000 scale hydrogeological map[3];
- review of peat probe survey field data; and
- a site walkover to identify suitable borrow pit locations.

1.2.2 Two walkover surveys were undertaken. One survey targeted Borrow pit locations 1 to 5 across the proposed turbine array. The second walkover targeted a potential borrow pit area within the solar array to the east. Two former disused quarry locations are present within the turbine array area, adjacent to borrow pit search areas BP2 and BP4. Both locations were identified as suitable for rock extraction.

1.2.3 The two reconnaissance site walkovers and general survey work were undertaken in April and June 2024 respectively. All survey work recorded detailed field notes and photographs of the potential borrow pit sites, including details of the geological and hydrogeological aspects of each identified location. A hand-held GPS was used to determine the grid reference.

1.2.4 The suitable borrow pit locations have been considered in more detail with preliminary layouts and volume estimates calculated of material which could be extracted. This is discussed in more detail in subsequent sections.

Borrow Pit Constraints

1.2.5 One of the principal factors affecting borrow pit location is the thickness of overburden material, due to the increased effort required for its excavation and handling before the source of the aggregate is reached. Therefore, this assessment has identified an optimal borrow pit location where there would be no, or only a very thin veneer of superficial deposits, especially peat (due to its high moisture content).

1.2.6 In addition, the borrow pit assessment has sought to avoid areas of high groundwater table in order to reduce potential for effects on groundwater dependent terrestrial ecosystems (GWDTE). In doing so, the potential borrow pit location also reduces the potential for erosion and additional processes required for handling and treatment of groundwater. At this stage groundwater mitigation measures, including an application for a Controlled Activities Regulation License (CAR)[4], are considered not to be required. Groundwater levels within the proposed borrow pit search areas will be confirmed as part of the findings from detailed ground investigation.

1.2.7 The borrow pit locations have also been selected to avoid existing watercourses, due to the potential for runoff of sediment and fine grained material.

[1] British Geological Society BGS Geo Index mapping [Accessed 11/05/2024) Available: https://mapapps2.bgs.ac.uk/geoindex/home.html

2 Scottish Environment Protection Agency flood map. [Accessed 11/05/2024] Available: http://map.sepa.org.uk/floodmap/map.htm

[3] British Geological Survey, 1:625,000 scale digital hydrogeological data. [Accessed 11/05/2024] Available: http://www.bgs.ac.uk/products/hydrogeology/maps.html

[4] The Water Environment (Controlled Activities) (Scotland) Regulations 2011

1.2.8 Consideration is also given to the potential for visual effects and impacts on the setting of cultural heritage features; however it is considered that, with sensitive development and appropriate restoration, long term significant effects associated with borrow pits can be avoided.

1.2.9 The locations of the potential borrow pits have been selected to be close to the existing access tracks where possible and in all cases close to proposed site infrastructure to minimise new track requirements.

1.2.10 Existing active quarry locations are present on Site; however these sites are due to be reinstated once quarry works have been suspended, prior to construction of the Proposed Development. Therefore, existing active quarry formations have not been considered within this assessment.

1.3 Desk Study and Site Information

1.3.1 The Site location and setting are described in Chapter 2: Development Description (EIAR Volume 2).

Topography

1.3.2 The Site topography is generally undulating, moderately shallow rising ground from the southeast to the northwest across the Site at elevations of between 200 m to 350 m Above Ordnance Datum (AOD) at the summit of Outer Law Hill. Black Hill is located within the south of the Site with steep rising ground to its summit at 385 mAOD. Topography elevations are shown on Figure 8.3.1, Technical Appendix 8.3: Peat Landslide Risk Assessment (EIAR Volume 4).

Superficial Geology

1.3.3 The 1:50,000 scale geological mapping available from the British Geological Survey (BGS)[1] shows the superficial geology of the south of the Site predominantly comprises Quaternary aged, Devensian, Till – Diamicton. An area of peat is shown to be present within the southwest of the site. Mapping shows the northern extents of the Site are absent of superficial deposits.

1.3.4 Peat probing undertaken in 2024 confirmed the presence of peat within the southwest part of the Site and within isolated pocket across the northwestern and central Site area. Areas to eastern Site extents are shown to be absent of peat. The findings of the survey are presented within Technical Appendix 8.3.1: Peat Depth Survey Results (EIAR Volume 4).

1.3.5 The depth of superficial deposits was taken into account when selecting potential borrow pit locations, typically avoiding areas with >0.5 m peat or other superficial deposits.

Bedrock Geology

1.3.6 The 1:50,000 scale geological mapping available from the British Geological Survey (BGS)[1] shows the north and western extent of the Site are underlain by Devonian aged sedimentary bedrock of the Auchtitench Sandstone Formation. The formation is made up of medium and coarse grained sandstones and conglomerates. The central and southern extents of the Site are underlain by bedrock of the Marchburn and Kirkcolm formations, wacke turbidite sequence rocks comprising sandstones and siltstones. Bedrock geology is shown on Figure 8.3.3, Technical Appendix 8.3: Peat Landslide Risk Assessment (EIAR Volume 4).

Structural Geology

1.3.7 BGS mapping[1] shows two fault lines, running approximately parallel in a southwest to northeast direction across the central region of the Site. The faults represent boundaries between the sedimentary and turbidite sequence rock formations discussed in Section 1.3.6 above.

Hydrogeology and Hydrology

1.3.8 The BGS 1:625,000 scale hydrogeology mapping[3] defines the sedimentary rocks of the Auchtitench formation as a moderate productive aquifer. These deposits underlay the majority of the proposed turbine array within the Site. The Wacke formation rock formations underlying the remainder of the Site are classed as impermeable rock. Any groundwater flow within the wacke formation bedrock will be limited to the weathered zone or secondary fractures.

Surface Water Features

1.3.9 A number of watercourses run through the Site. Mill Burn is present at the northeastern application boundary and Black Burn is present at the southern application boundary The solar array areas drain in a generally easterly direction towards the Duneaton Water and River Clyde, to the east and north.

Groundwater Dependent Terrestrial Ecosystems (GWDTE)

1.3.10 The following information should be read in conjunction with Technical Appendix 8.5 GWDTE (EIAR Volume 4).

1.3.11 The borrow pit search areas have been selected to avoid borrow pit extraction within 50 m of existing watercourses or waterbodies and with standard mitigation (i.e., an upslope cut-off/ diversion ditch to intercept surface water together with minor attenuation features or soakaways) the borrow pits are not considered likely to have any significant effect on surface water.

Suitability of Bedrock at the Site as an Aggregate

1.3.12 The Site is predominantly underlain by sedimentary rock formations, predominately comprising Sandstone or conglomerate. The wacke bedrock beneath the southern areas of the Site are sedimentary rocks of predominantly Sandstone and Siltstone. The latter of these has the potential for generating increased fines during crushing and may limit its use as a structural fill material.

1.3.13 Sandstone is commonly used source of construction aggregate and, according to the BGS, the vast majority of sandstone quarried in the UK is used for crushed rock aggregate. Its suitability as aggregate largely depends on its strength, porosity and durability, which are in turn governed by characteristics such as mineralogical composition, grain size and sorting, cementation and weathering state.

1.3.14 A key factor in the suitability of the rock as aggregate is the mineral constitution and mode of occurrence, as often their quality is not uniform. The weathering state of the rock is also of high importance, as this weakens the aggregate and reduces durability. The depth of weathering is dependent on the distribution of joints and other rock discontinuities. From the exposures observed at the Site, the discontinuity spacing varies from medium to thinly bedded. This suggests there are potentially more discontinuities for weathering to exploit leaving the majority of the rock mass fresh and of good quality. The two former disused quarry rock exposures showed sandstone rocks that generally did not appear to contain a significant amount of fine grained material, with larger grained materials dominating.

1.3.15 Quarrying is currently in progress in the central areas of the turbine array area, in order to supply rock aggregate for commercial purposes. Further quarrying is also taking place within the south of the Site, which suggests that rock would be suitable for use in construction of the Proposed Development

1.3.16 The wacke formation rocks have not been observed during walkover surveys as there were no exposures present within proximity to the borrow pit search area locations BP5 and BP6 in the south of the Site. Grading is unlikely to be uniform within wacke formation due to the turbid process involved within the deposition of their sediments. Therefore, the likely localised presence of fine-grained beds within the bedrock formation may constrain their potential for aggregate production. As such, potential extraction

sites within these formations should be carefully sited and investigated to minimise extraction of argillaceous strata or material with a potential for high fines content after excavation/ grading.

1.4 Borrow Pit Search Areas and Restoration Details

1.4.1 The proposed borrow pit search areas have been selected based on a preferential morphology for stone extraction (limited cover, rock close to surface and steep slopes). The proposed borrow pit locations have been sited to avoid areas with >0.5 m peat or other superficial deposits. The locations also take into account visual, ecological, hydrological and cultural heritage constraints. The search areas identified allow for any adjustments following the results of the ground investigation. The borrow pits are likely to be different in size to the search areas.

1.4.2 The borrow pit search areas are located across the Site with the aim of providing several areas of site-won rock across the Site, in an effort to minimise transportation of aggregate.

1.4.3 The preliminary estimation of potential material quantities which could be extracted from the proposed borrow pit locations are provided in Tables 2.2.1 to 2.2.6 . The volumes given have been calculated from indicative cross-sections of the borrow pits assuming all extraction is undertaken from a single layer or 'bench', taking into account gradients of the ground surface and the indicative borrow pit footprint dimension and depth approximations. Please note that these figures do not account for any reductions due to wastage (associated with bands of unsuitable fine grained bedrocks or highly weathered material) or bulking of excavated materials.

1.4.4 No account has been taken in the calculations for 'winning' rock during the construction phase (e.g. through track and turbine base excavations and widening of the existing track). The extent of material sourced in this manner would minimise the extraction of rock from the borrow pits.

1.4.5 Overburden/ soils together with processing residue would be carefully stockpiled adjacent to the excavation void for use in the borrow pit restoration process. The stockpiles would be located and battered so as to limit instability and erosion. Silt fences and mats will be used to minimise sediment levels in runoff from the stockpiles.

1.4.6 It is anticipated that, upon completion, the borrow pit would be partially reinstated. This will involve the reworking of faces to stabilise them, partial infilling with site-won material and landscaping with soils excavated during construction of the Proposed Development. There may also be the potential for environmental enhancement by creating small wetlands or other desirable habitats.

1.4.7 Typically the borrow pit restoration would utilise processing residues and overburden, and would create slopes within the excavation at an approximate gradient of 2 (V) in 1 (H). The crest of the slopes would intersect the uppermost rock face at a position which partially obscures the lower part of the faces. The toe of the restoration faces would be blended in to the borrow pit floor, which itself would be re-profiled to allow drainage and the re-introduction of appropriate cover. The upper part of the borrow pit faces would remain exposed and would be allowed to become weathered. It is envisaged that this face would acquire an appearance similar to that of other natural rock exposures in the locality.

Borrow Pit Details

1.4.8 An indicative borrow pit design has been prepared for each proposed borrow pit search area, and includes the following details and assumptions:

- the footprint area of the excavation for the proposed borrow pit;
- a typical cross section for the borrow pit;
- assumed quarry face profile approximately 70 degrees;
- the intermediate bench, if required, would be excavated to a maximum width of 1.5 m;
- the borrow pit floor is excavated to a nominal depth but would in practice be inclined gently down slope into the excavation;
- the maximum height of any single face would be no more than 8 m; and
- drainage would be managed using a peripheral cut off ditch.

1.4.9 Borrow Pit Search Areas BP1 to BP6 are shown on Figure 2.2.1

Proposed Borrow Pit BP1

1.4.10 Proposed borrow pit BP1 is located adjacent to the proposed Turbine 4 access track, to the north of the Site on the southern slope of the Outer Law hill formation, as shown on Figure 2.2.1. No peat cover is present at this location based on the peat probe surveys undertaken.

Table 2.2.1: Proposed Borrow Pit BP1 (NGR 288858, 628023)	
Site Area	Maximum dimensions of search area: 50 m length 50 m width
Borrow Pit Search Area	250 m²
Borrow Pit Excavation Dimensions	Assumed dimensions: 110 m length 100 m width
Height of Excavation	6.1 m maximum
Area of Land Impacted	11,000 m²
Slope Angle from DTM mapping	The slope angle of the search area is approx 3.5 degrees
Elevation of floor during construction	345 to 346 mAOD
Details of Extraction	Hard digging to easy ripping (Sandstone). This is based on observed rock within nearby disused quarry during the walkover surveys. Current estimates of fracture/ bedding spacing are between 0.2 m and 0.6 m. Bedding would be marginally unfavourable with dip direction of 100° and 10° angle of dip of bedding planes. .
Overburden Type and Depth	Superficial deposits during the peat probing survey recorded 0.1 to 0.2 m of superficial soils in this location, an overburden of less than 0.3 m is assumed.
Indicative volume of aggregate extraction	Approximate volume of 34,000 m³ between levels of approximately 345 m and 352 mAOD over the length of borrow pit.
Aggregate Composition	Assumed medium to coarse grained Sandstone with moderate weathering. Fracture spacing 0.2 m to 0.6 m. Disused Quarry located nearby

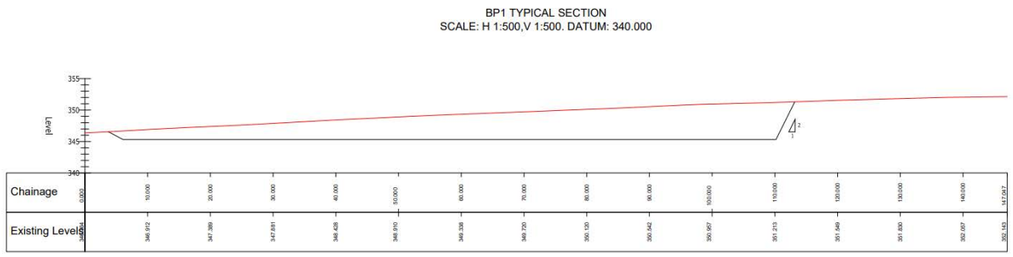


Figure 2.2 1 BP1 Typical Section

Proposed Borrow Pit BP2

1.4.11 Proposed borrow pit BP2 is located adjacent to the proposed Turbine 5, within the north of the Site, as shown on Figure 2.2.1. Maximum peat cover present is 0.2 m at this location based on the peat probe surveys undertaken.

Table 2.2.2: Proposed Borrow Pit BP2 (NGR 289102, 627715)	
Site Area	Maximum dimensions of search area: 50 m length 50 m width
Borrow Pit Search Area	250 m²
Borrow Pit Excavation Dimensions	Assumed dimensions: 100 m length 70 m width
Height of Excavation	7 m maximum
Area of Land Impacted	7,000 m²
Slope Angle from DTM mapping	The slope angle of the search area is between 3 and 11 degrees.
Elevation of floor during construction	330 mAOD
Details of Extraction	Hard digging to easy ripping (Sandstone). This is based on observed rock within nearby disused quarry during the walkover surveys. Current estimates of fracture/ bedding spacing are between 0.2 m and 0.6 m. Bedding would be marginally unfavourable with dip direction of 100º and 10º angle of dip of bedding planes. .
Overburden Type and Depth	Superficial deposits during the peat probing survey recorded 0.1 to 0.3 m of superficial soils in this location, an overburden of less than 0.3 m is assumed.
Indicative volume of aggregate extraction	Approximate volume of 32,500 m³ between levels of approximately 330 m and 336 mAOD over the length of borrow pit.
Aggregate Composition	Assumed medium to coarse grained Sandstone with moderate weathering. Fracture spacing 0.2 m to 0.6 m. Disused Quarry located nearby.

BP2 TYPICAL SECTION
SCALE: H 1:500,V 1:500. DATUM: 325.000

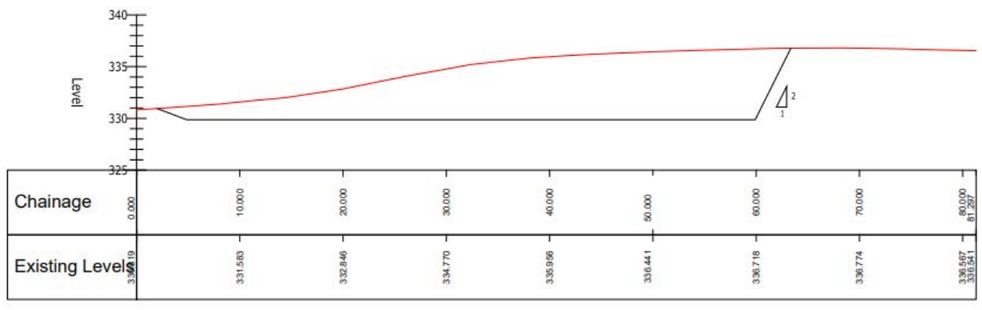


Figure 2.2 2 BP2 Typical Section

Proposed Borrow Pit BP3

1.4.12 Proposed borrow pit BP3 is located adjacent to an existing track to the southwest of Turbine 4 within the north of the Site, as shown on Figure 2.2.1. No peat cover present at this location based on the peat probe surveys undertaken.

Table 2.2.3: Proposed Borrow Pit BP3 (NGR 288505, 627879.)	
Site Area	Maximum dimensions of search area: 50 m length 50 m width
Borrow Pit Search Area	250 m²
Borrow Pit Excavation Dimensions	Assumed dimensions: 70 m length 60 m width
Height of Excavation	13 m maximum
Area of Land Impacted	4,200,600 m²
Slope Angle from DTM mapping	The slope angle of the search area is between 6 and 15 degrees.
Elevation of floor during construction	342 mAOD
Details of Extraction	Hard digging to easy ripping (Sandstone). This is based on observed rock within nearby disused quarry during the walkover surveys. Current estimates of fracture/ bedding spacing are between 0.2 m and 0.6 m. Bedding would be favourable with dip direction of 100º and 10º angle of dip of bedding planes. .
Overburden Type and Depth	Superficial deposits during the peat probing survey recorded 0.1 to 0.2 m of superficial soils in this location, an overburden of less than 0.3 m is assumed.
Indicative volume of aggregate extraction	Approximate volume of 27,600m³ between levels of approximately 342 m and 355 mAOD over the length of borrow pit.
Aggregate Composition	Assumed medium to coarse grained Sandstone with moderate weathering. Fracture spacing 0.2 m to 0.6 m. Disused Quarry located nearby.

BP 3 TYPICAL SECTION
SCALE: H 1:500,V 1:500. DATUM: 335.000

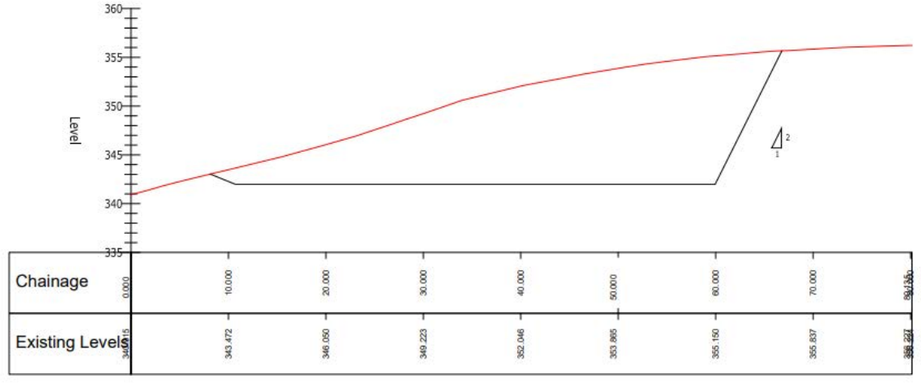


Figure 2.2.2 3 BP3 Typical Section

Proposed Borrow Pit BP4

1.4.13 Proposed borrow pit BP4 is located adjacent to a proposed track between Turbines 11 and 12 within the central regions of the proposed turbine array, as shown on Figure 2.2.1. There is potential for 0.3 m of peat cover present at this location based on the peat probe surveys undertaken.

Table 2.2.4: Proposed Borrow Pit BP4 (NGR 289121, 626806)	
Site Area	Maximum dimensions of search area: 50 m length 50 m width
Borrow Pit Search Area	250 m²
Borrow Pit Excavation Dimensions	Assumed dimensions: 110 m length 60 m width
Height of Excavation	4.3 m maximum
Area of Land Impacted	6,600 m^2
Slope Angle from DTM mapping	The slope angle of the search area is between 3 and 5 degrees.
Elevation of floor during construction	299 mAOD
Details of Extraction	Hard digging to easy ripping (Sandstone/siltstone). This is based on observed rock within nearby disused quarry during the walkover surveys. Current estimates of fracture/ bedding spacing are between 0.1 m and 0.4 m. Bedding would be marginally unfavourable with dip direction of 120º and 20º angle of dip of bedding planes. .
Overburden Type and Depth	Superficial deposits during the peat probing survey recorded 0.1 to 0.3 m of superficial soils in this location, an overburden of less than 0.4 m is assumed.
Indicative volume of aggregate extraction	Approximate volume of 15,000 m^3 between levels of approximately 299 m and 304 mAOD over the length of borrow pit.
Aggregate Composition	Assumed medium to coarse grained Sandstone interbedded with bands of siltstone with moderate weathering. Fracture spacing 0.1 m to 0.4 m. Disused Quarry located nearby.

BP4 TYPICAL SECTION
SCALE: H 1:500,V 1:500. DATUM: 295.000

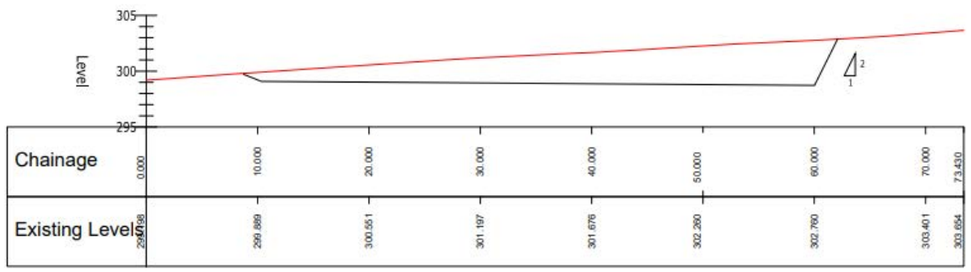


Figure 2.2.2 4 BP4 Typical Section

Proposed Borrow Pit BP5

1.4.14 Proposed borrow pit BP5 is located adjacent to a proposed track to the southeast of Turbine 22 within the south of the Site, as shown on Figure 2.2.1. No peat cover present at this location based on the peat probe surveys undertaken.

Table 2.2.5: Proposed Borrow Pit BP5 (NGR 290374, 624914)	
Site Area	Maximum dimensions of search area: 50 m length 50 m width
Borrow Pit Search Area	250 m²
Borrow Pit Excavation Dimensions	Assumed dimensions: 110 m length 30 m width
Height of Excavation	12 m maximum
Area of Land Impacted	3,300 m^2
Slope Angle from DTM mapping	The slope angle of the search area is between 11 and 22 degrees.
Elevation of floor during construction	312 mAOD
Details of Extraction	Hard digging to easy ripping (Sandstone/siltstone. This is based on anticipated rock being wacke formation. No rock outcrops observed within the search area. Bedding is unknown at this stage
Overburden Type and Depth	Superficial deposits during the peat probing survey recorded 0.1 to 0.2 m of superficial soils in this location, an overburden of less than 0.3 m is assumed.
Indicative volume of aggregate extraction	Approximate volume of 22,500 m^3 between levels of approximately 312 m and 324 mAOD over the length of borrow pit.
Aggregate Composition	Assumed medium to coarse grained Sandstone interbedded with bands of siltstone Unknown weathering or Fracture spacing. No rock outcrops observed

BP5 TYPICAL SECTION
SCALE: H 1:500,V 1:500. DATUM: 305.000

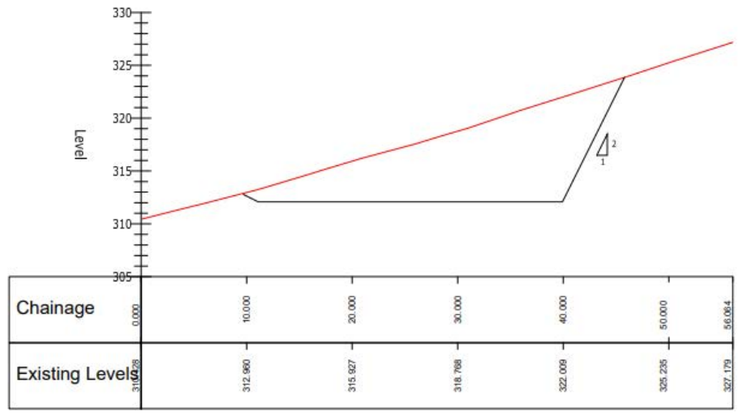


Figure 2.2.2 5 BP5 Typical Section

Proposed Borrow Pit BP6

1.4.15 Proposed borrow pit BP6 is located adjacent to a proposed track to the east of the Site within the proposed solar array, as shown on Figure 2.2.1. No peat cover present at this location based on the peat probe surveys undertaken.

Table 2.2.6: Proposed Borrow Pit BP6 (NGR 292359, 625187)	
Site Area	Maximum dimensions of search area: 50 m length 50 m width
Borrow Pit Search Area	250 m^2
Borrow Pit Excavation Dimensions	Assumed dimensions: 110 m length 100 m width
Height of Excavation	5.7 m maximum
Area of Land Impacted	11,000 m^2
Slope Angle from DTM mapping	The slope angle of the search area is between 3 and 5 degrees.
Elevation of floor during construction	256 mAOD
Details of Extraction	Hard digging to easy ripping (Sandstone/siltstone. This is based on anticipated rock being wacke formation. No intact rock outcrops observed within the search area. Boulders of fine grained sandstone and silstone showing moderate weathering.
Overburden Type and Depth	Superficial deposits during the peat probing survey recorded 0.1 to 0.4 m of superficial soils in this location, an overburden of less than 0.5 m is assumed.
Indicative volume of aggregate extraction	Approximate volume of 22,000 m^3 between levels of approximately 256 m and 262 mAOD over the length of borrow pit.
Aggregate Composition	Assumed medium to coarse grained Sandstone interbedded with bands of siltstone. Potential for moderate o high weathering based on boulders observed. Unknown bedding

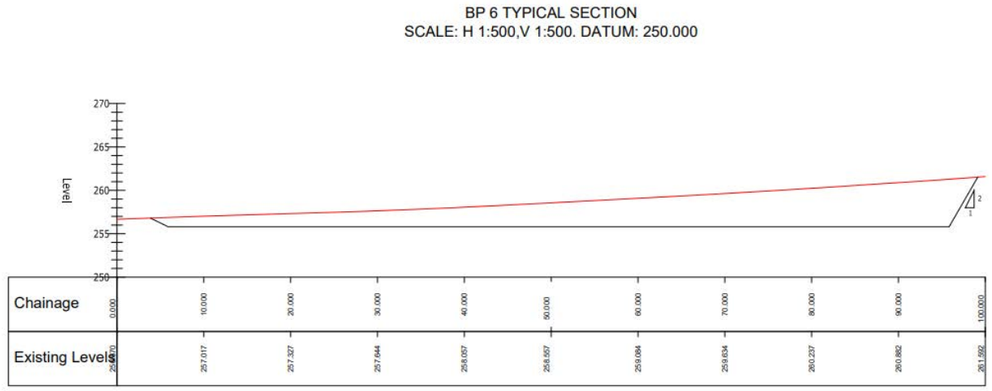


Figure 2.2.2 6 BP6 Typical Section

1.5 Summary

1.5.1 Exposures of bedrock comprising sandstone and siltstone have been identified across the Site. It is considered that the proposed borrow pit search areas would provide sufficient and suitable aggregate for access track construction given the strength and durability characteristics of the Sandstone formation. The Siltstone bands observed within quarry and boulder formation may not be suitable for structural fill material due to their potential to produce increased levels of fines when crushed and processed for aggregate. A detailed ground investigation including boreholes and trial pits would be required to determine the suitability of the rock and an assessment would be required to confirm the exact extraction methods based on the intrusive site investigation data[5].

1.5.2 Indicative aggregate volumes from the proposed borrow pits are assumed to be in the order of 153,600 m^3 based on the dimensions and levels provided in Table 2.2.1 to Table 2.2.6 . However, this would depend on a number of factors including:

- results from the detailed design and intrusive investigation work prior to extraction including volume, quality and quantity of rock available for extraction at each location; and
- potential visual impacts at each location.

1.5.3 It is estimated that the volumes of material available from the six borrow pit locations will provide sufficient material for all construction requirements for the Proposed Development. However, detailed analysis of the rock quality for reuse as structural fill will be required following ground investigation.

1.6 Construction Requirements

Extraction Operations

1.6.1 The requirement to produce various grades of aggregate would necessitate the use of mobile plant and equipment. This operation would comprise of a few different elements which are summarised below.

Excavation of Materials

1.6.2 Hard digging to easy ripping is envisaged to be the methodology required for extraction of materials based on the assessment of observed rock strength from the Site walkover. Rock samples should be taken for strength testing by an approved geotechnical laboratory to derive point load and Unconfined Compressive Strength (UCS) values. The contractor may wish to re-evaluate any alternatives to the requirement for digging on the basis of the available rock quality data (drilling and blasting may be required but it is considered unlikely).

Initial Stripping and Preparation

1.6.3 The initial access routes to the borrow pits would need to have some preparation prior to the introduction of the main items of excavation plant, particularly, those located off the existing Site access track.

1.6.4 It is anticipated that initial preparation would consist of a series of passes using an excavator with blade along or near to the final route of the permanent access track. This would have the effect of removing vegetation and any soft material, and also in compacting the weathered material located immediately above the bedrock. The gradients of prepared access way would be no steeper than 1(V) in 10(H). The borrow pit would be accessed from the existing track network. There is the potential for some short sections of track to be constructed from imported materials, unless locally sourced suitable materials can be located. In addition the area of the proposed borrow pits would require to be stripped of the

[5] A revision of the graphical method for assessing the excavatability of rock, Pettifer and Fooks, Quarterly Journal of Engineering Geology and Hydrogeology 1994; v. 27; p. 145-164,

superficial material including any soil which lies above bedrock. This material would need to be carefully lifted and placed in storage mounds within an appropriate storage area.

Crushing and Screening

1.6.5 The primary component of this operation would consist of a mobile crushing and screening system. Modern mobile crushing plants are available in a number of different formats and are usually available complete with screening capability. The contractor would need to provide a plant setup that meets the project requirements in terms of the ability to process the raw material, the quantities of the material required and the quality and size gradings of the product.

1.6.6 It is also envisaged that a rubber tyred front end loader would also be required in order to serve the crushing and stockpiling operation, as well as to produce loadout facilities for the truck and shovel based roadmaking operation.

Drainage

1.6.7 A drainage and surface water management system would be provided in order to control surface water runoff. Due to the relatively small size of any proposed excavation together with the associated plant site, the system would comprise of a peripheral cut-off ditch together with minor attenuation features or soakaways.

1.6.8 Given the low to moderate permeability and generally thin veneer of the overlying peat and superficial deposits it is not anticipated that groundwater ingress would be significant. However, the flow capacity of the bedrock would need to be determined to identify whether fracture flow is likely to be encountered and if standing water is likely to collect in the base of the excavation.

1.6.9 Water entering the borrow pit would need to be removed by either gravity drainage design or pumping depending on the overall morphology of the pit. The general topography in the areas identified is conducive to gravity drainage owing to the moderate to steep slopes. Discharge consent/ CAR licence may be required from SEPA for this activity. Water removed from the excavations would be passed through an appropriate sediment settling system to remove suspended sediment prior to discharge. The constructed drainage system and water pumped from the excavations would not be discharged directly to any natural watercourse.

1.6.10 It is not anticipated that groundwater would be largely encountered by the opening of the borrow pit at the Site due to the high elevations and slope angles. However, the groundwater regime would need to be verified through further ground investigation.

Environmental Management

1.6.11 The Proposed Development would be designed, constructed, operated and decommissioned in line with relevant environmental legislation, guidance and good practice, to ensure that soils, and both groundwater and surface water are not contaminated.

1.6.12 During construction activities, a Construction Environmental Management Plan (CEMP) would be used to manage the potential impacts on the environment, and a specific plan covering borrow pits would be developed as part of the CEMP.

1.6.13 Assuming good practice techniques are adhered to at all times and the implementation of mitigation measures as discussed above, it is anticipated that residual impacts from borrow pit activities on surface water, groundwater and soils would not be significant.

1.7 Conclusions and Recommendations

1.7.1 A reconnaissance walkover and supporting field surveys have been carried out within the Site to identify potential borrow pit locations. Six viable potential borrow pit search area locations have been identified from desktop data analysis, fieldwork and visual appraisals.

1.7.2 The surveys demonstrated that the areas of greatest potential in terms of bedrock excavation are located within the northern and central areas of the Site within the Auchtitench Sandstone Formation. Existing borrow pits and quarrying is prevalent in these areas of the Site.

1.7.3 The proposed borrow pits to the south and east of the Site are likely to be predominantly coarse grained, but maybe occasionally interbedded with fine grained materials. The quality of finer grained material would be verified through further ground investigation to minimise waste material being generated at the locations. No ground investigation has been undertaken at the Site to inform the assessment.

1.7.4 The proposed borrow pits are located on a slopes with slope angles between 3° and 22°, which could be excavated within a single layer of excavation. The overburden depths at the Site are generally shallow and predominantly less than or equal to 0.3 m with only two borrow pit locations possessing potential for limited peat cover.

1.7.5 The estimated amount of aggregate which could be won from the proposed borrow pits has been calculated as approximately 153,600 m^3 which is in excess of the estimated volume of aggregate required during the construction of the Proposed Development. This figure does not allow for any reduction for unsuitable material. No allowance has been made for the bulking of materials on excavation.

1.7.6 The primary use of aggregate arisings would be for the construction of tracks using unbound aggregate to the turbine suppliers' specifications and conforming to the Specification for Highways Works.

1.7.7 Detailed ground investigations, slope stability assessments and geotechnical testing would be required to inform the detailed design of the borrow pit to confirm the suitability of the material for use as part of the Proposed Development. It is anticipated that impacts on groundwater, surface water and soils from extraction of aggregate would not be significant, assuming use of good practice construction techniques and implementation of mitigation measures as set out in this document.

ANNEX 2.2.1: SITE WALKOVER OBSERVATIONS

Disused Quarry Locations & Borrow Pit Search Areas

Disused Quarry near Borrow Pit Search Areas BP1 to BP3 (NGR 289113, 627692)	Lithology	Comment
Disused Quarry/ Borrow Pit, Dimensions, approx. 15m by 15m. Superficial cover of 0.3 m. 	Medium to coarse grained sandstone, moderate weathering, close to medium space bedding, 0.1 to 0.5 thick, dip angle 10º. Dip direction 100º, Strike 10º	Excavation via hard digging easy ripping. For BP Search Areas BP1 to BP3 with variable favourability of bedding across the 3 proposed Borrow Pit Locations
Disused Quarry near Borrow Pit Search Area BP4 (NGR 289076, 626766)	Lithology	Comment
Disused Quarry/ Borrow Pit, Dimensions, approx. 15m by 20m. Superficial cover of 0.3 m. 	Medium to coarse grained sandstone with thin bands of siltstone, moderate weathering, close to medium space bedding, 0.1 to 0.4 thick, angle of dip 20º degrees. Dip direction 120º degrees. Strike 30º	Excavation via hard digging easy ripping. For BP Search Area BP4 with favourable bedding.

Borrow Pit Search Area BP5 (NGR 290370, 624967)	Lithology	Comment
Steep hillside with no rock outcropping. 	Unknown. Likely to be Wacke formation, topography would suggest rock close to surface	Excavation assumed as hard digging
Borrow Pit Search Area BP6 (NGR 292350,625138)	Lithology	Comment
Shallow slope with occasional boulder and area of subsoil exposure 	Boulders of fine grained sandstone and siltstone. Exposures show sandy gravelly clay type material, potentially weathered rock	Possible high to moderate weathering potential of Wacke formation rocks.

Technical Appendix 2.3: Forestry Management Plan

Technical Appendix 2.3: Forestry and Woodland

1.1 Introduction

1.1.1 This Technical Appendix (TA) of the Environmental Impact Assessment Report (EIAR) evaluates the potential effects of the Proposed Development on forestry activities and woodland areas within the Site.

1.1.2 This TA has been prepared by Neil McKay MICFor, Director of Neil McKay Forestry Consultant Limited, a professional member of the Institute of Chartered Foresters (ICF) since 1994 with more than 35 years' forestry practice in the public and private sectors throughout Scotland. Neil McKay has more than ten years' experience producing forestry inputs for EIARs for renewable energy and energy transmission infrastructure developments across Scotland.

1.1.3 This TA describes the existing forestry and woodland features that would be either directly or indirectly affected by the Proposed Development, with specific reference to woodland removal requirements. The nature of the Proposed Development and the interactions with woodland mean that likely significant effects on woodland as a material asset, or on forestry as a land use have not been identified. Nevertheless, there is requirement to demonstrate how the Proposed Development complies with policy relating to the conservation of woodland and control of woodland removal.

1.1.4 This TA describes the plans resultant from the Proposed Development through the felling, replanting and maintenance of successor tree crops. The changes to the forest structure are also described as well as any forestry waste generated. The forestry proposals are interlinked with environmental effects which are outside the scope of this TA but which should be read in conjunction with the following EIAR chapters in relation to forestry:

- Proposed Development;
- Design Evolution;
- Landscape and Visual Amenity;
- Ecology;
- Ornithology;
- Hydrology, Hydrogeology and Geology; and
- Traffic and Transport.

1.1.5 This TA identifies areas of forest to be permanently or temporarily removed for the construction and operation of the Proposed Development and outlines the proposed management practices, while identifying the replanting proposals and subsequent aftercare. The Proposed Development has direct implications to a single privately owned predominantly conifer plantation while the Site has other conifer plantations to the north and northeast. Most of the Site is outside the forestry plantations.

1.1.6 The forestry proposals have been developed to:

- identify areas permanently lost to forest cover;
- identify those areas which may be cleared as a result of the Proposed Development and replanted on Site; and
- demonstrate how the Proposed Development fits within the future forest structure.

1.1.7 This TA is structured as follows:

- Forestry Study Area;
- Baseline Conditions;
- Potential Impacts;
- Mitigation; and
- Summary

Legislation, Policy and Guidance

1.1.8 This TA has been informed by the following guidelines/policies:

- The Scottish Government (2023). Scotland's National Planning Framework 4 (NPF4)[1]
- Forestry Commission Scotland (2019): Scottish Government's policy on control of woodland removal: implementation guidance[2];
- Forestry Commission Scotland (2009): The Scottish Government's Policy on Control of Woodland Removal, Edinburgh[3];
- Forestry Commission (2023). The UK Forestry Standard: The Government's Approach to Sustainable Forestry, 5th Edition, Forestry Commission, Edinburgh[4];
- The Scottish Government (2019) Scotland's Forestry Strategy 2019-2029[5];
- The Scottish Government (2020) Scotland's Forestry Strategy Implementation Plan ››2020-2022[6];
- Forestry and Land Management (Scotland) Act 2018[7];
- The Scottish Government (2011). Scottish Land Use Strategy[8]; and
- South Lanarkshire Council, Strategic Development Plan, Forestry and Woodland Strategy.

1.2 Consultation

1.2.1 Consultation responses received in relation to forestry can be reviewed in Technical Appendix 1.1: Consultation Register.

1.3 Methodology

1.3.1 Forestry assessment through desk study specifically included:

[1] Scottish Government, National Planning Framework 4, available at: https://www.gov.scot/publications/national-planning-framework-4/ [accessed 26/06/2024]

[2] Forestry Commission Scotland, 2019. Scottish Government's policy on control of woodland removal: implementation guidance. Online. Available at: https://forestry.gov.scot/images/corporate/pdf/Implementation-Guidance-Control-of-woodland-removal.pdf [accessed 26/06/2024]

[3] Forestry Commission Scotland, 2009. The Scottish Government's Policy on Control of Woodland Removal, Edinburgh.

[4] Forestry Commission, 2023. The UK Forestry Standard: The governments approach to sustainable forestry. Online. Available at: https://www.gov.uk/government/publications/the-uk-forestry-standard [accessed 26/06/2024]

[5] The Scottish Government (Scottish Forestry) 2019. Scotland's Forestry Strategy 2019-2029. Online. Available at: https://www.gov.scot/publications/scotlands-forestry-strategy-20192029/ [accessed 26/06/2024]

[6] The Scottish Government (Scottish Forestry), 2020. Scotland's Forestry Strategy Implementation Plan 2020-2022. Online: Available at: https://forestry.gov.scot/publications/793-scotland-s-forestry-strategy-implementation-plan-2020-2022 [accessed 26/06/2024]

[7] The Scottish Government, 2018, Forestry and Land Management (Scotland) Act 2018. Available at https://www.legislation.gov.uk/asp/2018/8/contents/enacted [accessed 26/06/2024]

[8] The Scottish Government, 2021.Scottish Land Use Strategy: Land use - getting the best from our land: strategy 2021 to 2026. Online. Available at: https://www.gov.scot/publications/scotlands-third-land-use-strategy-2021-2026-getting-best-land/ [accessed 26/04/2024]

- Scottish Forestry Map Viewer[9], Scottish Forestry (SF) is the Scottish Government agency responsible for forestry policy, support and regulation, the map viewer enables view of what forest management plans or felling approvals are in place or have now expired.
- Datasets including the Native Woodland Survey of Scotland[10] (NWSS) provide a baseline survey of all native woodlands, nearly native woodlands and Plantations on Ancient Woodland Sites (PAWS) sites in Scotland showing type, extent and condition of those woods.
- Datasets for Ancient Woodland Inventory (Scotland)[11] (AWI) categorise ancient woods recorded as being of semi-natural origin on either the 1750 Roy maps OR the 1st Edition Ordnance Survey maps of 1860.
- The Land Information Search (LIS) is a map-based tool that allows search for data such as Sites of Special Scientific Interest and Native Woodland that may fall within the area of interest.
- No forest digital data has been provided by the woodland owners or agents.
- A forestry site walkover was undertaken in May 2024 to identify the tree species, their current height and condition.

Assumptions and limitations

1.3.2 As described, forests and woodlands are dynamic and are susceptible to natural influences such as catastrophic wind throw, infestation by pests and diseases as well as changes in management or owners' objectives.

1.3.3 Limited forest information has been made available by the forest owner or agents. The digital shapefiles used are those on the Scottish Forestry Open Data[12].

1.4 Forestry Study Area

1.4.1 The Forestry Study Area is confined to the woodland creation area referred to as Blackburn Farm woodland and is illustrated in Figure 2.3.1 Forestry Study Area. Other established small woodlands are within the Site but are not impacted by the Proposed Development.

1.5 Baseline Conditions

1.5.1 There are no ancient woodland sites shown on AWI or NWSS within the Forestry Study Area.

1.5.2 Forestry Grant Scheme 16FGS10015 was approved by Scottish Forestry, Central Scotland Conservancy in 2016.

Woodland Description

1.5.3 The woodland areas are defined, for the purposes of this appraisal, by the listings on the Scottish Forestry datasets in Table 2.3.1 below:

Table 2.3.1 Planted area (ha) by species and planting year

Species	Planting Year	Area (ha)
Sitka spruce	2017	27.49
Mixed conifer	2017	4.73
Native broadleaved	2017	3.90
Totals		36.12

1.5.4 The site visit in May 2024 confirmed the woodland establishment on ploughed ground within a deer fence. The species recorded as mixed conifers are Lodgepole pine and the native broadleaves include birch and rowan. All species have established with most areas performing well in terms of growth and vigour. The tree crop is described as "thicket stage" and current tree heights were estimated at between 2 m and 3 m. The baseline species on the Site are illustrated on Figure 2.3.2.

1.5.5 The woodland creation design avoided planting areas of peat greater than 0.5 m depth, as determined through the woodland creation assessment. A grant aid application and consent for tree planting were granted by SF prior to planting in 2017.

1.6 Potential Impacts

1.6.1 The Proposed Development within the Blackburn Farm woodland creation areas require permanent tree removal for the tracks and three turbine hardstandings. Furthermore, an additional area of permanent tree removal is required to accommodate the stand-off between trees and turbines as mitigation following the NatureScot guidance, 'Bats and Onshore Wind Turbines, Survey, Assessment and Mitigation, August 2021[13]. The area, in hectares (ha), of permanent woodland removal shall be taken forward as compensatory planting with areas identified within the BEMP.

1.6.2 As part of the outline BEMP, to enhance the Red Moss priority habitat, it is also proposed to remove all the planted non-native conifer trees and replace these in situ with low density native broadleaved trees. This falls under temporary clearance and does not require compensatory planting elsewhere.

1.6.3 The established, planted native broadleaved trees are not required to be removed for the Proposed Development and shall be maintained as part of the BEMP. The areas of woodland removal are described in Table 2.3.2 below, and illustrated on Figure 2.3.3 Forestry Conifer Clearance.

Table 2.3.2 Woodland clearance by species and area (ha)

Species	Tree clearance. Area (ha)	Replant in situ with low density broadleaved. Area (ha)	Permanent woodland loss Area (ha)	No intervention. Area (ha)
Sitka spruce and Lodgepole pine	32.22	24.09	8.13	
Native broadleaved				3.90

1.7 Mitigation

1.7.1 Replanting in situ with 24.09 ha native broadleaved trees is part of the BEMP with 8.13 ha compensatory planting taking place in the riparian margins of the Duneaton Water and the Black Burn, within the Site and on adjacent watercourses outside the Site. The aims of the riparian planting is to reduce erosion,

[9] Scottish Forestry Map Viewer. Available at https://www.forestry.gov.scot/support-regulations/scottish-forestry-map-viewer [Accessed 26/06/2024]

[10] Native Woodland Survey of Scotland. Available at https://www.forestry.gov.scot/forests-environment/biodiversity/native-woodlands/native-woodland-survey-of-scotland-nwss [Accessed 26/06/2024]

[11] Ancient Woodland Inventory (Scotland Available at https://www.data.gov.uk/dataset/c2f57ed9-5601-4864-af5f-a6e73e977f54/ancient-woodland-inventory-scotland [Accessed 26/06/2024}

[12] Scottish Forestry Open Data. Available at https://open-data-scottishforestry.hub.arcgis.com/ [Accessed 26/06/2024]

[13] Bats and Onshore Wind Turbines, Survey, Assessment and Mitigation, August 2021. Available at https://www.nature.scot/doc/bats-and-onshore-wind-turbines-survey-assessment-and-mitigation. [Accessed 26/06/2024]

increase shade to support fish populations and for water quality improvement in the area downstream of the Red Moss SAC/SSSI. Further tree planting is planned for screening around the substation, the compound and BESS. Proposed planting is illustrated on Figure 2.3.4 Forestry Open Ground and Replanting In Situ.

1.7.2 Planting plans will be formed as part of the BEMP which clearly identify the areas of new woodland which is compensatory planting. The replanting on site will also be detailed within the BEMP.

1.7.3 If the material is a suitable size to meet the biomass market all material will be removed from Site. If this option is not available at the time of construction a forestry waste plan will be prepared. The removal of the conifers will be undertaken by competent forestry contractors and follow the best practice at the time.

1.8 Summary

1.8.1 The Forestry Study Area is 36.12 ha of primarily conifer woodland planted in 2017, known as Blackburn Farm Woodland. This woodland was grant aided as a “conifer option” under a Forestry Grant Scheme. The Proposed Development requires the permanent removal of 8.13 ha conifer woodland for infrastructure and environmental buffers. In order to enhance biodiversity and improve the nearby Red Moss priority habitat the Applicant will remove the remaining 24.09 ha thicket stage non-native conifer plantation and replace in situ with low density native broadleaved trees. Further tree planting within the Site includes screening of some infrastructure. The planted native broadleaved (3.90 ha) will be unaffected by the Proposed Development and will be maintained as part of the overall BEMP.

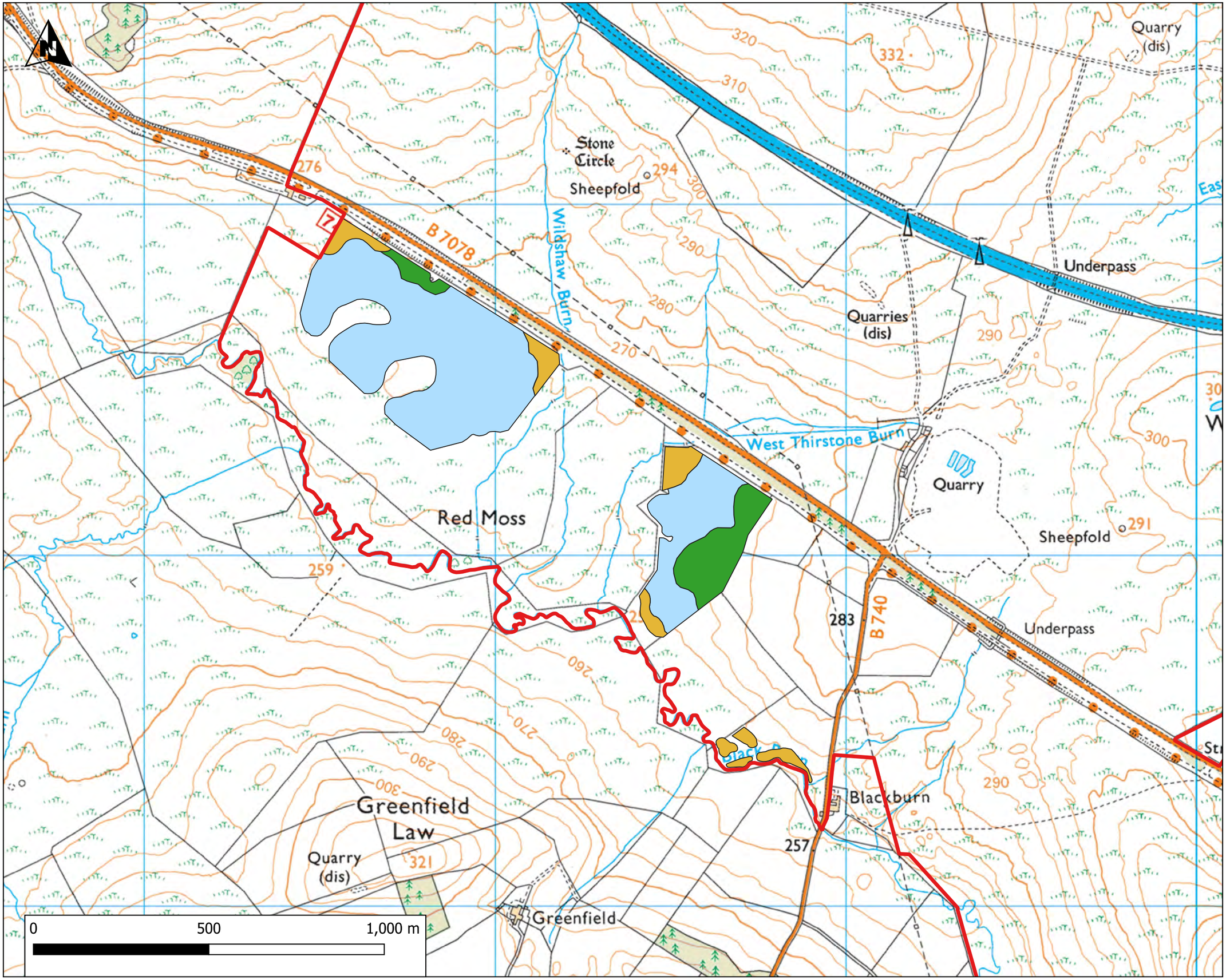
Legend

- Site Boundary
- Blackburn Farm Woodland Creation
- Other Conifer Woodland

Figure Title	Forestry Study Area
Project Name	M74 West Renewable Energy Park
Project Number	1620015684
Figure No.	2.3.1
Date	26/06/2024
Prepared By	NM
Scale	1:20,000 @A3
Issue	1
Client	**M74 West Ltd**

RAMBOLL

0 500 1,000 m

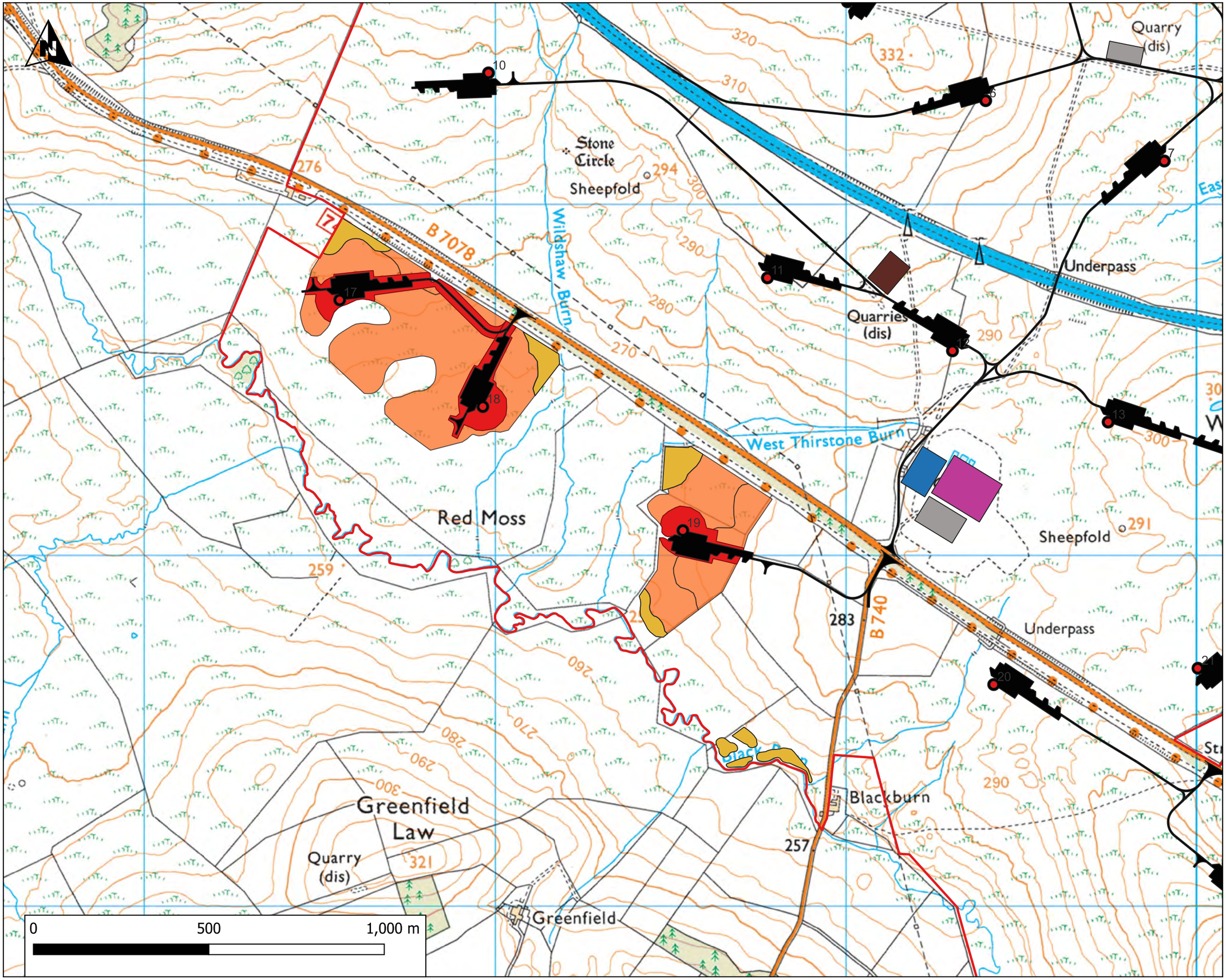


Legend

- Site Boundary
- Mixed Conifer
- Native Mixed Broadleave
- Sitka Spruce

Figure Title	Forestry Baseline Species
Project Name	M74 West Renewable Energy Park
Project Number	1620015684
Figure No.	2.3.2
Date	26/06/2024
Prepared By	NM
Scale	1:10,000 @A3
Issue	1
Client	**M74 West Ltd**

RAMBOLL



Legend

- Site Boundary
- Turbine locations
- Access tracks, Junctions & Turning Heads
- Battery Site
- Borrow pit search area
- Construction Compound
- Met mast
- Substation
- Conifer Removal to be replanted
- Native Mixed Broadleaved to be retained
- Permanent Conifer Woodland Removal

Figure Title	Forestry Conifer Clearance
Project Name	M74 West Renewable Energy Park
Project Number	1620015684
Figure No.	2.3.3
Date	13/08/2024
Prepared By	NM
Scale	1:10,000 @A3
Issue	2
Client	**M74 West Ltd**

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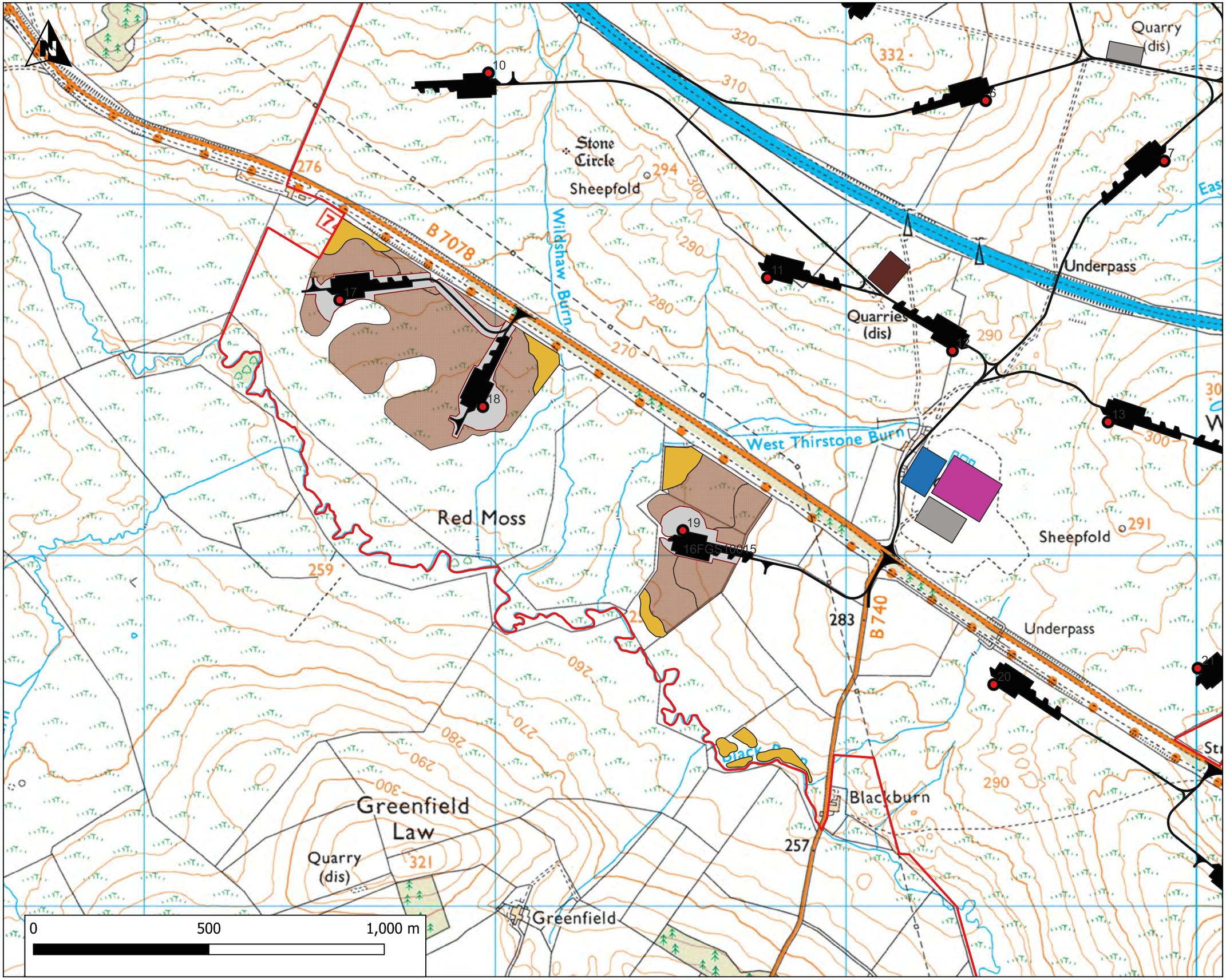


Legend

- Site Boundary
- Turbine locations
- Access tracks, Junctions & Turning Heads
- Battery Site
- Borrow pit search area
- Construction Compound
- Met mast
- Substation
- Native Mixed Broadleaved retained
- Wind Farm Open Ground
- Low Density Native Broadleaved

Figure Title
Forestry Open Ground and Replanting In Situ

Project Name
M74 West Renewable Energy Park

Project Number	Figure No.
1620015684	2.3.4
Date: 13/08/2024	Prepared By: NM
Scale: 1:10,000 @A3	Issue: 2

Client
M74 West Ltd

RAMBOLL

Technical Appendix 2.4: Carbon Balance Assessment

Technical Appendix 2.4: Carbon Balance Assessment

1.1 Introduction and Methodology

1.1.1 This carbon assessment report has been prepared on behalf of the Applicant in support of an application for consent to construct and operate the Proposed Development.

1.1.2 The carbon assessment has been undertaken using the Scottish Government's online calculation tool[1] which has been developed to assess the carbon impact of the wind farm development. The carbon assessment tool calculates the CO_2 emissions from the Proposed Development and compares these against the CO_2 emissions estimated from other electricity generation sources.

1.1.3 This Technical Appendix is supported by the following:

- Annex 2.4.1: Carbon Calculator Inputs; and
- Annex 2.4.2: Carbon Calculator Results and Charts.

1.1.4 The online carbon calculator tool uses the methodology and approach developed by Nayak *et al*[2]*.*

1.2 Input Parameters

1.2.1 This report should be read in conjunction with the online carbon calculator inputs (which are detailed in Annex 2.4.1 and summarised in this Technical Appendix) and the Development Description in EIAR Volume 2: Chapter 2. Information to inform the online carbon calculator has been derived from either specific parameters from the Proposed Development itself or has been based on industry standard information.

Characteristics of the Proposed Development

1.2.2 The Proposed Development would comprise up to 22 turbines with an operational life of 40 years, and a total installed capacity of between 134.2 MW and 165 MW. The net capacity factor for the Proposed Development is estimated to be approximately 37.89%, which has been estimated based on wind data analysis.

1.2.3 The CO_2 emissions generated during the life of the wind turbines themselves, including those from created during manufacture and removal are calculated using default values within the carbon calculator.

1.2.4 The Proposed Development also includes solar power generators, of approximately 80 MW generating capacity, and a Battery Energy and Storage System (BESS) with up to 50 MW capacity and 200 MW/h of storage which are not included in the calculations.

Peatland and Environmental Characteristics of the Site

1.2.5 The Site covers an area of approximately 1,275 ha and is located immediately northwest of Abington and approximately 4.5 km southeast of Douglas, South Lanarkshire.

1.2.6 The Site predominantly comprises open moorland, improved and semi-improved grassland, an area of forestry, and is intersected by the M74 motorway and B7078 and B740 local roads. The landscape is typical of the wider location, with the Site positioned in the northern portion of the Southern Upland Hills, with Tinto Hill located approximately 8 km to the north.

1.2.7 The Duneaton Water, a tributary of the River Clyde, passes through the eastern part of the Site and forms part of the northern and southern boundary. The A702 forms the eastern boundary.

1.2.8 There are extant and disused quarries present at the Site which are understood to have been used for sand and gravel extraction (central area between the B7078 and M74, and north of the M74) and rock extraction (north westernmost part of the Site, north of the M74).

1.2.9 The Site is centred at approximate Ordnance Survey National Grid Reference NS 989983 26013. The Site location and setting are described in more detail within Chapter 2: Development Description.

1.2.10 Geological mapping indicates that the superficial deposits underlying the Site predominantly comprise Devensian Till (Diamicton) with alluvium, gravel, sands and silts mapped along the River Clyde and burns. Peat is shown mapped in the central part of the Site to the west of White Rig. Areas of glaciofluvial sands and gravels are also shown to the south of Mill Burn in the northern part of the Site, and in smaller areas across the Site. The higher parts of the Site are shown as unmapped indicating that there are potentially no superficial deposits present.

1.2.11 Geological mapping indicates that the underlying bedrock across most of the western part of the Site is mapped as the Auchtitench Sandstone Formation, comprising volcaniclastic conglomerate. The central part of the Site is mapped as the Marchburn Formation, comprising wackes, and the eastern part of the Site is mapped as the Kirkcolm Formation, again comprising wackes.

1.2.12 Two peat depth probing surveys were undertaken at the Site, with a combined total of 2,415 peat probes taken. This comprised 900 peat probes during a Stage 1 survey, as part of a low resolution survey across the Site, and a further 1,515 probes during Stage 2 based on a more mature development layout. The results of the surveys were used to inform the design layout of the Proposed Development and are presented in Technical Appendix 8.1 Peat Depth Survey Results.

1.2.13 Overall, the findings of the peat depth survey found that the Site is either absent of peat or where present, is relatively shallow (98% of samples). The mean probe depth recorded across the Site is 0.1 m. The deepest areas of peat, up to 4.4 m, were noted to be in the western area of the Site south of the B7078. Other smaller pockets of deeper peat were noted in the central part of the Site south of the M74. The Proposed Development has been located away from these deeper peat locations where practicable, taking into account other environmental and technical constraints, or microsited to minimise potential adverse effects. No turbines are located on deep peat.

1.2.14 The expected, minimum and maximum values relevant for the Site included within the carbon calculator are 0.1 m, 0 m and 4.4 m respectively although it should be noted that the assessment of peat/ soil depth assumes peat exists to the full depth of the probed depth value, with potential for an over estimation dependent on the underlying organic material/clay present.

1.2.15 The mean annual temperature was derived based on the mean annual air temperature for Abington over a five year period between 2019 to 2023[3]. The mean annual air temperature for Abington was found to be 6.8 °C, with minimum and maximum values of -4 °C and 18 °C respectively. However, 0 °C and 15 °C have been used as the minimum and maximum values in the carbon calculator as these are the maximum and minimum values allowed.

1.2.16 The carbon content of the peat has been derived using laboratory test analysis of peat cores taken at the Site (Technical Appendix 8.1: Peat Depth Survey Results), where the mean total carbon (%)

[1] https://informatics.sepa.org.uk/CarbonCalculator/index.jsp

[2] Nayak D.R., Miller D., Nolan A., Smith P., Smith J.U. (2011). *Calculating Carbon Savings from Windfarms on Scottish Peat Lands: A New Approach.*

[3] Abington Annual Weather Averages - South Lanarkshire, GB (worldweatheronline.com)

was found to be 92.1 %. The minimum and maximum values of 67% and 98% respectively have been used as these are default values in the carbon calculator.

1.2.17 Generic hydrological parameters have been used for average groundwater. A value of 0.3 m has been used as the expected value. A 'maximum' value of 0.5 m has been used to represent areas of intact peat (the higher the water table the longer the payback period), and a 'minimum' value of 0.1 m has been used to represent areas of eroded peat.

1.2.18 The extent of drawdown on drainage features due to excavations onsite is variable, and can extend between 2 m and 50 m horizontally around the feature. Site specific values are not available, so the standard values from 'Windfarm Carbon Calculator Web Tool, User Guidance' have been used. Therefore, the expected value is 10 m, minimum is 5 m and maximum 50 m.

1.2.19 For dry soil bulk density a value of 0.105 g/cm^3 has been used based on the lab testing undertaken.

1.2.20 The online calculator restricts the minimum and maximum values to at 0.05 g/cm^3 and 0.3 g/cm^3 respectively so a maximum value of 0.3 g/cm^3 has been used in the model.

1.2.21 For vegetation restoration, it has been assumed that five years is a reasonable time period for regeneration of most bog plants based on the Site elevation, location and current conditions, with minimum and maximum values of 2 and 10 years. The carbon accumulation rate for peatland has been derived based on the carbon calculator guidance, 0.25 tC ha^{-1} yr^{-1}, with the accumulation rates of 0.12 tC ha^{-1} yr^{-1} and 0.31 tC ha^{-1} yr^{-1} adopted as the minimum and maximum values respectively.

Counterfactual Emission Factors

1.2.22 The most recent counterfactual emission factors for three methods of energy generation have been used as provided in the online carbon calculator. These are 0.207 tCO$_2$ MWh^{-1} CO$_2$ emissions for grid mix, 0.945 tCO$_2$ MWh^{-1} for coal, and 0.424 tCO$_2$ MWh^{-1} for fossil fuel mix.

Proposed Development

1.2.23 For the purposes of this assessment, the turbine foundations were assumed to remain unchanged regardless of its location within the Site and the calculation were based on a central excavation of approximately 27 m diameter and an approximate depth of 3 m to 5 m subject to prevailing ground conditions. Based on the peat probing survey results, the average peat depth at the turbine footprint is estimated to be 0.1 m. The minimum and maximum expected peat depths are 0 m and 0.5 m respectively.

1.2.24 The proposed turbine permanent area of the hardstandings and laydowns total 38,522 m^2, with the same excavation footprint. Based on the peat probing survey results, the average peat depth at the turbine hardstandings is calculated as 0.1 m. For the purposes of the carbon calculator, minimum and maximum depths recorded around hardstandings of 0.0 m and 0.5 m respectively are used.

1.2.25 It is expected that the total volume of concrete used for the Proposed Development would be approximately 50,000 m^3. This volume is a high level assumption based on professional experience. The exact volume of concrete required would be confirmed at detailed design stage.

1.2.26 A total of 21,100 m of new access tracks would be constructed as part of the Proposed Development. All of the tracks are proposed to be excavated. The proposed width of the excavated access track is 5 m with 0.5 m shoulders on both sides. A total of 1,170 m of existing tracks are proposed to be upgraded as part of the Proposed Development. The minimum and maximum expected peat depths are 0 m and 1.0 m respectively with the average of 0.1 m used).

1.2.27 A total of 32.22 ha of forestry is to be cleared as part of the Proposed Development with 24.09 ha to be replanted.

1.2.28 A proposed substation compound (of a total footprint of approximately 0.96 ha) and (total footprint of 2 ha) has also been considered in the carbon balance assessment. The peat depth at these locations has been assumed as being 0.5 m and 1.5 m respectively.

1.2.29 The potential peat excavation volumes associated with six borrow pit search area locations has also been considered.

1.2.30 Temporary infrastructure such as construction compounds, and cable trenches are not expected to result in a permanent displacement of peat.

1.2.31 Peat excavation volumes have been estimated based on the interpolated peat depth survey information, and outlined in the Outline Peat Management Plan (Technical Appendix 8.2, EIAR Volume 4).

1.2.32 The peat landslide hazard is fixed as 'negligible' in the online carbon calculator.

Opportunities for Carbon Sequestration

1.2.33 Any local improvements to carbon sequestration, such as areas of peatland habitat restoration, would result in a reduction in the net carbon emissions from the Proposed Development.

1.2.34 Given the absence/shallow, and potentially modified condition of the peat at the Site as a result of artificial drainage, there are opportunities, as part of the Proposed Development, to restore and enhance the peat condition. These are summarised as part of the Outline Biodiversity Enhancement Management Plan (OBEMP) (Technical Appendix 6.6, EIAR Volume 4) and Outline Peat Management Plan (Technical Appendix 8.2, EIAR Volume 4).

1.2.35 Drainage implemented during the construction phase of the Proposed Development would be removed prior to operation, and has been assumed to be temporary in duration. For the purposes of the carbon calculator the expected value for completion of backfilling, removal of any surface drains, and restoration of the hydrology is 0.25 years, and the minimum and maximum are assumed to be 0.1 year and 3 years respectively.

1.2.36 It has been assumed that at the end of the operational phase of the Proposed Development, the Site would either be re-powered or decommissioned. In the event of decommissioning, it has been assumed that access tracks constructed would remain in situ, drainage channels and gullies in peat would be blocked, and turbine infrastructure removed.

1.3 Results

1.3.1 The estimated total carbon losses as calculated by the online carbon calculator as shown in Table 2.4.1 below.

Table 2.4.1: Total Carbon Losses

Source	Expected CO_2 Losses (tCO_2)	Minimum Value CO_2 Losses (tCO_2)	Maximum Value CO_2 Losses (tCO_2)
Losses due to turbine life	145,293	130,904	159,682
Losses due to backup	111,130	0	122,570
Losses due to reduced carbon fixing potential	3,213	885	18,171
Losses from soil organic matter	3,732	-12,926	129,494
Losses from Dissolved Organic Carbon and Particulate Organic Carbon leaching	29	0	25,052
Losses due to forestry felling	51,982	46,934	53,240
Total losses of carbon dioxide	315,378	165,796	508,209

1.3.2 The carbon losses calculated are independent of the generation mix used to calculate the overall carbon balance. It is assumed that back up capacity is derived from conventional fossil fuel generation.

1.3.3 The predicted payback time for the Proposed Development, as determined from the online carbon calculator, is shown in Table 2.4.2.

Table 2.4.2: Carbon Payback Period

Source	Counterfactual Emission Factors (t CO_2 MWh^{-1})	Carbon Payback Period (years)		
		Expected Value	Minimum Value 0 % Balancing Capacity	Maximum Value 5 % Balancing Capacity
Coal fired generation	0.945	0.7	0.3	1.2
Grid mix generation	0.207	3.1	1.2	5.6
Fossil fuel mix generation	0.424	1.5	0.6	2.8

1.4 Summary

1.4.1 The carbon assessment indicates that the carbon emission payback time for the Proposed Development would be between 0.6 and 2.8 years, with an expected value of 1.5 years. This is when compared against a fossil fuel mix generation.

Annex 2.4.1: Carbon Calculator Inputs

Carbon Calculator v1.8.1
M74 West Renewable Energy Park Location: 55.524346 -3.753178
M74 West Limited

Core input data

Input data	Expected value	Minimum value	Maximum value	Source of data
Windfarm characteristics				
Dimensions				
No. of turbines	22	22	22	EIAR Chapter 2 Development Description
Duration of consent (years)	40	40	40	EIAR Chapter 2 Development Description
Performance				
Power rating of 1 turbine (MW)	6.8	6.1	7.5	EIAR Chapter 2 Development Description
Capacity factor	37.89	37	38	Generated from the Applicants internal wind analysis for the Proposed development
Backup				
Fraction of output to backup (%)	5	0	5	Calculating Potential Carbon Losses and Savings from Wind Farm Analysis from Wind Farms on Scottish Peatlands Technical Note
Additional emissions due to reduced thermal efficiency of the reserve generation (%)	10	10	10	Fixed
Total CO2 emission from turbine life ($tCO2\ MW^{-1}$) (eg. manufacture, construction, decommissioning)	Calculate wrt installed capacity	Calculate wrt installed capacity	Calculate wrt installed capacity	
Characteristics of peatland before windfarm development				
Type of peatland	Acid bog	Acid bog	Acid bog	EIAR Volume 4 Ecological Technical Appendices
Average annual air temperature at site (°C)	6.8	0	15	Data derived based on local weather station at Abington, South Lanarkshire for period 2019 to 2023 (https://www.worldweatheronline.com/abington-weather-averages/south-lanarkshire/gb.aspx). Maximum and minimum temperatures of 0 and 15 degrees used as per tool limitations.
Average depth of peat at site (m)	0.1	0	4.4	EIAR Volume 4 Technical Appendix 2.3 Peat Depth Survey Report
C Content of dry peat (% by weight)	65	19	65	EIAR Volume 4 Technical Appendix 2.3 Peat Depth Survey Report. Maximum and minimum values of 65% and 19% used as per tool limitations.
Average extent of drainage around drainage features at site (m)	10	5	50	Wind Farm Carbon Calculator Web Tool, User Guidance
Average water table depth at site (m)	0.3	0.1	0.5	Wind Farm Carbon Calculator Web Tool, User Guidance
Dry soil bulk density ($g\ cm^{-3}$)	0.105	0.05	0.3	Maximum value of 0.3g cm-3 used as per tool limitations.
Characteristics of bog plants				
Time required for regeneration of bog plants after restoration (years)	5	2	10	Five years used as a precautionary approach based on location and elevation of the site.
Carbon accumulation due to C fixation by bog plants in undrained peats ($tC\ ha^{-1}\ yr^{-1}$)	0.25	0.12	0.31	Wind Farm Carbon Calculator Web Tool, User Guidance
Forestry Plantation Characteristics				
Area of forestry plantation to be felled (ha)	32.22	32	33	EIAR Volume 4 Technical Appendix 2.3 Forestry
Average rate of carbon sequestration in timber ($tC\ ha^{-1}\ yr^{-1}$)	11	10	11	Wind Farm Carbon Calculator Web Tool, User Guidance
Counterfactual emission factors				
Coal-fired plant emission factor ($t\ CO2\ MWh^{-1}$)	0.945	0.945	0.945	
Grid-mix emission factor ($t\ CO2\ MWh^{-1}$)	0.207	0.207	0.207	
Fossil fuel-mix emission factor ($t\ CO2\ MWh^{-1}$)	0.424	0.424	0.424	
Borrow pits				
Number of borrow pits	6	6	6	EIAR Volume 4 Technical Appendix 2.2 Borrow Pit Assessment
Average length of pits (m)	99.5	50	147	EIAR Volume 4 Technical Appendix 2.2 Borrow Pit Assessment
Average width of pits (m)	77.3	50	110	EIAR Volume 4 Technical Appendix 2.2 Borrow Pit Assessment
Average depth of peat removed from pit (m)	0.25	0	0.5	EIAR Volume 4 Technical Appendix 2.2 Borrow Pit Assessment
Foundations and hard-standing area associated with each turbine				
Average length of turbine foundations (m)	27	27	27	EIAR Chapter 2 Development Description
Average width of turbine foundations (m)	27	27	27	EIAR Chapter 2 Development Description
Average depth of peat removed from turbine foundations(m)	0.1	0	0.5	EIAR Volume 4 Technical Appendix 8.1 Peat Depth Survey
Average length of hard-standing (m)	50	50	50	EIAR Chapter 2 Development Description (based on area of 1,751m2 per turbine)
Average width of hard-standing (m)	35	35	35	EIAR Chapter 2 Development Description ((based on area of 1,751m2 per turbine)

Input data	Expected value	Minimum value	Maximum value	Source of data
Average depth of peat removed from hard-standing (m)	0.1	0	0.5	EIAR Volume 4 Technical Appendix 8.1 Peat Depth Survey
Volume of concrete used in construction of the ENTIRE windfarm				
Volume of concrete (m^3)	50000	50000	50000	EIAR Chapter 2 Development Description/Estimates on professional judgement (2187m3 per turbine rounded up)
Access tracks				
Total length of access track (m)	22270	22250	22290	EIAR Chapter 2 Development Description
Existing track length (m)	1170	1160	1180	EIAR Chapter 2 Development Description
Length of access track that is floating road (m)	0	0	0	No floating tracks proposed
Floating road width (m)	6	6	6	No floating tracks proposed
Floating road depth (m)	0	0	0	No floating tracks proposed
Length of floating road that is drained (m)	0	0	0	No floating tracks proposed
Average depth of drains associated with floating roads (m)	0	0	0	No floating tracks proposed
Length of access track that is excavated road (m)	21100	21090	21110	EIAR Chapter 2 Development Description
Excavated road width (m)	6	6	6	EIAR Chapter 2 Development Description
Average depth of peat excavated for road (m)	0.1	0	0.5	EIAR Chapter 2 Development Description
Length of access track that is rock filled road (m)	0	0	0	No rock filled roads proposed
Rock filled road width (m)	6	6	6	No rock filled roads proposed
Rock filled road depth (m)	0	0	0	No rock filled roads proposed
Length of rock filled road that is drained (m)	0	0	0	No rock filled roads proposed
Average depth of drains associated with rock filled roads (m)	0	0	0	No rock filled roads proposed
Cable trenches				
Length of any cable trench on peat that does not follow access tracks and is lined with a permeable medium (eg. sand) (m)	0	0	0	EIAR Chapter 2 Development Description - all trenches follow access tracks
Average depth of peat cut for cable trenches (m)	0	0	0	EIAR Chapter 2 Development Description - all trenches follow access tracks
Additional peat excavated (not already accounted for above)				
Volume of additional peat excavated (m^3)	34800	34800	34800	EIAR Volume 4 Technical Annex 8.2 Outline Peat Management Plan
Area of additional peat excavated (m^2)	29600	29600	29600	EIAR Volume 4 Technical Annex 8.2 Outline Peat Management Plan
Peat Landslide Hazard				
Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments	negligible	negligible	negligible	Fixed
Improvement of C sequestration at site by blocking drains, restoration of habitat etc				
Improvement of degraded bog				
Area of degraded bog to be improved (ha)	0	0	0	Conservative assumption that no bog improvement required.
Water table depth in degraded bog before improvement (m)	0	0	0	
Water table depth in degraded bog after improvement (m)	0	0	0	
Time required for hydrology and habitat of bog to return to its previous state on improvement (years)	0	0	0	
Period of time when effectiveness of the improvement in degraded bog can be guaranteed (years)	0	0	0	
Improvement of felled plantation land				
Area of felled plantation to be improved (ha)	32.22	32	33	Assumed that area will be improved based on removal of trees
Water table depth in felled area before improvement (m)	0.3	0.1	0.5	Same assumptions as used previously for average water table depth
Water table depth in felled area after improvement (m)	0.2	0	0.4	Assumption based on an improvement to water table following improvement
Time required for hydrology and habitat of felled plantation to return to its previous state on improvement (years)	5	2	10	Assumption based on professional experience
Period of time when effectiveness of the improvement in felled plantation can be guaranteed (years)	5	2	10	Assumption based on professional experience
Restoration of peat removed from borrow pits				
Area of borrow pits to be restored (ha)	5.78	5.7	5.8	Based on EIAR Volume 2 Chapter 2 and TA 2.2
Depth of water table in borrow pit before restoration with respect to the restored surface (m)	0.2	0	0.4	Assumption based on an improvement to water table following improvement

Input data	Expected value	Minimum value	Maximum value	Source of data
Depth of water table in borrow pit after restoration with respect to the restored surface (m)	0.1	0	0.3	Assumption based on an improvement to water table following improvement
Time required for hydrology and habitat of borrow pit to return to its previous state on restoration (years)	5	2	10	Assumption based on an improvement to water table following improvement
Period of time when effectiveness of the restoration of peat removed from borrow pits can be guaranteed (years)	40	40	40	Assumption based on an improvement to water table following improvement and scheme operating life
Early removal of drainage from foundations and hardstanding				
Water table depth around foundations and hardstanding before restoration (m)	0.3	0.1	0.5	Windfarm Carbon Calculator Web Tool, User Guidance
Water table depth around foundations and hardstanding after restoration (m)	0.1	0.05	0.3	Windfarm Carbon Calculator Web Tool, User Guidance
Time to completion of backfilling, removal of any surface drains, and full restoration of the hydrology (years)	0.25	0.1	3	Windfarm Carbon Calculator Web Tool, User Guidance
Restoration of site after decomissioning				
Will the hydrology of the site be restored on decommissioning?	Yes	Yes	Yes	
Will you attempt to block any gullies that have formed due to the windfarm?	Yes	Yes	Yes	This will form part of a decommissioning and restoration plan for the site in future
Will you attempt to block all artificial ditches and facilitate rewetting?	Yes	Yes	Yes	This will form part of a decommissioning and restoration plan for the site in future
Will the habitat of the site be restored on decommissioning?	Yes	Yes	Yes	
Will you control grazing on degraded areas?	Yes	Yes	Yes	This will form part of a decommissioning and restoration plan for the site in future
Will you manage areas to favour reintroduction of species	Yes	Yes	Yes	This will form part of a decommissioning and restoration plan for the site in future
Methodology				
Choice of methodology for calculating emission factors	Site specific (required for planning applications)			

Annex 2.4.2: Carbon Calculator Results and Charts

Payback Time and CO_2 emissions • BVEP-H5CK-DYV9 v1

1. Windfarm CO2 emission saving over...	Exp.	Min.	Max.
...coal-fired electricity generation (t CO2 / yr)	469,237	411,046	519,043
...grid-mix of electricity generation (t CO2 / yr)	102,785	90,039	113,695
...fossil fuel-mix of electricity generation (t CO2 / yr)	210,536	184,427	232,883
Energy output from windfarm over lifetime (MWh)	19,861,877	17,398,762	21,970,080

Total CO2 losses due to wind farm (tCO2 eq.)	Exp.	Min.	Max.
2. Losses due to turbine life (eg. manufacture, construction, decomissioning)	145,293	130,904	159,682
3. Losses due to backup	111,130	0	122,570
4. Lossess due to reduced carbon fixing potential	3,213	885	18,171
5. Losses from soil organic matter	3,732	-12,926	129,494
6. Losses due to DOC & POC leaching	29	0	25,052
7. Losses due to felling forestry	51,982	46,934	53,240
Total losses of carbon dioxide	315,378	165,796	508,209

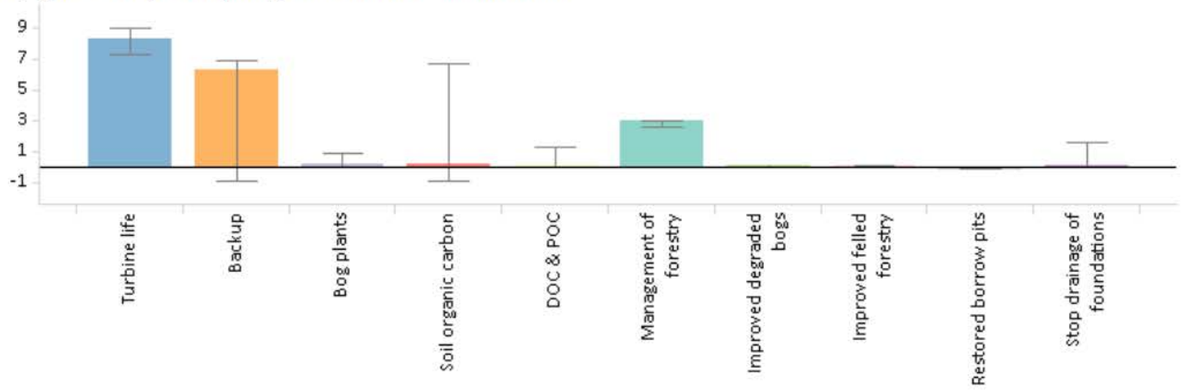
8. Total CO2 gains due to improvement of site (t CO2 eq.)	Exp.	Min.	Max.
8a. Change in emissions due to improvement of degraded bogs	0	0	0
8b. Change in emissions due to improvement of felled forestry	0	0	-2,989
8c. Change in emissions due to restoration of peat from borrow pits	-625	0	-1,825
8d. Change in emissions due to removal of drainage from foundations & hardstanding	272	0	-29,960
Total change in emissions due to improvements	-353	0	-34,774

RESULTS	Exp.	Min.	Max.
Net emissions of carbon dioxide (t CO2 eq.)	315,026	131,023	508,209
Carbon Payback Time			
...coal-fired electricity generation (years)	0.7	0.3	1.2
...grid-mix of electricity generation (years)	3.1	1.2	5.6
...fossil fuel-mix of electricity generation (years)	1.5	0.6	2.8
Ratio of soil carbon loss to gain by restoration (not used in Scottish applications)	10.66	-0.37	No gains!
Ratio of CO2 eq. emissions to power generation (g/kWh) (for info. only)	15.86	5.96	29.21

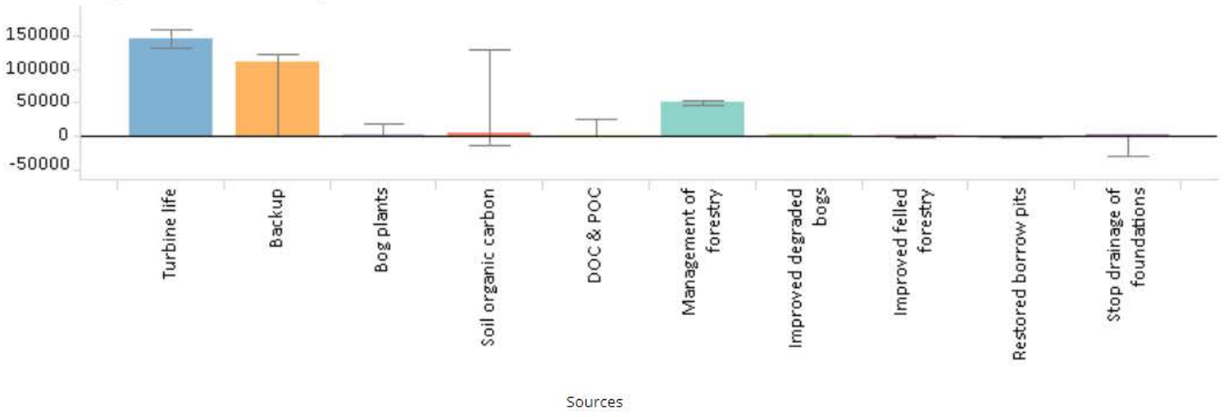
Payback Time and CO_2 emissions • BVEP-H5CK-DYV9 v1

MENU

Carbon payback time (months) using fossil-fuel mix as conterfactual



Greenhouse gas emissions (t CO2 eq.)



Proportions of greenhouse gas emissions from different sources