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Appendix 3.1

Outline Construction Method Statement

Keerglen Wind Farm

Support Document to Planning Application

August 2024

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1 Introduction

The purpose of this Outline Construction Method Statement (OCMS) is to identify the key mitigation and environmental control measures specific to the construction of Keerglen Wind Farm and grid connection that must be adhered to at all times, in order to ensure that the project is developed in a sensitive manner and provides environmental reassurance to Mayo County Council, National Parks and Wildlife Services and Inland Fisheries Ireland on the manner in which the works will be undertaken.

The Main Contractor will be experienced in wind farm construction and will work closely with all the statutory authorities and construction management team throughout the full contract period to manage all aspects of the works, identifying and addressing potential issues with the relevant parties. All construction work will be carried out by an ISO9001 / ISO14001 accredited and experienced Main Contactor, implementing appropriate construction and environmental management systems. All works including production, breakdowns and environmental concerns shall be clearly recorded and detailed. This information will be made available at all times. Works will be undertaken in accordance with contract specifications and guidelines.

Concrete structures will be manufactured using sulphate resistant cement for improved protection of the structure and receiving environment. A Geotechnical Risk Register (GRR) will be developed and maintained throughout the duration of the construction period. The Main Contractor will base the Detailed Construction Method Statement(s) for the works on the principles established in this OCMS.

This document should be read in conjunction with the EIAR and the Environmental Management Plan set out in Appendix 3.5.

1.1 Main Construction Activities

The main construction activities are:

- Temporary accommodation works to facilitate passage of abnormal loads along the selected turbine delivery route
- Construct approximately 3.7km of new site access tracks with locally sourced stone, and 3.5km of upgraded existing agricultural tracks.
- Install sufficient access track ditches and culverts with associated run off/sediment controls to safely access and maintain the site, whilst protecting existing infrastructure and environment (specifically off-site freshwater habitats).
- Construct eight wind turbine generator (WTG) bases. Only a small section of the upper most collar / plinth of the concrete bases will be visible on completion.
- Construction of eight hard-standing areas, adjacent to the Wind Turbine Generator (WTG)

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bases, for installation and maintenance of the WTG's.

- Construct new wind farm electrical substation and compound.
- Install below ground power cables between WTG's and the substation.
- Removal of all non-permanent areas (temporary construction compound) and reinstatement of these areas.

2 Balance of Plant Civil Engineering Works

Balance of plant civil engineering works describe all the civil engineering work required to complete the wind farm. It does not include electrical works (including connection to the National Grid) or mechanical installation of the turbines.

2.1 Public road works (temporary widening/removal of street furniture)

It is proposed that the wind turbine components will be delivered from either Killybegs Port via Donegal, Sligo, Tobercurry, Charlestown, Swinford and Ballina.

From here, the turbine components are delivered to site of the Keerglen Wind Farm via the local route, L1108 and the regional route, R315.

The final route will be the responsibility of the chosen turbine supplier and subject to their detailed route assessments.

Certain Points of Interest (POI), or constraint areas, have been identified along the various route options from the Port of Killybegs. These are illustrated in Figure 1.1

A separate planning application will be made for any grid connection works, a temporary meteorological mast, substantial turbine haulage route works (additional to what is being screened for the purposes of an Environmental Impact Assessment as part of this planning application) and final construction details will be agreed with Mayo Council Road Service prior to commencement of development. Certain works could include:

- the stoning up of verges;
- the removal of street/road furniture and signage
- the removal/cutting of certain hedges/trees;
- widening of local roads at defined Points of Interest
- creation of areas of hard standing on agricultural or scrub lands etc.

All works would be temporary to allow the passage of the abnormal load and the lands would be fully reinstated afterwards, in so far as possible.

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2.2 Site Entrance Access

Keerglen Wind Farm will have one new main site entrance, formed along the L51723 as illustrated in the Planning Drawing pack. The proposed site entrance forms a simple T junction to provide ease of access for HGVs into the site. The access onto the public road will be adequately set back from the road edge to enable other users to see traffic emerging from the entrance.

The new site entrance will serve as the main construction entrance to the site, facilitating material deliveries (stone, steel, and concrete) and staff access, as well as large oversize components such as turbine blades, tower sections and substation components. This temporary access junction and road will be re-instated land following the completion of construction works.

2.3 Access Track Design and Construction Methodology

Access to the proposed turbines will be via the existing and proposed internal site track network. The proposed internal site track layout will permit access for vehicles during the construction phase, for maintenance during the operation phase, and for vehicles to decommission the turbines at the end of the life of the development.

Internal access tracks will be constructed from layers of compacted selected fill and imported aggregate in order to allow access to the turbine locations during the construction period and longer-term maintenance and eventual decommissioning. The proposed layout identifies approximately 3.7km of new internal access road as being required. Approximately 3.5km of existing agricultural tracks will be upgraded. The existing roads are good quality 3-4m wide tracks but will require widening and strengthening in some sections. The site tracks would generally have a 5-7 m wide running surface, with widening at bends (of up to typically 8 m), junctions and crane hard standings to suit the turning requirements of the abnormal load vehicles.

In designing the layout of internal tracks, the main considerations have been as follows:

- Existing site contours - avoid excessive cross slopes and deep cut and fill sections into existing terrain;
- Environmentally sensitive areas - tracks have been routed where possible to avoid ecological, hydrological and slope slide sensitive areas.

The access tracks proposed will be typically constructed using the traditional excavate and backfill technique.

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It is appropriate from a sustainability perspective that the existing infrastructure be used where possible rather than constructing new infrastructure in parallel to existing. In this regard, the Contractor will maximise the use of the existing infrastructure for the wind farm and reduce the extent of new works required, and therefore reduce the environmental impact caused by the development.

As part of the pre-tender design work, a detailed Ground Investigation will be carried out to assess the ground conditions. The detailed civil engineering design to produce vertical and horizontal track alignments will be carried out using 3D modelling software (e.g. Autodesk Civil 3D).

It is anticipated that site tracks will be constructed from imported locally sourced aggregate material. There are several quarries in the vicinity of the site which can supply suitable materials and a vegetation survey will be carried out first to check for the presence of invasive species.

The Planning Drawing pack shows typical sections for construction of new track and upgrading existing site tracks by widening and overlay.

All roads and roadside drainage will be maintained during the project with alterations being made where and when necessary.

2.4 Water Crossings

Where it is necessary to cross existing watercourses and drains within the application site, it is proposed that the water crossing structures will be culverts.

Proposals for crossing natural watercourses are set out in the accompanying EIAR and will be Subject to Section 50 application at detailed design stage and prior to commencement of development.

All works will be carried out in accordance with the recommendations of: *"Forest & Water Guidelines"* 5th Edition, "*Good Practice During Wind Farm Construction"*, SEPA, October 2010 and the NIEA guidelines PPG01 General guide to the prevention of water pollution PPG05 Works and maintenance, in or near water PPG06 Working at Construction and Demolition Sites PPG21 Pollution Incident Response Planning.

2.5 Borrow Pits

A borrow pit is proposed as part of the planning application to be placed centrally, identified in the Planning Drawing pack. The site won material will be used as the bottom base layer for the internal

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roads and will then be covered with layers of higher quality stone aggregates from local quarries. No crushing or screening of the site won material will occur on site. Stone and concrete will be sourced from local quarries.

2.6 Construction Compound

A temporary site construction compound is envisaged for the construction period. The area of the compound (50m x 50m) will be large enough to set up car parking, fuel storage, material storage and to support the welfare of site personnel (this is likely to include temporary office accommodation, canteens, drying rooms and a toilet block with a storage tank for collection and offsite disposal of foul water). The site compound will be located adjacent to the proposed electrical site substation.

The site accommodation will be to a good standard and will meet the requirements of the current Health and Safety Legislation for the Construction Industry. To comply with this legislation, power, water, and welfare facilities must be provided.

An indicative layout for the construction compound is shown in the Planning Drawing Pack.

2.6.1 Compound Construction and Laydown Area Methodology

Any accommodation used for the construction works will be temporary. Sewage will be stored in holding tanks and water will be stored in purpose made tanks or bowsers. The following guidelines will be adhered to: PPG04 "*Treatment and disposal of Sewage where no foul sewer is available*". A diesel-powered generator will be used to provide electricity. This will be operated in accordance with the guidelines PPG02 *"Above ground oil storage tanks"* and PPG07 *"Refueling Facilities".* Water supply to the compound will be tankered.

An area will be selected to form the fuel storage and refueling area. A concrete plinth will be constructed to accommodate double skinned diesel storage tanks. This will be operated in accordance with the guidelines PPG02 *"Above ground oil storage tanks"* and PPG07 *"Refueling Facilities".* The refueling area will be bunded approximately for the fuel usage volume for the period of the construction. It will have a concrete surface and be fitted with an appropriate oil interceptor. All bunded areas will provide 110% capacity of the maximum volume to be stored. All work associated with the compound will comply with:

PPG01 General guide to the prevention of water pollution, PPG02 Above ground oil storage tanks, PPG05 Works and maintenance in or near water, PPG06 Working at construction and demolition sites, PPG07 Refueling Facilities, PPG08 Safe storage and disposal of used oils, PPG21 Pollution Incident Response Planning, PPG26 Storage and Handling of Drums & Intermediate Bulk Containers.

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All plant will be regularly checked for fuel and oil leaks and all static plant will sit on drip trays which will be regularly inspected and emptied in accordance with the Environmental Management System. Fuel will be kept in bunded tanks. The designated fueling point will be remote from watercourses and trained and designated fillers will carry out fuel dispensing.

2.7 Crane Hardstandings

Hardstand areas will be required at each turbine. The hardstands will accommodate a main crane and an assist crane during the assembly of the turbine, as well as during occasional maintenance during the operation of the wind farm.

The main hardstanding area will be approximately 50m x 35m with temporary additional set down areas as shown in the Planning Drawing Pack. The area of the hardstanding provided is deemed suitable for the assembly of a turbine with the proposed dimensions.

2.7.1 Crane Hardstandings Construction Methodology

Crane hardstanding will follow the same general construction methodology as new site tracks. Soft material, namely topsoil and sub-soil will be excavated and either placed in designated storage or stockpiled separately for environmental improvement work, landscaping and restoration. Suitable fill produced during the excavation for the turbine base will be used to form the crane hard standing as well as backfill for the base. The remainder of the fill and aggregate will be sourced from local quarries. Excavation of the turbine base and construction of corresponding crane hardstanding will run together as the crane pad cannot be completed until the base is back filled.

The crane hardstandings will initially be made to a standard suitable for construction traffic with a final grading with imported aggregate taking place before the turbine delivery starts. The crane hardstandings will be designed to a minimum bearing pressure, as verified by plate bearing tests. The surrounding bunds of stored soil and sub-soil material will be measured and the appropriate amount of material will be left for final reinstatement after the turbine erection and commissioning works.

2.8 Cable Installation

Electrical cables are required to connect the wind turbines with the site sub-station / control building. The cable routes will be agreed with the Engineer and cable-laying contractor. All ducted road crossings will be marked. Cable routes will generally run parallel to the tracks within the soft shoulder and offset by around 5 m (where other environmental constraints permit) from the edge of new track.

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2.8.1 Cable Installation Methodology

The preferred method for installing cables is by excavated trenches with appropriate sand/leanmix surround instead of the cable plough.

At drainage crossings within the site Cable Route Bride Crossing Methodology will be used as is detailed in the Planning Drawing Pack drawings.

2.9 Foundation work

Reinforced concrete foundations for the turbines are typically 24 - 26 m diameter by 2.5 - 3 m high and will be constructed from reinforcing steel and sulphate resistant concrete to a specified mix design.

2.9.1 Turbine base construction methodology

Marking out, stripping the vegetation and stockpiling or storage will follow the same methodology as described for the crane hardstandings and site access track. Before the bulk excavation starts, suitable drainage arrangements will be put in place. Existing drainage, ground water and the surrounding terrain will all be taken into account. As with all excavations of this nature, the on-site excavation will start at the lowest area where silt traps or pump sumps can be established. Topography may dictate pumped disposal to siltation ponds and then dispersal overland. Pumped disposal will be controlled by a permit-to-work system.

Rock and boulder clay excavated from the foundation will be side cast. If the material is suitable it will be retained at the base location for backfilling over the base and to form the crane pad. Surplus or unsuitable material will either be used in final landscaping or used as fill.

When formation has been passed as suitable for construction (by a suitably qualified Engineer), a layer of blinding concrete will be placed. The blinding will be about 1 m oversized to allow room for shutters and steel fixer access. The exact position of the base will be marked out on the blinding allowing the reinforcing steel to be fixed and the concrete formwork or shutters to be erected and shored. The concrete will be poured using a lorry mounted pump. The concrete will be delivered to each base by ready mix trucks. Once the ready mix trucks have discharged the concrete, the chutes only will be washed down in the designated concrete wash-out area. The remaining contents in the drum will be taken off site and the drum will be cleaned at the ready mix yard.

When the concrete has cured, the shutters will be removed and backfilling will commence. The

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selected fill will be placed in compacted layers. The type of material and the compaction plant used will determine the depth of the layers.

The final landscaping and restoration around the top of each base will be completed after the wind turbine is erected.

2.10 Sub-station building and Compound

A sub-station with associated compound will be constructed to house electrical switch gear, transformers and control systems for the wind farm. The Planning Drawing pack illustrates the sub-station building elevations and plan of the substation and compound.

There are no anticipated underground services in the vicinity of the application site but should underground services be present, trial pits will be excavated by hand to identify – suitable protection measures to be put in place. There will be a level hard standing area in front of the building to facilitate parking and deliveries and the compound will be secured with palisade fencing.

2.10.1 Method statement for the Construction of the Control Building

The building will be constructed from traditional cavity wall concrete block construction with pitched roof and basement. The area will be cleared of trees and soils will be excavated to a firm formation level. The formation will be inspected by engineering staff and acceptability of the formation recorded. Upon completion of the excavation works, the safety of the excavation will be assessed prior to personnel entry, and a route of access created.

Service ducts and drainage required to service the building will be excavated, laid and protected using specified backfill material, and the levels will be controlled to ensure formation is achieved. The location of any service penetrations will be checked. Concrete will be placed as blinding to the excavation using a tracked excavator.

The sub-station building will be supplied with a grey harled render. The roof will be pitched and finished with artificial slate tiles. The building will be of traditional masonry construction. The roof

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will be of timber truss construction.

2.11 Temporary Meteorological Mast

The planning application pack screens for the purposes of the accompanying Environment Impact Assessment a 100-112m high temporary meteorological mast. The planning application does not seek permission for the mast at this time. However, the mast which is being screened in will be self-supporting of triangular lattice bolted galvanised steel construction. The Planning Drawing Pack details the mast elevation and also shows an illustrative location of the meteorological mast.

2.12 Method Statement of the Construction of the Temporary Meteorological Mast

A met mast foundation would be constructed following a similar methodology as the turbine foundations. The mast would be transported to site in sections which can be assembled on the ground within a dedicated set down and assembly area beside the foundation. The sections would be assembled into larger modules which can be craned into place and bolted together.

2.13 Post construction restoration/reinstatement of working areas

The principal aim of the work will be to protect, conserve and where necessary, restore sites in a natural, sensitive and inconspicuous manner. All disturbed areas will be reinstated with the same vegetation type as exists at present by preservation of the seed bank where possible, thereby ensuring minimum disruption to the surrounding landscape.

The overall requirement is that work should be carried out to cause the least disturbance possible to the existing vegetation, soils, drainage patterns and watercourses. The following general conditions will be adopted:

- Access to the works will be restricted to the established routes.
- Excavated sub-soil and topsoil will be stacked separately for re-use in backfilling and landscaping.

Restoration areas will be seeded with an approved seed mix, then lightly firmed, but not compacted, to reduce the risk of erosion from rainfall.

2.14 Site Drainage

The two overarching principles of the site drainage system are to:

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- keep *'clean'* water clean by constructing separate collection systems to intercept runoff and to provide earthworks drainage, and
- provide a treatment train of swales and settlement/attenuation before discharge.

The construction drainage will be designed to intercept clean run-off water and minimise the amount of water for sediment treatment in a location specific way during excavation activities. The temporary construction drainage will be adopted and modified to become permanent operational drainage immediately after turbines and hardstandings have been constructed. The final design of the permanent operational drainage will be evolved during the construction stage.

Chapter 7 of the EIAR provides detailed drainage mitigation proposed by avoidance and by engineering design. The proposed site drainage plan details are set out and included as Appendix 7.6 of the EIAR, both of which provide further details of site-specific measures.

As a general overview:

- It is proposed that excavated soil will be used for landscaping where required.
- During the initial construction of roads, silt fences, straw bales and biodegradable geogrids will be used to control surface water runoff from works areas.
- Where applicable, the vegetative top-soil layer of the spoil management areas will be rolled back to facilitate placement of excavated spoil up to a maximum height of 1.0 metres, following which the vegetative-top soils layer will be reinstated. Where reinstatement is not possible, spoil management areas will be sealed with a digger bucket and seeded as soon possible to reduce sediment entrainment in runoff.
- Construction of the Wind Farm Site drainage system will only be carried out during periods of low rainfall, and therefore minimum runoff rates. This will minimise the risk of entrainment of suspended sediment in surface water runoff, and transport via this pathway to surface watercourses. Construction of the drainage system during this period will also ensure that attenuation features associated with the drainage system will be in place and operational for all subsequent construction works.
- An inspection and maintenance plan for the on-site drainage system will be prepared in advance of commencement of any works. Regular inspections of all installed drainage systems will be undertaken, especially after heavy rainfall, to check for blockages, and ensure there is no build-up of standing water in parts of the systems where it is not intended.
- Any excess build-up of silt levels at dams, the settlement pond, or any other drainage features that may decrease the effectiveness of the drainage feature, will be removed.

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- During the construction phase field testing (visual, supplemented with pH, electrical conductivity, temperature, dissolved oxygen and turbidity monitoring), sampling and laboratory analysis of a range of parameters with relevant regulatory limits and EQSs should be undertaken for each primary watercourse, and specifically following heavy rainfall events (i.e. weekly, monthly and event based).

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3 Environmental Management

The works will be managed with due care and attention to the environment. This will include putting measures in place to prevent pollution from fuel spills, mud on the road, dust, sediment discharge, flood waters etc.

Once the works are underway, the supervising engineers and environmental staff will make regular site inspections to ensure that all permanent and temporary arrangements are being carried out in accordance with the agreed best practice. Non-compliances and concerns will be reported to the supervising Engineer named in the construction contract who will take appropriate action. Major non-compliances will be also be reported to the Regulatory Authority.

Onsite meetings with statutory authorities or other interested parties can be arranged to discuss / comment on the proposed final road alignment and location of stockpiles.

The developer and main contractor will ensure that best environmental practice and the measures set-out in the Environmental Management Plan (EMP) are being adhered.

3.1 Fuel handling and storage (for construction and operational phases)

During the construction phase and the operational phase, all fuels and oils will be stored and handled in accordance with the following guidelines:

PPG01 General guide to the prevention of water pollution, PPG02 Above ground oil storage tanks, PPG05 Works and maintenance in or near water, PPG06 Working at construction and demolition sites, PPG07 Refuelling Facilities, PPG08 Safe storage and disposal of used oils PPG21 Pollution Incident Response Planning, PPG26 Storage and Handling of Drums & Intermediate Bulk Containers.

3.1.1 Fuel storage

Diesel fuel will be the most frequently used on site and will be needed in large quantities when the construction phase of the project is well established. All fuel containers will be locked or stored in locked containers when not in use.

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3.1.2 Fuel Delivery

Fuel will be delivered up to twice a week from a National supply company. Enough space will be allowed to park the delivery tanker as close as possible to the tanks to minimise the amount of hose required and to ensure that the nozzle is operated over the concrete apron. A spill kit and absorbent granules will be kept at the tanks. The main operation of the delivery nozzle, turning on and off and attaching it to and disconnection from the tank's delivery pipe will all be carried out within the bunded section of the storage tanks.

3.1.3 Fuelling Plant

Only the person nominated and dedicated to fuelling plant will be permitted to carry out the fuelling procedure. Only nozzles that cannot be locked open will be used to ensure that the refuelling operative must be present whilst fuelling.

3.1.4 Contingency Plans

A Pollution Incident Plan with emergency telephone numbers will be in place and displayed throughout the site. The Plan will be briefed to appropriate personnel at the Site Induction and during Tool Box Talks and will include instructions on actions in case of various pollution incidents.

Spill kits will be available throughout the site for use by site personnel trained in their use by means of Tool Box Talk and practice drills.

3.2 Cleaning of site entrance, site tracks and adjacent public road

Most of the construction vehicle movements remain within the confines of the application site. Delivery vehicles will at all times remain within the confines of the access tracks and hardstanding areas and as such should not create a high risk of contaminating the public road with mud or debris. The entrance area will attract the majority of any detritus on vehicles leaving the site. The surfaced junction will be maintained in a clean condition to prevent the build-up of mud and debris. The condition of vehicles exiting on to the public road will be monitored and we will take appropriate action to ensure that mud and debris does not cause a hazard to other public road users. From our experience on other wind farms, a wheel wash has not been necessary.

3.3 Dust Management Plan

The main source of dust will be vehicular movements along the access track and from excavations. There will be very few instances when significant material cutting will be required

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(another common source of dust on construction sites).

To limit dust arising from vehicle movements, the capping layer on the road will not be formed from fine dust or other fine grained material, but will be a well graded material. Additionally, vehicle speeds will be closely controlled throughout the works. This will ensure that dust generation is minimised. Reducing speed limits on unbound road surfaces can have a dramatic effect on reducing the amount of dust generated. If necessary, dust suppression by spraying water can be employed.

For excavations, dust is generally not a problem due to the natural moisture content of soils excavated during the works.

3.4 Water Abstraction

It is not anticipated that this will be required. In the event that water abstraction is required, it will be agreed with the Competent Authority.

3.5 Blasting Operations

There is currently no requirement for blasting on this site.

3.6 Pollution Prevention Plan

There are two main sources of potential pollution – (i) from a point source caused by an oil or fuel spillage, or (ii) where silt-laden run-off enters a watercourse untreated.

The procedures described in Chapter 7 of the EIAR and section 3.1 of this document will be implemented to mitigate the risk of an oil or fuel spillage. The latter risk will be controlled using the following SuDS principles in conjunction with good management techniques:

- Pollution will be prevented wherever possible using ditches to intercept surface water run-off before it becomes contaminated. The attenuation of contaminated water will be minimised by regularly treating and discharging water from within the roadside drainage.
- Water treatment will reduce suspended solids using the natural process of sedimentation, filtration and absorption.
- Watercourses will be monitored regularly to provide an early warning of potential failures.
- Staff and operatives will be briefed on procedures in the event of an emergency.

A regular maintenance scheme will be implemented to maintain the SuDS.

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A detailed pollution prevention plan will be provided for approval prior to the commencement of development. The plan will include contact details for site management staff, emergency services and other relevant authorities. It will address what procedures are to be put in place and what actions will be taken if there is a catastrophic pollution event.

In the event of exceptionally heavy rainfall, work onsite would be suspended and resources diverted into inspecting and shoring up silt fences and other defences to prevent silt from getting into the natural watercourses.

3.6.1 Rainwater, Surface Water

Consideration will be given to appropriate storage of materials in wet weather. Also, certain site activities may be assessed as needing to be postponed or suspended during exceptional adverse weather conditions to prevent the risk of polluting watercourses. These rainfall events are defined as forecast:

- >10 mm/hr (i.e. high intensity local rainfall events); or
- >25 mm in a 24 hour period (heavy frontal rainfall lasting most of the day); or
- >half monthly average rainfall in any 7 days.

3.6.2 Chemical, cement and fuel spills

The Main Contractor shall comply with an Environmental Management System certified to EN ISO 14001, and as part of this system, spill plans and emergency telephone numbers will be in place and displayed throughout the site. A specialist company will be available on 24hr call out for major spills. A detailed site-specific emergency spill plan will be available before the start of construction.

Maintenance of all site plant, including engine or gearbox oil changes, will be carried out away from watercourses. All waste oil generated from maintenance will be collected in proprietary waste containers and removed from site for disposal upon completion of the operation.

All static plant will be placed in drip trays.

The likelihood of concrete contaminating a watercourse will be negligible while concreting the turbine bases because they are all sufficient distance away from a watercourse. The use of cut-off ditches and silt fences will ensure cement is not carried away by water run-off.

A concrete wash out bay for ready mix concrete trucks will be constructed at a single location on

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site using a holding tank to collect contaminated water. All ready mix concrete trucks chutes will only be washed out at this location to control pollution from cement laden water. The location of the wash out bay will be chosen to maximise the distance from any watercourse. Our contractor will consult appropriate environmental experts on the location of, and control measures at, the concrete wash out facility and agree the final requirements. The contents of the holding tank will be disposed off site periodically.

Each base excavation will be free of water prior to concrete being placed, therefore the risk of concrete entering ground water and carrying it to adjacent watercourses is stopped at source.

Silt run off will be controlled using settlement ponds, cut off ditches and sealing stockpiles.

As part of the site induction of all operatives, Pollution Prevention Guidelines will be discussed. During the Toolbox Talk prior to concreting, all operatives will be reminded of the importance of avoiding any loss of cement. Special attention will be given to the following guidelines:

PPG01 General guide to the prevention of water pollution, PPG02 Above ground oil storage tanks, PPG05 Works and maintenance in or near water PPG06 Working at construction and demolition sites, PPG07 Refuelling Facilities, PPG08 Safe storage and disposal of used oils, PPG21 Pollution Incident Response Planning, PPG26 Storage and Handling of Drums & Intermediate Bulk Containers.

Prior to any turbine base being poured, potential run off areas from the base excavation to a watercourse will be identified and blocked with a temporary earth bund. If not drained by gravity, any water build up due to rain or from natural sources within the ground will be pumped from the excavation and treated in accordance with *"SuDS".* This will prevent any concrete spillage being diluted and subsequently leaving the vicinity of the base excavation.

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4 Project Structure and Management

The developer will put a structure in place to oversee the delivery of the project. This will include having adequate supervision of the contractors on site during the pre-construction, construction and post construction stages.

The Project Team / Project Organisational Structure and roles are defined for the following:

- Client
- Client's Reps
- Civil Works Contractor (CWC) and designers
- Electrical Contractor with Civil sub-Contractor and designers
- Turbine Supplier
- PSDP
- PSCS
- Environmental Monitoring

4.1 Civil Works Management Structure

The Contractor as the CWC will also act as Project Supervisor Construction Stage (PSCS) for the project. The Contractor will put an experienced construction management team in place. The Project Manager will have overall responsibility for environmental management on the site. The EHS Manager will report to the Project Manager. In turn, EHS Officers will report to the Site EHS Manager. An organogram of the site structure is included as Figure 1 below.

The roles and responsibilities of personnel involved in the construction of Keerglen Wind Farm are outlined in the following sections. These sections also outline the lines of communication between the various parties.

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The roles and responsibilities are indicative and may be amended over the course of the project.

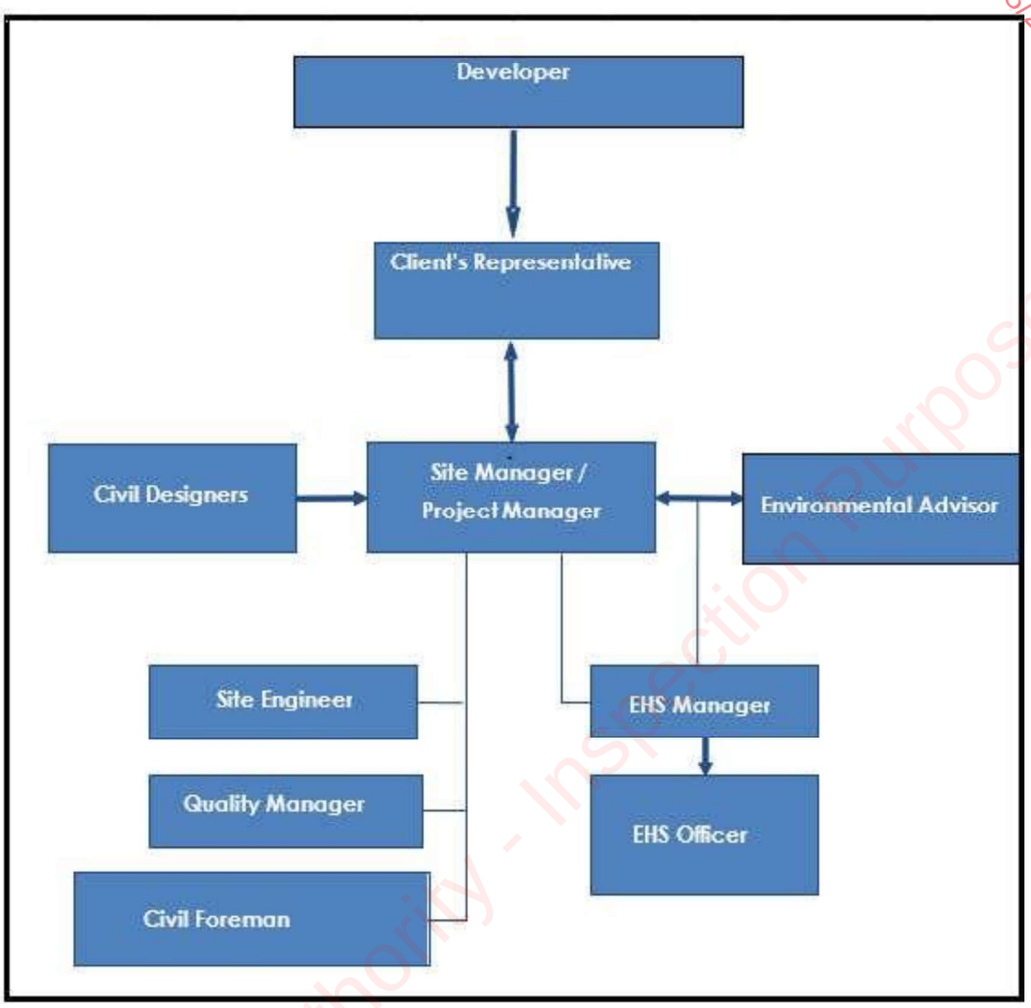


Figure 1 Example Civil Construction Management Structure

4.1.1 Project Manager – The Contractor

The Contractor's Project Manager will report to the Client Project Manager. Their responsibilities are as follows:

- Management of the project;
- The implementation of the Construction and Environmental Management Plan;
- Ensuring that no deterioration of local environment occurs;
- Co-ordinating the construction teams;
- Implementing the Contractor's Health and Safety Plan and associated responsibilities;
- Liaison with the client's representative staff;
- Production of construction programmes; and
- Maintaining a project diary.

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4.1.2 Quality Manager – The Contractor

The Contractor's QA Manager for the Works reports to the Project Manager. They will be responsible for:

- The implementation of the Construction and Environmental Management Plan;
- Management of quality issues relating to the project;
- Co-ordinating the construction teams;
- Ensuring that method statements are in place;
- Implementing the Contractor's Health and Safety Plan; and
- Liaison with the client's representative staff.

4.1.3 Senior Engineers – The Contractor

The Contractor's Senior Technical Engineers report to the Project Manager. They are responsible for:

- Ensuring that all aspects of the project comply with the Construction and Environmental Management Plan;
- Materials procurement;
- Design of Temporary Works;
- Administration;
- Programming and planning;
- Implementing the Contractor's Health and Safety Plan; and
- Maintaining a project diary.

4.1.4 EHS Manager – The Contractor

An EHS Manager will be appointed on a full-time basis to the project. EHS Officers on the site will report to the EHS Manager who will be responsible for:

- Carrying out the duty of Health & Safety Co-ordinator
- Construction Stage;
- Ensuring all personnel onsite receive safety inductions
- Ensuring the Contractor's Health and Safety Plan is implemented
- Investigation of any accidents, incidents, near misses etc.
- Ensuring the Construction Stage Environmental Management Plan is being followed at all times; and

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- Auditing the Site Health & Safety & updating Plan as necessary.

4.1.5 Environmental Advisor

An Environmental Advisor will be assigned as required over the duration of the project. The responsibilities assigned to the environmental advisor include:

- Developing the civil contractor's Construction Environmental Management Plan and updating where necessary;
- Undertaking compliance audits to establish if requirements of the CEMP are being implemented;
- Review and update Method Statements and Risk Assessments on request of site management and;
- Undertaking site audits on an as required basis.

The Environmental Advisor will also act as Environmental Officer, responsible for:

- Implementing the Environmental Requirements of the CEMP and updating it as necessary;
- Management of all environmental aspects of the construction works;
- Ensuring all relevant mitigation measures are implemented as required;
- Site inspections;
- Onsite and Offsite water quality monitoring
- Liaison with the client representative staff; and
- Auditing the construction works from an environmental viewpoint.

4.1.6 Construction Personnel

It is anticipated that between 10 to 15 no. operatives will be employed full-time on site during the construction period. This figure will rise to between 15 and 25 no. operatives during turbine erection.

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5 Reference List

Pollution Prevention Guidelines, namely;

- PPG1: General guide to the prevention of pollution;
- PPG2: Above ground oil storage tanks;
- PPG4: Treatment and disposal of sewage where no foul sewer is available;
- PPG5: Works and maintenance in or near water;
- PPG6: Working at construction and demolition sites;
- PPG8: Safe storage and disposal of used oils;
- PPG13: Vehicle washing and cleaning;
- PPG21: Pollution incident response planning; and
- PPG26: Storage and handling of drums & intermediate bulk containers
- DEFRA Good Practice Guide for Handling Soils (MAFF 2000);
- Control of water pollution from construction sites. Guidance for consultants and contractors (C532) (CIRIA, 2001);
- The SuDS Manual (C697) (CIRIA 2007)
- Culvert design and operation guide (C689) (CIRIA, 2010)
- Environmental good practice on site (C692) (CIRIA, 2010)
- UK Forestry Standard Guidelines -Forests and water (UK Forestry Commission 2011),
- Forest & Water Guidelines" 5th Edition, "Good practice during wind farm construction", SEPA, October 2010

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Appendix 3.2

Cable Route Construction Methodology

Keerglen Wind Farm

Support Document to Planning Application

August 2024

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UNDERGROUND ELECTRICITY EXPORT CONNECTION

CABLE ROUTE CONSTRUCTION METHODOLOGY



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Document History

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INTRODUCTION

This outline document presents the overall construction methodology for 38kV cable routes including bridge crossings, stream crossings, directional drilling and trenching along roads and open country. Each of the above are addressed separately below in the following sections and indicative drawings are included within the appendices.

The methods are indicative and generic in nature and may require modification to suit specific situations.

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1. CABLE ROUTE BRIDGE CROSSINGS

This outline document presents the overall methodology for bridge crossing works along cable routes. Initial assessments of bridges will involve a complete survey of the structural dimensions to estimate the available depth below the road surface, and may in some cases involve trial pits, slit trenches, cores or geophysical surveys to confirm the depth to the deck slab or the crown of the arch, depending on the type of structure.

The methodology below relates to structures where there was sufficient depth of cover in the road or roadside verge at a given bridge crossing to take the 38kV cable ducting. Where possible the 38kV cable ducting should be installed in the roadside verge across the bridge, or within the road itself where there is no verge or the verge is too narrow. If there is a risk to the stabililty of the parapet or spandrel walls it may be more appropriate to place the trench towards the centre of the lane or the road itself, maintaining a greater separation distance from the parapets.

If the scenario above is not possible, ie. where there is insufficient depth within the roadbase, then an alternative method may be required such as directional drilling below the entire bridge and river, or by diverting the cable route to cross the stream directly between river banks. These are discussed in detail in Sections 2 and 3. In certain scenarios where insufficient depth is available it may be possible to create a raised verge to encase the cables within galvanised steel plates and concrete. A less preferred option may be to attach the cables externally along the spandrel wall.

A sample drawing is contained in Appendix A for a typical bridge crossing.

This outline method statement should be further developed by the contractor prior to construction stage to provide site specific procedures for each bridge crossing. It may be necessary to provide a detailed method statement and risk assessment to the relevant County Council and also Inland Fisheries Ireland (IFI) prior to commencement of construction at river bridge crossings.

1.1 Programme

It is estimated that the bridge crossing at each location will take one or two days to complete, depending on the scale of the bridge.

1.2 Methodology

Prior to the commencement of any works all construction workers will be given site specific tool box talks, addressing the environmental risks and mitigation measures required at each bridge crossing. The Environmental Clerk of Works shall ensure all mitigation requirements are followed.

The bridge ducting works should be carried out in a manner that does not impact on the local ecology. The impacts for this type of crossing should be limited to the construction phase which is short term, typically carried out over 1-2 days at a given bridge, and very localised without any impacts on the river below provided the appropriate environmental measures below are adhered to.

A constraints zone will be identified and implemented at each crossing location. The purpose of the constraint zone is to:

- avoid physical damage to surface water channels;
- provide a buffer against hydraulic loading by additional surface water run-off;
- avoid the entry of suspended sediment and associated nutrients into surface waters from excavation and earthworks;
- prevent any leaching of construction materials through the bridge structure into the waterway below;
- provide a buffer against direct pollution of surface waters by pollutants such as hydrocarbons from construction plant materials used during construction and chemicals or waste associated with temporary on–site sanitary facilities, or concrete leachate;

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Detailed cross sections of the 38kV cable design at each bridge crossing should be prepared in advance of construction. These site specific details will then be used by the building contractor to create the detailed construction method statement and risk assessment.

Inland Fisheries Ireland (IFI) should be notified as to the exact date the proposed crossings will take place, a detailed method statement with specific crossing details will be provided to the relevant county council and the IFI by the appointed contractor. The appointed contractor shall demonstrate evidence of competence in comparable works undertaken successfully in previous similar environmentally sensitive bridge crossings.

A comprehensive traffic management plan shall be provided by the building contractor and approved by the local authority. The following documentation may also be provided in Special Areas of Conservation (SAC) and used in conjunction with the construction method statements:

- site specific Construction Environmental Management Plan (CEMP) to be drawn up in conjunction with the project's Ecologist or Civil/Environmental Engineer both familiar with the site and the SAC;
- provide an Invasive Species Management Plan (ISMP) where deemed necessary - to be drawn up in conjunction with the project's Ecologist or Civil/Environmental Engineer both familiar with the site and the SAC.

Special provision should be made in the event that culturally significant or protected structures are being crossed. The arches, spandrels and parapets should not be impacted or damaged during trenching works. Where there is a potential risk of destabilising the parapet or spandrel walls during trenching the depth and/or position of the trench should be modified to minimise any potential impacts. Where a protected structure is being crossed the clearance between the trench and the crown of the arch barrel should be maximised by adopting a shallower trench option. It may be necessary to carry out a pre-condition survey and to assess the bridge during and after works to ensure no cracking or damage has occurred. Tell-tale crack monitors may also be used on stone arches where deemed necessary.

1.3 General Bridge Crossing Method

The cable route bridge crossing trench works will not require works instream works. The mitigation measures below will ensure the protection of the watercourse below.

- No works will be undertaken in the river corridor, or on the banks of the river;
- All works to be planned in line with weather conditions. No works to be undertaken in heavy rain conditions.
- All trenching works will be undertaken using a cut and fill procedure, to ensure that only short sections of the trench are open, all trenching works will be covered during wet weather conditions to prevent surface water entering the trenching works.
- No stockpiling of excavated materials will be permitted within the constraint zone.
- Any excess construction material shall be immediately removed from the area and disposed of in a fully licenced landfill. No stockpiling of imported materials will be permitted in the constraint zone.
- Spill kits shall be available in each item of plant required to complete the bridge crossings. Refuelling will be undertaken >50m from any watercourse and isolated from surface water drains, spill kits will be available on each item of plant. A spill mat will be used by the fuel tanker while refuelling. The fuel bowser will have an automatic cut out.
- The cable ducting bridge crossing design should be undertaken by a qualified civil engineer in communication with the Electricity Supply Board Networks (ESBN) and the relevant county council roads engineer.
- The ducting will be placed in the bridge as per the specific cable design drawings.
- The footprint of the works will be kept to a minimum.

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- Works will be carried out between 08.00 and 20.00 hours, no working in the dark where artificial lighting is required will be permitted.
- Machinery is to be cleaned down prior to arriving on site, to prevent invasive species being brought into the working areas by loose material from previous sites that may be lodged on the machinery.
- A full traffic management plan will be designed by the building contractor and approved by the relevant county council.
- Tool box talks will be undertaken with all site staff by the building contractor which encompasses all of the CEMP and ISMP documents that may apply.
- Detailed method statement regarding the ducting works will be provided by the building contractor. The construction method statement will be reviewed by the project's Ecologist or Civil/Environmental Engineer where necessary, both should be familiar with the site and where applicable the SAC.
- The method statement will include for the placement of a sealed silt fence at both sides of the bridge crossing point and to a minimum of 10m upstream and downstream of each crossing on both sides of the road. This will divert water and runoff from the road into silt traps at each corner of the road. The size and design of these silt traps will vary and be suited to local conditions. The silt traps and sealed silt fence will be installed prior to any construction works commencing at each bridge crossing.
- An assessment of all areas of natural drainage from the area of works will be carried out, and silt traps will be put in place to prevent any material draining from the trenching works into the river corridor.
- The method statement and risk assessment will also take the National Roads Authority's "Guidelines on Management of Noxious Weeds and Non-Native Plant Species on National Roads" into account.
- Following the trench excavation, ducts will be installed and surrounded with concrete. The placement of the concrete will be controlled in such a manner as to prevent any concrete entering the stream. A Terram liner will be used underneath the ducting and concrete to prevent any cementitious leachate permeating through the bridge structure.
- A dry or semi-dry concrete mix will be used as a secondary precaution to prevent leachate through the bridge structure, the concrete will initially set within 2 hours and will continue to gain strength for the normal concrete curing period of 28 days.
- Concrete trucks will washout at the concrete manufacturing plants to prevent any concrete entering the waterways at the bridge crossings.
- Cable markers will be placed above the cable ducts as per the ESB requirements.
- Upon completion of works at each bridge crossing, the site shall be cleaned and any waste will be disposed of at a licenced facility.

1.4 Monitoring

This preliminary method statement has been developed to guide all works in line with the Inland Fisheries Ireland SAC requirements. The information for site specific method statements should be gathered on a site walkover and any additional features should be noted and site specific measures adopted. This should be carried out by a qualified civil/environmental engineer, and in some circumstances and in SACs it may be necessary to carry this out in conjunction with Inland Fisheries Ireland and an ecologist.

- All bridge crossing works undertaken, including preparatory works, will be carried out under supervision of an Environmental Clerk of Works.

- The construction method statements will be reviewed, if necessary, in consultation with the Inland Fisheries Ireland and the National Parks and Wildlife Service prior to works commencing. A final detailed construction method statement will be developed by the building contractor engaged to complete each bridge crossing.

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- The silt traps and sealed silt fences will be monitored to ensure they are working as planned.
- All identified pathways from the roadside/bridge to the river will be monitored to ensure no leakage to the waterway below.
- The underside of the bridge will be monitored to ensure no leachate from construction materials permeates through the bridge structure into the waterway below.
- Weather will be monitored. Works to be carried out during normal water levels. Work will be planned with consideration for the projected weather conditions, and will be carried out in dry weather, insofar as is possible. Met Eireann will be consulted for the 5 day forecast in advance of works.
- All machinery will be inspected routinely to ensure there is no leakage of hydrocarbons or concrete.

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2. ONSITE CABLE ROUTE DRAIN/DITCH CROSSINGS

This outline document presents the overall method to be adopted for onsite cable route drain/ditch crossing works. A map indicating the location of drain/ditch crossings should be provided, including coordinates of the proposed crossing points. A detailed site specific method statement and risk assessment shall be prepared by the contracted party for each drain/ditch crossing and made available to all stakeholders prior to commencement of construction.

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2.1 Programme

It is estimated that the drain/ditch crossing at each location will take one day to complete and in general should be carried out within the period of May to September inclusive, and during a period of low rainfall intensity, unless agreed otherwise with an ecologist and Inland Fisheries Ireland.

2.2 Methodology

Prior to the commencement of any works at the drain/ditch crossing locations all construction workers will be given a site specific tool box talk, addressing the environmental risks and mitigation measures required at each drain/ditch crossing. The Environmental Clerk of Works shall ensure all mitigation requirements are followed.

A constraints zone will be identified and implemented at each crossing location. The purpose of the constraint zone is to:

a) avoid physical damage to surface water channels;
b) provide a buffer against hydraulic loading by additional surface water run-off;
c) avoid the entry of suspended sediment and associated nutrients into surface waters from excavation and earthworks;
d) provide a buffer against direct pollution of surface waters by pollutants such as hydrocarbons from construction plant materials used during construction and chemicals or waste associated with temporary on–site sanitary facilities;
e) identify any invasive species in line with Invasive Species Ireland, prevent the spread of invasive species throughout the works carried at each drain/ditch crossing. http://invasivespeciesireland.com/, www.noticenature.ie/construction.html
f) identify any vulnerable aquatic species and work with a suitably qualified Ecologist to reduce the impact at each of the drain/ditch crossings.

In the event that hogweed is identified at a drain/ditch crossing location the following control measures are detailed on the NRA website for the control of such invasive species:

- "*The control of giant hogweed should aim to eradicate the plant entirely or at minimum, prevent the plant from producing seed. As seed may remain viable for 15 years, control will require continued input over several years to be complete. Soil within 4m of established plants is likely to contain vast numbers of seed from previous years flowering and should not transferred to other parts of asite unless as part of a control measure. The majority of seeds however, are contained within the top 5cm of soil and will only persist for 1–2 years (Booy & Wade 2007)*" Never stockpile potentially Hogweed polluted material within 10 metres of a watercourse.

  The Hogweed will be eradicated prior to the works commencing to reduce the risk of contamination on the removal of soil from site or to the additional drain/ditch crossing locations.

  Digging and Spraying is a quick method of removing Giant Hogweed and involves the clearing of above ground leaf/stem material together with the removal of ground material polluted with roots and seeds. Due to the risk of contact with sap from this plant, removal by hand should be restricted and not considered once the plant has grown above 1 metre in height. A risk assessment will be prepared for any works to remove, cut or work in the vicinity of Giant Hogweed. It is vital to minimise the potential

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for workers' skin to come into contact with plants of this species and particularly any sap produced. Measures to reduce the risk of any cutting and removal works should include, but are not limited to:

- *The establishment of an exclusion zone around any Giant Hogweed plants identified on site and around any cutting/removal works. Only personnel involved with the removal of this species should be permitted entry to this exclusion zone.*
- *Risks associated with this species should be outlined to employees prior to work commencing.*
- *The use of full wet weather clothing with gloves and face visor or similar to undertake any cutting or removal of this species.*
- *The provision of washing facilities and eyewash for operatives involved with this operation.*
- *The majority of seeds that are produced fall to ground within four metres of the parent plant.*
- *This area should be considered as polluted and be removed. Even with great care, a certain number of seeds may remain. A watching brief is advised after polluted ground material has been removed for any re-growth.*

*Polluted material should be removed from the site for disposa*l through a registered waste company and will not be used for infilling any areas. *Any bags/skips containing Giant Hogweed or polluted soil leaving the site should be covered to avoid spread along public highways. Waste Transfer documentation will be required for any polluted material leaving the site.*

Check with the disposal site in advance that they can receive material containing incidental contamination with Giant Hogweed. Disposal sites may require notice to allow an area to be prepared for this material away from the landfill liner.

Mitigation measures to reduce the impacts of the release of suspended sediment and associated nutrients during earthworks and removal of vegetation cover.

a) Works are generally to be carried out during the period May to September inclusive, avoiding the salmonid closed season specified by Inland Fisheries Ireland if this applies at a given drain/ditch, and coinciding with the lowest expected rainfall, and therefore minimum run-off rates;
b) All machinery to be cleaned down prior to starting works at each drain/ditch crossing location and to prevent the carrying of invasive plant species to each of the drain/ditch crossing locations.
c) Protection of the riparian zone watercourses by implementing a constraints zone around drain/ditch crossings, in which construction activity will be limited to the minimum, i.e. works solely in connection with duct laying at the drain/ditch crossing. No stock-piling of construction materials will take place within the constraints zone. No refuelling of machinery or overnight parking of machinery is permitted in this area. No concrete truck chute cleaning is permitted in this area, the constraints zone will be stipulated by the building contractor and reviewed by the Environmental Clerk of Works;
d) Works shall not take place at periods of high rainfall, and shall be scaled back or suspended if heavy rain is forecast;
e) Plant will travel slowly across bare ground at a maximum of 5kph. Bog mats will be employed to protect tracked areas as necessary. Machinery shall be prohibited from crossing the drain/ditchs at these locations. Machinery deliveries shall be arranged using existing structures along the public road. All machinery operations shall take place from the drain/ditch bank.
f) Any excess construction material shall be immediately removed from the area and disposed of in a fully licenced landfill. No stockpiling of materials will be permitted in the constraint zones;
g) Spill kits shall be available in each item of plant required to complete the drain/ditch crossing. Refuelling will be undertaken >50m from any water course and isolated from surface water drains, spill kits will be available on each item of plant. A spill mat will be used by the fuel tanker while refuelling. The fuel bowser will have an automatic cut out.
h) Machinery will be washed down of all foreign material as part of the invasive species prevention protocol. If hogweed is identified at any drain/ditch crossing the machinery should also be cleaned down in a suitable area identified for this purpose to prevent carrying the hogweed to further

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locations. All clay removed from the plant at this site should be disposed of to a licenced waste company, with details of the hogweed contamination provided to the disposal company in advance. Contaminated soils should be treated carefully. Ensure soil within 4m of the plants is not transferred to another area and clean uncontaminated tracked machinery and equipment is used at infested sites.

i) Trees to be cut back in the winter period to prevent excessive foliage entering the drain/ditchs, and to improve access for the machinery during the drain/ditch crossing works. Note that the bird breeding season is from 1st of March to the 31st of September so clearing back of hedgerows and trees to be avoided during this period. If unavoidable such works should not be carried out without the approval of an ecologist.

Specific Objectives and Methods:
Installation of 38kV ESB ducting within a trench 1.25 m deep by 0.60m wide at drain/ditch crossing points.

The Inland Fisheries Board will be notified as to the exact date the crossings will take place. A detailed site specific method statement, which will include the mitigation measures outlined in this report, will be provided to the Inland Fisheries Board by the appointed contractor. The appointed contractor shall demonstrate evidence of competence in comparable works undertaken successfully in previous similar environmentally sensitive drain/ditch crossings.

2.3 General Drain/ditch Excavation Method (partial or full width)

- A qualified ecologist shall be engaged to translocate fish where necessary. These requirements are to be established during a site walkover by an appointed ecologist and Inland Fisheries Ireland prior to method statements being prepared. A further review of drain/ditch crossings may be required prior to any in-drain/ditch works to ascertain if translocation of fish is required.
- The footprint of the works is to be kept to a minimum.
- Works to be carried out during normal water levels, plan work with considerations for weather and work in the dry insofar as is possible. Consult Met Eireann for the 5 day forecast in advance of works.
- Works will be carried out between 8.00 and 20.00 hours, no night working will be permitted.
- Machinery is to be cleaned down prior to site mobilisation and on the mobilisation to each drain/ditch crossing location.
- Two possible methods can be adopted, one by partially sandbagging on one half allowing works to be carried out in stages without impacting fully on the entire drain/ditch, and another involving sandbagging across an entire drain/ditch and pumping or diverting beyond to an outflow point immediately downstream.
- Where a complete drain/ditch crossing is not constructible in full from one drain/ditch bank partial sandbagging shall be adopted. Sand bags should be placed to form an upstream bund in order to facilitate excavation on one half of the drain/ditch. Up to 1t of well-sealed sand bags may be required for typical drain/ditch crossings. Particular care will be taken placing these sand bag walls to ensure minimal water ingress into the area of work. The works continue on one half of the drain/ditch until the first section is complete, then sand bags should be adjusted and realigned to allow work on the second half of the drain/ditch. The same procedure will be used to complete the crossing, working from the opposite drain/ditch bank.
- Where full sandbagging of a drain/ditch is carried out either over-pumping or a diversion channel will be required.
- Where over-pumping is to be employed to bypass the area of works all outflow to be onto a flat-plate to prevent erosion of the receiving body.
- The least invasive method is to create a temporary diversion channel. This may be specified at certain crossings by Inland Fisheries.
- A sump hole will be excavated on the upstream side of the duct line to remove any water that penetrates the bund. Water taken from this sump will be pumped via a silt trap and allowed to dissipate over adjacent grassland, i.e. this water will not be allowed to flow directly into drainage channels entering the drain/ditch without first flowing through a silt trap;

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- Following trench excavation the ducts will be installed and surrounded with 20N concrete to within 0.30m of the original drain/ditch bed level. The placement of the concrete will be controlled in such a manner as to prevent any concrete entering the drain/ditch. 20kg sand bags will be placed on top of the placed concrete to further protect from any seepage water that penetrates the bund;
- Concrete trucks will washout at the concrete plants to prevent any concrete entering the waterways on site.
- A depth of 0.30m of river gravel will be placed above the crossing location and reinstated to its original level, medium sized rocks and stone will also be placed to prevent any scouring.
- All sand bags and equipment will be removed from the vicinity of the drain/ditch bank immediately following completion.
- Where necessary the drain/ditch bank at each side will be reinstated using rocks/boulders (rock armour) to prevent any future erosion, local rocks and boulders and gravel excavated during the works should be used where possible;
- Cable markers posts shall be placed at each drain/ditch bank to identify the location of the cable crossing.

2.4 Monitoring

All drain/ditch crossing works undertaken including preparatory works will be carried out under supervision of an Environmental Clerk of Works.

Upon completion of works at each drain/ditch crossing the site shall be properly cleaned and any waste disposed of to a licenced facility.

Replanting of the riparian zones with local native plants should be carried out as required.

The construction method statements will be reviewed, if necessary, in consultation with the Inland Fisheries Ireland and the National Parks and Wildlife Service prior to works commencing. A final detailed construction method statement will be developed by the building contractor engaged to complete each drain/ditch crossing.

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3. CABLE ROUTE DIRECTIONAL DRILLING

This outline method statement presents directional drilling methods to be utilised for cable route stream crossings. This outline method statement shall be further developed by the contracted entity carrying out the works.

A detailed method statement and risk assessment by the contracted party shall be made available prior to commencement of construction at the stream crossings.

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3.1 Programme

It is estimated that the stream crossing at each location will take two days to complete and will preferably be carried out during drier periods.

3.2 Methodology

The stream crossing points should be clearly identified on drawings including coordinates of drilling pits. Prior to the commencement of any works at these locations, all construction workers will be given a tool box talk addressing the environmental risks and mitigation measures.

Where the works are within a Natura 2000 site the exact location for launch and reception pits will be examined beforehand by an ecologist to ensure sensitive habitats adjoining the river are avoided.

A constraints zone will be identified and implemented at each crossing location. The purpose of the constraint zone is to:
a) avoid physical damage to surface water channels;
b) provide a buffer against hydraulic loading by additional surface water run-off;
c) avoid the entry of suspended sediment and associated nutrients into surface waters from excavation and earthworks;
d) provide a buffer against direct pollution of surface waters by pollutants such as hydrocarbons from construction plant materials used during construction and chemicals or waste associated with temporary on–site sanitary facilities;

Mitigation measures to reduce the impacts of the release of suspended sediment and associated nutrients during earthworks and removal of vegetation cover.
a) Protection of the riparian zone watercourses by implementing a constraints zone around stream crossings, in which construction activity will be limited to the minimum, i.e. works solely in connection with duct laying at the stream crossing. No stock-piling of construction materials will take place within the constraints zone. No refuelling of machinery or overnight parking of machinery is permitted in this area. No concrete truck chute cleaning is permitted in this area;
b) Works shall not take place at periods of high rainfall, and shall be scaled back or suspended if heavy rain is forecast;
c) Plant will travel slowly across bare ground at a maximum of 5km/hr. Bog mats will be employed to protect tracked areas as necessary. Machinery shall be prohibited from crossing the streams at these locations. Machinery deliveries shall be arranged using existing structures along the public road. All machinery operations shall take place from the stream bank.
d) Any excess construction material shall be immediately removed from the area and disposed of in a fully licenced landfill. No stockpiling of materials will be permitted in the constraint zones.
e) Spill kits shall be available in each item of plant required to complete the stream crossing;
f) Silt fencing will be erected at a setback distance of 5m from the reception and launch pits used for directional drilling.

Mitigation Measures relating to the use of bentonite:
a) The area around the bentonite batching, pumping and recycling plants shall be bunded using terram and sandbags in order to contain any spillages;
b) One or more lines of silt fences shall be placed between the works area and adjacent rivers and streams on both banks;

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c) Spills of bentonite shall be cleaned up immediately and transported off site for disposal at a licensed facility;
d) Adequately sized skips to be used where temporary storage of arising is required;
e) A geotechnical assessment shall be carried out prior to directional drilling, in particular where drilling is carried out through fissured or fractured rock or other geological formations where there is a risk of bentonite blow-out occurring. Directional drilling shall only be carried out where conditions are suitable, thereby minimising the risk of bentonite breaking out into a stream or river. If necessary the depth of the bore should be increased to maintain a greater clearance from the river bed;
f) The drilling process shall be constantly monitored to detect any possible breakout or leaking of bentonite into the surrounding geology. This can be gauged by observation and by monitoring pumping rates and pressures. If any of signs of breakout appear then drilling and bentonite pumping should be stopped immediately and a higher viscosity bentonite mix used. If the problem remains then an alternative crossing alignment or an alternative crossing method should be considered.

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3.3 Directional Drilling Process

- Reception and Launch pits for the directional drilling process shall be excavated 20m from the stream banks.
- Excavated material shall be stored a minimum of 20m from the stream bank. Silt fences shall be placed downslope of the excavated stockpiles as an environmental protection measure.
- To avoid reception and launch pits being open for longer than is absolutely necessary, all HDPE ducting required is to be available on site prior to commencement of pit excavation.
- A bore plan is to be included in the final method statement prepared by the contracted entity carrying out the works. This shall include proposed depths of the borehead, which is to be continuously monitored by an operative using a depth tracker during pilot boring;
- On completion of the pilot bore through to the reception pit, the drill head is removed and the reamer is then pulled through the bore with the HDPE ducts attached.
- Marker posts will be placed at each side of the stream identifying the location of the crossing;
- Ducting works outside of the 20m buffer zone shall proceed in accordance with the ESB specification.

3.4 Monitoring

All stream crossing works undertaken including preparatory works will be carried out under supervision of a suitably qualified Environmental Engineer.

Upon completion of works at each directional drilled stream crossing the site shall be properly cleaned and any waste disposed of to a licenced facility.

Replanting of the riparian zones with local native plants should be carried out as required at drilling pit locations.

The construction method statements will be reviewed, if necessary, in consultation with the Inland Fisheries Ireland and the National Parks and Wildlife Service prior to works commencing. A final detailed construction method statement will be developed by the building contractor engaged to perform the directional drilling.

Stream crossing works within a Natura 2000 site will be monitored by an ecologist.

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4. CABLE ROUTE ALONG ROADS

This section presents the construction methodology relating to cable trenching works along roads or road verges. This is not a substitute for a contractor's construction method statement and risk assessment but provides an outline guide.

The initial process requires a site inspection and survey of the route, coupled with separate utility searches to identify any existing services. Detailed layout drawings should be provided along the route indicating the locations of any services that may exist, if any. Drawings provided by utilities such as water, electricity and telecom should be taken as indicative, with precise locations identified on site by visual inspection and by the use of scanners. Hand dug trial holes or slit trenches can also be carried out to confirm service locations. A safe buffer should be provided to existing services, particularly where there is uncertainty of precise locations. Minimum clearances to existing services are provided by the various utilities, this varies from a minimum of 0.3m to 1.0m.

The 38kV cable ducting will be installed either directly within the road or in the roadside verge. This will depend primarily on the available verge width and the nature of the road and adjoining terrain. In some instances it may not be permitted to excavate trenches within the verge if there is a perceived risk that the edge of the road may be destabilised. This is a particular risk on raised embankments. In such scenarios it may be preferable to excavate a trench within the middle of the lane, or the middle of the roadway. Or additional stabilising measures may be required to reinforce the verge and edge of the road.

This outline methodology should be further developed to provide site specific procedures for each location and a detailed method statement and risk assessment should be provided by the contracted party prior to commencement of trenching and duct laying works.

Prior to works commencing the following will generally be required:

- Road opening licence from the local authority;
- Traffic management plan to be prepared by the Contractor;
- Inspection by county council roads engineer;
- Inspection by ESB.

4.1 Methodology

At the beginning of the construction phase the contractor will be required to implement the traffic management plan, including setting out of signage in accordance with Chapter 8 of the Traffic Signs Manual.

Excavation should be carried out with due regard to Health and Safety Regulations including the HSA Code of Practice for Avoiding Danger from Underground Services.

Trench dimensions shall be sufficient to allow the cable installer to install the ducts and cables at the depth and spacing specified, and within the bend radii specified. The inside of a bend may require strengthening in some cases to avoid duct displacement during cable pulling.

Power ducts to be placed typically within a 1.2m deep and 0.6m wide trench with a minimum cover of 0.95m from top of trefoil group of ducts. ESB comms ducts to be placed with a minimum cover of 0.75m.

Red cable protection strips ESB Code 2995103 are to be placed above each set of ducts, and a yellow warning tape ESB Code 2955092 placed above this again within the backfill material approximately 0.3m below finished surface level, as outlined below. Refer to typical trench details in Appendix D.

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4.2 General Trenching Method

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The cable route trenching sequence and mitigation measures are presented below.

- All trenching works will be undertaken using a cut and fill procedure, to ensure that only short sections of the trench are open, all trenching works will be covered during wet weather conditions to prevent surface water entering the trenching works.
- The cable ducting design should be undertaken by a qualified civil engineer in communication with the Electricity Supply Board Networks (ESBN).
- The ducting shall be placed in the trench as per the specific cable design drawings, generally following the sequence outlined below.
- The footprint of the works will be kept to a minimum.
- Works will be carried out between 08.00 and 20.00 hours, no working in the dark where artificial lighting is required will be permitted.
- Tool box talks will be undertaken with all site staff by the building contractor which encompasses all of the CEMP and ISMP documents that may apply.
- Detailed method statement regarding the ducting works will be provided by the building contractor. The construction method statement will be reviewed by the project's Ecologist or Civil/Environmental Engineer where necessary, both should be familiar with the project.
- An assessment of all areas of natural drainage from the area of works will be carried out, and measures put in place to prevent any material draining from the trenching works into adjacent drainage ditches or streams. Spill kits shall be available during trenching. A spill mat will be used by the fuel tanker while refuelling. The fuel bowser will have an automatic cut out.
- Following the trench excavation, ducts will be installed and surrounded with concrete. The placement of the concrete will be controlled in such a manner as to prevent any concrete entering adjacent drainage ditches or streams.
- Upon completion of trenching works the site shall be cleaned and any waste will be disposed of at a licenced facility.

The general trench installation sequence is as follows:

- Excavate the trench to the required dimensions, typically 1.2m deep and 0.6m wide;
- Place a level 65mm blinding layer with semi-dry leanmix concrete at the base of the trench;
- Place and joint the cable trefoil 110mm HDPE power ducts using cable ties at 3m intervals;
- Lay in and compact a 300mm layer of leanmix concrete CBM4 around and above ducts;
- Place an additional 90mm of CBM4 and install the 400mm wide red marker strips above the duct positions;
- Install a single 110mm HPDE comms cable duct, or two where required spaced a clear 200mm apart using appropriate spacers;
- Lay in and compact an additional 185mm of CBM4, and place another 400mm wide red marker strip above;
- Final backfill layer to include a 500mm wide yellow warning tape 300mm below the finished surface.

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5. CABLE ROUTE OPEN COUNTRY

This section presents the construction methodology relating to cable trenching across fields and open country. This is not a substitute for a contractor's construction method statement and risk assessment but provides an outline guide.

The initial process requires a site inspection and survey of the route. Although less likely in fields and open countryside the presence of any other services should be determined. Drawings provided by utilities such as water, electricity and telecom should be taken as indicative, with precise locations identified on site by visual inspection and by the use of scanners. Hand dug trial holes or slit trenches can also be carried out to confirm service locations. A safe buffer should be provided to existing services, particularly where there is uncertainty of precise locations. Minimum clearances to existing services are provided by the various utilities, this varies from a minimum of 0.3m to 1.0m.

The 38kV cable ducting will be installed within 1.2m deep trenches. The outline methodology below should be further developed to provide site specific procedures for each location and a detailed method statement and risk assessment should be provided by the contracted party prior to commencement of trenching and duct laying works.

5.1 Methodology

Excavation should be carried out with due regard to Health and Safety Regulations including the HSA Code of Practice for Avoiding Danger from Underground Services.

Trench dimensions shall be sufficient to allow the cable installer to install the ducts and cables at the depth and spacing specified, and within the bend radii specified. The inside of a bend may require strengthening in some cases to avoid duct displacement during cable pulling.

Power ducts to be placed typically within a 1.2m deep and 0.6m wide trench with a minimum cover of 0.95m from top of trefoil group of ducts. ESB comms ducts to be placed with a minimum cover of 0.75m.

Red cable protection strips ESB Code 2995103 are to be placed above each set of ducts, and a yellow warning tape ESB Code 2955092 placed above this again within the backfill material approximately 0.3m below finished surface level, as outlined below. Refer to Appendix D for typical trench details.

5.2 General Trenching Method

The cable route trenching sequence and mitigation measures are presented below.

- All trenching works will be undertaken using a cut and fill procedure, to ensure that only short sections of the trench are open, all trenching works will be covered during wet weather conditions to prevent surface water entering the trenching works.
- The cable ducting design should be undertaken by a qualified civil engineer in communication with the Electricity Supply Board Networks (ESBN).
- The ducting shall be placed in the trench as per the specific cable design drawings, generally following the sequence outlined below.
- The footprint of the works will be kept to a minimum.
- Works will be carried out between 08.00 and 20.00 hours, no working in the dark where artificial lighting is required will be permitted.
- Where topsoil is removed it should be stored separately for reinstatement later. Grass should be reinstated by either seeding or by replacing grass turves.
- Tool box talks will be undertaken with all site staff by the building contractor which encompasses all of the CEMP and ISMP documents that may apply.

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- Detailed method statement regarding the ducting works will be provided by the building contractor. The construction method statement will be reviewed by the project's Ecologist or Civil/Environmental Engineer where necessary, both should be familiar with the project.
- An assessment of all areas of natural drainage from the area of works will be carried out, and measures put in place to prevent any material draining from the trenching works into adjacent drainage ditches or streams. Spill kits shall be available during trenching. A spill-mat will be used by the fuel tanker while refuelling. The fuel bowser will have an automatic cut out.
- Following the trench excavation, ducts will generally be installed and surrounded with concrete. The placement of the concrete will be controlled in such a manner as to prevent any concrete entering adjacent drainage ditches or streams.
- Upon completion of trenching works the site shall be cleaned and any waste will be disposed of at a licenced facility.

The general trench installation sequence is as follows:

- Excavate the trench to the required dimensions, typically 1.2m deep and 0.6m wide;
- Place a level 65mm blinding layer with semi-dry leanmix concrete at the base of the trench;
- Place and joint the cable trefoil 110mm HDPE power ducts using cable ties at 3m intervals;
- Lay in and compact a 300mm layer of leanmix concrete CBM4 around and above ducts;
- Place an additional 90mm of CBM4 and install the 400mm wide red marker strips above the duct positions;
- Install a single 110mm HPDE comms cable duct, or two where required spaced a clear 200mm apart using appropriate spacers;
- Lay in and compact an additional 185mm of CBM4, and place another 400mm wide red marker strip above;
- Final backfill layer to include a 500mm wide yellow warning tape 300mm below the finished surface.

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Relevant Standards and Guidelines

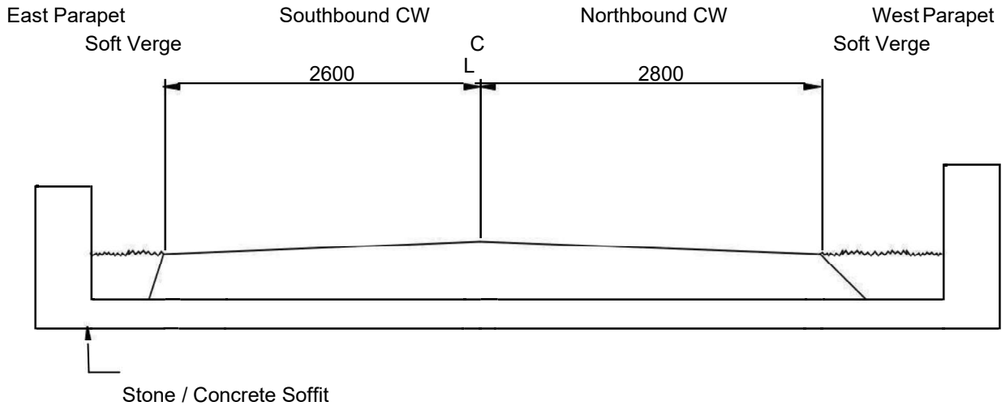
- HSA Code of Practice for Avoiding Danger from Underground Services
- ESBN Specification for the Installation of Ducts and Structurs for Underground 38kV Power Cables and Communication Cables
- DTTAS Traffic Signs Manual 2010 Chapter 8: Temporary Traffic Measures and Signs for Roadworks
- NRA Specification for Road Works
- Safety, Health and Welfare at Work Regulations
- Inland Fisheries Ireland Guidelines on Invasive Species

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APPENDIX A – CABLE ROUTE BRIDGE CROSSINGS

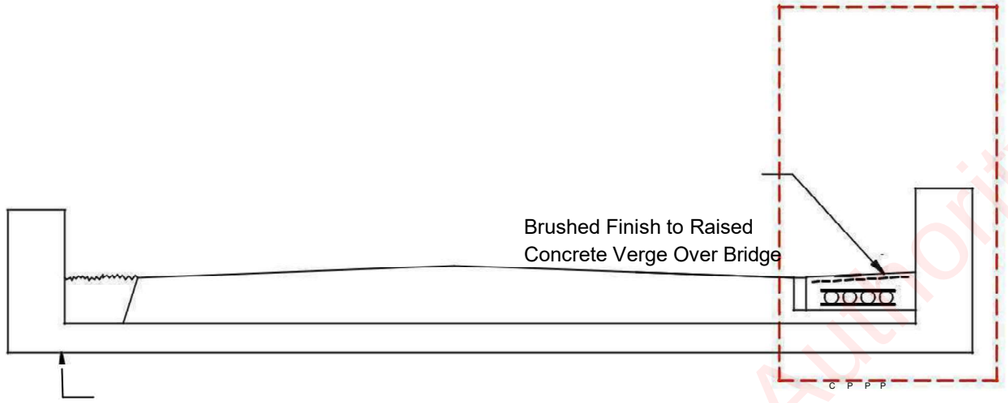
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TYPICAL SECTION THROUGH BRIDGE

Scale 1:50



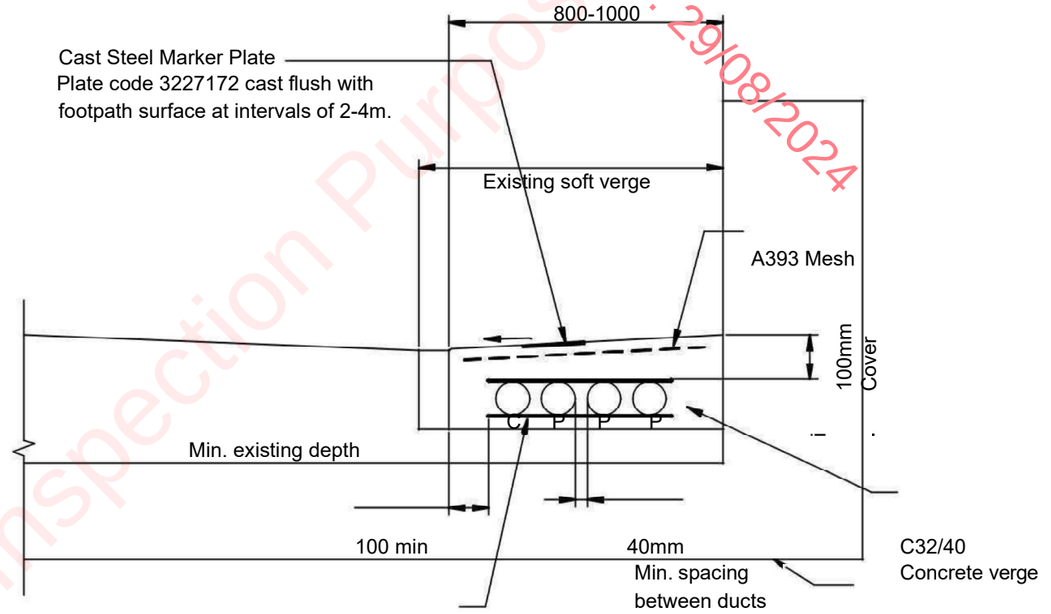
PROPOSED SECTION THROUGH BRIDGE

Scale 1:50

NOTES

1. Refer to relevant bridge location drawings
2. All dimensions are in mm
3. Ducting to be in accordance with ESBN Specification for the Installation of Ducts and Structures for Underground 38kV Power Cables and Communications Cables.

steel plates (ESB code 3227173) directly over each duct. 6mm galvanised steel plate to be provided under ducts over the length of the bridge spans.



DETAIL A

Scale 1:20

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PROJECT

38kV CABLE ROUTE

TITLE

BRIDGE CROSSING DETAIL

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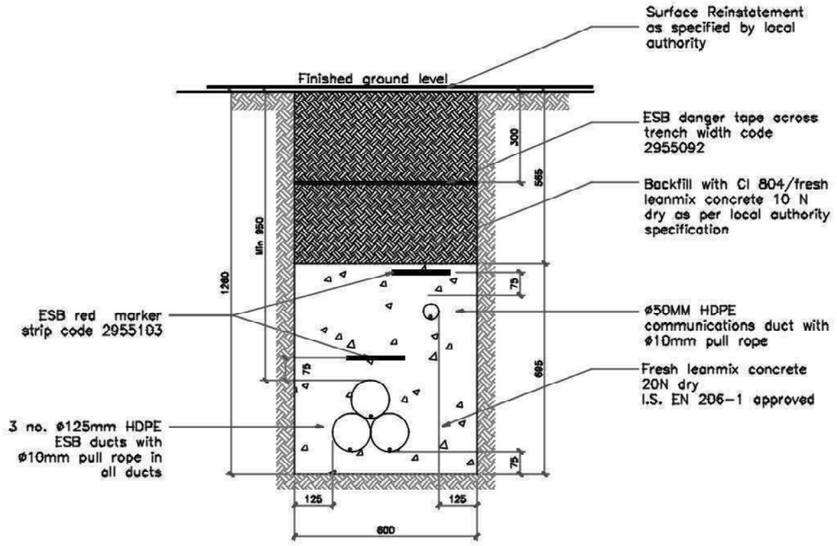
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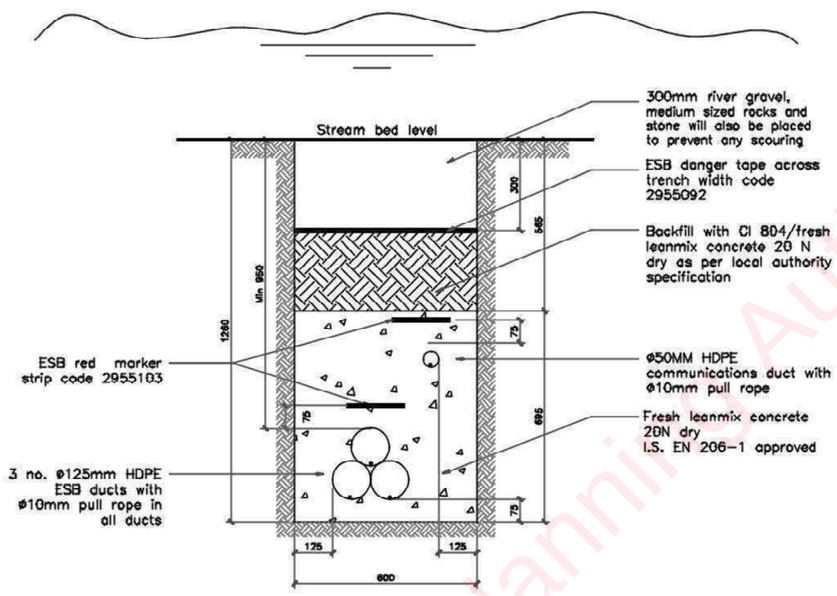
APPENDIX B – CABLE ROUTE STREAM CROSSINGS

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Typical detail of 38kV cable trench



Typical detail of 38kV stream crossing cable trench

SPECIFICATIONS TO BE FOLLOWED

1. I.S. EN206-1 dry or semi-dry leanmix to be specified
2. Ducting in accordance with ESB specification
3. 110mm HDPE ducting to be used (9 metre lengths)
4. All bends to be not less than 6 metre radius
5. ESB yellow danger tape to cover entire trench (code 2955092) at 300mm depth
6. Clearance to other utilities to be at least 300mm (greater if specified)
7. Every care to be taken to prevent ingress of dirt and moisture into duct (ducts to be sealed as they are being laid)
8. Ducting to be 75mm minimum from edge of trench
9. Ducting to be trefoiled using plastic duct ties at 3 metre centres
10. Ducting to be jointed by tapping home with smooth timber or plastic/rubber faced plank until wire mark is reached
11. Ducting coupling joints to be staggered to minimise extent of humps
12. Twisting of the ducting trefoil to be avoided
13. 12mm polypropylene rope to be laid into duct
14. Rope to be continuous and if over 220 metres spliced in an approved manner
15. Brush, mandrel and foam plug to be used to prove and clean duct
16. Ducts to be stored in an area free of dirty surface water and other foreign matters
17. ESB red marker strip to be placed 75mm above HV trefoil ducting and also 75mm above communications ducting
18. ESB specification cable markers to be placed on both sides of the stream banks

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PROJECT
38kV CABLE ROUTE

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STREAM CROSSING DETAIL

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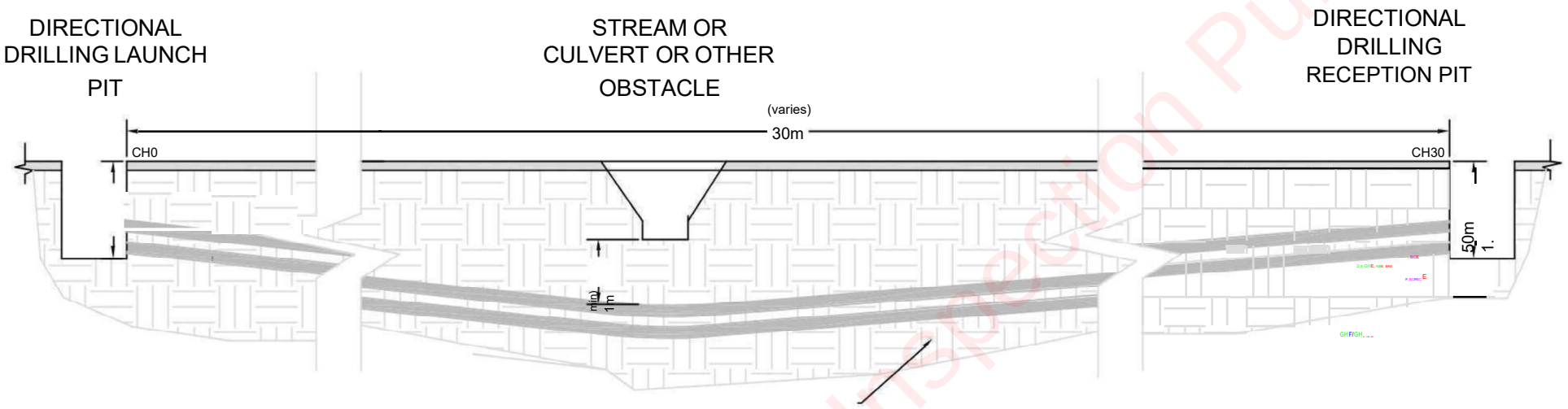
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APPENDIX C – CABLE ROUTE DIRECTIONAL DRILLING

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5no. 175mm drilled core filled with bentonite
5no. 125mm od SDR14.7 ducts (example only)

DIRECTIONAL DRILLING LONG SECTION

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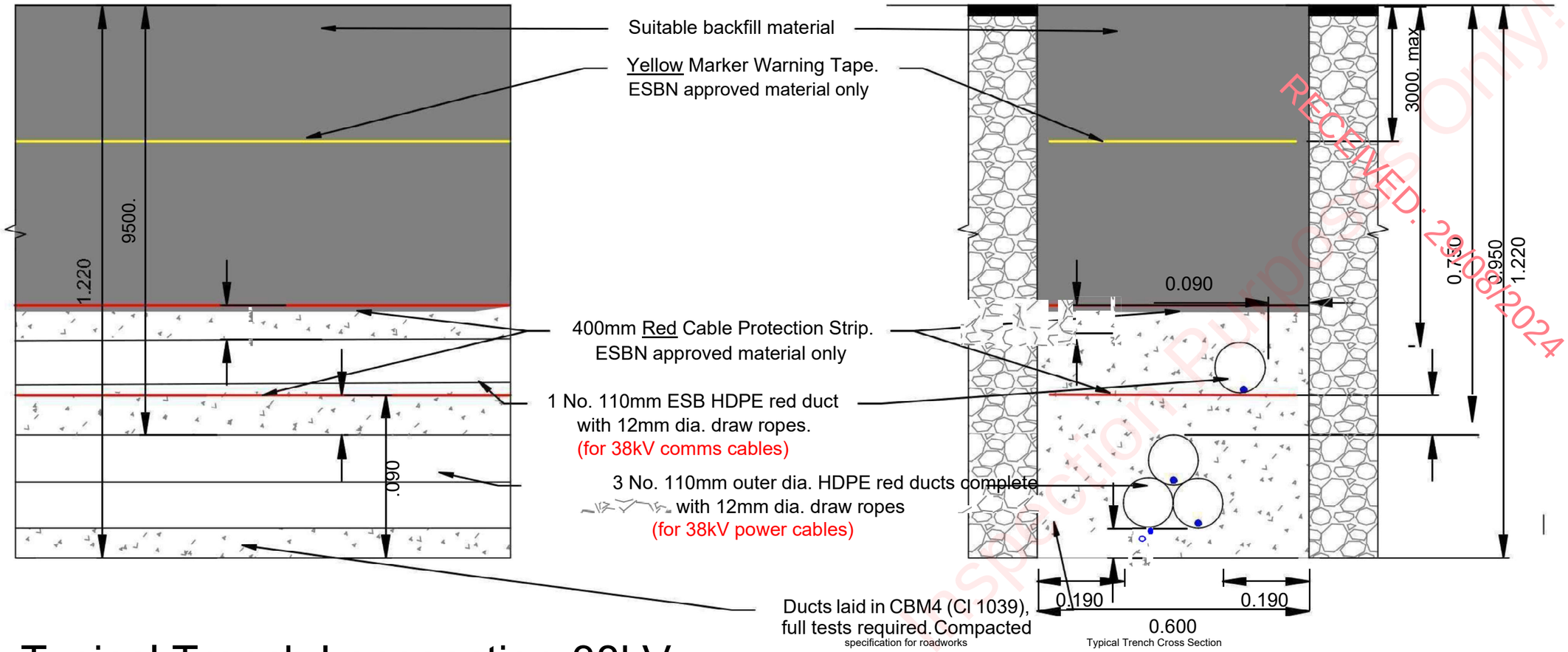
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APPENDIX D – CABLE ROUTE TYPICAL TRENCH DETAIL

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Typical Trench Longsection-38kV

Notes;

1. Figured dimensions only to be used. Drawings not to be scaled.
2. Miminum distance from existing services to be 0.3m. This minimum distance to be increased to 1.0m (min) when working alongside Gas distribution lines.
3. Drawings to be read in conjunction with
   - Department of Environment and Local Government Guidelines for the Opening, Backfilling and Reinstatement of Trenches in Public Roads (April 2002)
   - applicable amendments to the above issued in September 2005
   - ESB Networks Specification for the Installation of Ducts & Structures for Underground 38kV Power Cables & Communication Cables
   -Bord Gais Networks "safety advice for working in the vicinity of natural gas pipes"
   -HSA code of practice "Avoiding Danger from Underground Services"
4. All edges of excavated area to be saw cut prior to excavation.

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38kV CABLE ROUTE

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Appendix 3.3

Underground Electricity Export Connection Route Bridge & Culvert Inventory

Keerglen Wind Farm

Support Document to Planning Application

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1. Introduction

The Proposed Development includes for a Underground Electricity Export Connection (UEEC) of a 38kV cable connecting into the existing Tawnaghmore 110kV electrical substation or a potential Large Energy User located at the lands at Killala Business Park.

As described in detail in Chapter 3 of the EIAR, the proposed UEEC works comprises:

- four 110mm diameter HDPE ducts (three power and one communications) laid in a trench excavated to typically 1.2 m deep by 0.6 m wide (38kv Connection);
- three phase electrical cables;
- optical fibre cables;
- draw pits and joint bays;
- communication chambers;
- cable sheath sectionalising chambers;
- water crossings by bridge crossings or directional drilling as described in the Underground Electricity Export Connection Cable Route Construction Methodology (Appendix 3.2) or as detailed in Road Opening License;
- Technical works to terminus connection into the existing Tawnaghmore 110kV electrical substation or a potential Large Energy User located at the lands at Killala Business Park;
- Ancillary works.

The proposed circa.22.8 km route of the 38kV underground cable between Keerglen Wind Farm and into the existing Tawnaghmore 110kV electrical substation or a potential Large Energy User located at the lands at Killala Business Park is shown in Plate 1 below (and EIAR Figure 3.1). The route follows the public roads in a general south/south easterly direction to Tawnaghmore.

The proposed UEEC route will follow existing roads as outlined below:

- Wind Farm Substation to the L51723
- L51723 Ballykinlettragh / to R315
- R315 turn off onto L1110 via Kincon
- L1110 turn onto the L1107
- L1107 turn onto L1111
- Entrance to Killalla Business Park
- Killalla Business Park

There are multiple watercourse crossings / bridges that the proposed UEEC route will cross. This Appendix provides an inventory of the existing bridges along the UEEC route. The preferred method

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for crossing bridges is in a standard trench with ducts in trefoil formation or in flat formation for reduced cover. However, where the depth of cover is below the limit permissible for a reduced cover / flat formation detail, alternative methods such as horizontal directional drilling can be used. Preliminary recommendations are outlined below:

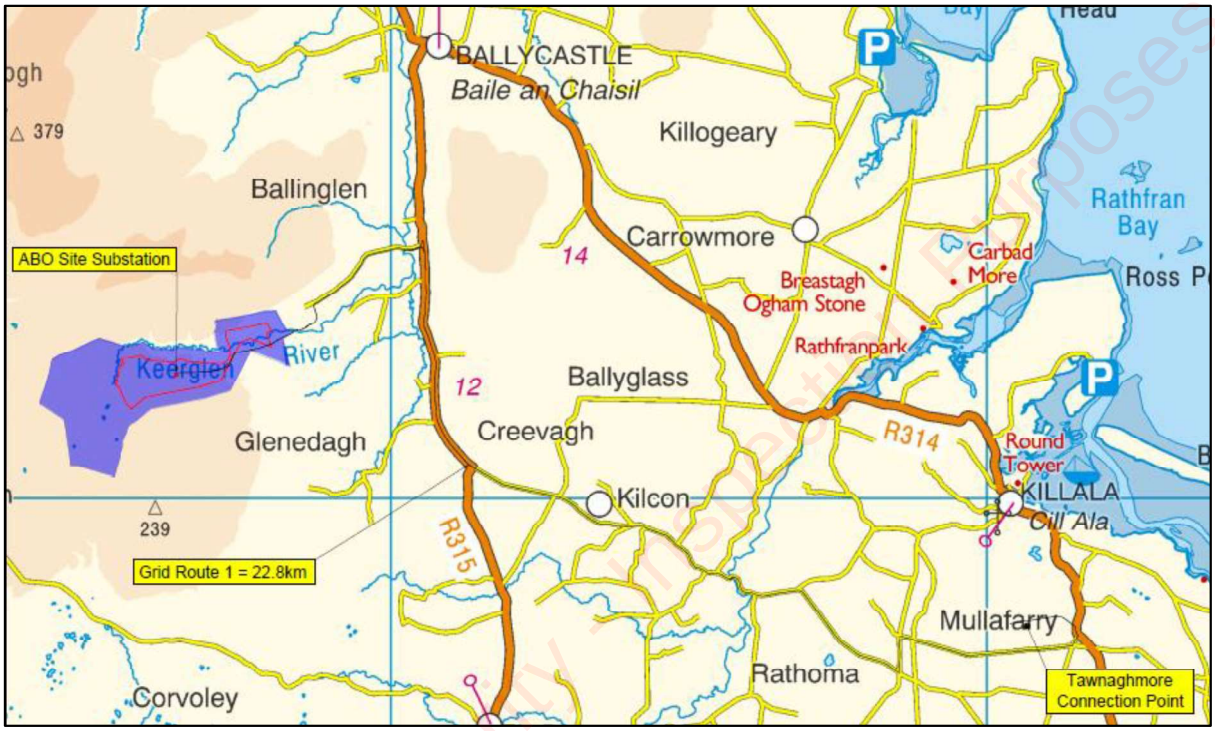


Plate 1 UEEC Route Connection to the existing Tawnaghmore 110kV electrical substation or a potential Large Energy User located at the lands at Killala Business Park

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Structure No.1– Pipe



General Data

Road Identification	L-51723
Road Name	Ballinglen to Ballykinlettragh
EIRSPAN ID	N/A
Location / Bridge Name	Gurran
ITM Co-ordinates	E508654 N833279
Crossing Feature	Drain

Structure Data

Construction Type	Twin Wall HDPE pipe
No. Spans	N/A
Total Span Length	Not recorded
Road Width / Verge Width	3m / Not recorded
Estimated Cover (Road Surface to Keystone/Slab	800mm
Recommended Crossing	Reduced cover trench

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Structure No.2 – Culvert



General Data

Road Identification	L-51723
Road Name	Ballinglen to Ballykinlettragh
EIRSPAN ID	N/A
Location / Bridge Name	Ballykinlettra
ITM Co-ordinates	E509122 N833575
Crossing Feature	Stream/Drain

Structure Data

Construction Type	Stone slab culvert
No. Spans	1
Total Span Length	Not recorded
Road Width / Verge Width	3m / 1m
Estimated Cover (Road Surface to Keystone/Slab	500mm
Recommended Crossing	Replace Culvert

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Structure No.3 – Ballinglen Bridge



General Data

Road Identification	L-51723
Road Name	Ballinglen to Ballykinlettragh
EIRSPAN ID	N/A
Location / Bridge Name	Ballinglen Bridge
ITM Co-ordinates	E510212.12 N834207.94
Crossing Feature	Keerglen River

Structure Data

Construction Type	Stone Arch
No. Spans	3
Total Span Length	15m
Road Width / Verge Width	2.8m / 1m (3.8m parapet to parapet)
Estimated Cover (Road Surface to Keystone/Slab	200 mm
Recommended Crossing	Horizontal Directional Drilling

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Structure No.4 – Culvert



General Data

Road Identification	L-51723
Road Name	Ballinglen to Ballykinlettragh
EIRSPAN ID	N/A
Location / Bridge Name	Ballyinteemore
ITM Co-ordinates	E510260 N834205
Crossing Feature	Drain

Structure Data

Construction Type	Stone slab culvert
No. Spans	Single
Total Span Length	Not recorded
Road Width / Verge Width	2.9m / 1m
Estimated Cover (Road Surface to Keystone/Slab	600mm
Recommended Crossing	Reduced cover trench (road level raised at approach to bridge)

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Structure No.5 – Loughcapple Bridge



General Data

Road Identification	R315-31
Road Name	R315
EIRSPAN ID	N/A
Location / Bridge Name	Ballykinlettra
ING Co-ordinates	E510546 N833643
Crossing Feature	Stream

Structure Data

Construction Type	Stone Arch Bridge
No. Spans	1
Total Span Length	Not recorded
Road Width / Verge Width	4.7m / 0.5m
Estimated Cover (Road Surface to Keystone/Slab	100mm
Recommended Crossing	Horizontal Directional Drilling

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Structure No.6 – Stone Slab Bridge



General Data

Road Identification	R315-31
Road Name	R315
EIRSPAN ID	N/A
Location / Bridge Name	Creevesbeg
ITM Co-ordinates	E510509 N832928
Crossing Feature	Stream

Structure Data

Construction Type	Stone slab culvert
No. Spans	1
Total Span Length	Not recorded
Road Width / Verge Width	4.2m / 1m
Estimated Cover (Road Surface to Keystone/Slab)	100mm
Recommended Crossing	Horizontal Directional Drilling

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Structure No.7 – Stone Slab Bridge



General Data

Road Identification	R315-31
Road Name	R315
EIRSPAN ID	N/A
Location / Bridge Name	Creevesbeg
ITM Co-ordinates	E510560 N832802
Crossing Feature	Stream

Structure Data

Construction Type	Stone slab
No. Spans	1
Total Span Length	Not recorded
Road Width / Verge Width	4.5m / 2m
Estimated Cover (Road Surface to Keystone/Slab)	700mm
Recommended Crossing	Reduced cover trench

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Structure No.8 – Stone Slab Culvert



General Data

Road Identification	R315-31
Road Name	R315
EIRSPAN ID	N/A
Location / Bridge Name	Creevesbeg
ITM Co-ordinates	E510685 N832447
Crossing Feature	Stream

Structure Data

Construction Type	Stone slab
No. Spans	2
Total Span Length	Not recorded
Road Width / Verge Width	4.2m / 1.4m
Estimated Cover (Road Surface to Keystone/Slab)	400mm
Recommended Crossing	Horizontal Directional Drilling

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Structure No.9 – Stone Slab Bridge



General Data

Road Identification	R315-31
Road Name	R315
EIRSPAN ID	N/A
Location / Bridge Name	Glenedagh / Crevagh
ITM Co-ordinates	E510748 N831287
Crossing Feature	Stream

Structure Data

Construction Type	Stone slab culvert
No. Spans	2
Total Span Length	Not recorded

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Road Width / Verge Width	5.7m / 2m
Estimated Cover (Road Surface to Keystone/Slab)	500mm
Recommended Crossing	Horizontal Directional Drilling

Structure No.10 – Stone Slab Culvert



General Data

Road Identification	L-1110
Road Name	Creevagh to Kincon village
EIRSPAN ID	N/A
Location / Bridge Name	Kincon
ITM Co-ordinates	E513688 N829578
Crossing Feature	Stream

Structure Data

Construction Type	Stone slab
No. Spans	2
Total Span Length	Not recorded
Road Width / Verge Width	4.7m / 700mm
Estimated Cover (Road Surface to Keystone/Slab)	750mm
Recommended Crossing	Reduced cover trench

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Structure No.11 – Stone Arch Bridge



General Data

Road Identification	L-1110-30
Road Name	Creevagh to Kincon village
EIRSPAN ID	N/A
Location / Bridge Name	Tonrehown Bridge
ITM Co-ordinates	E515683.25 N828686.3582
Crossing Feature	Cloonaghmore Rover

Structure Data

Construction Type	Stone Arches
No. Spans	8
Total Span Length	Not recorded
Road Width / Verge Width	4.4m (parapet to parapet)
Estimated Cover (Road Surface to Keystone/Slab)	300mm
Recommended Crossing	Horizontal Directional Drilling

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Structure No.12 – Concrete Slab Bridge



General Data

Road Identification	L-1110-30
Road Name	Creevagh to Kincon village
EIRSPAN ID	N/A
Location / Bridge Name	Barranran Upper
ITM Co-ordinates	E516071 N828406
Crossing Feature	Stream

Structure Data

Construction Type	Concrete Slab Bridge
No. Spans	2
Total Span Length	Not recorded
Road Width	5.2m
Estimated Cover (Road Surface to Keystone/Slab)	300mm
Recommended Crossing	Horizontal Directional Drilling

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Structure No.13 – Concrete Slab Bridge



General Data

Road Identification	L-1110-56
Road Name	Creevagh to Kincon village
EIRSPAN ID	N/A
Location / Bridge Name	Foxboro
ITM Co-ordinates	E517897 N827354
Crossing Feature	Stream

Structure Data

Construction Type	Concrete slab
No. Spans	2
Total Span Length	Not recorded
Road Width / Verge Width	5.5m / 3m
Estimated Cover (Road Surface to Keystone/Slab)	1m
Recommended Crossing	Reduced cover trench

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Structure No.14 – Stone Arch Culvert



General Data

Road Identification	L-1110-56/L-1107-99
Road Name	Fotish to Carrowgarve north
EIRSPAN ID	N/A
Location / Bridge Name	Foxboro
ITM Co-ordinates	E518489 N827083
Crossing Feature	Stream

Structure Data

Construction Type	Stone Arch
No. Spans	1
Total Span Length	Not recorded
Road Width / Verge Width	5m / 1.8m
Estimated Cover (Road Surface to Keystone/Slab)	150mm
Recommended Crossing	Horizontal Directional Drilling

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Structure No.15 – Stone Arch Bridge



General Data

Road Identification	L-1107-99/L1111-0
Road Name	Fotish to Carrowgarve north
EIRSPAN ID	N/A
Location / Bridge Name	Foxboro
ITM Co-ordinates	E518509 N827699
Crossing Feature	Stream

Structure Data

Construction Type	Stone arch
No. Spans	1
Total Span Length	Not recorded
Road Width / Verge Width	Not recorded
Estimated Cover (Road Surface to Keystone/Slab)	850mm
Recommended Crossing	Reduced cover trench

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Structure No.16 – Concrete Slab Bridge



General Data

Road Identification	L-1111-13
Road Name	Magherabrack to Lisglennon
EIRSPAN ID	N/A
Location / Bridge Name	Ballintean
ITM Co-ordinates	E521134 N827498
Crossing Feature	Stream

Structure Data

Construction Type	Concrete slab

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No. Spans	1
Total Span Length	Not recorded
Road Width / Verge Width	5.7m / 0.5m
Estimated Cover (Road Surface to Keystone/Slab)	250mm
Recommended Crossing	Horizontal Directional Drilling

Structure No.17 – Concrete Culverts



General Data

Road Identification	Not available at time of survey
Road Name	Entrance Killalla Business Park
EIRSPAN ID	N/A
Location / Bridge Name	Ballintean
ITM Co-ordinates	E521453 N827874
Crossing Feature	Stream

Structure Data

Construction Type	Concrete Culverts
No. Spans	2
Total Span Length	Not recorded
Road Width	13m
Estimated Cover (Road Surface to Keystone/Slab)	1.8m
Recommended Crossing	Standard trench

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Appendix 1: Keerglen UEEC Route Map

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Appendix 3.4
Decommissioning Plan

Keerglen Wind Farm

Support Document to Planning Application

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1.0 Introduction

This Decommissioning and Reinstatement Plan has been submitted as part of the planning application for the proposed Keerglen Wind Farm. The operational period for the wind farm shall be for approximately 30 years from the date of commissioning of the wind turbines, where after the use shall cease. Ordinarily the structures shall be removed and the site reinstated in accordance with this reinstatement plan, unless a further permission is granted to extend the operational period of the wind farm prior to the expiry of this permission.

ABO Energy has prepared this Decommissioning and Reinstatement Plan to demonstrate to the planning authority the decommissioning phase of the project has been adequately described prior to commencement of development and to establish the best practice which will ensure the best outcome is delivered at the end of the wind farm's operational life. Decommissioning means the removal of turbines and other infrastructure and includes the reinstatement of the site where required. The plan also applies to re-powering wind farms which involves the replacement of older turbines with next generation technology (SNH, 2016).

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2.0 The Developer

ABO Energy Ireland Ltd was established in Ireland in 2008 and is a subsidiary of ABO Energy AG, one of Europe's most successful developers of renewable energy projects. With headquarters in Wiesbaden, Germany we plan, build, maintain and operate wind farms along with other renewable energy technologies. Since 1996, the company has developed and sold wind energy, solar and biogas projects with an output of circa 3,500 megawatts.

In Ireland, ABO Energy Ireland Ltd (formerly ABO Wind Ireland Ltd.) has successfully developed and constructed numerous wind farms with a capacity of circa 106 Megawatts, including Glenough Wind Farm in Co. Tipperary, Gortahile Wind Farm in Co. Laois, Gibbet Hill Wind Farm in Co. Wexford, Cloghreavaddy, County Donegal and Sheskin, Bellacorrick, Co, Mayo. ABO Energy Ireland Limited has also built a 220-kilovolt transformer station to connect the Glenough wind farm (32.5 megawatts) to the grid.

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3.0 Overview of Plan

The operational period for Keerglen Wind Farm is approximately 30 years from the date of commissioning of the wind turbines.

Given there would commonly be in excess of 30 years between commissioning and decommissioning of a wind farm, SNH (2016) recommends that the plan should be sufficiently flexible. This is because environmental conditions, laws and techniques may change during the lifetime of the development. Accordingly, the plan will be refined and updated towards the end of the operational period to allow for best practice at that time and to ensure the best outcome is delivered at end of a wind farm's operational life.

The Decommissioning Plan should be reviewed at least every 5 years throughout the lifetime of the development, and more frequently should the need arise. This is to ensure that site conditions, maintenance requirements and unexpected events do not compromise the objectives of the plan. For example, unexpected impacts may arise during/following construction that affect the initial objectives of the plan, or guidance and best practice may have been superseded. Consultation with the statutory bodies should be considered at these review stages, where appropriate.

In the 3-5 years prior to the year of decommissioning, the plan should be revised, if required, and completed to provide full details of decommissioning. This time period allows full exploration of the options and provides sufficient time for surveys and site investigations to be carried out. The plan should be submitted to the Planning Authority for approval, in consultation with others as appropriate.

It should be noted that this plan is a live document that may be altered in agreement with the planning authority and other regulatory body during the operational lifetime of the development. This flexibility will allow for the best practicable environmental option.

3.1 Objectives

The following are the overriding objectives of the plan:

- The plan will remain sufficiently flexible in order to account for environmental conditions, laws and techniques which may change during the lifetime of the development;
- The plan will be reviewed every five years throughout the lifetime of the development, and more frequently should the need arise
- The plan will be refined and updated at the end of the operational period to allow for best practice at that time and to ensure the best outcome is delivered at the end of a wind farm's operational life;

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- The final plan will include an assessment of the site's natural and built characteristics (its setting and relationship with surrounding area) and how these respond to change in order to critically assess any impacts of the decommissioning plan (e.g. construction works, habitat restoration, ground stability etc.);
- The plan will be refined and updated the end of the operational period and include appropriate mitigation measures where necessary to be implemented;
- The plan for infrastructure removal will reflect best practice techniques and approaches that will result in the least disturbance to the environment, subject to the wider aims of the decommissioning plan;
- The plan from a landscape and visual perspective will achieve the greatest improvements with the least disturbance and impacts on landscape fabric, character or visual amenity of neighbouring receptors through careful control of the works.
- The plan will address all excess components and materials collected during the deconstruction phase thoroughly. They will be taken off site to be reused, recycled or disposed of according to industry best practices at an authorised facility.
- The overarching principles of restoration must be maintained throughout the implementation of the Decommissioning & Reinstatement Plan, mitigation of impacts and monitoring and management of residual effects.

3.2 Timeline

This plan outlines scenarios that could occur at the end of the operation period. The developer expects either of the follow to occur.

- **Decommissioning & Reinstatement**: This means the removal of turbines and other infrastructure and includes the reinstatement of the site where required.
- **Decommissioning & Repowering**: This involves the replacement of older turbines with next generation technology.

The table below sets out the actions required in the delivery of these scenarios.

Table 1 Timeline of Plan

Year	Action
> 0	Submit financial bond (which is linked to a Wholesale Price Index), , if required, to the planning authority
0	Give notice to the planning authority of the date which the wind farm is commissioned.
5	Review the Decommissioning Plan to ensure that site conditions, maintenance requirements and unexpected events do not compromise its objectives.
10	Review the Decommissioning Plan to ensure that site conditions, maintenance requirements and unexpected events do not compromise its objectives.
15	Review the Decommissioning Plan to ensure that site conditions, maintenance requirements and unexpected events do not compromise its objectives.
20	Review the Decommissioning Plan to ensure that site conditions, maintenance requirements and unexpected events do not compromise its objectives.
25	Review the Decommissioning Plan to ensure that site conditions, maintenance requirements and unexpected events do not compromise its objectives.

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28-30	Review the Decommissioning Plan and ensure it is completed to provide full details of decommissioning and submit completed Plan[1] to the planning authority for review.	
28-30	Carry out necessary actions for repowering if applicable (i.e. acquire required planning consents)	
30	Carry out necessary actions for decommissioning (i.e. removal of turbines and other infrastructure)	
	Reinstatement	Repowering
29-31	Carry out necessary actions for reinstatement (i.e. restoration of the lands to original state)	Carry out further actions for repowering (i.e. replacement of older turbines with next generation technology)
30-60	Operation of agriculture or other use on site.	Operation of repowered wind farm
> 30	Monitoring of reinstated area.	

[1] The final Decommissioning Plan should contain a similar level of detail to a Construction and Environmental Management Plan. It will need to be informed by contemporary habitat and protected species surveys, and other information on potential constraints (e.g. watercourses, deep peat, or sensitive areas restored during the lifetime of the development). It should include all relevant information, maps and figures. This is to ensure that future readers can understand what it is seeking to achieve, why, where, how and when.

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4.0 Executing the Decommissioning

The decommissioning of a wind farm will require removal of infrastructure and further construction related activities to reinstate the site. The removal of elements of the wind farm will be a relatively short-term activity, but the legacy of what is left and what is done to restore the site can have a much longer-term impact on the site. A logical sequence for planning and executing the decommissioning with regards to the construction activities is suggested as follows:

Table 2 Decommissioning Actions

Year	Action
De-energising of the Site	This would involve initially high voltage (HV) disconnection or isolation in the event of re-energising of the site or partial decommissioning, followed by low voltage (LV) disconnection of affected turbines.
Handover of Site	Responsibility given to a Principal Contractor for management of access and site set up.
Decommissioning of Structures	This is most likely to be a reverse of the installation procedure and involve: - Stripping out of turbine internals and removal of transformer; - Controlled dismantling of turbines (blades, nacelle, tower); - Removal of turbine base (partial) and backfilling void; - Removal of cables (whole or partial) and making good trenches (throughout); - Removal of crane pads (whole or partial) and backfilling/landscaping; - Removal of Sub-station and associated buildings; - Removal of access tracks (whole or partial) and associated water crossings, passing areas etc. (Working from end point towards exit point); - Reinstating watercourses and /or removing watercourse crossings; - Final landscaping (seeding) and making good remaining borrow pits etc.; and - Make good public road junction, if required
Addressing Redundant Materials & Waste	There are significant redundant materials and wastes likely to be generated during the decommissioning phase which will include the following: - Excavated Material: Any excess excavated material will be sent to an appropriate licenced facility for reuse, recycling or disposing. - Deconstructed Material. Any excess deconstruction material will be sent to an appropriate licenced facility for reuse, recycling or disposing. - Domestic Waste: Any excess domestic waste will be collected on site, stored in an enclosed skip and sent to an appropriate licenced facility for reuse, recycling or disposing. All components collected during the deconstruction phase will be taken off site to be, reused, recycled or disposed of according to industry best practices at an authorised facility. As a principle, a zero waste approach will be taken where excesses are prevented and avoided where possible.
Begin Another Use	Providing 'as-built' documentation including residual risks to Landowner and Planning Authority.
Monitoring	Monitoring and maintaining the site to achieve end-use requirement.

The plan addresses all excess components and materials collected during the deconstruction phase thoroughly. They will be taken off site to be reused, recycled or disposed of according to industry best practices at an authorised facility. These are described in Table 3.

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Table 3 Components to be Decommissioned

Element	Component	Constituent	Recycling Options	Action/Recommendation
Turbine	Blades (3 per turbine)	Resin	Yes / Offsite	The turbine will be dismantled at ground level and removed from site for onward disposal, recycling or reuse off site. This will involve a crane and then haulier to remove all components from site. A Transport Assessment may be required to assess the traffic and access issues including the vehicles required and haul route to be used. The dismantling of the turbine structure should have minimal environmental impact and costs would be driven by crane hire and haulage charges.
		Fibre Glass		
	Blade Hub & Nose Cone	Resin	Yes / Offsite	
		Fibre Glass		
	Nacelle / Gear Box	Iron	Yes / Offsite	
		Steel		
		Copper		
		Resin		
		Silca		
Turbine Base	Tower	Steel (Sections)	Yes / Offsite	The removal of the turbine base would require the breaking out of reinforced concrete using steel cutting equipment and hydraulic breakers, excavators and dump trucks to remove them from the site. The concrete can be processed through the removal of steel (for recycling) and made into granular material for further reuse on or off site. In most cases the concrete can also be left in situ as it is a relatively inert material given its durability. An assessment of the soil will be required to identify corrosive agents that could affect the base if being retained. Depending on the landform to be achieve a partial removal of the structure may be appropriate, such as the tower base up-stand. Partial removal of the base (typically to 1m below finished ground level) which exposes reinforcement may lead to this reinforcement having to be protected/capped. A complete removal of the base, without appropriate backfilling, would leave a sizeable void that could result in significant hazard or water feature. Consideration of the localised influence of the groundwater table associated with such filling may be required. It should be noted, the noise, ground disturbance and cost (excavation / breaking / processing / transporting), along with associated carbon emissions of removing a turbine base may create a larger environmental impact than leaving such concrete in situ.
	Backfill	Fill	Yes / Onsite	
		Crushed Rock		
	Concrete Bases	Concrete	Yes / On & Offsite	
		Steel Reinforcement		
	Concrete Piles	Concrete	Limited / Offsite	

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		Steel Reinforcement		Concrete Piles are difficult to remove as the piles may rely on skin friction in their design to provide the bearing capacity required for the base which should be very difficult to overcome. Depending on size, materials, in situ conditions, depth etc. it may be possible to extract piles, especially shallower end bearing piles. Where piles consist of concrete within a steel case these should be removed as a single unit. For driven reinforced concrete piles, there is a risk that these can break and snap during extraction, and therefore contingency measures may be required to further excavate snapped piles, or to cap exposed reinforcement. In most cases, leaving such piles in situ should not create a significant environmental issue, In the event that shallow piles can be extracted, these can then be cut if required and then loaded onto a Heavy Goods Vehicle (HGV) for onward processing/storage. The piles should be processed and made into material for further reuse on or off site.
		Casing		
Transformer	Transformer	Electrical Components	Limited / Offsite	These are likely to be removed from the site as part of any decommissioning, or removed and upgraded with a new one where the intention is to repower the site. This would involve lifting equipment, such as a crane or lifting arm, and a transporter. Transformers and some other components within wind turbines can contain oils and other lubricants. During decommissioning, it is recommended that all fuel, oils and lubricants are drained from the components under a controlled method and then recycled or disposed of appropriately. Similarly, consideration may need to be given to the secure transit of such components. Any storage on site for processing, bulking or onward collection should be sited to mitigate any risk of contamination of local water courses and groundwater. Measures such as use of a low permeable liner may be required in any storage locations.
	Concrete Base	Concrete		Any associated concrete slab could be broken up by hydraulic breakers and the material removed from site for onward recycling and reuse, or processed on site and used as backfill or engineering fill if the conditions permit
		Steel Reinforcement		
Crane Pad	Hard standing	Crushed rock	Yes / Onsite	The reinstatement of the crane hard standing would generally involve the removal of the compacted granular material using an excavator and dump trucks. This could be from the whole area or part of it as required. The area would then be backfilled with a more suitable material (e.g. original in situ material) if required, then dressed off with the topsoil/vegetation layer material. Re-seeding may be required to accelerate the restoration process. Excavated material is likely to be suitable for a number of engineering uses either on site, as required, or at an off-site location. If the material is to be removed, this can amount to a significant quantity, and therefore this is likely to be a time consuming and expensive operation with associated environmental impact such as traffic movements, carbon emissions and noise and waste legislation implications. The most significant issue associated with the reinstatement of the crane pads is likely to be the availability of suitable topsoil (or equivalent) material and prevention of soil contamination. Careful consideration of the stockpiling and acquisition of
		Geogrid Reinforcement		
	Soils	In-situ soils retained		

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				suitable material should be given at the design and construction stage. A large volume of material may be required to be imported or removed, in order to allow the re-made ground to suit local levels bringing with it the risk of soil contamination.
Tracks	Roads (Granular Fill / Floating)	Crushed Rock	Yes / Onsite	The removal of compacted granular tracks can be removed using excavators and dump trucks. These could be used elsewhere on site if required, such as new tracks, backfilling borrow pits, filling in turbine base excavations etc., or transferred to road tippers for onward re-use at another location. Geotextiles/geogrids etc. can be selectively removed for recycling or disposal. Should the reinstated use for the site make use of some or all of these tracks this could justify a reduction in the number that might need to be removed. In most cases, and certainly for granular based tracks (but also concrete and asphalt) these materials are mostly inert and stable over the long-term, so will not pose a contamination risk if left in situ. Conversely, if the development is in an area to be rewilded, it may be desirable to remove the tracks altogether. Of course, it should be noted, the noise, ground disturbance and cost (excavation / breaking / processing / transporting), along with associated carbon emissions of removing the tracks may create a larger environmental impact than leaving such concrete in situ. There may be a requirement for new tracks or tracks to be upgraded as part of an extension or re-powering of a site. In such cases, it may be possible to recycle track material or processed concrete. Consideration should also be given to the placement of newly excavated topsoil and subsoil material from these new tracks to areas that are required to be restored.
		Geotextile Separators		
		Geogrids		
	Bituminous / Asphaltic Road	Bitmac	Yes / Offsite	
		Tarmac		
		Bitumen		
		Aggregate		
Buildings	Control Building	Timber	Limited / Offsite	The sub-station and control building are co-located. See information below under Substation.
		Brick		
		Prefabricated Panels		
		Glass		
		Steel		
		Concrete		
		O/H Services		
Substation	Switchgear / Cabling	Switchgear / Cabling	Yes / Offsite	Following the isolation of electrical power, it is likely that, unless there is any future use of these, all elements of the sub-station and buildings would be demolished by controlled demolition using cranes and specialist contractors and subsequently removed using excavators, dumpers and tipper trucks. Structures could be converted to other uses post-decommissioning, such as an agricultural buildings. Standard methods and procedures should be adopted to remove these buildings and restore the site as required. However, this activity could be subject to the same
		Other Miscellaneous – Fencing / Lighting etc.		

				constraints as other hard standing and roads/tracks, in that restoration soils may be difficult to procure. Note: The ownership of parts of the substation and cables will be passed over to ESB Networks and managed as part of the national grid. It will be the decision of ESB Networks as to whether they will be decommissioned after 25 years with the wind farm.
	Hard standing	Compacted Granular Material	Yes / Onsite	The sub-station hard standing may be retained in place and covered with restoration soils, but in general all activities associated with the decommissioning of these elements are low risk activities from an environmental perspective. However, this activity could be subject to the same constraints as other hard standing and roads/tracks, in that restoration soils may be difficult toprocure. Note: The ownership of part of the substation and cables will be passed over to ESB Networks and managed as part of the national grid. It will be the decision of ESB Networks as to whether they will be decommissioned after 30 years with the wind farm.
		Concrete Plinths		
Cables (Internal Wind Farm)	Cables	Copper	Yes / Offsite	It is likely that internal cables connecting the turbines with the site substation will be removed upon decommissioning and reinstatement. However, if decommissioning and repowering then it is possible that the cables may be re-used., Once the cable route has been identified and marked out, extraction may involve an excavator pulling/digging the cable and then loading onto a dump truck for onward bulking and removal off site for recycling. Given that the cables are in trenches that were previously excavated, access for their removal should in most cases be achievable. In general, it is recommended that cables are removed and the trenches reinstated with the existing material, with vegetation preserved and replaced on completion. Should any cable be left in situ, then providing it is undisturbed, it should remain relatively inert due to the rubber/plasticised coating.
		Aluminum		
		Fibre optic		
		Plastic And Rubber Sheaths		
		Ducting		
Public Road Junctions	Fill	bituminous/asphalt	Yes / Offsite	If the track and road junctions are to be fully reinstated, this should be a standard operation undertaken by a suitably qualified highways contractor in which all bituminous/asphalt compounds should be removed for recycling and the public carriageway verge reinstated to its original condition. It is unlikely that any further work would be needed to services that were previously protected, but if this is the case then a suitably qualified contractor would seek the permissions and undertake these works with minimum environmental impact.
Miscellaneous	Surface Water Management	Several	Varies	Most of these structures will generally be simply removed or upgraded as part of any decommissioning and after use of the site, which will be undertaken using standard engineering procedures. However, consideration may be required prior to any decommissioning of routes and facilities with regards to access rights, shared access and potential impact for any other developments and users in and around the site.
	Meteorological Masts	Several		
	Culverts	Several		
	Bridges	Several		

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	Borrow Pits	Several		
	Display Panels / Fences	Several		
	Other	Several		

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4.0 Implementation

The developer is committed to this Decommissioning Plan and intends implementing it upon cessation of the project. However, to ensure its implementation the planning authority may impose a suitably worded condition on any grant of planning permission for the proposed development, requiring that that the developer lodge with the planning authority a bond for an insurance company or bank to secure the satisfactory reinstatement of the site upon cessation of the project, coupled with an agreement empowering the planning authority to apply such security or part thereof to the satisfactory reinstatement of the site.

5.0 Conclusion

The plan is sufficiently flexible in order to account for environmental conditions, laws and techniques which may change during the lifetime of the development in accordance with guidance. The plan will be reviewed every five years throughout the lifetime of the development, and more frequently should the need arise. The plan will be refined and updated at the end of the operational period to allow for best practice at that time and to ensure the best outcome is delivered at the end of a wind farm's operational life. The overarching principles of restoration will be maintained throughout the implementation of the Decommissioning & Reinstatement Plan, mitigation of impacts and monitoring and management of residual effects.

6.0 References

Department of the Environment, Heritage and Local Government (2006). *Wind Energy Planning Guidelines*. Dublin: DEHLG.

Scottish Natural Heritage (SNH) (2016). *Decommissioning and Restoration Plans for Wind Farms Guidance Version 2*. Edinburgh: SNH. Available: http://www.snh.gov.uk/docs/A1434319.pdf

Welstead, J., Hirst, R., Keogh, D., Robb G. and Bainsfair, R. (2013*). Research and Guidance on Restoration and Decommissioning of Onshore Wind Farms*. Scottish Natural Heritage Commissioned Report No. 591.

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Appendix 3.5
Environmental Management Plan

Keerglen Wind Farm

Support Document to Planning Application

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1 Introduction

ABO Energy Ireland Ltd. (ABO) are applying for planning permission to develop a wind farm with 8 No. wind turbines with a maximum overall tip height of between 176-180m, comprising rotor diameters ranging between 133-150m and hub heights ranging between 105-112m high, 1no.38kV electrical substation and all associated works in the townlands of Keerglen, Ballinglen and Ballkinlettragh on a site measuring a combined c.81.88 ha.

Prior to commencement of construction a Construction Environmental Management Plan (CEMP) will be prepared and submitted to the local planning authority. This is an administrative tool and documentation system used to ensure that best working practices and required environmental mitigation measures are implemented. The CEMP is a 'live' document developed by the Main Contractor with input from specialist consultants and contractors, as necessary. The CEMP will also be used to identify unintended effects of the project through analysis and reporting on the environmental monitoring results and will identify whether additional monitoring is required. The CEMP forms an integral part of the site health, safety, environmental and quality management system that constitutes a component of the Construction Health and Safety Plan documentation. The CEMP is also subject to the requirements of the site quality management system with respect to documentation and record control. An Operational Environmental Management Plan (OEMP) and Decommissioning Environmental Management Plan (DEMP) will similarly be developed for the Operational and Decommissioning Phases of the Wind Farm Project.

This Environmental Management Plan (EMP) is essentially a precursor to the CEMP, prepared at the planning phase to establish a framework for proposed mitigation measures and environmental monitoring to ensure that changes arising from the construction and operation of the wind farm do not exceed environmental quality standards or objectives of the project. An EMP is also commonly referred to as an outline CEMP.

The EMP provides details of responsibilities and timeframes for the implementation of measures and management controls for each environmental discipline (where relevant) covered in the Environmental Impact Assessment Report (EIAR).

2 Project Context and Description

The proposed wind energy project, to be known as *'Keerglen Wind Farm'*, is located in the townlands of: Keerglen, Ballinglen and Ballykinlettragh, Co. Mayo.

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The Keerglen Wind Farm site is situated in a small upland valley of moorland and forestry, opening to low rural/pastoral landscape with higher population to the east. The site is contained within the Nephin ridge complex but at its dissipating eastern end. In terms of land use, the site generally comprises of peat bogland and low value agricultural grassland. In this regard the site offers the opportunity of a multifunctional land use comprising a wind farm, agricultural operations and turf cutting. It is located approximately 5.5 km to the south west of Ballycastle.

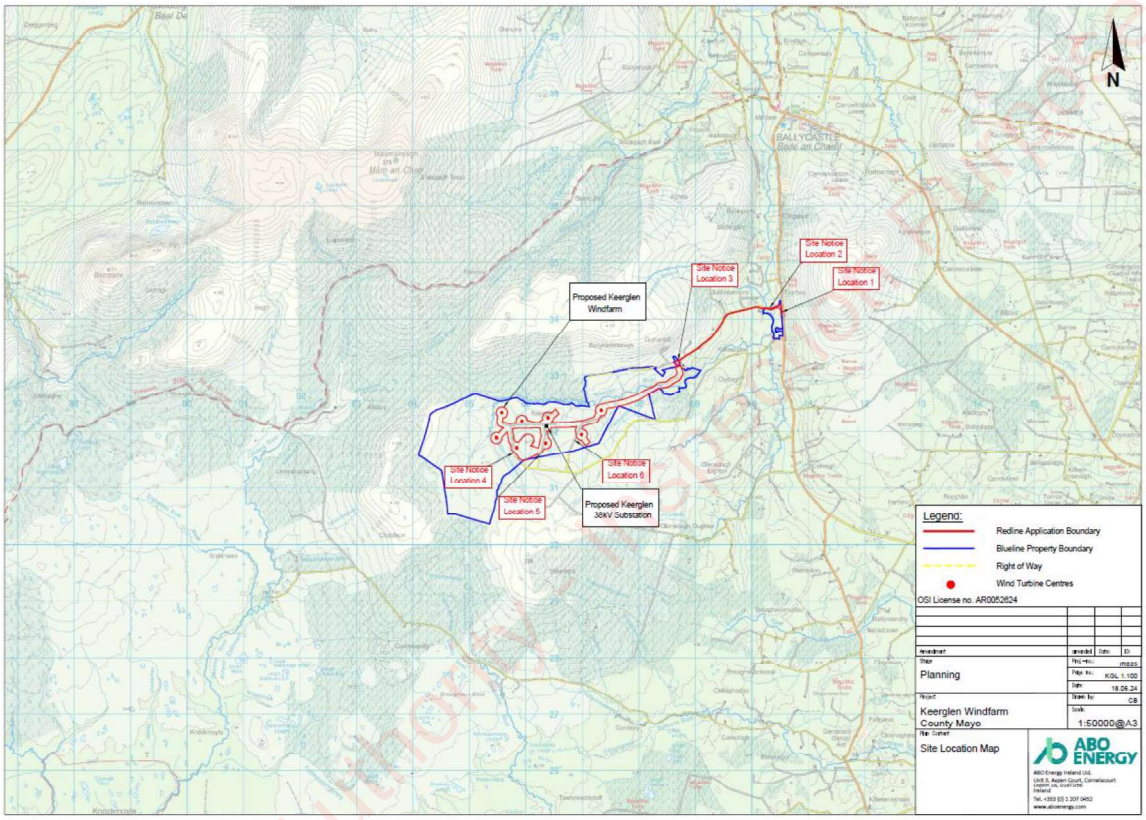


Figure 1: Wind Farm Boundary Outlined in red.

The wind farm comprises the following main elements;

- Construction of up to 8 No. wind turbines with a maximum overall tip height of between 176-180m, comprising rotor diameters ranging between 133-150m and hub heights ranging between 105-112m high;
- Associated Wind Turbine foundations and hard stand areas at each turbine;
- 1 No. 38kV electrical substation building, compound and associated infrastructure works;
- 1 No. temporary welfare site compound and associated works;
- 20kV underground cables facilitating the connection of turbines to 38kV electrical substation and all associated infrastructure and works;
- Provision of a new temporary roadway connecting the R315 and the L51723 in the townland of Ballinglen to facilitate the delivery of turbine components and other abnormal loads;

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- Widening and ancillary works to sections of the L51723 in the townlands of of Keerglen and Ballykinlettragh;
- Provision of new permanent site access of the L51723;
- Upgrading of existing agricultural tracks and drainage infrastructure, and construction of new internal site tracks and all associated works as required;
- Construction of a clear-span bridge crossing the Keerglen River within the development area;
- 1 no. borrow pit;
- Designated peat storage areas alongside internal side roads;
- Site drainage;
- Ancillary forestry felling to facilitate construction and operation of the proposed development;
- All associated infrastructure and site development works.

For the purposes of the EIA Directive[1], the EIAR further considers:

- Temporary minor off-site works along the turbine delivery route;
- Approximately c. 22.8km of 38kV underground cable grid connection and associated works along public roads and private lands to include horizontal directional drilling at bridge locations;
- Temporary met mast of between 100-112m in height and all associated infrastructure and works;

3 Structure and Scope of EMP

There are two types of environmental management documents for controlling mitigation and monitoring at the proposed wind farm;

- The EMP which will be developed by the Main Contractor into the CEMP and then further into an OEMP by the site Operator (ABO Energy Operations Management Services), and
- Specific Management Plans developed by specialist consultants or contractors and incorporated into the CEMP to ensure that the mitigation measures outlined in EIAR will be fully implemented.

The EMP consolidates the mitigation measures and monitoring activities from each environmental impact and receptor identified within each of the EIAR Chapters and assigns an objective, management and/or oversight responsibility and a timeframe.

The EMP and subject-specific management plans collectively provide details of the required monitoring schedules and frequencies, monitoring locations, parameters and methodologies for environmental management of the project.

The EMP is designed to ensure compliance with best practice national and international environmental standards. The CEMP can be amended to take into consideration planning conditions or changes in

[1] Please note there are differences in what is being applied for under Part III of the *Planning and Development Act 2000, as amended* and what is being presented under Part X of the same statute.

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legislation.

The spatial extent of the EMP is determined by each subject specific study area. For example water quality issues will extend to the relevant watercourses that could be impacted. Traffic management issues would include access from the national roads.

The following subject specific management plans support and feed into the EMP.

- Surface Water Management Plan
- Outline Construction Method Statement
- Outline Invasive Species Management Plan (to be prepared for CEMP)
- Outline Biodiversity Management Plan (to be prepared for CEMP)
- Construction Traffic Management Plan (to be prepared for CEMP)
- Dust Management Plan (to be prepared for CEMP)

4 Roles and Responsibilities

Table 1 below provides details of the indicative roles and responsibilities for organisations and staff responsible for implementing and overseeing the environmental management of the wind farm project.

Table 1: Summary of Roles and Responsibilities of Project Team

Role	Responsibility
ABO Energy Project Manager	Overall responsibility for delivery of the project, including appointment of Specialist Consultants, Main Contractor, Specialist Contractors & ECOW. Overall budgetary control.
ABO Energy Project Engineer	Overall responsibility for administering the civil engineering contracts and environmental aspects of the project. Review and sign-off on the CEMP produced by the Main Contractor, overseeing the implementation of remedial action(s) if necessary and sign off on completed remedial tasks if necessary. Chairing regular (monthly) site progress meetings to discuss environmental performance and associated issues such as environmental monitoring and implementation of the CEMP. Liaising with Mayo County Council, NPWS, IFI and other regulatory bodies and coordinating all environmental reporting to regulators. Liaising with the local community to keep them informed about activities onsite especially regarding potential disruption e.g. during delivery of turbine components.

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Main Contractor's Environmental Manager	For a project of this size and complexity it is expected that the Main Contractor would appoint a dedicated Environmental Manager to oversee the preparation and implementation of the CEMP. Develop the CEMP, based on the EMP, for daily practical implementation, including the subject specific management plans, allowing sufficient resourcing of labour, plant and materials to ensure compliance with environmental standards.

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Role	Responsibility
	Review sub-contractor method statements to ensure they are competent to meet the environmental requirements including those specified in the CEMP. Oversee co-ordination of the environmental management of the project during the Construction Phase. Liaise with the Project Engineer and ECOW to ensure the implementation of the prescribed mitigation measures, environmental monitoring and record keeping arrangements are in place. Overall responsibility for the administration, collation and storage of records on site so they are available for inspection on site. Principal responsibility for environmental monitoring and liaising with ECOW and other specialist consultants responsible for subject specific monitoring. Reviewing and reporting performance against the requirements of the CEMP in the form of a monthly report to the project management team. Ensuring corrective and remedial actions feed back into the CEMP. Reviewing and updating the CEMP throughout the Construction Phase.
Environmental Clerk of Works (ECOW)	Routine inspections and monitoring of all construction activities and oversight of the mitigation measures in the CEMP to ensure environmental compliance. A key function of the ECOW is to provide first hand onsite identification, direction for intervention and immediate resolution of environmental issues as they arise. Review of the CEMP and input into updates. Auditing of the subject specific environmental management plans. Co-ordinate monitoring and inspections with specialist consultants and contractors e.g. Project Archaeologist, Project Ecologist, Project Hydrologist, Geotechnical Engineer. Auditing results from environmental monitoring and reporting performance against requirements of the CEMP in the form of a monthly report to the project management team. Provide induction training for all site personnel on environmentally sensitive areas and environmental regulations applicable to their responsibilities, included specific subject related tool box talks e.g. protection of watercourses. Establish and maintain a site Wildlife Register and Photographic Record

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Project Ecologist	Preparation of subject specific management plans to feed into the CEMP e.g. Invasive Species Mapping and Preparation of an Invasive Species Management Plan. Specialist monitoring including; Vantage Point and general bird survey monitoring. Pre-construction Mammal Survey, direct & supervise installation of Bat Boxes. Identification of areas suitable for turve extraction. Direction and review of proposals for restoration of peat storage areas including re-seeding.

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Role	Responsibility
	The Project Ecologist is not a member of the site based project staff but will be called upon to carry out specific tasks and monitoring duties throughout the Construction Phase. The Project Ecologist will be on-call should circumstances require technical environmental expertise and will liaise closely with the ECOW. The Project Ecologist will also be available to liaise with statutory bodies and prepare formal environmental monitoring reports.
Project Hydrologist	The Project Hydrologist will establish and implement an independent surface water monitoring programme to compliment that of the Main Contractor. Liaise with the Project Engineer, Main Contractor and ECOW over the implementation of SuDS (location of settlement ponds, silt traps etc.). The Project Hydrologist is not a member of the site based project staff but will be called upon to carry out specific tasks and monitoring duties throughout the Construction Phase. Typically this will include a monthly site visit to collect samples for water quality analysis at a certified laboratory and preparation of quarterly monitoring reports. The Project Hydrologist will be on-call should circumstances require technical environmental expertise e.g. if a specialist silt buster treatment system is being considered.
Project Archaeologist	Supervise and monitor a programme of pre-construction archaeological test trenching under licence to the DAHG, National Museum and Mayo County Council. Prepare a written and photographic record of archaeological and heritage assets on site and the river crossings along the grid connection cable route. Carryout archaeological monitoring of groundworks. The Project Archaeologist is not a member of the site based project staff but will be called upon to carry out specific tasks and monitoring duties throughout the Construction Phase. The project Archaeologist will liaise closely with the Project Engineer and Main Contractor especially on the construction schedule.
Other Specialist Consultants	Other specialist consultants such as Geotechnical Engineers, Forestry Consultant and Traffic Engineer may be called on from time-to-time during the Construction Phase to supervise, advise or monitor, particular aspects of the project environmental management.

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Sub-Contractors	The contracts of sub-contractors will stipulate and require the adoption of all relevant good practice guidance relating to environmental management and control The activities of sub-contractors will be monitored for environmental compliance.

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Role	Responsibility
	Specialist sub-contractors such as the Site Investigation Contractor, Felling Contractor, Piling Contractor, Ducting Contractor, Drilling Contractor and Specialist Transport Contractor will be required to prepare plans and method statements and may be asked to input into the CEMP.
Construction Personnel	Site personnel do not have a formal role in the CEMP but their observations when environmental issues arise are important for the successful environmental management of the project. As such, construction personnel should have a basic awareness and knowledge of environmental principles so they are the first to observe any non-compliance or potential environmental impact. The ECOW will ensure all construction personnel are made aware of sensitive receptors such as Annex I habitats or water courses during basic site induction and environmental 'toolbox talk' which will be mandatory.

5 Reporting

A critical early task of the CEMP will be to develop templates for the monitoring and reporting of environmental monitoring results, auditing, inspections and non-compliances. Reporting of all monitoring will be retained onsite with the Main Contractor or ECOW, or with the responsible specialist consultant.

- **Monitoring templates should include**; details of methodologies and instrumentation to be used, details of parameters to be monitored, monitoring locations, monitoring frequencies, personnel responsible for carrying out the monitoring, standards or limits to determine non-compliance and procedure for reporting non-compliance.

Each monitoring report will be appropriate to the level of decision making required to find a solution should there be an exceedance of environmental standards. If the problem is relatively straightforward then a simple direct action onsite can be agreed between the Main Contractor and ECOW and recorded. If however an issue is more complex or significant and cannot be resolved easily onsite then the problem must be escalated up a level to the Project Engineer or Project Manager, who may call upon advice from specialist consultants. The ultimate responsibility for implementation of corrective actions lies with the developer ABO Energy.

It will be the role of the site based staff and appointed specialist consultants to monitor, record and report any environmental exceedances to the Project Engineer.

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Monitoring data and reporting will be collated by the Environmental Manager and ECOW and presented in abbreviated format at the monthly site progress meeting. The Monitoring data and reporting will be compiled into a quarterly CEMP Report and reviewed by The Project Engineer.

The Quarterly CEMP Reports should be available to Mayo County Council or prescribed bodies such as National Parks and Wildlife Service should they be requested.

Full details of expected monitoring and reporting (e.g. as conditions of planning) to external stakeholders will be developed and agreed as appropriate.

The CEMP will also establish templates for the reporting/auditing of mitigation measures.

- **Templates for auditing mitigation measures should include**; drawings and methodology for implementation of any necessary infrastructure (e.g. silt traps), frequency of inspection, details of personnel carrying out inspections, staff training details, reporting details (frequency/reporting to).

Issues arising from the CEMP will be included as an agenda item at each monthly site progress meeting with the following general structure:

- Identification of any environmental exceedances in monitoring results and required corrective actions.
- Environmental accidents / incidents (e.g. spills), including cause and remedial action.
- Community liaison, including complaints, cause and corrective action.

The table in Appendix A is compiled from the monitoring and mitigation measures detailed in the Environmental Impact Assessment Report (Volume 2 Main Text). It indicates which phase of the project the mitigation or monitoring relates to and identifies the environmental impact and environmental receptor. Overall objectives are set for each mitigation and monitoring measure as well as who should be responsible for implementation and immediate oversight and a schedule for when each measure applies.

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Phase	Environmental Impact & Receptor	Mitigation Measure or Monitoring Activity	Objective	Responsibility	Schedule
Chapter 5 Biodiversity - Ornithology					
Pre-Construction	Bird Species	Confirmatory breeding bird surveys focused on red grouse, golden plover and snipe, will take place in the spring/summer prior to construction to establish the breeding status and distribution within the Wind Farm Site to a distance of at least 500 m from any works area. As the site has some potential for breeding merlin (though not recorded in the baseline surveys), this species will also be included in the confirmatory surveys. From the results of monitoring, the likely need for restrictive zones to avoid or minimise the potential for adverse effects on breeding activities will be determined. All monitoring surveys will be undertaken by a suitably qualified ornithologist, with the red grouse survey following the tape lure method (under licence). Monitoring of all bird species will take place as required to identify locations of nesting birds during the construction phase should vegetation need to be removed.	Negate Impact to Bird Species	Project Ecologist/ Ornithologist Project Manager	Pre-Construction
Post Construction	Bord Species	Post-construction bird monitoring is required to establish possible effects on bird species as a result of the Project. The monitoring programme will comprise the following: Flight activity surveys Flight activity surveys will be undertaken using the Vantage Point method (Scottish Natural Heritage 2017) during the operational phase of the wind farm. This will use the same two vantage points as used for the baseline EIAR surveys. The surveys will be undertaken monthly in Years 1, 2, 3, 5, 10 and 15 of the life-time of the Project (in accordance with Scottish Natural Heritage Guidance 2009). Distribution and abundance surveys Distribution and abundance surveys will be undertaken to monitor short-term and long-term effects on bird populations within the Wind Farm Site. Survey methodology will be similar to the transect methods employed for baseline summer and winter on-site EIAR surveys, which will allow a comparison of data to be made for each monitoring year. For red grouse, a repeat of the pre-construction red grouse tape lure survey (under licence) will take place in Years 1, 2, 3 and 5 of operation. This will establish whether red grouse maintain a presence on site in the area of the wind farm infrastructure. Surveys will follow the standard methodology as used in the baseline EIAR survey. Collision Searches The Wind Farm project will provide an opportunity to gain baseline data on bird/turbine interactions and hence the Wind Farm Site will be monitored for bird fatalities. Carcass search was traditionally completed by human observers whose efficiency is influenced by several factors including carcass type, environmental conditions and observer competence. Numer-ous studies have been conducted demonstrating that dogs have a superior ability to detect bird and bat carcasses than humans, particularly with small carcasses or in dense vegetation (see NatureScot 2021). A standard plot size will be selected at each turbine location where search will occur. Searcher efficiency and predation tests will be carried out at the commencement of the programme in order to calibrate the results to account for the search dog's ability to find bird corpses and to also account for scavenging of corpses by animals. The collision searches for birds will be combined with the bat carcass searches which will be carried out following guidance by NatureScot (2021). In addition, winter searches will be carried out for birds in each of the survey years owing to the occurrence of wintering golden plover in the area.	Negate Impact to Bird Species	Project Ecologist/ Ornithologist Project Manager	Post Construction
Construction	Sensitive Bird Species	The present assessment has identified the potential for significant disturbance effects on three breeding species of conservation importance as a result of the construction works. These species are red grouse, golden plover and snipe. Best available evidence has been reviewed and it is suggested that these species could be disturbed by construction works, including tree felling, at the following distances: Red grouse 500 m Golden plover 500 m Snipe 400 m	Negate Impact to Sensitive Bird Species	Project Ecologist/ Ornithologist Project Manager	During Construction

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		Should any of these species be recorded breeding within the given distances of the works area through confirmatory surveys before and/or during construction, a buffer zone (using above distances) shall be established around the expected location of the nest (location identified as far as is possible without causing disturbance to the bird) and all works will be restricted within the zone until it can be demonstrated by an ornithologist that the species has completed the breeding cycle in the identified area. Any restricted area that is required to be set up will be marked clearly using hazard tape fencing and all site staff will be alerted through toolbox talks. The above mitigation, as needed, will apply from March to August (inclusive) and will ensure that the works will not have an adverse disturbance effect on the identified species of conservation im-portance recorded during the baseline surveys or in pre-construction surveys			
Construction	Nesting Birds	A range of passerine bird species breed within the site, including meadow pipit (Red-listed) and sky-lark (Amber-listed). Disturbance to, or destruction of, active nests during construction activities could contravene Section 22 of the Wildlife Acts 1976 to 2021. Clearance of ground vegetation will take place outside of the bird breeding season (1st March – 31st August) to minimise the possibility of disturbance and destruction to occupied bird nests during the construction phase. However, it is possible that some ground may still need to be cleared of vegetation during the breeding season or that previously cleared ground will have developed colonising vegetation which could attract nesting birds such as wren. Should these occurrences arise, the following protocol will be followed: – The area will be surveyed by a qualified ecologist with ornithological experience up to 10 days before any clearance. Should an active nest be located, the area will be restricted from works by a distance where it is considered that the works would not cause disturbance or abandonment of the nest. Such distances, which will vary according to species and local topography, will be determined by the ornithologist. The restriction will be maintained until it is established that any young birds present have fledged. – Should an instance arise where the placement of a restriction would have significant implications for the time frame of the project, and where no alternative mitigation is available to prevent disturbance to the nest, the ecologist will evaluate the situation in the context of the conservation status of the species and the stage of breeding, i.e. nest with eggs, nest with young chicks, nest with large young near fledging stage, and will advise on the best approach in the context of the Wildlife Acts. In such cases, the local representative of NPWS would be consulted. With the above mitigation implemented, the effect of disturbance to nesting passerine species can be avoided or reduced to Not Significant.	Negate impact on nesting birds	Project Ecologist / Ornithologist Project Manager	During construction, Pre-Construction
Operational	Bird Species	A requirement for mitigation during the operational phase of the wind farm has not been identified. However, should post construction monitoring identify an impact, such as higher collision rates than predicted for a particular species due perhaps to a change in population distribution since the baseline surveys, mitigation will be considered following best practice available at the time. This could involve the regular clearance of vegetation within the area of the identified turbine to discourage birds such as kestrel from hunting too close to the turbine.	Negate impact on bird species	Project Ecologist / Ornithologist Project Manager	During Operation
Decomissioning	Bird Species	As the decommissioning works will involve works similar to those involved at construction stage, these could result in similar effects on birds. Hence, the mitigation that will be undertaken during construction will also be applied during the decommissioning phase (taking into account changes in bird populations and distributions that may have occurred locally during the operational life of the project).	Negate impact on bird species	Project Ecologist Ornithologist	During decomissioning
Chapter 6 Biodiversity - Ecology					
Construction	Non-Volant Mammals	A pre-construction mammal survey will be carried out by a suitably qualified Ecologist immediately before the commencement of vegetation clearance. The Ecologist will advise on the need for any additional requirements in the event the ecological context of the site has changed.	Mitigate impact on non-volant mammals	ECOW Project Ecologist	Ongoing during Construction Pre-construction
Construction	Bats	Pre-construction surveys will be carried out by an Ecologist immediately prior to the commencement of clearance to establish if the baseline conditions reported herein remain valid, given the potential for delays between reporting and the commencement of construction.	Mitigate impact on bats	ECOW Project Ecologist	Ongoing during Construction Pre-construction

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		Night-time lighting will be limited in extent (both static lighting and vehicle headlights) as standard construction operations will take place during the hours of daylight in as far as possible to minimise disturbances to bats and other wildlife.			
Construction	Other Taxa	Areas where spoil is to be stored temporarily, or permanently, should be checked in advance for the presence of Frogs (and spawn). If protected species are present, the environmental staff will translocate these, if possible (under licence if applicable). The same measure should be applied for any drains or areas of standing water forded by construction machinery. These areas will be checked on an ongoing basis by the ECoW and any areas with breeding frogs, spawn or tadpoles will be mapped and if possible, fenced off temporarily to allow Frogs to metamorphose. If such areas cannot be avoided by site traffic the environmental staff will translocate the frogs (adults/young) under licence if applicable. If other taxa such as Lepidoptera, Common Lizard etc. are recorded within or adjacent to the site, or the turbine delivery and grid connection routes, these sightings will be logged on the wildlife register and appropriate mitigation measures will be implemented as necessary in accordance with the advices of the appointed project ecologist or ECoW.	Mitigate impact on other Taxa	ECOW Project Ecologist	Ongoing during Construction Pre-construction
Construction	Aquatic Ecology	Construction phase mitigation measures for aquatic ecology predominantly involve the preservation of water quality. Construction phase mitigation for hydrology and water quality is detailed in Chapter 7 which presents detailed measures which will protect water quality during the course of construction works to include peat extraction, water crossings, felling, directional drilling and wastewater disposal.	Mitigate impact on aquatic ecology	ECOW Project Ecologist	Ongoing during Construction Pre-construction
Construction	Habitats and Flora	No removal of habitats outside the footprint of the development will take place. Measures are Peat and Spoil Management Plan (Fehily Timoney, 2024) for peat placement during the construction phase. Peat will only be stored at the borrow put or in degraded areas of cutover bog (PB4), and not on any other habitats. A Peat and Spoil Management Plan (Fehily Timoney, 2024) has been prepared for the proposed development (Appendix 8.2). General measure to minimise the potential risk of peat instability during the construction phase are detailed in the management plan. Where excessive peat movement is recorded then all activities will cease in the affected area, monitoring will be increased and the location until such time that the movement ceases and the works will only recommence following agreement with all parties involved. As a contingency measure a check barrage procedure has been included in the management plan to prevent peat slide from moving downstream within a watercourse. This will involve the placement of rock fill (from the onsite borrow pit) across a watercourse which will allow the passage of water but not the passing of peat debris. It is proposed that the borrow pit be reinstated using excavated peat and soil, while the excavated rock will be used for the construction of infrastructure on site (i.e. hardstands etc.) Cells will be constructed within the row pit for the placement of excavated peat and spoil. This is to allow for the safe placement and grading of the peat and spoil using dumper trucks and excavators and eliminates the need to construct above ground retaining structures which may have an unnecessary impact and increase the development footprint of the proposed wind farm. A 'Habitat and Species Management Plan' (HSMP) will be prepared and submitted to the local authority prior to construction	Mitigate impact on habitats and flora	ECOW Project Ecologist Project Manager Operation Manager	Ongoing during Construction Pre-construction
Operational	Non-Volant Mammals	No operational phase measures are considered warranted in relation to non-volant mammals.	N/A	N/A	N/A
Operational	Bats	No vegetation buffers around the turbines are considered necessary in the context of the proposed development, given the nature of the existing environment within which the turbines are proposed (i.e. cutover bog / upland blanket bog). Reduced rotation speed will be implemented when turbines are idling. 'Feathering' of idling blades may reduce fatality rates by up to 50% and does not result in loss of output (SNH, 2021). No additional control measures to avoid/reduce collision related bat fatalities are considered warranted in this instance. Post-construction fatality monitoring will be carried out in years 1, 2, 3 and 5 post construction. The purpose of this monitoring will be to contribute to the understanding of the impacts of wind energy developments on bat populations in an Irish context. Post-construction monitoring will consist of:	Mitigate impact on bats	ECOW Project Ecologist Project Manager Operation Manager	Post-construction Operational

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		Passive bat monitoring at eight turbine locations during the bat activity season in order to monitor changes in activity levels relative to pre-construction baseline information (presented herein). Fatality monitoring following the methodology presented NIEA (2022). Carcass searches, to monitor and record bat (and bird) fatalities, will be conducted at each turbine. This will include searcher efficiency trials and an assessment of scavenger removal rates to determine the appropriate correction factor to be applied in relation to determining an accurate estimate of collision mortality. Post-construction monitoring data will be analysed and presented in report format to the relevant planning authority. No additional lighting will be provided during the operational phase.			
Operational	Other Taxa	Other taxa will benefit from the measures outlined above in relation to habitats and flora and protection of water quality in particular. It is considered that no additional measures are required.	Mitigate impact on other taxa	N/A	N/A
Operational	Aquatic Ecology	Operational phase mitigation measures for aquatic ecology are outlined in Chapter 7 and include off-site refuelling, the presence of spill kits in all on-site vehicles, bunding of any storage areas to 110% (with storm drainage systems and appropriate oil interceptors), and the use of authorised quarries (washed substrata) for use in road and hardstand maintenance. No other measures are considered warranted.	Mitigate impact on aquatic ecology	ECOW Project Ecologist Operation Manager	Post-construction Operational
Operational	Habitats and Flora	Regular inspections will be carried out by site staff to ensure that the drainage regime is adequately maintained to protect the future stability of the surrounding high value habitats and botanical species as a whole. Measures detailed in the Habitat and Species Management Plan to establish a peatland vegetative community on the peat deposition areas will be fully implemented. This includes monitoring of the revegetation process post-construction.	Mitigate impact on habitats and flora	ECOW Project Ecologist Operation Manager	Post-construction Operational
Decommissioning	Mammals, habitats and other taxa	A Decommissioning Environmental Management Plan (DEMP) will be developed for the decommissioning phase of the proposed wind farm development (EMP, 2024). There will be no additional habitat loss associated with the decommissioning of the Proposed Development and therefore there will be no significant effects in this regard. In addition, the removal of the in infrastructure will involve similar operations to those involved in construction but without the largescale earth moving or excavations as the turbine bases and roads etc. will be left in place. These works would therefore be of a smaller scale but would have similar impacts on ecology to those experienced during construction. There would be no additional or ancillary impacts associated with the decommissioning phase. The same mitigation to prevent significant impacts on water quality and associated aquatic fauna and other terrestrial fauna during construction will be applicable to the decommissioning phase. The CEMP for the project provides the details of the mitigation and best practice that will be employed to avoid any potential for significant residual effects on biodiversity during decommissioning of the proposed wind farm. The proposed development will generate waste through the decommissioning phase which will be treated in accordance with the specific site waste management plan prepared at that time. All above surface mechanical/electrical equipment and the control building will be removed, the concrete bases will be covered over with soil, reinstated and allowed to naturally revegetate. The proper handling and disposal of any contamination material (e.g. lubricating/cooling oils) will be ensured by the developer such that all contaminating material will be removed from the site in accordance with best practice.	Minimise impact to mammals, habitats and other taxa	Main Contractor Project Engineer ECOW	Ongoing during decommissioning 1 Year post decommissioning
Chapter 7 Hydrology, Hydrogeology					
Construction	Earthworks Resulting in Suspended Solids Entrainment in Surface Waters	All of the key development components within the Wind Farm Site are located significantly away from the delineated 50m watercourse buffer zones with the exception of the upgrading of the existing watercourse crossing, new drain crossings, upgrades to existing site tracks and the new proposed bridge crossing over the Keerglen River. The large setback distance from sensitive hydrological features means that adequate room is maintained for the proposed drainage mitigation measures (discussed below) to be properly installed and operate effectively. The proposed buffer zone will: • Avoid physical damage (river/stream banks and river/stream beds) to watercourses and the associated release of sediment; • Avoid excavations within close proximity to surface watercourses; • Avoid the entry of suspended sediment from earthworks into watercourses; and,	Minimise impact on water quality	Main Contractor ECOW Project Hydrologist Project Engineer	During Construction Pre-Commencment

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		• Avoid the entry of suspended sediment from the construction phase drainage system into watercourses, achieved in part by ending drain discharge outside the buffer zone and allowing percolation across the vegetation of the buffer zone. The Proposed Development design has been optimised to utilise the existing infrastructure (i.e. roads) where practicable. This design prevents the unnecessary disturbance of peat and spoil, and reduces the potential for elevated concentrations of suspended solids in runoff. Presented below are temporary and long-term drainage control measures that will be utilised during the construction phase of the Proposed Development. As stated above there is an existing drainage network in some areas of the Proposed Development Site which comprises of peat drains and natural streams. The measures outlined below will be used in conjunction with the existing drainage network to ensure the protection of all rivers and downstream watercourses. Source controls: • Interceptor drains, vee-drains, diversion drains. • Small working areas, covering temporary stockpiles, weathering off of side-cast peat/spoil, cessation of works in certain areas or other similar/equivalent or appropriate measures. In-Line controls: • Interceptor drains, vee-drains, temporary sumps/attenuation lagoons, sediment traps, pumping systems, settlement ponds, temporary pumping chambers, or other similar/equivalent or appropriate systems. Treatment systems: • Temporary sumps and attenuation ponds, temporary storage lagoons, sediment traps, and settlement ponds, and proprietary settlement systems such as "Siltbuster", and/or other similar/equivalent or appropriate systems. There is an existing network of drains present at the Wind Farm Site and in some areas, these will be integrated and enhanced as required and used within the Proposed Development drainage system. The key elements are the upgrading and improvements to water treatment elements, such as in-line controls and treatment systems, including silt traps and settlement ponds. The main elements of interaction with existing drains will be as follows: • Apart from interceptor drains, which will convey clean runoff water to the downstream drainage system, there will be no direct discharge (without treatment for sediment reduction, and attenuation for flow management) of runoff from the proposed wind farm drainage into the existing site drainage network. This will reduce the potential for any increased risk of downstream flooding or sediment transport/erosion; • Temporary silt traps will be placed in the existing drains downstream of construction works, and these will be diverted into proposed interceptor drains, or culverted under/across the works area; • During the operational phase of the wind farm runoff from individual turbine hardstanding areas will be not discharged directly into the existing drainage network but discharged locally at each turbine location through field drains, main drains, and existing settlement ponds; • Buffered outfalls which will be numerous over the site will promote percolation of drainage waters across the bog surface and close to the point at which the additional runoff is generated, rather than direct discharge to the existing drains of the site; • Velocity and silt control measures such as check dams, sandbags, oyster bags, straw bales, flow limiters, weirs, baffles, silt fences will be used during the upgrade construction works; and, • Existing culverts will be lengthened where necessary to facilitate access road widening.			
Construction	Potential Impacts on Groundwater Levels during Excavation Works	The Wind Farm Site is underlain by a Poor Aquifer and contains bedrock which is generally unproductive. The site is elevated and groundwater will flow downslope towards the Keerglen River. The topographical (i.e., the elevation of the turbines) and hydrogeological setting of the turbine locations means no significant groundwater dewatering is expected to be required. Moreover, direct rainfall and surface water runoff will be the main inflows that will require water volume and water quality management. For the avoidance of doubt. we would generally define dewatering as a requirement to permanently drawdown the local groundwater table by means of over pumping, e.g. as would be required for the operation of a bedrock quarry in a valley floor. Relevant environmental management guidelines from the EPA quarry 2006 guidance document – "Environmental Management in the Extractive Industry" in relation to groundwater issues will be implemented during the construction phase.	Prevent impact on water quality from suspended solids due to earthworks	Main Contractor Project Engineer	Ongoing during Construction

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Construction	Excavation Dewatering and Potential Effects on Surface Water Quality	The Wind Farm Site is underlain by a Poor Aquifer and contains bedrock which is generally unproductive. The site is elevated and groundwater will flow downslope towards the Keerglen River. The topographical (i.e., the elevation of the turbines) and hydrogeological setting of the turbine locations means no significant groundwater dewatering is expected to be required. Moreover, direct rainfall and surface water runoff will be the main inflows that will require water volume and water quality management. Relevant environmental management guidelines from the EPA quarry 2006 guidance document – "Environmental Management in the Extractive Industry" in relation to groundwater issues will be implemented during the construction phase.	Prevent impact on water quality from suspended solids due to excavation de-watering	Main Contractor Project Engineer	Ongoing during Construction
Construction	Potential Release of Hydrocarbons during Construction and Storage	All plant will be inspected and certified to ensure they are leak free and in good working order prior to use on the wind farm site; On-site re-fuelling of machinery will be carried out using a mobile double skinned fuel bowser. The fuel bowser, a double axel custom-built refuelling trailer or truck will be re-filled off site and will be towed/driven around the wind farm site to where machinery are located. The 4x4 jeep/fuel truck will also carry fuel absorbent material and pads in the event of any accidental spillages. The fuel bowser will be parked on a level area in the construction compound when not in use and only designated trained and competent operatives will be authorised to refuel plant. Mobile measures such as drip trays and fuel absorbent mats will be used during all refuelling operations; Fuels stored on the wind farm site will be minimised. Any storage areas will be bunded appropriately for the fuel storage volume for the time period of the construction; The electrical control building will be bunded appropriately to the volume of oils likely to be stored and to prevent leakage of any associated chemicals and to groundwater or surface water. The bunded area will be fitted with a storm drainage system and an appropriate oil interceptor; The plant used will be regularly inspected for leaks and fitness for purpose; and, An emergency plan for the construction phase to deal with accidental spillages will be contained within the Construction Environmental Management Plan. Spill kits will be available to deal with accidental spillages.	Prevent impact on downstream surface water quality from the use of Silt Buster	Main Contractor	Ongoing during Construction
Construction	Potential ground and surface water contamination from wastewater disposal	During the construction phase, a self-contained port-a-loo with an integrated waste holding tank will be used at each of the site construction compounds, maintained by the providing contractor, and removed from the site on completion of the construction works; Water supply for the site office and other sanitation will be brought to site and removed after use by a licensed contractor to be discharged at a suitable off-site treatment location; and, No water or wastewater will be sourced on the site, nor discharged to the site.	Prevent impact on water quality and hygiene from wastewater disposal	Main Contractor	Ongoing during Construction
Construction	Surface Water Quality Impacts During Excavations Along the Grid and TDR Works (haul route)	No in-stream works are required at any of these crossings, however due to the proximity of the streams to the construction work at the crossing locations, there is a potential for surface water quality impacts during trench excavation work. Mitigation measures are outlined below. A constraint/buffer zone will be maintained for all crossing locations where possible, whereby all watercourses will be fenced off. In addition, measures which are outlined below will be implemented to ensure that silt laden or contaminated surface water runoff from the excavation work does not discharge directly to the watercourse. The large setback distance from sensitive hydrological features means that adequate room is maintained for the proposed drainage mitigation measures (discussed below) to be properly installed and operate effectively.	To limit any hydrocarbons being released during construction	Main Contractor ECOW	Ongoing during Construction
Construction	Surface Water Quality Impacts During Directional Drilling Works Along the Grid	Although no in-stream works are proposed, the drilling works will only be done over a dry period between July and September (as required by IFI for in-stream works) to avoid the salmon spawning season and to have more favourable (dryer) ground conditions; The crossing works area will be clearly marked out with fencing or flagging tape to avoid unnecessary disturbance; There will be no storage of material / equipment or overnight parking of machinery inside the 15m buffer zone; Before any ground works are undertaken, double silt fencing will be placed upslope of the watercourse channel along the 15m buffer zone boundary; Additional silt fencing or straw bales (pinned down firmly with stakes) will be placed across any natural surface depressions / channels that slope towards the watercourse; Silt fencing will be embedded into the local soils to ensure all site water is captured and filtered;	Reduce Impact on water quality	Main Contractor Project Engineer ECOW	Ongoing during Construction During Operation

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		The area around the bentonite batching, pumping and recycling plant will be bunded using terram (as it will clog) and sandbags in order to contain any spillages; Drilling fluid returns will be contained within a sealed tank / sump to prevent migration from the works area; Spills of drilling fluid will be clean up immediately and stored in an adequately sized skip before been taken off-site; If rainfall events occur during the works, there will be a requirement to collect and treat small volumes of surface water from areas of disturbed ground (i.e. soil and subsoil exposures created during site preparation works); This will be completed using a shallow swale and sump down slope of the disturbed ground; and water will be pumped to a proposed percolation area at least 50m from the watercourse The discharge of water onto vegetated ground at the percolation area will be via a silt bag which will filter any remaining sediment from the pumped water. The entire percolation area will be enclosed by a perimeter of double silt fencing; Any sediment laden water from the works area will not be discharged directly to a watercourse or drain; Works shall not take place during periods of heavy rainfall and will be scaled back or suspended if heavy rain is forecasted; Daily monitoring of the compound works area, the water treatment and pumping system and the percolation area will be completed by a suitably qualified person during the construction phase. All necessary preventative measures will be implemented to ensure no entrained sediment, or deleterious matter is discharged to the watercourse; If high levels of silt or other contamination is noted in the pumped water or the treatment systems, all construction works will be stopped. No works will recommence until the issue is resolved and the cause of the elevated source is remedied; On completion of the works, the ground surface disturbed during the site preparation works and at the entry and exit pits will be carefully reinstated and re-seeded at the soonest opportunity to prevent soil erosion; The silt fencing upslope of the river will be left in place and maintained until the disturbed ground has re-vegetated; There will be no batching or storage of cement allowed at the watercourse crossing; There will be no refuelling allowed within 100m of the watercourse crossing; and, All plant will be checked for purpose of use prior to mobilisation at the watercourse crossing.			
Construction	Release of cement-based products	No batching of wet-cement products will occur on the wind farm site. Ready-mixed supply of wet concrete products and/or emplacement of pre-cast elements will take place; Pre-cast elements for culverts and concrete works will be used; No washing out of any plant used in concrete transport or concreting operations will be allowed on-site; Where concrete is delivered on the wind farm site, only the chute will be cleaned, using the smallest volume of water possible. No discharge of cement contaminated waters to the construction phase drainage system or directly to any artificial drain or watercourse will be allowed. Chute cleaning water is to be isolated in temporary lined wash-out pits located near the proposed wind farm site compound. These temporary lined wash-out pits will be removed from the wind farm site at the end of the construction phase; The contractor will use weather forecasting to plan dry days for pouring concrete; and, The contractor will ensure pour site is free of standing water and plastic covers will be ready in case of sudden rainfall event.	Prevent contamination from release of cement-based products	Main Contractor	Ongoing during Construction
Construction	Potential effects from use of Siltbuster on Downstream Surface Water Quality	Chemical dosing is intended to force smaller/lighter particles to join together and therefore be heavy enough to settle out. As such the added chemicals are bound in the flocc and do not get carried over into the treated discharge water. As such, the risk to water quality relates to operational issues, such as spill management and prevention of overdosing. Measures that will be employed to prevent spills and prevent overdosing and potential chemical carryover include: Use of bunded chemical storage areas; Loading and unloading of chemical containers by trained staff; Use of spill kits and emergency response procedures in the event of a spill; The siltbuster system comprises an electronic in-line dosing system which provides an accurate means of adding agents so overdosing does not occur;	Provide flow attenuation to reduce risk of flooding	Operations Manager	Ongoing during Operations

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		Continued monitoring and water analysis of pre and post treated water by means of an inhouse lab and dedicated staff, means the correct amount of chemical is added by the dosing system; Dosing rates of chemical to initiate settlement is small, being in the order of 2-10 mg/L and the vast majority of the chemical is removed in the deposited sediment; Final effluent not meeting the discharge criteria is recycled and retreated, which has a secondary positive effect of reducing carryover; and, Use of biodegradable chemical agents can be used at very sensitive sites (i.e. adjacent to SACs).			
Construction	Excavation Dewatering and Potential Effects on Surface Water Quality	Management of surface water and groundwater seepages and subsequent treatment prior to discharge into the drainage network will be undertaken as follows: Appropriate interceptor drainage, to prevent upslope surface runoff from entering excavations will be put in place; If required, pumping of excavation inflows will prevent build-up of water in the excavation; The interceptor drainage will be discharged to the wind farm site constructed drainage system or onto natural vegetated surfaces and not directly to surface waters; The pumped water volumes will be discharged via volume and sediment attenuation ponds adjacent to excavation areas, or via specialist treatment systems such as a Siltbuster unit; There will be no direct discharge to surface watercourses, and therefore no risk of hydraulic loading or contamination will occur; Daily monitoring of excavations by a suitably qualified person will occur during the construction phase. If high levels of seepage inflow occur, excavation work will immediately be stopped and a geotechnical assessment undertaken; and, A mobile 'Siltbuster' or similar equivalent specialist treatment system will be available on-site for emergencies in order to treat sediment polluted waters from settlement ponds or excavations should they occur. Siltbusters are mobile silt traps that can remove fine particles from water using a proven technology and hydraulic design in a rugged unit. The mobile units are specifically designed for use on construction-sites. They will be used as final line of defence if needed.	Reduce Impact on water quality	Main Contractor	Ongoing during Construction
Operational	Progressive Replacement of Natural Surface with Lower Permeability Surfaces	The Proposed Development design has been optimised to utilise the existing infrastructure (i.e. site access roads) where practicable. This design prevents the unnecessary creating of additional hardstand areas which would increase surface water runoff from the Proposed Development Site. As part of the proposed wind farm drainage design, it is proposed that runoff from the proposed infrastructure will be collected locally in new proposed silt traps, settlement ponds and vegetated buffer areas prior to release into the existing site drainage network. The new proposed drainage measures will then create significant additional attenuation to what is already present. The operational phase drainage system will be installed and constructed in conjunction with the existing site drainage network and will include the following: Interceptor drains will be installed up-gradient of all proposed infrastructure to collect clean surface runoff, in order to minimise the amount of runoff reaching areas where suspended sediment could become entrained. It will then be directed to areas where it can be re-distributed into downstream field drains; Collector drains will be used to gather runoff from access roads and turbine hardstanding areas of the site likely to have entrained suspended sediment, and channel it to new local settlement ponds for sediment settling; On sections of access road transverse drains ('grips') will be constructed where appropriate in the surface layer of the road to divert any runoff off the road into swales/roadside drains; Check dams will be used along sections of access road drains to intercept silts at source. Check dams will be constructed from a 4/40mm non-friable crushed rock; Settlement ponds, emplaced downstream of access road sections and at turbine locations, will buffer volumes of runoff discharging from the drainage system during periods of high rainfall, by retaining water until the storm hydrograph has receded, thus reducing the hydraulic loading to existing drains; Settlement ponds will be designed in consideration of the greenfield runoff rate; and, All surface water runoff from the development will have to pass through the proposed settlement ponds prior to release into the existing site drainage network	Control and guide run off to minimise impact on water quality	Main Contractor Project Engineer	Ongoing during construction

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Chapter 8 Soils and Geology					
Construction	Potential Impact on Site Lands	The Proposed Development will be constructed in a phased manner to reduce the potential impacts of the Proposed Project on the Soils and Geology. Phased construction reduces the amount of open, exposed excavations at any one time. Given that the works comprises a significant proportion of excavation and earthworks, suitably qualified and experienced geotechnical personnel will be required on site to supervise the works. Excavation of peat, subsoil and bedrock will be required for site levelling and for the installation of infrastructure and foundations for the access roads and turbines. This will result in a permanent removal of peat, subsoil and bedrock at excavation locations. There is no loss of peat or subsoil, it will just be relocated within the site	Reduce the potential impacts of the Proposed Project on the Soils and Geology	Main Contractor	Ongoing through construction
Construction	Earthworks	Minimisation of volumes of excavated materials to be exported off site. All excavated peat/spoil will be retained on-site. This will include: - Use of suitable site won material (crushed rock) as general fill in the construction of access tracks, hardstands and in reinstatement around turbine foundations. - Surplus peat/spoil will be re-used on site in the form of landscaping. The minimum possible volume of peat and subsoil will be removed to allow for infrastructural work to take place in comparison to the total volume present on the site due to optimisation of the layout by mitigation by design. Surplus peat/spoil excavated during the course of the works will be temporarily stored in a level area adjacent to the construction phase excavations prior to reuse.	Minimise impact on excavated materials	Main Contractor Project Engineer	During construction
Pre-Construction	Earthworks	Prior to the commencement of any earthworks, the work corridor will be pegged, and machinery will stay within this corridor so that soils outside the work area are not damaged. Excavations will then be carried out from access tracks as they are constructed in order to reduce the compaction of soft ground.	To mitigate against the compaction of soil at the site.	Main Contractor Project Engineer	During construction
Construction	Earthworks	All excavations will be constructed and backfilled as quickly as possible. Excavations will stop during or prior to heavy rainfall events (>5mm/hour). To mitigate against possible contamination of the exposed soils and bedrock, refuelling of machinery and plant will only occur at designated refuelling areas.	To mitigate against erosion of the exposed soil or rock.	Main Contractor Project Engineer	During construction
Construction	Earthworks	All temporary cuts/excavations will be carried out such that they are stable or adequately supported. Gravel fill will be used to provide additional support to temporary cuts/excavations where appropriate. Unstable temporary cuts/excavations will not be left unsupported. Where appropriate and necessary, temporary cuts and excavations will be protected against the ingress of water or erosion.	To mitigate against erosion of the exposed soil or rock.	Main Contractor Project Engineer	During construction
Construction	Earthworks	Peat removed from turbine locations and access roads will be used for landscaping, spread within the proposed peat placement areas around certain turbines and used to reinstate the proposed borrow pit. The acrotelm will be stored with the vegetation part of the sod facing the right way up to encourage growth of plants and vegetation at the surface of the stored peat within the borrow pit. Reseeding and spreading/planting of heather and moss cuttings will also be carried out in these areas.	To prevent erosion of stored peat in the long term	Main Contractor Project Engineer	During construction
Construction	Earthworks	Any excess temporary mounded peat in storage for long periods will be sealed using the back of an excavator bucket. Silt fences will be installed around stockpiles to limit movement of entrained sediment in surface water runoff. The use of bunds around earthworks and mounds will prevent egress of water from the works.	This will minimise erosion of soil	Main Contractor Project Engineer	During construction
Construction	Earthworks	All excavations will be constructed and backfilled as quickly as possible, although this will depend on the nature of the excavation – a hardstand excavation can be backfilled immediately, however a turbine base excavation will remain open for a prolonged period of time as the base is constructed. Excavations will stop during or prior to heavy rainfall events.	To mitigate against erosion of the exposed soil or rock	Main Contractor Project Engineer	During construction
Construction	Peat Stability Risk	• Appointment of experienced and competent Contractor; • The site will be supervised by experienced and qualified personnel, including a Project Geotechnical Engineer; • Allocate sufficient time for the project (be aware that decreasing the construction time has the potential to increase the risk of initiating a peat movement); • Loading or stockpiling of materials on the surface of soft ground will be avoided. Loading or stockpiling on other deposits will not be undertaken without first establishing the adequacy of the ground to support loads by an appropriately qualified geotechnical engineer	Assist in the management of Peat associated risks at the site	Main Contractor Project Engineer	During construction

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		experienced in construction within upland conditions. No stockpiling of material shall take place on steep slopes. • Prevent undercutting of slopes and unsupported excavations. All temporary cuts/excavations will be carried out such that they are stable or adequately supported. Gravel/rock fill will be used to provide additional support to temporary cuts/excavations where appropriate, as determined by the Project Geotechnical Engineer. Unstable temporary cuts/excavations will not be left unsupported. Where appropriate and necessary, temporary cuts and excavations will be protected against the ingress of water or erosion. Open excavations will be inspected on a daily basis. • Excavation will be carried out from access roads or hardstanding areas to avoid tracking of construction plant across areas of soft ground/peat. • Excavations which could have the potential to undermine the up-slope component of an existing slope will be sufficiently supported to resist lateral slippage and careful attention will be given to the existing drainage. • Blasting of rock will not be permitted. • Maintain a managed robust drainage system; • Drainage infrastructure will be put in place in advance of excavations. Drains will divert surface water and groundwater away from excavations into the existing and proposed surface drainage network. Uncontrolled, direct and concentrated discharges of water onto the ground surface will be avoided. • Prevent placement of loads/overburden on marginal ground as detailed in the peat stability assessment report; • Set up, maintain and report findings from monitoring systems (as described in the Peat & Spoil Management Plan, Appendix 8.2); • Undertake strength testing of peat directly prior to access road construction for new access roads. • Earthworks will not be commenced when heavy or sustained rainfall (orange or red weather warnings) is forecast. A series of rainfall gauges will be installed across the Proposed Development site to provide a record of rainfall intensity. An inspection of site stability and drainage by the Geotechnical Engineer will be carried out on site when a daily rainfall of over 5mm/hr or 25mm/day is recorded on site, works will only recommence after heavy rain with the prior approval of the Geotechnical Engineer following their inspection. • An emergency plan will be updated at pre-construction stage detailing the action plan which would be implemented in the unlikely event of a landslide/slope failure. Should a landslide/slope failure occur or if signs of instability/ground movement are observed, work will cease immediately. • Engineer and Contractor to ensure that construction method statements are followed; and, • Revise the Geotechnical Risk Register, as necessary as construction progresses.			
Operational	Earthworks	There is a low risk to the geology receptors from compaction of soils due to the movement of HGVs and maintenance vehicles. All site traffic will be limited to access tracks, thereby reducing the area over which compaction of the underlying natural soils can occur. In relation to indirect impacts a small amount of granular material will be required to maintain access tracks during operation which will place intermittent minor demand on local quarries. Please note the onsite borrow pit will have been reinstated with excavated peat and spoil following the construction stage and will not be available to source aggregate during the operational phase. None of these potential impacts are considered to be significant, as they are of such small scale and also of an intermittent nature.	Prevent impact of operational activities on land	Main Contractor Project Manager Project Engineer	Ongoing through construction
Construction		Any excavation and construction related works will be subject to a design risk assessment at detailed design stage to determine risk levels for the construction, operation and maintenance and decommissioning of the works. Identified impacts will be minimised by the application of principles of avoidance, prevention and protection. Information on residual impacts will be recorded and relayed to appropriate parties. A detailed method statement for each element of the works will be prepared by the Contractor prior to any element of the work being carried out. Given that the works comprise a significant proportion of excavation and earthworks, suitably qualified and experienced geotechnical personnel will be required on site to supervise the works. The Contract will require programming of the works such that earthworks are not scheduled during severe weather conditions.		Main Contractor Project Manager Project Engineer	Ongoing through construction

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Chapter 9 Material Assets – Telecommunications and Aviation					
Construction		Although it is envisaged that there will be no impact due to the proposed Keerglen wind turbines, it is recommended that the turbines would be fitted with aviation lighting in accordance with standard industry practice. Following the consultations with 2RN there was a requirement for a protocol agreement for mitigation measures to be put in place to remediate any potential TV interference impacts, caused by the proposed wind farm, to viewers in the area. If required, the mitigations measures could include; -TV Antenna re-alignment and increase in height -Antenna Re-tuning (getting signal from a different RTE TV transmitter) - SaorSAT Satellite based TV service	Minimise impact on material assets and telecommunications	Project Manager	Pre-Construction During construction
Chapter 10 Landscape and Visual Assessment					
Construction and operation	Potential impact on the local environment	The colour will be industry standard off-white/light grey semi-matt non-reflective finish; Transmission lines between individual turbines and the substation will be placed underground if possible	Reduce visual impact on surrounding landscape	Project Engineer Main Contractor	Construction
Decommissioning	Potential impact on the local environment	The decommissioning phase will see a similar nature of effects to the construction stage due to the movement of heavy machinery within the site and to and from the site removing turbine components. However, such effects will be temporary in duration and decrease in scale as turbines are removed from view and the landscape is substantially reinstated to former uses. As with construction stage impacts, decommissioning stage effects are not considered to be significant.	Reduce impact on landscape	Project Engineer Main Contractor	Decomissioning
Chapter 11Shadow Flicker					
Operational	Shadow flicker on houses	To eliminate shadow flicker or to mitigate the impacts to the degree necessary, a shadow flicker control system will be deployed at each of the turbines where it is necessary. The operation of the installed shadow flicker control measures will ensure that there will be no impact from shadow flicker. The operation and performance of the shadow flicker control measures will be monitored on an ongoing basis.	Mitigate shadow flicker effect	Project Manager Operations Manager	Pre-Construction Ongoing during operation
Chapter 12 Noise					
Construction	Noise Pollution	General guidance for controlling construction noise through the use of good practice given in BS 5228 will be followed. Construction and Decommissioning of the Development shall be limited to working times given and any controls incorporated in any planning permission. Limiting the hours during which site activities likely to create high levels of noise or vibration are permitted; Establishing channels of communication between the contractor/ developer, Local Authorities and residents; Monitoring typical levels of noise and vibration during critical periods and at sensitive locations;	Mitigate impact of noise	Main Contractor	Ongoing during construction / Decommissioning
Chapter 13 Archaeology and Cultural Heritage					
Pre-Construction	Potential permanent indeterminable direct impact on previously unrecorded archaeological remains	Pre-development archaeological testing of all areas if land take associated with the proposed development. Test trenching will be carried out under Licence to the Department of Housing, Local Government and Heritage, the National Museum of Ireland, and to the satisfaction of the Mayo County Council Archaeologist. Further archaeological mitigation measures may be recommended pending the results of the test trenching programme, and in agreement with the Department of Housing, Local Government and Heritage and the Mayo County Council Archaeologist.	Mitigate any impact on previously unrecorded archaeological remains	Site Investigation Contractor Main Contractor Project Archaeologist Project Engineer	Pre-construction

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Construction	Architectural and Cultural Heritage	Should any areas of proposed land take not be suitable for test trenching (such as along the line of the access track, locations with deep bog, etc.), it is recommended that archaeological monitoring of construction works be carried out in those areas. Monitoring will be carried out under Licence to the Department of Housing, Local Government and Heritage, the National Museum of Ireland, and to the satisfaction of the Mayo County Council Archaeologist. Further archaeological mitigation measures may be recommended pending the results of the monitoring programme, and in agreement with the Department of Housing, Local Government and Heritage and the Mayo County Council Archaeologist.	Mitigate any impact on previously unrecorded archaeological remains	Project Archaeologist	Pre-construction
Construction		Post-consent pre-construction Architectural Impact Assessment of Ballinglen Bridge, containing written, drawn and photographic records, be carried out by a recognised historic building consultant/Conservation Architect.	Record feature	Project Archaeologist Conservation Architect	Pre-construction
Chapter 14 Transport and Traffic					
Construction	Short-term temporary inconvenience and safety of local and regional road users	A Construction Traffic Management Plan will be prepared in consultation with Mayo County Council that will maximise the safety of the workforce and the public and minimises construction traffic generation and disruption, while maintaining access to properties at all times. The contractor shall provide an appropriate information campaign for the duration of the construction works so local residents and visitors are aware of the traffic management measures that are to be implemented. Procedures and timetables regarding the passage and escort of abnormal loads will be agreed in advance as part of the Construction Traffic Management Plan. The deliveries of abnormal loads will be carefully co-ordinated to avoid conflict with any other road works or neighbouring developments. The large turbine components will be transported at off peak times with Garda and safety vehicle escort as required. Visual inspections will also be undertaken and recorded regularly and frequently throughout the construction phase. Evidence of any defects arise during the construction phase will be recorded and any necessary remedial actions will be carried out.	To ensure safety and minimise inconvenience for road users	Main Contractor Project Engineer	Pre-construction During construction
Construction	Roads along the grid connection route	Preparation of a Construction Traffic Management Plan to include designated delivery route, delivery schedule, road improvements, temporary signage and road maintenance measures (wheel wash, road sweeping etc.).	To ensure safety and minimise inconvenience for road users	Main Contractor Project Engineer	Ongoing during Construction
Construction	Road Safety	The works contractor will be required to appoint a Traffic Management Engineer who will ensure that road safety is fully considered, and that the construction works and traffic management measures are in line with the Department of Transport, Traffic Signs Manual, Chapter 8.	To ensure safety for passage of abnormal loads	Project Engineer Traffic Management Engineer,	Pre-construction During construction
Chapter 15 Population and Human Health					
Construction		The Development will be constructed, operated, and decommissioned in accordance with the Safety, Health and Welfare at Work (Construction) Regulations 2013. Site design and inbuilt buffers from sensitive receptors, will minimise the risk to humans from the operation of the Development. Risks to public safety will be mitigated by restricting the Development Site access. Appropriate safety regulation signage will be erected, directing and informing the public of diverted routes where/if necessary.	To minimise impact on human health	Main Contractor Project Engineer	During Construction, Operation and Decommissioning
Chapter 16 Air Quality					
Construction	Temporary reduction in air quality due to dust emissions	The main contractor will be responsible for the coordination, implementation and ongoing monitoring of the Dust Management Plan. The key aspects of controlling dust are listed below which will be incorporated into the Construction Environmental Management Plan (CEMP) for the site. These measures are appropriate for sites with a high to medium risk of dust impacts and aim to ensure that no significant	Reduce impact from dust	Main Contractor	Ongoing during Construction and Decommissioning

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		nuisance occurs at nearby sensitive receptors, including ecology. The mitigation measures draw on best practice guidance from Ireland (DCC, 2018), the UK (IAQM (2024), BRE (2003), The Scottish Office (1996), UK ODPM (2002)) and the USA (USEPA, 1997). These measures will be incorporated into the overall Construction Environmental Management Plan (CEMP) prepared for the site. The measures are divided into difference categories for difference activities: • Communications • Site Management • Preparing and Maintaining the Site • Operating Vehicles / Machinery and Sustainable Travel • Operations • Waste Management • Measures Specific to Earthworks • Measures Specific to Construction • Measures Specific to Trackout • Monitoring			
Operational	Traffic Maintenance	Although the intensity of activity will be only a small fraction of the construction phase, all employees and contractors that are on site will ensure that machinery used is properly maintained and is switched off when not in use to avoid unnecessary exhaust emissions from maintenance traffic. No other mitigation is proposed.	Avoid unnecessary exhaust emissions from maintenance traffic	Main Contractor	Ongoing during Operation
Chapter 17 Climate					
Construction	Mitigate Extreme Weather conditions	The main contractor will be required to mitigate against the effects of extreme rainfall/flooding through site risk assessments and method statements. The main contractor will also be required to mitigate against the effects of extreme wind/storms, temperature extremes through site risk assessments and method statements. During construction, the Contractor will be required to mitigate against the effects of fog, lighting and hail through site risk assessments and method statements.	Reduce impact from rainfall / flooding / wind / storms /fog	Main Contractor	Ongoing during Construction
Operational	Traffic Maintenance	Although the intensity of activity will be only a small fraction of the construction phase, all employees and contractors that are on site will ensure that machinery used is properly maintained and is switched off when not in use to avoid unnecessary exhaust emissions from maintenance traffic. No other mitigation is proposed.	Avoid unnecessary exhaust emissions from maintenance traffic	Main Contractor	Ongoing during Operation

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Appendix 3.6 (1 of 2)

Delivery Route Bridge Inspection Report

Keerglen Wind Farm

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ABO WIND IRELAND LIMITED

Keerglen Wind Farm, Co. Mayo

Delivery Route Bridge Inspections Report

January 2023

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DOCUMENT APPROVAL

PROJECT	Keerglen Wind Farm, Co, Mayo	
CLIENT / JOB NO	ABO Wind Ireland Limited	6900
DOCUMENT TITLE/No.	Delivery Route Bridge Inspections Report	6900-JOD-00-XX-RP-S-001-P2 Keerglen TDR Bridges Inspec Report

	Prepared by	**Reviewed by**	**Approved by**
Issue / Revision P1	Name Eamon Morrissey	Name John McElvaney	Name David Kiely
Date 03 November 2022	Signature	Signature	Signature

Issue / Revision P2	Name Eamon Morrissey	Name John McElvaney	Name David Kiely
Date 04 January 2023	Signature	Signature	Signature

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APPENDICES

APPENDIX 1.0: MAINTENANCE INSPECTION RATING SYSTEM

APPENDIX 2.0: COMPONENT CONDITION RATING SYSTEM

APPENDIX 3: NORDEX DOCUMENT "TRANSPORT, ACCESS ROADS AND CRANE REQUIREMENTS - WIND TURBINE CLASS K08 DELTA" REFERENCE 2001709EN REV 01 / 2020-04-15

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1. INTRODUCTION

1.1. Terms of Reference

Jennings O'Donovan and Partners Ltd. (JOD) have been appointed by ABO Wind Ireland Limited to undertake inspections of the existing bridges / water crossings along the proposed delivery route from Ballina to the proposed Keerglen Wind Farm in Ballinglen, Co. Mayo.

The JOD scope of works includes an inspection and report on the each of the existing bridges / water crossings. This report contains information and comments relating to the structural condition and defects present at the time of the visual inspection by JOD and an assessment of the structural integrity of the bridges. No opening up of the structures was carried out at the time of the inspections.

The reporting on the bridges follows the same format as set out in the document entitled 'Bridge Asset Management System for Regional and Local Roads', September 2019, developed by the Department of Transport, Tourism and Sport, that sets out Guidelines for:

- Identifying the location of the structure and recording its dimensions – The Bridge Inventory Survey (BIS);
- Assigning an initial rating to the structure – Maintenance Inspections (MI);
- Assigning Component Condition Ratings to individual structure elements (cCR's) and an overall Condition Rating to the Structure – Engineering Inspections (EI).

All naming conventions are as per the above guidelines.

The maximum vehicle loadings as taken from Nordex document "*Transport, access roads and crane requirements - Wind turbine class K08 delta*" Reference 2001709EN Rev 01 / 2020-04-15 are as follows:

- Max. load per axle approx. 12 t (for roads that are used only for transporting components)
- Max. load per axle approx. 16 t (for roads that are used for relocating cranes between two WT sites)
- Max. overall weight: approx. 180 t

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The hydrology industry standard for river bank and abutment description has been adopted, i.e. the left-hand river bank (LHB) is always when the observer is facing downstream as indicated in Figure 1.2 below.

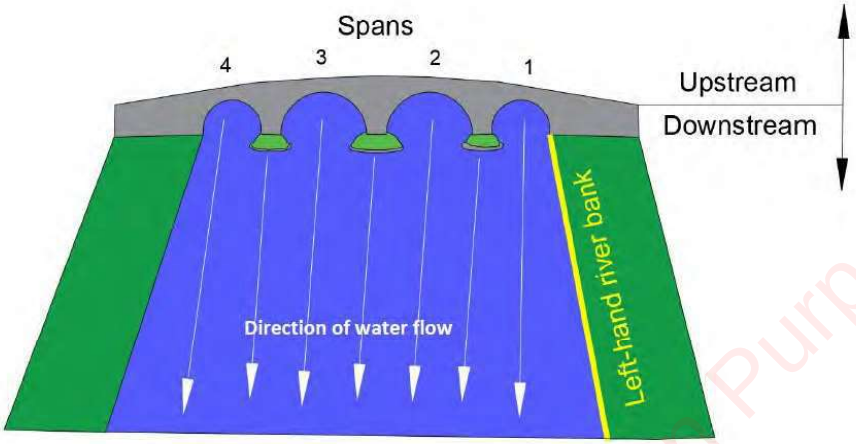


Figure 1.2 – River Bank and Abutment Description

Figures 1.3, 1.4, 1.5 and 1.6 below, are taken from the Guidelines noted above and to indicate the various dimensions referenced in this report.



Figure 1.3 – Total Span

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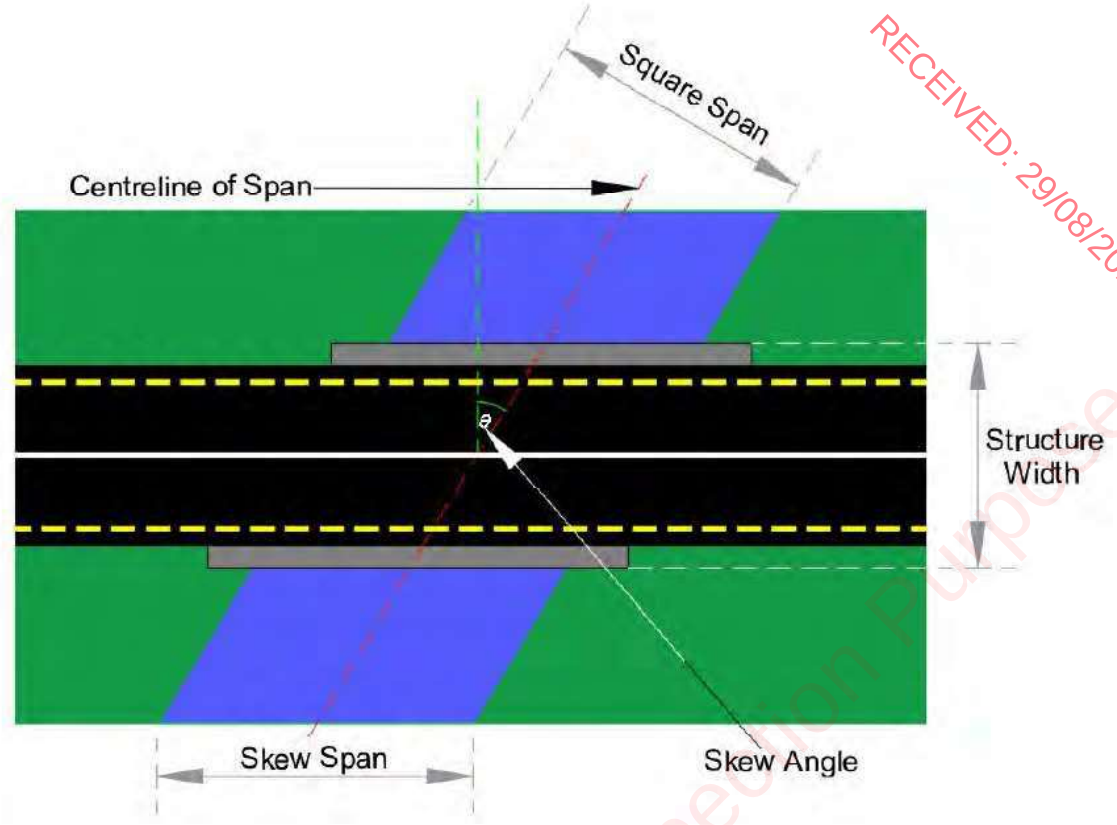


Figure 1.4 – Span, Width and Skew Angle



Figure 1.5 – Maximum and Minimum Span

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Figure 1.6 – Overall Bridge Length

2. BRIDGE INSPECTION PROCEDURES

Eamon Morrissey and John McElvaney of JOD carried out visual inspection of the bridges / water crossings on 5th October 2022. Insofar as was practicable, the inspections included measurement of key dimensions and a record of the condition of the various elements of the structures. Safe access was not available to carry out a detailed inspection of the underside of the structures.

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3. CROSSING NO. 1



Figure 3.1 – Crossing No. 1 Location

3.1. Inspection Record

3.1.1. Stage 1 – Bridge Inventory Survey

Access Hazard	Excessive vegetation & Steep bank	
Culvert	No	
Structure Type	Arch	
Location	Latitude: 54.13352	Longitude: -9.275847
Road Number	L1108	
Structure Number	Not available	
Structure Name (Alias)	Not available	
Structure Material	Masonry	
Number of Spans	1	
Total Span	5.0 m	
Maximum Span	5.0 m	
Minimum Span	5.0 m	
Structure Length	8.5 m	
Structure Width	7.7 m	
Principle Function	Public Road	
Structure Over	Watercourse	
Height of Opening	Not measured, estimate 2.5 m	

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Skew Angle	0°
Height Restriction	No
Weight Restriction	No
Services Present	No
Comments	Bridge structure was not accessible for a full inspection. Approximate cover to crown of arch = 1 m. Carriageway width = 5.3 m. Southwestern verge width = 0.9 m. Northeastern verge width = 0.6 m.

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3.1.2. Stage 2 – Maintenance Inspection

Maintenance Inspection Rating					
Main Element	**Red**	**Amber**	**Green**	**Not Applicable**	
Parapets			✓		**Non-Structural**
Access and Egress	✓				
Vegetation		✓			
External Walls				✓	**Structural**
Abutments and Piers			✓		
Deck or Arch			✓		
See Appendix 1 for explanation of rating system					

Maintenance Inspection Notes	
Parapets	Good condition. Vegetation growth on SW parapet should be cut back.
Access and Egress	Steep banks, with drainage channels and soft ground in combination with hedgerows prevent safe access to the underside of the structure.
Vegetation	Vegetation growth on SW parapet, minor vegetation growth on NE parapet. Two trees are in close proximity to the NW face of the structure.
External Walls	Not present
Abutments and Piers	Not inspected. Walls appear in good condition from a distance

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Deck or Arch	Not inspected. Walls appear in good condition from a distance

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3.1.3. Stage 3 – Engineering Inspection

	Component Condition Rating (cCR)				
Component	**1** **Insignificant Damage (VL)**	**2** **Some Damage (L)** Repair when convenient	**3** **Significant Damage (M)** Repair needed very soon	**4** **Critical Damage (H)** Repair needed immediately. Consider load restriction/propping	**5** **Ultimate Damage (U)** Bridge closure/lane restriction needed
Bridge Surface	✓				
Footpath, Verges, Rubbing Strips, Medians	✓				
Parapets and safety Rails	✓				
Embankment and Revetments	✓				
Wing Walls and Retaining Walls	**N/A**				
Abutments (also see riverbed)	✓				
Piers (also see riverbed)	**N/A**				
Spandrels	✓				
Arch Barrels and External Voussoirs	✓				
Beams / Girders	**N/A**				
Slab / Deck	**N/A**				
Riverbed	**Not Inspected**				
Bearings and Expansion Joints	**N/A**				
OVERALL BRIDGE CONDITION RATING	**1**	**2**	**3**	**4**	**5**
See Appendix 2 for explanation of rating system					

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Engineering Inspection Notes	
1	Based on a visual inspection from the road.
2	The underside of the bridge could not be inspected for bat roosts.

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3.1.4. Photographic Record



Photo No. 3.1.1
General view of bridge from its northwestern end looking southeast.



Photo No. 3.1.2
Southwestern verge and parapet showing watercourse and connecting drainage channel.



Photo No. 3.1.3
Northeastern verge and parapet.

3.2. Load Capacity Assessment

An analysis of the load capacity of the bridge was carried out to the MEXE method as specified in Section 3 of TII Standard AM-STR-06002 (formerly BA 16/14).

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Arch dimensions used

- Span L = 5.0m
- Rise r_c = 2.5m
- Rise at quarter points r_q = 2.2m
- Thickness of arch barrel d = 0.4m
- Average depth of fill, h = 1.0m

Provisional Axle Loading (PAL) (BA 3.10)

PAL $= [740 \times (d+h)^2] / L^{1.3}$ or 70 (whichever is less)

$= [740 \times (0.4+0.5)^2] / 5^{1.3}$ or 70 (whichever is less)

= 179 or 70 (whichever is less)

PAL = 70 tonnes

Modifying factors

- Span/rise = 5.0 / 2.5 = 2.0
- Span/Rise Factor (F_{sr}) = 1.00 (as actual span / rise is less than 4 – figure 3.3)

- Profile Factor (F_p) $= 2.3[(r_c-r_q)/r_c]^{0.6}$

$=2.3[(2.5-2.2)/2.5]^{0.6}$

= 0.64

- Material Factor (F_m) $= [(F_b \times d) + (F_f \times h)]/(d + h)$

Where:

- Barrel Factor (F_b) = 1.0 (Table 3.1)
- Fill Factor (F_f) = 0.7 (Table 3.2)

Therefore:

- Material Factor (F_m) $= [(1.0 \times 0.4) + (0.7 \times 1.0)] / (0.4 + 1.0)$

= 0.79

- Joint Factor (F_j) $= F_w \times F_d \times F_{mo}$

Where:

- Width Factor (F_w) = 0.9 (Table 3.3)
- Mortar Factor (F_{mo}) = 0.9 (Table 3.4)
- Depth Factor (F_d) = 0.8 (Table 3.5)

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Therefore:

- Joint Factor (F_j) = 0.9 x 0.9 x 0.8
  = 0.65
- Condition factor (F_{cM}) = 0.90 (based on proven capacity and good condition)
- Axle Factors (A_f) = 1.00 (Figure 3.5a) (no axle lift off)
  = 0.70 (Figure 3.5b) (with axle lift off)

Modified Axle Loading = F_{sr} x F_p x F_m x F_j x F_{cM} x A_f x PAL

= 1 x 0.64 x 0.79 x 0.65 x 0.9 x 1 x 70 (no axle lift off)

= 21 tonnes (no axle lift off)

Road vertical alignment is flat so axle lift off is not a concern.

It should be noted that this carrying capacity is for the arch alone, and that the capacity of the full bridge is a combination of several other elements including fill materials buttresses and foundations. It should also be noted that this method can return quite variable results as the modifying factors are subjective. In particular the Condition Factor of 0.9 was taken in this instance due to the overall good condition and proven existing traffic capacity.

The recommended maximum allowable axle load for the bridge without modification is **12 tonnes**.

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4. CROSSING NO. 2



Figure 4.1 – Crossing No. 2 Location

4.1. Inspection Record

4.1.1. Stage 1 – Bridge Inventory Survey

Access Hazard	Steep banks & vegetation	
Culvert	Yes	
Structure Type	Pipe	
Location	Latitude: 54.15225	Longitude: -9.335764
Road Number	L1108	
Structure Number	Not available	
Structure Name (Alias)	Not available	
Structure Material	Concrete	
Number of Spans	1	
Total Span	0.9 m	
Maximum Span	0.9 m	
Minimum Span	0.9 m	
Structure Length	5.0 m	
Structure Width	9.0 m	
Principle Function	Public Road	

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Structure Over	Watercourse
Height of Opening	0.9 m
Skew Angle	0°
Height Restriction	No
Weight Restriction	No
Services Present	No
Comments	Culvert is in good condition. Depth from road surface to crown of pipe is approx. 1.5 m. Pipe wall thickness = not accessible to measure Carriageway width – 5.0 m. Upstream verge width = 0.3 m. Downstream verge width = 0.3 m.

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4.1.2. Stage 2 – Maintenance Inspection

Not required under the Bridge Asset Management System for a culvert type structure.

4.1.3. Stage 3 – Engineering Inspection

Not required under the Bridge Asset Management System for a culvert type structure.

4.1.4. Photographic Record



Photo No. 4.1.1
General view of culvert from its southeastern end looking northwest.

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Photo No. 4.1.2
General view of downstream side of culvert.
Note that the embankment is faced with concrete up to road level.

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4.2. Load Capacity Assessment

An analysis of the load capacity of the culvert was carried out to the method as specified in IS EN 1295-1:2019 - Structural design of buried pipelines under various conditions of loading. General conditions and TII Standard DN-STR-03016 (formerly BD 82/00).

Culvert dimensions used

- Diameter of pipe = 0.9m
- Depth of fill over pipe =1.5m

Modifying factors

- Factor of Safety (F_{se}) = 1.25
- Bedding Factor (F_m) = 1.1

Load Check

- Pipe Test Strength (F_n) = 120 x diameter kN/m
  = 120 x 0.9
  = 108 kN/m

- Design Load Capacity = (F_n x F_m) / F_{se} kN/m
  = (108 x 1.1) / 1.25
  = 95 kN/m

- Applied Loading = Soil weight + 12t axle load dispersed through soil kN/m
  = 24 + 55 kN/m

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= 79 kN/m

The Design Load Capacity is greater than the Applied Loading.

The recommended maximum allowable axle load for the bridge without modification is **12 tonnes**.

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5. CROSSING NO. 3



Figure 5.1 – Crossing No. 3 Location

5.1. Inspection Record

5.1.1. Stage 1 – Bridge Inventory Survey

Access Hazard	Steep banks, deep water, fast moving water, vegetation, traffic & services	
Culvert	No	
Structure Type	Slab	
Location	Latitude: 54.16449	Longitude: -9.34545
Road Number	R315	
Structure Number	MO-R315-012.00	
Structure Name (Alias)	Cloonaghmore River Bridge	
Structure Material	Concrete	
Number of Spans	3	
Total Span	22.0 m	
Maximum Span	6.4 m	
Minimum Span	6.2 m	
Structure Length	25.0 m	
Structure Width	9.61 m	
Principle Function	Public Road	

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Structure Over	Watercourse (Cloonaghmore River)
Height of Opening	2.0 m freeboard at time of inspection, could not confirm water depth
Slew Angle	45°
Height Restriction	No
Weight Restriction	No
Services Present	Yes Lighting column located in downstream footpath, no overhead lines so power supply is on the bridge. 2 number 100mm metal ducts fixed to upstream face of bridge. 1 number 300mm metal duct fixed to downstream face of bridge.
Comments	Approximate depth from road surface to deck soffit = 0.4 m. Assume 0.1m pavement, 0.3m RC slab All piers and abutments are 1.6 m wide. Parapets are 1.1 m high x 0.4 m wide, stone-faced concrete.

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5.1.2. Stage 2 – Maintenance Inspection

Maintenance Inspection Rating					
Main Element	**Red**	**Amber**	**Green**	**Not Applicable**	
Parapets			✓		**Non-Structural**
Access and Egress		✓			
Vegetation			✓		
External Walls			✓		**Structural**
Abutments and Piers			✓		
Deck or Arch			✓		
See Appendix 1 for explanation of rating system					

Maintenance Inspection Notes	
Parapets	Good condition. Quality stone facing to concrete walls.

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Access and Egress	Steep banks and walls prevent access to the underside of the structure, specially when combined with the flow in the river.
Vegetation	Not a problem on this bridge.
External Walls	Good condition.
Abutments and Piers	Good condition.
Deck or Arch	Could not be inspected.

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5.1.3. Stage 3 – Engineering Inspection

	Component Condition Rating (cCR)				
Component	**1** **Insignificant Damage (VL)**	**2** **Some Damage (L)** Repair when convenient	**3** **Significant Damage (M)** Repair needed very soon	**4** **Critical Damage (H)** Repair needed immediately. Consider load restriction/propping	**5** **Ultimate Damage (U)** Bridge closure/lane restriction needed
Bridge Surface	✓				
Footpath, Verges, Rubbing Strips, Medians	✓				
Parapets and safety Rails	✓				
Embankment and Revetments	✓				
Wing Walls and Retaining Walls	✓				
Abutments (also see riverbed)	✓				
Piers (also see riverbed)	✓				
Spandrels	**N/A**				
Arch Barrels and External Voussoirs	**N/A**				
Beams / Girders	**N/A**				
Slab / Deck	✓				
Riverbed	**Not Inspected**				

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Bearings and Expansion Joints	**N/A**				
OVERALL BRIDGE CONDITION RATING	**1**	**2**	**3**	**4**	**5**
See Appendix 2 for explanation of rating system					

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Engineering Inspection Notes	
1	Given the speed of the flow in the river it may be worth carrying out routine checks of the riverbed at the piers in case scour becomes a problem. This could not be inspected at the time due to the speed of the flow, the depth of the water, and the access difficulties at the structure.
2	The underside of the bridge could not be inspected for bat roosts.

5.1.4. Photographic Record



Photo No. 5.1.1

General view of bridge from its southern end looking north.



Photo No. 5.1.2

General view of bridge from its southern end looking north

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Photo No. 5.1.3

View of upstream side of bridge.

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5.2. Load Capacity Assessment

It was not possible to carry out intrusive testing to confirm the reinforcement details and concrete grade used in the construction of the bridge deck. Without this information a calculation cannot be undertaken. The bridge is in good condition however, and it is carrying a regional road which is heavily trafficked. It is on the Local Authority Eirspan register of structures, meaning that it is inspected at regular intervals.

Following our assessment JOD consider the bridge structurally adequate to withstand the proposed loadings.

The recommended maximum allowable axle load for the bridge without modification is **12 tonnes**.

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6. CROSSING NO. 4



Figure 6.1 – Crossing No. 4 Location

6.1. Inspection Record

6.1.1. Stage 1 – Bridge Inventory Survey

Access Hazard	Fast moving water, fencing restricts access.	
Culvert	No	
Structure Type	Arch	
Location	Latitude: 54.16929	Longitude: - 9.347772
Road Number	R315	
Structure Number	MO-R315-013.00	
Structure Name (Alias)	Not available	
Structure Material	Masonry	
Number of Spans	2	
Total Span	4.6 m	
Maximum Span	1.8 m	
Minimum Span	1.8 m	
Structure Length	19.0 m	
Structure Width	5.0 m	
Principle Function	Public Road	

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Structure Over	Watercourse
Height of Opening	2.5 m estimate
Skew Angle	30°
Height Restriction	No
Weight Restriction	No
Services Present	Yes – Overhead telecom lines at upstream end.
Comments	Structure is in good condition. Depth from road surface to crown of arch is approx. 0.3 m. Carriageway width – 3.9 m. Upstream verge width = 0.2 m. Downstream verge width = 0.2 m.

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6.1.2. Stage 2 – Maintenance Inspection

Maintenance Inspection Rating					
Main Element	**Red**	**Amber**	**Green**	**Not Applicable**	
Parapets			✓		**Non-Structural**
Access and Egress			✓		
Vegetation			✓		
External Walls			✓		**Structural**
Abutments and Piers			✓		
Deck or Arch			✓		
See Appendix 1 for explanation of rating system					

Maintenance Inspection Notes	
Parapets	Good condition stone parapets
Access and Egress	Could not get access to the underside of the structure due to fencing and the flow in the river at the time of the inspection.
Vegetation	Not a problem on this bridge.

External Walls	Good condition stone walls.
Abutments and Piers	Good condition cut stone.
Deck or Arch	Could not be inspected from beneath, however the arch barrels were recently repointed.

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6.1.3. Stage 3 – Engineering Inspection

	Component Condition Rating (cCR)				
Component	**1** **Insignificant Damage (VL)**	**2** **Some Damage (L)** Repair when convenient	**3** **Significant Damage (M)** Repair needed very soon	**4** **Critical Damage (H)** Repair needed immediately. Consider load restriction/propping	**5** **Ultimate Damage (U)** Bridge closure/lane restriction needed
Bridge Surface	✓				
Footpath, Verges, Rubbing Strips, Medians	✓				
Parapets and safety Rails	✓				
Embankment and Revetments	✓				
Wing Walls and Retaining Walls	✓				
Abutments (also see riverbed)	✓				
Piers (also see riverbed)	✓				
Spandrels	✓				
Arch Barrels and External Voussoirs	✓				
Beams / Girders	**N/A**				
Slab / Deck	**N/A**				
Riverbed	**Not Inspected**				
Bearings and Expansion Joints	**N/A**				
OVERALL BRIDGE CONDITION RATING	**1**	**2**	**3**	**4**	**5**

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See Appendix 2 for explanation of rating system

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Engineering Inspection Notes	
1	The riverbed was not inspected due to the speed of the flow in the stream.
2	No bat roosts were observed under the bridge.

6.1.4. Photographic Record



Photo No. 6.1.1
General view of bridge from its southern end looking north.



Photo No. 6.1.2
General view of upstream side of bridge from new pedestrian bridge.



Photo No. 6.1.3
View of downstream side of bridge.

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6.2. Load Capacity Assessment

An analysis of the load capacity of the bridge was carried out to the MEXE method as specified in Section 3 of TII Standard AM-STR-06002 (formerly BA 16/14).

Arch dimensions used

- Span L = 1.8m
- Rise r_c = 0.9m
- Rise at quarter points r_q = 0.78m
- Thickness of arch barrel d = 0.3m
- Average depth of fill, h = 0.3m

Provisional Axle Loading (PAL) (BA 3.10)

PAL $= [740 \times (d+h)^2] / L^{1.3}$ or 70 (whichever is less)

$= [740 \times (0.3+0.3)^2] / 1.8^{1.3}$ or 70 (whichever is less)

= 124 or 70 (whichever is less)

PAL = 70 tonnes

Modifying factors

- Span/rise = 1.8 / 0.9 = 2.0
- Span/Rise Factor (F_{sr}) = 1.00 (as actual span / rise is less than 4 – figure 3.3)

- Profile Factor (F_p) $= 2.3[(r_c-r_q)/r_c]^{0.6}$

$=2.3[(0.9-0.78)/0.9]^{0.6}$

= 0.69

- Material Factor (F_m) $= [(F_b \times d) + (F_f \times h)]/(d + h)$

Where:

- Barrel Factor (F_b) = 1.0 (Table 3.1)
- Fill Factor (F_f) = 0.7 (Table 3.2)

Therefore:

- Material Factor (F_m) $= [(1.0 \times 0.3) + (0.7 \times 0.3)] / (0.3 + 0.3)$

= 0.85

- Joint Factor (F_j) $= F_w \times F_d \times F_{mo}$

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Where:

- Width Factor (F_w) = 0.9 (Table 3.3)
- Mortar Factor (F_{mo}) = 1.0 (Table 3.4)
- Depth Factor (F_d) = 0.9 (Table 3.5)

Therefore:

- Joint Factor (F_j) = 0.9 x 1.0 x 0.9
  = 0.81
- Condition factor (F_{cM}) = 0.90 (based on proven capacity and good condition)
- Axle Factors (A_f) = 1.00 (Figure 3.5a) (no axle lift off)
  = 1.00 (Figure 3.5b) (with axle lift off)

Modified Axle Loading = $F_{sr} \times F_p \times F_m \times F_j \times F_{cM} \times A_f \times PAL$

= 1 x 0.69 x 0.85 x 0.81 x 0.9 x 1 x 70 (no axle lift off)

= 30 tonnes (no axle lift off or with axle lift off).

It should be noted that this carrying capacity is for the arch alone, and that the capacity of the full bridge is a combination of several other elements including fill materials buttresses and foundations. It should also be noted that this method can return quite variable results as the modifying factors are subjective. In particular the Condition Factor of 0.9 was taken in this instance due to the overall good condition and proven existing traffic capacity.

The recommended maximum allowable axle load for the bridge without modification is **12 tonnes**.

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7. CROSSING NO. 5



Figure 7.1 – Crossing No. 5 Location

7.1. Inspection Record

7.1.1. Stage 1 – Bridge Inventory Survey

Access Hazard	Deep and fast moving water, very tall structure, fencing restricts access.	
Culvert	No	
Structure Type	Arch	
Location	Latitude: 54.17666	Longitude: - 9.353561
Road Number	R315	
Structure Number	Not available	
Structure Name (Alias)	Dunowen River Bridge	
Structure Material	Masonry	
Number of Spans	2	
Total Span	12.0 m estimated	
Maximum Span	5.5 m	
Minimum Span	5.5 m	
Structure Length	59.4 m including approach from north	
Structure Width	9.2 m	
Principle Function	Public Road	
Structure Over	Watercourse	
Height of Opening	2.5 m estimate	

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Skew Angle	0°
Height Restriction	No
Weight Restriction	No
Services Present	Yes, overhead lines on upstream side of road.
Comments	Structure is in good condition. Depth from road surface to crown of arch is approx. 1.5 m. Carriageway width – 7.0 m. Upstream verge width = 0.6 m. Downstream verge width = 0.7 m.

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7.1.2. Stage 2 – Maintenance Inspection

Maintenance Inspection Rating					
Main Element	**Red**	**Amber**	**Green**	**Not Applicable**	
Parapets			✓		**Non-Structural**
Access and Egress		✓			
Vegetation			✓		
External Walls			✓		**Structural**
Abutments and Piers			✓		
Deck or Arch			✓		
See Appendix 1 for explanation of rating system					

Maintenance Inspection Notes	
Parapets	Good condition stone parapets
Access and Egress	Could not get access to the underside of the structure due to fencing.
Vegetation	Not a problem on this bridge.
External Walls	Good condition stone walls, approach embankment extends north to junction.

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Abutments and Piers	Good condition cut stone.
Deck or Arch	Could not be inspected from beneath.

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7.1.3. Stage 3 – Engineering Inspection

	Component Condition Rating (cCR)				
Component	**1** **Insignificant Damage (VL)**	**2** **Some Damage (L)** Repair when convenient	**3** **Significant Damage (M)** Repair needed very soon	**4** **Critical Damage (H)** Repair needed immediately. Consider load restriction/propping	**5** **Ultimate Damage (U)** Bridge closure/lane restriction needed
Bridge Surface	✓				
Footpath, Verges, Rubbing Strips, Medians	✓				
Parapets and safety Rails	✓				
Embankment and Revetments	✓				
Wing Walls and Retaining Walls	✓				
Abutments (also see riverbed)	✓				
Piers (also see riverbed)	✓				
Spandrels	✓				
Arch Barrels and External Voussoirs	✓				
Beams / Girders	**N/A**				
Slab / Deck	**N/A**				
Riverbed	**Not Inspected**				
Bearings and Expansion Joints	**N/A**				
OVERALL BRIDGE CONDITION RATING	**1**	**2**	**3**	**4**	**5**
See Appendix 2 for explanation of rating system					

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Engineering Inspection Notes	
1	The riverbed was not inspected due to lack of access.
2	The underside of the bridge could not be inspected for bat roosts.

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7.1.4. Photographic Record



Photo No. 7.1.1
General view of downstream face of bridge from southeast looking northwest.



Photo No. 7.1.2
General view of bridge from north looking south.



Photo No. 7.1.3
General view of upstream face of bridge from northwest looking southeast.

7.2. Load Capacity Assessment

An analysis of the load capacity of the bridge was carried out to the MEXE method as specified in Section 3 of TII Standard AM-STR-06002 (formerly BA 16/14).

Arch dimensions used

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- Span L = 5.5m
- Rise r_c = 2.5m
- Rise at quarter points r_q = 2.13m
- Thickness of arch barrel d = 0.4m
- Average depth of fill, h = 1.5m

Provisional Axle Loading (PAL) (BA 3.10)

PAL $= [740 \times (d+h)^2] / L^{1.3}$ or 70 (whichever is less)

$= [740 \times (0.4+1.5)^2] / 5.5^{1.3}$ or 70 (whichever is less)

= 291 or 70 (whichever is less)

PAL = 70 tonnes

Modifying factors

- Span/rise = 5.5 / 2.5 = 2.2

– Span/Rise Factor (F_{sr}) = 1.00 (as actual span / rise is less than 4 – figure 3.3)

– Profile Factor (F_p) $= 2.3[(r_c-r_q)/r_c]^{0.6}$

$=2.3[(2.5-2.13)/2.5]^{0.6}$

= 0.73

– Material Factor (F_m) $= [(F_b \times d) + (F_f \times h)]/(d + h)$

Where:

– Barrel Factor (F_b) = 1.0 (Table 3.1)
– Fill Factor (F_f) = 0.7 (Table 3.2)

Therefore:

– Material Factor (F_m) $= [(1.0 \times 0.4) + (0.7 \times 1.5)] / (0.4 + 1.5)$

= 0.76

– Joint Factor (F_j) $= F_w \times F_d \times F_{mo}$

Where:

– Width Factor (F_w) = 0.9 (Table 3.3)
– Mortar Factor (F_{mo}) = 1.0 (Table 3.4)
– Depth Factor (F_d) = 0.9 (Table 3.5)

Therefore:

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- Joint Factor (F_j) = 0.9 x 1.0 x 0.9
  = 0.81
- Condition factor (F_{cM}) = 0.90 (based on proven capacity and good condition)
- Axle Factors (A_f) = 1.00 (Figure 3.5a) (no axle lift off)
  = 0.70 (Figure 3.5b) (with axle lift off)

Modified Axle Loading = F_{sr} x F_p x F_m x F_j x F_{cM} x A_f x PAL

= 1 x 0.73 x 0.76 x 0.81 x 0.9 x 1 x 70 (no axle lift off)

= 28 tonnes (no axle lift off)

Road vertical alignment is flat so axle lift off is not a concern.

It should be noted that this carrying capacity is for the arch alone, and that the capacity of the full bridge is a combination of several other elements including fill materials buttresses and foundations. It should also be noted that this method can return quite variable results as the modifying factors are subjective. In particular the Condition Factor of 0.9 was taken in this instance due to the overall good condition and proven existing traffic capacity.

The recommended maximum allowable axle load for the bridge without modification is **12 tonnes**.

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8. CROSSING NO. 6

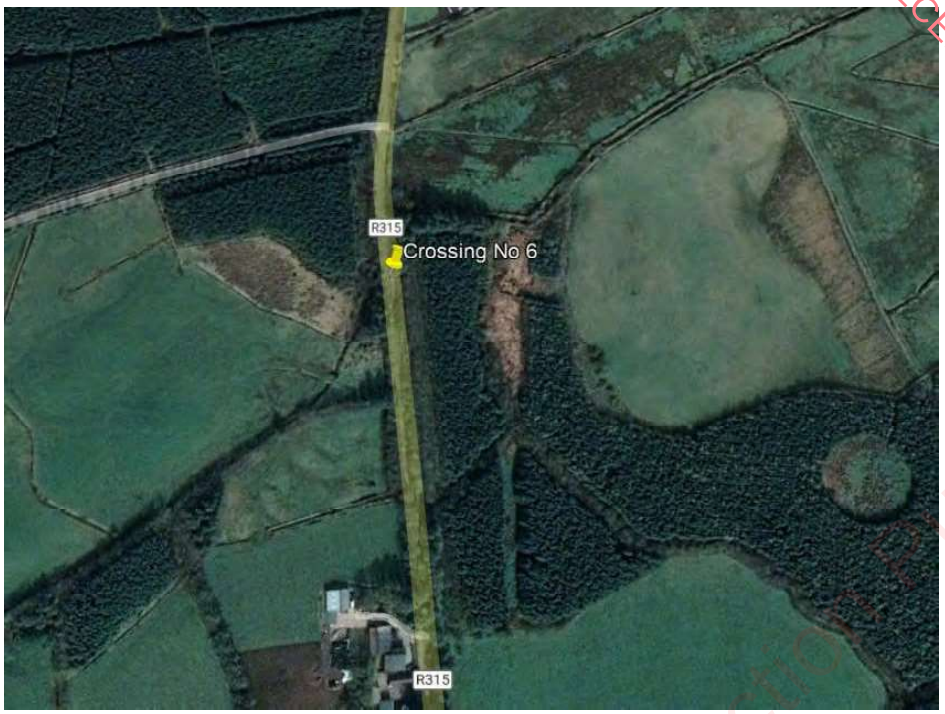


Figure 8.1 – Crossing No. 6 Location

8.1. Inspection Record

8.1.1. Stage 1 – Bridge Inventory Survey

Access Hazard	Vegetation	
Culvert	No	
Structure Type	Arch	
Location	Latitude: 54.19307	Longitude: - 9.349836
Road Number	R315	
Structure Number	Not available	
Structure Name (Alias)	Not available	
Structure Material	Masonry	
Number of Spans	1	
Total Span	1.2 m	
Maximum Span	1.2 m	
Minimum Span	1.2 m	
Structure Length	3.0 m	
Structure Width	9.0 m	
Principle Function	Public Road	

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Structure Over	Watercourse
Height of Opening	1.6 m
Skew Angle	15°
Height Restriction	No
Weight Restriction	No
Services Present	Yes – Overhead telecom lines at downstream end.
Comments	Structure is in need of repointing. Depth from road surface to crown of arch is approx. 0.5 m. Carriageway width – 7.0 m. Upstream verge width = 1.0 m. Downstream verge width = 1.0 m.

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8.1.2. Stage 2 – Maintenance Inspection

Maintenance Inspection Rating					
Main Element	**Red**	**Amber**	**Green**	**Not Applicable**	
Parapets				✓	**Non-Structural**
Access and Egress			✓		
Vegetation			✓		
External Walls			✓		**Structural**
Abutments and Piers		✓			
Deck or Arch		✓			
See Appendix 1 for explanation of rating system					

Maintenance Inspection Notes	
Parapets	No parapets on structure
Access and Egress	While overgrown access was safely achieved to both ends of the structure.
Vegetation	Structure is not readily visible from the road due to the vegetation present.

External Walls	No external walls on structure.
Abutments and Piers	Abutments are stone with brick facing to arch ring.
Deck or Arch	The arch barrels need to be repointed.

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8.1.3. Stage 3 – Engineering Inspection

	Component Condition Rating (cCR)				
Component	**1** **Insignificant Damage (VL)**	**2** **Some Damage (L)** Repair when convenient	**3** **Significant Damage (M)** Repair needed very soon	**4** **Critical Damage (H)** Repair needed immediately. Consider load restriction/propping	**5** **Ultimate Damage (U)** Bridge closure/lane restriction needed
Bridge Surface	✓				
Footpath, Verges, Rubbing Strips, Medians	**N/A**				
Parapets and safety Rails	**N/A**				
Embankment and Revetments	✓				
Wing Walls and Retaining Walls	✓				
Abutments (also see riverbed)		✓			
Piers (also see riverbed)	**N/A**				
Spandrels	✓				
Arch Barrels and External Voussoirs		✓			
Beams / Girders	**N/A**				
Slab / Deck	**N/A**				
Riverbed	✓				
Bearings and Expansion Joints	**N/A**				
OVERALL BRIDGE CONDITION RATING	**1**	**2**	**3**	**4**	**5**

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See Appendix 2 for explanation of rating system

Engineering Inspection Notes	
1	The bottom corner of the south abutment is damaged with some stones displaced. We suggest that the Local Authority be advised of this.
2	Pointing to the arch has degraded. We suggest that the Local Authority be advised of this, and that guniting will be required.
3	No bat roosts were observed under the bridge.

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8.1.4. Photographic Record



Photo No. 8.1.1

General view of bridge from its southern end looking north.



Photo No. 8.1.2

General view of downstream side of bridge showing damage to south abutment.



Photo No. 8.1.3

View of arch interior from downstream showing pointing degradation to arch.

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8.2. Load Capacity Assessment

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An analysis of the load capacity of the bridge was carried out to the MEXE method as specified in Section 3 of TII Standard AM-STR-06002 (formerly BA 16/14).

Arch dimensions used

- Span L = 1.2m
- Rise r_c = 0.6m
- Rise at quarter points r_q = 0.52m
- Thickness of arch barrel d = 0.2m
- Average depth of fill, h = 0.5m

Provisional Axle Loading (PAL) (BA 3.10)

PAL $= [740 \times (d+h)^2] / L^{1.3}$ or 70 (whichever is less)

$= [740 \times (0.2+0.5)^2] / 1.2^{1.3}$ or 70 (whichever is less)

$= 286$ or 70 (whichever is less)

PAL = 70 tonnes

Modifying factors

- Span/rise = 1.2 / 0.6 = 2.0
- Span/Rise Factor (F_{sr}) = 1.00 (as actual span / rise is less than 4 – figure 3.3)

- Profile Factor (F_p) $= 2.3[(r_c-r_q)/r_c]^{0.6}$

$=2.3[(0.6-0.52)/0.6]^{0.6}$

$= 0.69$

- Material Factor (F_m) $= [(F_b \times d) + (F_f \times h)]/(d + h)$

Where:

- Barrel Factor (F_b) = 1.0 (Table 3.1)
- Fill Factor (F_f) = 0.7 (Table 3.2)

Therefore:

- Material Factor (F_m) $= [(1.0 \times 0.2) + (0.7 \times 0.5)] / (0.2 + 0.5)$

$= 0.79$

- Joint Factor (F_j) $= F_w \times F_d \times F_{mo}$

Where:

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- Width Factor (F_w) = 0.9 (Table 3.3)
- Mortar Factor (F_{mo}) = 0.9 (Table 3.4)
- Depth Factor (F_d) = 0.8 (Table 3.5)

Therefore:

- Joint Factor (F_j) = 0.9 x 0.9 x 0.8
  = 0.65

- Condition factor (F_{cM}) = 0.90 (based on proven capacity and good condition)

- Axle Factors (A_f) = 1.00 (Figure 3.5a) (no axle lift off)
  = 0.70 (Figure 3.5b) (with axle lift off)

Modified Axle Loading = F_{sr} x F_p x F_m x F_j x F_{cM} x A_f x PAL

= 1 x 0.69 x 0.79 x 0.65 x 0.9 x 1 x 70 (no axle lift off)

= 22 tonnes (no axle lift off)

Road vertical alignment is flat so axle lift off is not a concern.

It should be noted that this carrying capacity is for the arch alone, and that the capacity of the full bridge is a combination of several other elements including fill materials buttresses and foundations. It should also be noted that this method can return quite variable results as the modifying factors are subjective. In particular the Condition Factor of 0.9 was taken in this instance due to the overall good condition and proven existing traffic capacity.

The recommended maximum allowable axle load for the bridge without modification is **12 tonnes**.

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9. CROSSING NO. 7



Figure 9.1 – Crossing No. 7 Location

9.1. Inspection Record

9.1.1. Stage 1 – Bridge Inventory Survey

Access Hazard	Fast moving water.	
Culvert	No	
Structure Type	Slab, widened on downstream face with box culvert unit	
Location	Latitude: 54.19725	Longitude: - 9.351067
Road Number	R315	
Structure Number	MO-R315-015.00	
Structure Name (Alias)	Not available	
Structure Material	Masonry/Concrete	
Number of Spans	1	
Total Span	3.2 m	
Maximum Span	3.2 m	
Minimum Span	3.2 m	
Structure Length	5.2 m	
Structure Width	8.7 m	
Principle Function	Public Road	
Structure Over	Watercourse	

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Height of Opening	1.3 m
Skew Angle	0°
Height Restriction	No
Weight Restriction	No
Services Present	Yes – Overhead telecom line at upstream end.
Comments	Structure is in good condition. Depth from road surface to top of slab is approx. 0.1 m. Carriageway width – 7.0 m. Upstream verge width = 0.5 m. Downstream verge width = 0.4 m.

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9.1.2. Stage 2 – Maintenance Inspection

Maintenance Inspection Rating					
Main Element	**Red**	**Amber**	**Green**	**Not Applicable**	
Parapets			✓		**Non-Structural**
Access and Egress			✓		
Vegetation			✓		
External Walls			✓		**Structural**
Abutments and Piers			✓		
Deck or Arch			✓		
See Appendix 1 for explanation of rating system					

Maintenance Inspection Notes	
Parapets	Parapets in good condition, stone faced concrete upstream and stone faced block downstream
Access and Egress	Could not get access to the underside of the structure due to the flow in the river at the time of the inspection.
Vegetation	Not a problem on this bridge.
External Walls	As parapets.

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Abutments and Piers	Good condition
Deck or Arch	Good condition.

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9.1.3. Stage 3 – Engineering Inspection

	Component Condition Rating (cCR)				
Component	**1** **Insignificant Damage (VL)**	**2** **Some Damage (L)** Repair when convenient	**3** **Significant Damage (M)** Repair needed very soon	**4** **Critical Damage (H)** Repair needed immediately. Consider load restriction/propping	**5** **Ultimate Damage (U)** Bridge closure/lane restriction needed
Bridge Surface	✓				
Footpath, Verges, Rubbing Strips, Medians	✓				
Parapets and safety Rails	✓				
Embankment and Revetments	✓				
Wing Walls and Retaining Walls	✓				
Abutments (also see riverbed)	✓				
Piers (also see riverbed)	**N/A**				
Spandrels	**N/A**				
Arch Barrels and External Voussoirs	**N/A**				
Beams / Girders	**N/A**				
Slab / Deck	✓				
Riverbed	**Not Inspected**				
Bearings and Expansion Joints	**N/A**				
OVERALL BRIDGE CONDITION RATING	**1**	**2**	**3**	**4**	**5**
See Appendix 2 for explanation of rating system					

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Engineering Inspection Notes	
1	The riverbed was not inspected due to the speed of the flow in the stream.
2	No bat roosts were observed under the bridge.

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9.1.4. Photographic Record



Photo No. 9.1.1

General view of bridge from its northern end looking south.



Photo No. 9.1.2

View under bridge looking downstream.



Photo No. 9.1.3

View of upstream parapet.

9.2. Load Capacity Assessment

It was not possible to carry out intrusive testing to confirm the reinforcement details and concrete grade used in the construction of the bridge deck. Without this information a calculation cannot be undertaken. The bridge is in good condition however, and it is

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carrying a regional road which is heavily trafficked. It is on the Local Authority Eirspan register of structures, meaning that it is inspected at regular intervals.

Following our assessment JOD consider the bridge structurally adequate to withstand the proposed loadings.

The recommended maximum allowable axle load for the bridge without modification is **12 tonnes**.

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10. CROSSING NO. 8



Figure 10.1 – Crossing No. 8 Location

10.1. Inspection Record

10.1.1. Stage 1 – Bridge Inventory Survey

Access Hazard	Fencing restricts access to upstream end.	
Culvert	No	
Structure Type	Clapper	
Location	Latitude: 54.23308	Longitude: - 9.369986
Road Number	R315	
Structure Number	Not available	
Structure Name (Alias)	Not available	
Structure Material	Masonry	
Number of Spans	2	
Total Span	2.6 m	
Maximum Span	1.0 m	
Minimum Span	0.8 m	
Structure Length	3.6 m	
Structure Width	7.2 m	
Principle Function	Public Road	
Structure Over	Watercourse	
Height of Opening	0.4 m	

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Skew Angle	30°
Height Restriction	No
Weight Restriction	No
Services Present	Yes – Overhead telecom lines at upstream end. Private water pipe through left span.
Comments	Structure is in good condition. Depth from road surface to top of clapper is approx. 0.3 m. Carriageway width – 4.5 m. Upstream verge width = 1.5 m. Downstream verge width = 1.2 m.

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10.1.2. Stage 2 – Maintenance Inspection

Maintenance Inspection Rating					
Main Element	**Red**	**Amber**	**Green**	**Not Applicable**	
Parapets				✓	**Non-Structural**
Access and Egress			✓		
Vegetation			✓		
External Walls				✓	**Structural**
Abutments and Piers			✓		
Deck or Arch			✓		
See Appendix 1 for explanation of rating system					

Maintenance Inspection Notes	
Parapets	N/A
Access and Egress	Could not get access to the upstream end of the structure due to fencing.
Vegetation	Vegetation is present around structure but is not causing a problem.
External Walls	N/A.

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Abutments and Piers	Good condition cut stone.
Deck or Arch	Stone slabs 75mm thick approx.

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10.1.3. Stage 3 – Engineering Inspection

	Component Condition Rating (cCR)				
Component	**1** **Insignificant Damage (VL)**	**2** **Some Damage (L)** Repair when convenient	**3** **Significant Damage (M)** Repair needed very soon	**4** **Critical Damage (H)** Repair needed immediately. Consider load restriction/propping	**5** **Ultimate Damage (U)** Bridge closure/lane restriction needed
Bridge Surface	✓				
Footpath, Verges, Rubbing Strips, Medians	✓				
Parapets and safety Rails	**N/A**				
Embankment and Revetments	**N/A**				
Wing Walls and Retaining Walls	**N/A**				
Abutments (also see riverbed)	✓				
Piers (also see riverbed)	✓				
Spandrels	**N/A**				
Arch Barrels and External Voussoirs	**N/A**				
Beams / Girders	**N/A**				
Slab / Deck	✓				
Riverbed	✓				
Bearings and Expansion Joints	**N/A**				
OVERALL BRIDGE CONDITION RATING	**1**	**2**	**3**	**4**	**5**
See Appendix 2 for explanation of rating system					

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Engineering Inspection Notes	
1	The structure is in good condition.

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10.1.4. Photographic Record



Photo No. 10.1.1
General view of bridge from its northern end looking south.



Photo No. 10.1.2
General view of downstream side of structure.

10.2. Load Capacity Assessment

The abutments and piers supporting the stone clappers are well constructed and are in good condition. These supports will act as stocky columns to transfer the applied wheel loads to the underlying ground. JOD consider the support walls structurally adequate for this purpose.

The deck is constructed using stone slabs spanning between support walls under the road pavement and grass verges. JOD consider that there is an unacceptably high risk of damage to these slabs under the proposed loading. In order to reduce this risk to an acceptable level, we propose that a series of 25mm thick mild steel plates be placed over the crossing to transfer the load directly to the support walls, as shown in Figure 10.1.1. below.

Following our assessment, based on the above works being carried out, JOD consider the bridge structurally adequate to withstand the proposed loadings.

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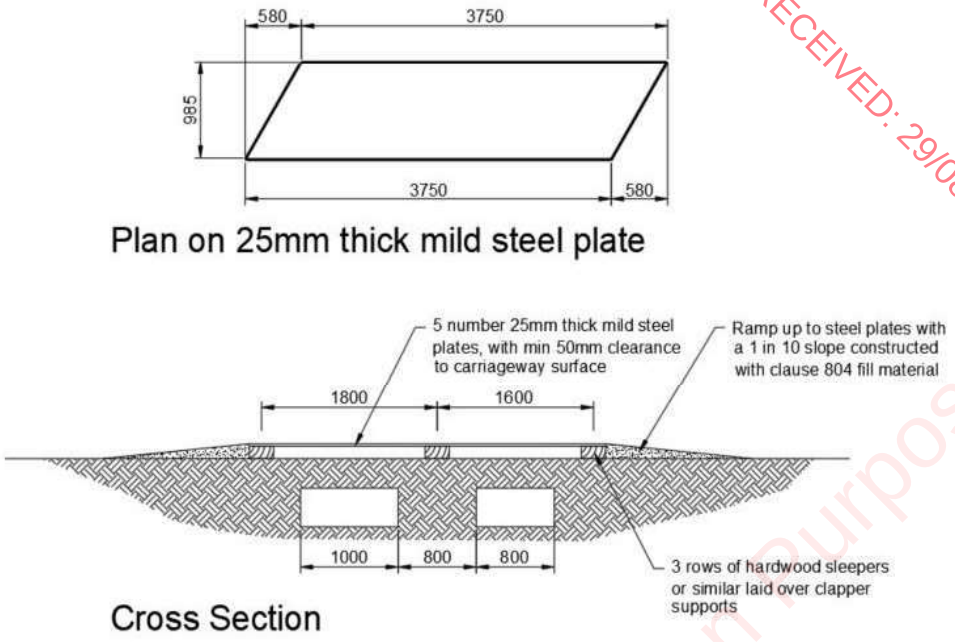


Figure 10.1.1: Temporary strengthening works

The recommended maximum allowable axle load for the bridge with the above modification is **12 tonnes**.

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11. CROSSING NO. 9

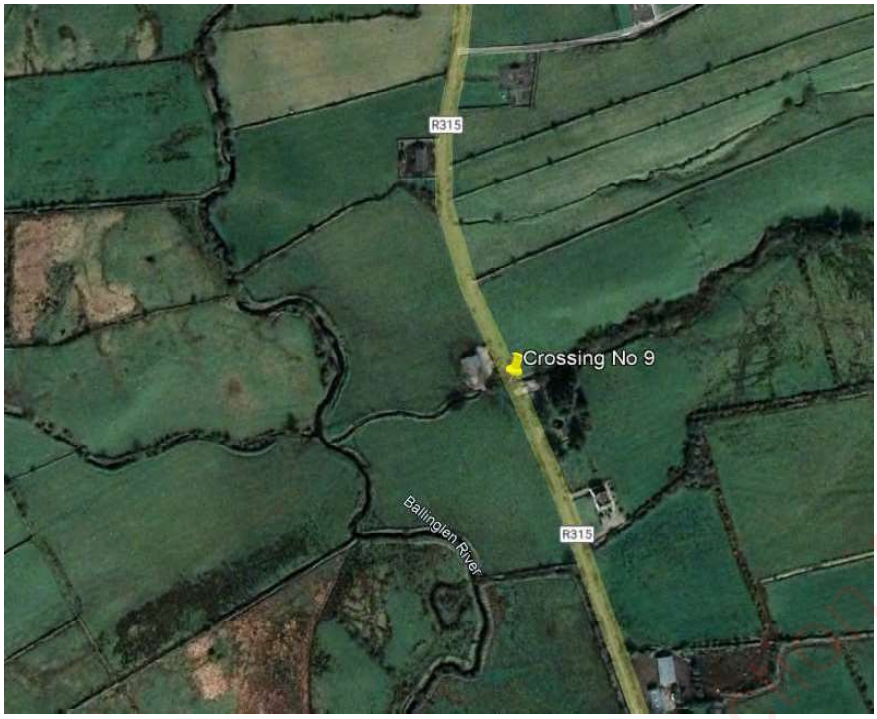


Figure 11.1 – Crossing No. 9 Location

11.1. Inspection Record

11.1.1. Stage 1 – Bridge Inventory Survey

Access Hazard	Steep banks, fast moving water, vegetation, and fencing restricts access.	
Culvert	Yes	
Structure Type	Clapper	
Location	Latitude: 54.23624	Longitude: - 9.372033
Road Number	R315	
Structure Number	Not available	
Structure Name (Alias)	Not available	
Structure Material	Masonry	
Number of Spans	1	
Total Span	1.0 m	
Maximum Span	1.0 m	
Minimum Span	1.0 m	
Structure Length	2.0 m	
Structure Width	6.5 m	

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Principle Function	Public Road
Structure Over	Watercourse
Height of Opening	1.2 m
Skew Angle	15°
Height Restriction	No
Weight Restriction	No
Services Present	Yes – Overhead telecom lines at upstream end.
Comments	Structure is in good condition. Depth from road surface to top of clapper varies, but is approx. 1.0 m minimum. Carriageway width – 4.5 m. Upstream verge width = 1.0 m. Downstream verge width = 1.0 m.

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11.1.2. Stage 2 – Maintenance Inspection

Not required under the Bridge Asset Management System for a culvert type structure.

11.1.3. Stage 3 – Engineering Inspection

Not required under the Bridge Asset Management System for a culvert type structure.

11.1.4. Photographic Record



Photo No. 11.1.1

General view of bridge from its southern end looking north.

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Photo No. 11.1.2
General view of upstream side of culvert.

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11.2. Load Capacity Assessment

The abutments supporting the stone clappers are well constructed and are in good condition. These supports will act as columns to transfer the applied wheel loads to the underlying ground. JOD consider the support walls structurally adequate for this purpose.

The deck is constructed using stone slabs spanning between support walls under the road pavement and grass verges. The applied wheel loads will disperse through the 1m depth of fill above the clappers JOD consider that the risk of damage to these slabs under the proposed loading is acceptable.

The recommended maximum allowable axle load for the bridge without modification is **12 tonnes**.

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12. CROSSING NO. 10



Figure 12.1 – Crossing No. 10 Location

12.1. Inspection Record

12.1.1. Stage 1 – Bridge Inventory Survey

Access Hazard	Deep and fast moving water, fencing restricts access.	
Culvert	No	
Structure Type	Arch	
Location	Latitude: 54.24871	Longitude: - 9.377269
Road Number	Not available	
Structure Number	Not available	
Structure Name (Alias)	Ballinglen Bridge	
Structure Material	Masonry	
Number of Spans	3	
Total Span	23.0 m	
Maximum Span	7.0 m	
Minimum Span	7.0 m	
Structure Length	42.5 m	
Structure Width	4.8 m	
Principle Function	Public Road	
Structure Over	Watercourse	
Height of Opening	3.0 m estimate	
Skew Angle	0°	

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Height Restriction	No
Weight Restriction	No
Services Present	Yes – Overhead telecom line at upstream end.
Comments	Bridge is on the National Inventory of Architectural Heritage with registration number 31301403. Structure is generally in good condition. Depth from road surface to crown of arch is approx. 0.5 m. Carriageway width – 3.0 m. Upstream verge width = 0.5 m. Downstream verge width = 0.5 m.

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12.1.2. Stage 2 – Maintenance Inspection

Maintenance Inspection Rating					
Main Element	**Red**	**Amber**	**Green**	**Not Applicable**	
Parapets		✓			**Non-Structural**
Access and Egress			✓		
Vegetation			✓		
External Walls		✓			**Structural**
Abutments and Piers			✓		
Deck or Arch			✓		
See Appendix 1 for explanation of rating system					

Maintenance Inspection Notes	
Parapets	1.0m high stone parapets in need of localised repairs.
Access and Egress	Could not get access to the underside of the structure due to the flow in the river at the time of the inspection. Fencing was also an issue.
Vegetation	Some small trees growing in downstream face to be removed.
External Walls	Stone walls in need of localised repairs.

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Abutments and Piers	Good condition cut stone.
Deck or Arch	Could not be inspected from beneath, however the arch barrels were viewed from the left bank and looked in good condition.

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12.1.3. Stage 3 – Engineering Inspection

	Component Condition Rating (cCR)				
Component	**1** **Insignificant Damage (VL)**	**2** **Some Damage (L)** Repair when convenient	**3** **Significant Damage (M)** Repair needed very soon	**4** **Critical Damage (H)** Repair needed immediately. Consider load restriction/propping	**5** **Ultimate Damage (U)** Bridge closure/lane restriction needed
Bridge Surface	✓				
Footpath, Verges, Rubbing Strips, Medians	✓				
Parapets and safety Rails		✓			
Embankment and Revetments	✓				
Wing Walls and Retaining Walls		✓			
Abutments (also see riverbed)	✓				
Piers (also see riverbed)	✓				
Spandrels		✓			
Arch Barrels and External Voussoirs	✓				
Beams / Girders	**N/A**				
Slab / Deck	**N/A**				
Riverbed	**Not inspected**				
Bearings and Expansion Joints	**N/A**				
OVERALL BRIDGE CONDITION RATING	**1**	**2**	**3**	**4**	**5**
See Appendix 2 for explanation of rating system					

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Engineering Inspection Notes	
1	The riverbed was not inspected due to the speed of the flow in the stream.
2	No bat roosts were observed under the bridge.

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12.1.4. Photographic Record



Photo No. 12.1.1
General view of bridge from its western end looking east.



Photo No. 12.1.2
General view of downstream side of bridge from left bank showing tree growing out of spandrel wall.



Photo No. 12.1.3
View of upstream parapet showing localised damage.

12.2. Load Capacity Assessment

An analysis of the load capacity of the bridge was carried out to the MEXE method as specified in Section 3 of TII Standard AM-STR-06002 (formerly BA 16/14).

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Arch dimensions used

- Span L = 7.0m
- Rise r_c = 2.5m
- Rise at quarter points r_q = 2.1m
- Thickness of arch barrel d = 0.4m
- Average depth of fill, h = 0.5m

Provisional Axle Loading (PAL) (BA 3.10)

PAL $= [740 \times (d+h)^2] / L^{1.3}$ or 70 (whichever is less)

$= [740 \times (0.4+0.5)^2] / 7^{1.3}$ or 70 (whichever is less)

$= 48$ or 70 (whichever is less)

PAL = 48 tonnes

Modifying factors

- Span/rise = 7.0 / 2.5 = 2.8

– Span/Rise Factor (F_{sr}) = 1.00 (as actual span / rise is less than 4 – figure 3.3)

– Profile Factor (F_p) $= 2.3[(r_c-r_q)/r_c]^{0.6}$

$=2.3[(2.5-2.1)/2.5]^{0.6}$

$= 0.77$

– Material Factor (F_m) $= [(F_b \times d) + (F_f \times h)]/(d + h)$

Where:

– Barrel Factor (F_b) = 1.0 (Table 3.1)
– Fill Factor (F_f) = 0.7 (Table 3.2)

Therefore:

– Material Factor (F_m) $= [(1.0 \times 0.4) + (0.7 \times 0.5)] / (0.4 + 0.5)$

$= 0.83$

– Joint Factor (F_j) $= F_w \times F_d \times F_{mo}$

Where:

– Width Factor (F_w) = 0.9 (Table 3.3)
– Mortar Factor (F_{mo}) = 0.9 (Table 3.4)
– Depth Factor (F_d) = 0.9 (Table 3.5)

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Therefore:

- Joint Factor (F_j) = 0.9 x 0.9 x 0.9
  = 0.73
- Condition factor (F_{cM}) = 0.90 (based on proven capacity and good condition)
- Axle Factors (A_f) = 0.95 (Figure 3.5a) (no axle lift off)
  = 0.70 (Figure 3.5b) (with axle lift off)

Modified Axle Loading = F_{sr} x F_p x F_m x F_j x F_{cM} x A_f x PAL

= 1 x 0.77 x 0.83 x 0.73 x 0.9 x 0.95 x 48 (no axle lift off)
= 19 tonnes (no axle lift off)

= 1 x 0.77 x 0.83 x 0.73 x 0.9 x 0.70 x 48 (axle lift off)
= 14 tonnes (axle lift off)

It should be noted that this carrying capacity is for the arch alone, and that the capacity of the full bridge is a combination of several other elements including fill materials buttresses and foundations. It should also be noted that this method can return quite variable results as the modifying factors are subjective. In particular the Condition Factor of 0.9 was taken in this instance due to the overall good condition and proven existing traffic capacity.

The recommended maximum allowable axle load for the bridge without modification is **12 tonnes**.

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13. CONCLUSION

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The maximum vehicle loadings as taken from Nordex document "*Transport, access roads and crane requirements - Wind turbine class K08 delta*" Reference 2001709EN Rev 01 / 2020-04-15 are as follows:

- Max. load per axle approx. 12 t (for roads that are used only for transporting components)
- Max. load per axle approx. 16 t (for roads that are used for relocating cranes between two WT sites)
- Max. overall weight: approx. 180 t

The load capacities of the crossings on the proposed turbine delivery route are as follows:

Location	Weight Restriction	Maximum Axle Load	Comments
Crossing No 1	None	12 tonnes	Crossing can take the specified loading without modification.
Crossing No 2	None	12 tonnes	Crossing can take the specified loading without modification.
Crossing No 3	None	12 tonnes	Crossing can take the specified loading without modification.
Crossing No 4	None	12 tonnes	Crossing can take the specified loading without modification.
Crossing No 5	None	12 tonnes	Crossing can take the specified loading without modification.
Crossing No 6	None	12 tonnes	Crossing can take the specified loading without modification. We suggest that the Local Authority be advised that the bottom corner of the south abutment is damaged with some stones displaced, and that pointing to the arch has degraded, so guniting will be required.

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Crossing No 7	None	12 tonnes	Crossing can take the specified loading without modification.
Crossing No 8	None	12 tonnes	Crossing can take the specified loading provided the temporary modifications shown in Figure 10.1.1. are carried out.
Crossing No 9	None	12 tonnes	Crossing can take the specified loading without modification.
Crossing No 10	None	12 tonnes	Crossing can take the specified loading without modification.

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APPENDIX 1

MAINTENANCE INSPECTION RATING SYSTEM

4.4 The Rating System

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The **RED** , **AMBER** , **GREEN** rating system is used to categorise the observed condition of each element of the bridge and is summarised below and tabulated in table 4.2;

- The **RED** rating indicates that the structure has serious defects present which left unchecked could result in the failure of the element (if it has not already failed)
- The **AMBER** rating indicates that there are defects present within the element which require repair but are not yet critical. Therefore the element is in moderate condition
- The **GREEN** rating indicates that the element is generally in good condition and functioning as intended
- **Not Applicable** is used to record an element that was not safe to inspect, that the inspector could not see or was not present. It is helpful to record reasons in the comment text box

The application, when all six elements have been assigned a rating, calculates the overall Maintenance Rating of the bridge automatically based on the structural elements only. The bridge will receive a rating of **RED** , **AMBER** or **GREEN** within the MapRoad PMS system, users can then filter bridges based on this basic rating to focus their attention and prioritise which bridges require an Engineering Inspection.

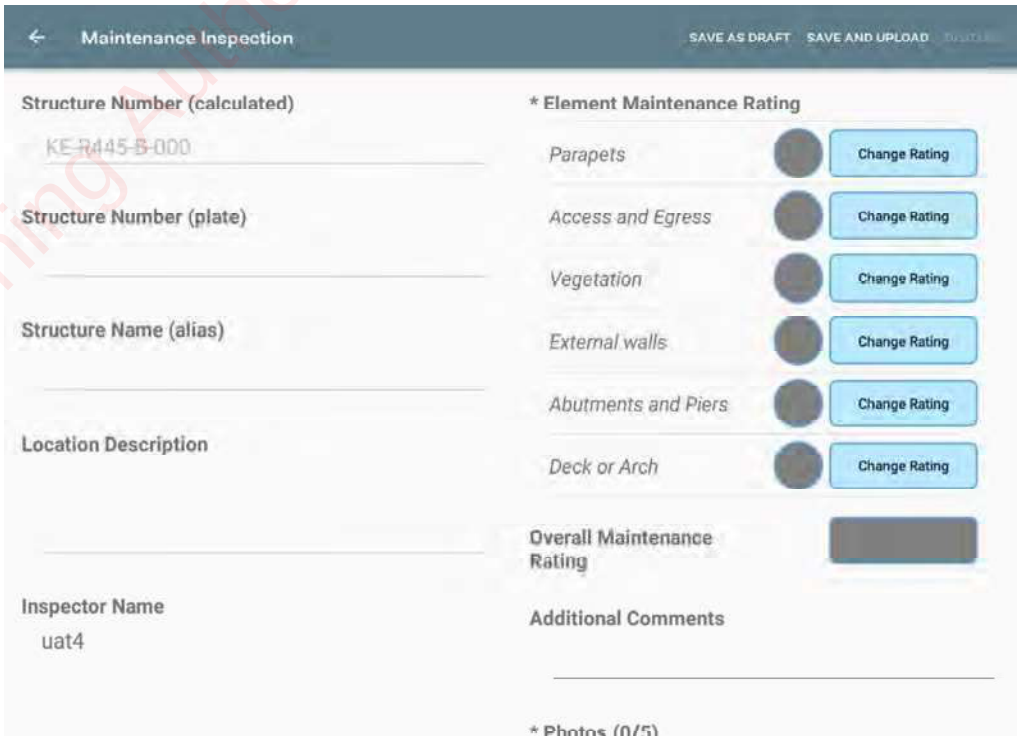


Figure 4.1 - Maintenance Inspection Screen

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Main Element	RED	AMBER	GREEN	NOT APPLICABLE	
Parapets	Part or all of parapet or safety rail missing, collapsed or significantly displaced.	Some damage - nuts missing, corrosion, deformation, cracking, vegetation causing disturbance, tilting, sliding, missing masonry.	Minor defects or vegetation growth only.	**Select this if it is obvious the Structure never had a parapet.** If unsure, please select **RED**	Non-structural
Access and Egress	Dangerous high risk ***DO NOT ENTER***	Some hazards and risk. Risk assessment required.	Easy and safe.		
Vegetation	Heavy growth and/or Invasive species.	Appreciable growth clearance required, includes some Ivy, small saplings, brambles.	None or minor growth only.		
External walls	Significant cracks, bulging, leaning, rotation, missing masonry, or a collapse. Significant exposed reinforcement and/or corrosion.	Some cracks, bulging, leaning, rotation, minor missing masonry, exposed reinforcement, corrosion.	No evidence of or minor defects present.	Structure doesn't have external walls Or Couldn't access.	Structural
Abutments and Piers	Severe scour holes below walls, Significant areas of missing masonry or failure. Significant rusting of steel members, buckling or steel missing.	Some scour in bed, pier or abutment. cracks, leaning, bulging, missing stones, exposed reinforcement, or rusting of steel members.	Minor or no evidence of scour in bed. Minor or no evidence of defects in pier or abutment.	Couldn't access.	
Deck or Arch	Large cracks, severe sagging, spalling, deformation, missing elements, arch separation. Severely exposed reinforcement, corroded or missing steel on struts, ties, beams or failure. Holes.	Some: cracks, sagging, spalling, missing elements, exposed rebar or rusting of steel, struts, ties, beams or corrugated or other jack arch elements.	None or minor cracks, sagging, spalling, or any other minor defect.	Couldn't access.	
Overall Rating determined by worst rating of the three structural components					

Table 4.2 – Maintenance Inspection Rating Guide

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APPENDIX 2

COMPONENT CONDITION RATING SYSTEM

5 ENGINEERING INSPECTIONS

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5.1 Introduction

Engineering Inspections (EI) shall be undertaken by Local Authority engineers at Executive Engineer level or above who have significant bridge experience and who have undertaken appropriate bridge related training. Preferably, they will be Chartered Engineers. This Engineering Inspection will assign a condition (CR) rating to the structure. The bridge location and bridge number will have been established in the Bridge Inventory Survey (BIS) (Chapter 3) and possibly the bridge name established from non-site information (Chapter 6). If not, newly found bridges can be added by going back to the BIS and inputting the basic data there first. The Engineering Inspection (EI) is designed to be used with a tablet Application, similar to the Pavement Surface Condition Index (PSCI). The inspection requires access to the river banks and under the soffit of the bridge, appropriate risk assessment and PPE and precautions must be taken (Chapter 2). The table below presents a description of some of the hazards that may be present at the structure that may affect the ability of an inspector to undertake a safe inspection. It is important that access hazards and other hazards are recorded to enable a risk assessment to be carried out (these will likely already be identified during the MI).

HAZARD	RISK
Steep/unstable banks	Potential fall
Deep water	Potential for drowning
Fast moving water	Potential to lose balance or be swept away
Size of structure	Very tall, etc
Unstable bed	Mud or silt within the stream
Overgrowth / vegetation	Restricts access, can conceal hazards, briars can cause cuts, sticks / branches can lance inspectors
Hazardous species (e.g. Giant hogweed)	Burns and blisters
Fencing	Restricts access, barbed wire can cause cuts, electric fences, impenetrable thorn bushes.
Illegal dumping	Ground may be unstable, needles, Weil's disease, potential health hazards
Livestock / pets	Can attack
Traffic	Speed, quantity
Services	Overhead / ducted / buried services may be present
Bridge condition	Risk of falling objects or collapse

Table 5.1 – Hazards and Risks

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This Engineering Inspection is essentially a visual inspection but some prodding and tapping may also be useful. The Engineer, however, may wish to take some measurements which are not compulsory at BIS stage to aid understanding and in assessing a particular structure's capacity, e.g. beam or slab depth, arch thickness at crow, cover, arch rise at crown and quarter points. Such additions can be included in the comment box. An element by element inspection is required and a rating is to be assigned to each element, the component Condition Rating (cCR). The overall Condition Rating (CR) is manually entered by the inspector.

The CR is based on the ratings of the structural elements only. Photographic evidence of the defect(s) must be collected. Up to 30 photographs can be collected in the Engineering Inspection module of the app and stored on the MapRoad system.



Figure 5.1 - Engineering Inspection Screen

Text examples hereunder show possible inputs/selections and will be dependent on the Inspectors' local knowledge, historic references, the detail of previous information already stored and emphasise the status of the structure. Some Local Authorities may already have a bridge database established but will be adding to it over time. The overall condition rating of the bridge is related to the structural elements only. Photographic evidence of the defect(s) of concern and brief note of the defects should be entered in the comment box.

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5.2 Condition Rating of Bridge Components (and the bridge)

The Engineer assesses the condition of the 14 components listed in the table beginning on page 84. Components are classified as either structural or non- structural. The Engineer must enter a rating for each component. When each component has been rated the overall rating of the structure is assigned by the inspector. This will normally be the highest rating of all the structural components but may be greater due to the cumulative effect of a number of defective structural elements. Examples are provided on page 73 and guidance is provided in the table beginning on page 84.

CONDITION RATING (CR) – GIVE RATING FROM ONE OF THESE CONDITIONS			
RATING	**LEVEL OF DAMAGE**	**WORKS REQUIRED**	**WHEN**
1	Insignificant damage	Minimal work required	Non-critical
2	Some damage	Minor repair work required	Repair when convenient
3	Significant damage	Repair work required	Repair soon
4	Critical damage	Urgent repairs or strengthening work required	Repair immediately
5	Ultimate damage	Bridge has failed	Strengthening works or replacement required, road closure or TMP

Table 5.2 – Component Rating and Works Required Chart

The table on page 85 provides guidance on the rating for all elements. It provides indications of levels of defects within the Condition Rating classification (1-5). A structural component is a component which would cause the bridge to be structurally compromised or collapse if it failed. The type, variety and complexity of defects that can arise in bridges cannot be covered fully by examples etc, and therefore engineering knowledge, judgement and experience will be necessary. The overall condition rating of the bridge is generally based on the worst condition rating of any structural component in the bridge; i.e. if the bridge is in near perfect condition but one structural component is critically damaged the bridge will have an overall rating of 4 or 5. However, the Engineer, when compiling a bridge repair programme, may decide that a non-structural defective component is also a priority in terms of, for instance, public safety e.g. a missing parapet or safety barrier.

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5.2.1 *Engineering Inspection - Comment Boxes*

There are two types of comment box available under Engineering Inspections, one general box and a component comment box. The general comment box provides the Engineer carrying out an Engineering Inspection with the opportunity to record an overall comment regarding the condition of the bridge and/or record details of the bridge not already covered by the Maintenance Inspection or the BIS. Such detail may include structural dimensions, extreme cover or near zero cover, plaque or pilaster information, angling access ways, or other relevant data, not previously recorded.

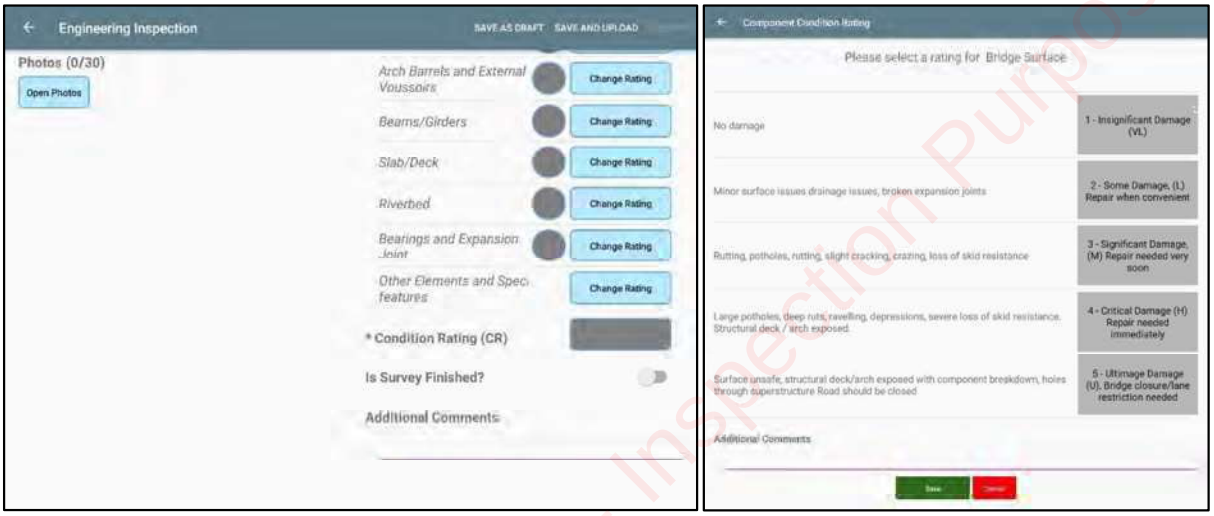


Figure 5.2 - Engineering Inspections – Comment Boxes

Engineers are also encouraged to insert comments on matters of conservation and unusual interest, or issues of concern, in order to better understand the structure and for the use of others at a later date. The Engineer may, however, choose to omit any or part of the information and simply add short text comments in the *component* comment box. Some examples of relevant information are provided below.

A. Describe the issue:

Brief Comment

- Three span stone arch bridge, with thin barrel thickness. Surface ponding.

Detailed Comment

- Triple span; approx. c8' (2.4M) central arch plus 2 x approx. 6'(1.8m) segmental arches, (d=10"(0.25m)) in rough cut, rough coursed sandstone, in spate stream. Approx. 6' high abutments, with dressed stone pilasters and coursed narrow limestone piers, single way traffic width, with grass margins, deck ponding evident. c0.6m crown fill. Date plaque '1794' on upstream road side parapet face. Heavy rain, above average river flow.

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B. Describe defects:

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The Engineer can record details of the problems found at a particular structure. There are many possible defects and combinations of defects, which can arise in bridges and the Engineer must decide which would be relevant or of benefit to add here and are provided in addition to the component comment.

Brief Comment

- Cracks in central span, wet soffit.

Detailed Comment

- approx. 40mm wide diagonal crack from LHS to RHS, LHS cutwater running into central crown, second longitudinal crack approx. 2m from spandrel face, plus spandrel separation downstream side, all in same arch (arch No. 3). Substantial mortar loss in arch No. 2, upstream half with dripping evident, reflective of road surface ponding above.

C. Propose Remedial Action:

The Engineer can record proposals for the next step; e.g. possible site investigations, possible remedial works, scour inspections, material testing, structural assessments, etc.

- Trial holes at crown required, restrict loading.
- Breakdown of barrel integrity, high priority for repair. SI to establish 'D' and 'H' to assess load capacity, erect load restriction sign?

5.2.2 Engineering Inspection – Condition Rating of Components – Component Condition Rating (cCR)

This Engineer rates the condition of each component (cCR) - 14 in total. The Engineer shall enter a rating for each component, if present. The rating assigned to structural components dictates the overall condition rating of the bridge by, normally, assigning the highest rating of each of the structural components as the overall condition rating of the bridge. This rating can be overridden if the Engineer concludes that the cumulative effect of some structural component ratings would be greater than the highest rating of an individual structural component. Guidance is given in the table and condition guidance examples.

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Example 1 - Barrel Cracks, cCR= 4, pier cCR =3: Overall structure CR =4.

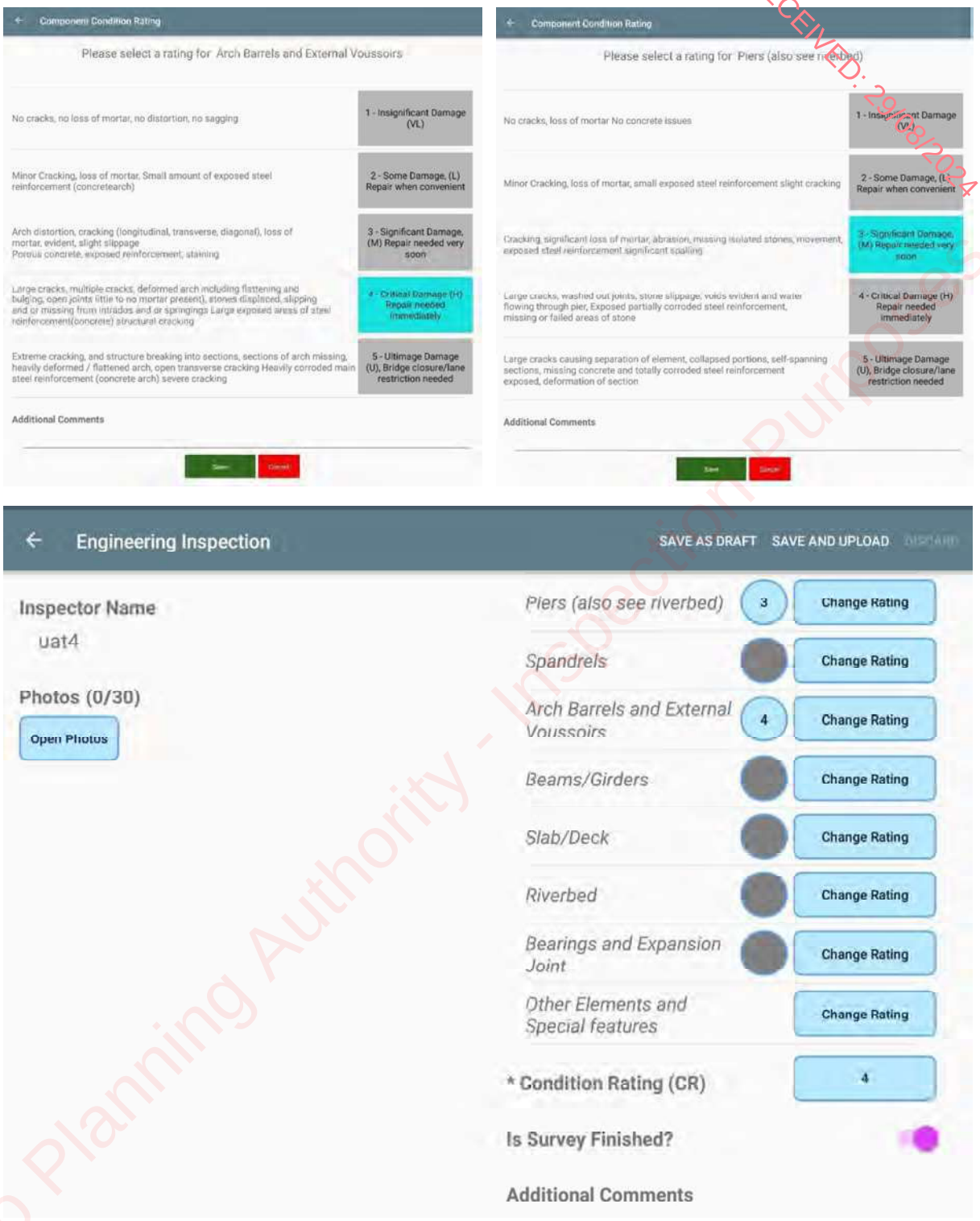
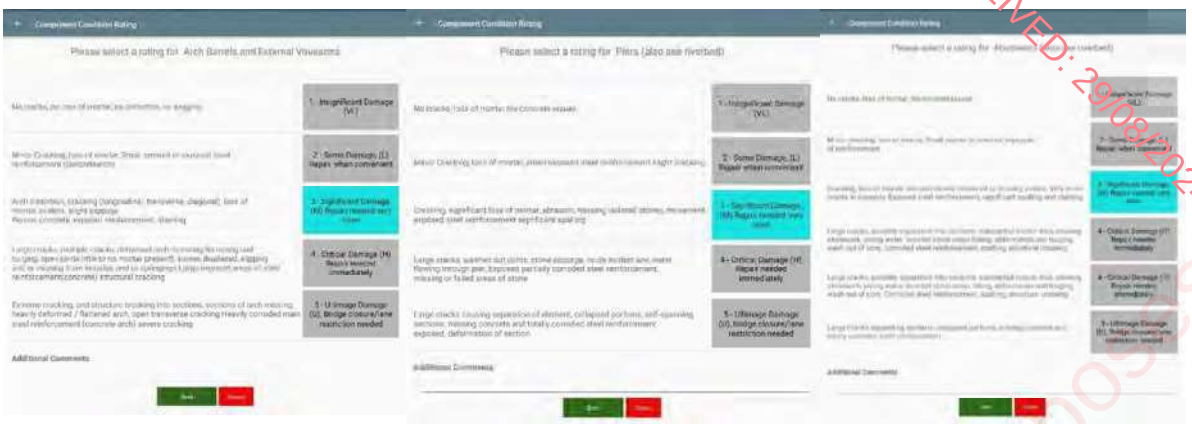


Figure 5.3 - Engineering Inspections – Example 1

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Example 2 - Barrel Cracks, cCR= 3, pier cCR =3, Abutments cCR =3:Overall structure CR =4.



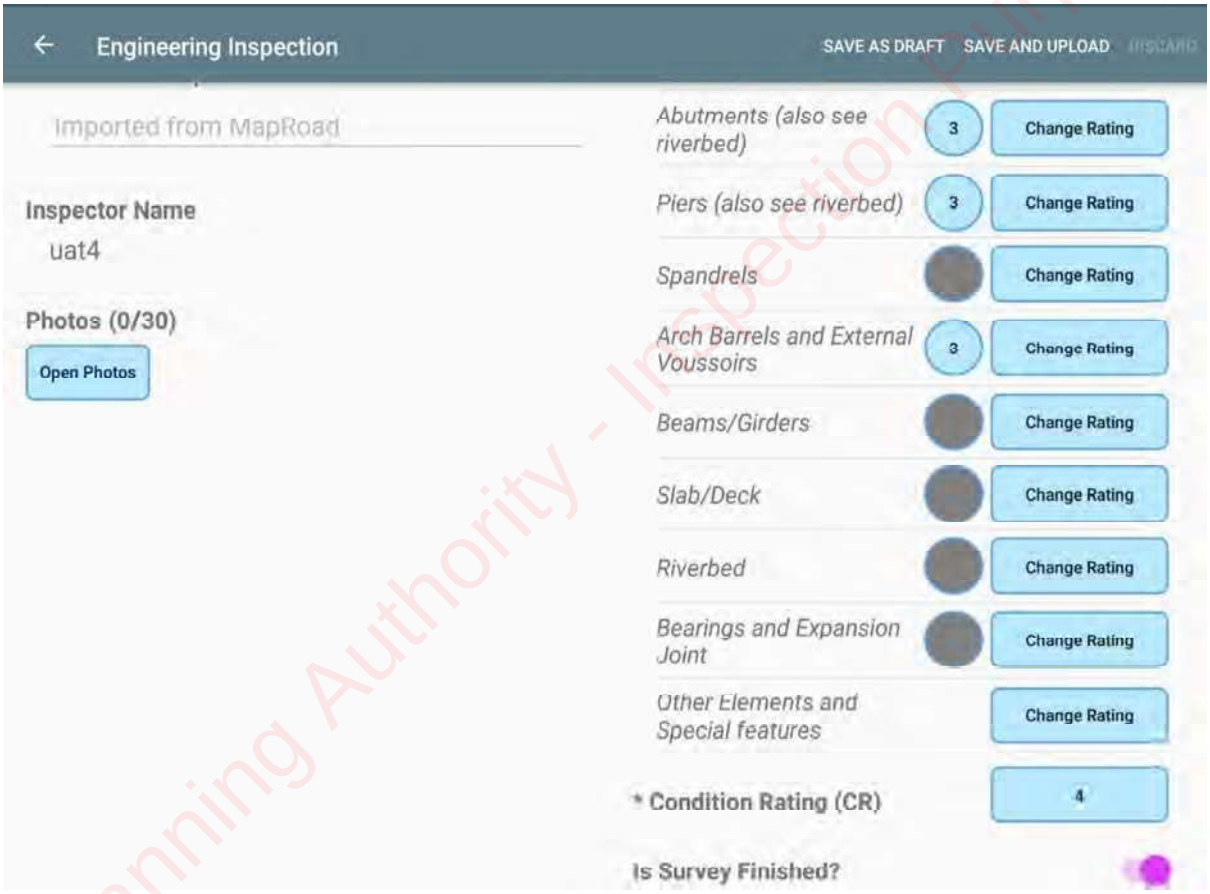


Figure 5.4 - Engineering Inspections – Example 2

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5.2.3 Engineering Inspection – Overall Bridge Condition Rating (CR)

There may be situations where the Engineer considers that the overall CR is higher than any component rating (cCR), i.e. the accumulating effect. cCR =3 for piers, abutments and arch barrel may result in an overall Condition Rating (CR) rating of 4 for the structure.

5.2.4 Engineering Inspection – Photographs

Photographs form an essential part of the Engineering Inspection can be taken using the Application. Sufficient photographs (up to a maximum of 30) should be taken to show any/all defects found; e.g., Intrados cracks, barrel distortion, foundation issues, scour holes, exposed rebar, sagging, bulging, corrosion, etc. This may or may not require a flash light- trial and error may be necessary. Inaccessible central span defects may often be photographed using a zoom facility from a distance. Photographs of other salient matters, including vegetation and tree growth, blockages, impact damage, hump backs, unusual features, services, etc, should also be taken, if not already captured when carrying out the Bridge Inventory Survey (BIS).

5.5 The Ratings Assistance Table

The table on the following pages provides assistance to Local Authority Engineers tasked with assigning condition ratings to bridge components, however, it is not intended as a substitute for technical education, training or experience



*This means the component is a **STRUCTURAL** component.*

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COMPONENT	RATING (cCR)				
	1	2	3	4	5
	Coarse Damage and Repair equivalence				
	Insignificant Damage (VL)	Some Damage (L) *Repair when convenient*	Significant Damage (M) *Repair needed very soon*	Critical Damage (H) *Repair needed immediately. Consider Load restriction/propping*	Ultimate Damage (U) *Bridge closure/lane restriction needed*
Bridge Surface	No damage.	Minor surface issues, drainage issues, broken expansion joints.	Rutting, potholes, slight cracking, crazing, loss of skid resistance.	Large potholes, deep ruts, ravelling, depressions, severe loss of skid resistance. Structural deck/arch exposed.	Surface unsafe, structural deck/arch exposed with component breakdown, holes through superstructure. Road should be closed.
Footpath Verges rubbing strips Medians	No damage.	Small potholes, ruts, hairline cracks, porous verges, vegetation growth.	Potholes, cracking of surfacing, shrub growth, services exposed.	Large potholes, major depressions, paving bricks displaced or lifting and broken paving slabs, shrub and tree growth lifting elements.	Large pothole, hole through superstructure, footpath should be closed.
Parapets and Safety Rails	Minor loss of mortar in masonry. Some painting of railing required.	Minor stone issues, loss of mortar. Light vegetation growth. Painting of metal railing required.	Loose stones, loose mortar, slight leaning, tilting, bulging or impact damage. Bolts corroded, isolated vertical rail missing, safety barriers slightly damaged, visibility reduced due the vegetation growth.	Parts of masonry parapet missing, part of parapet collapsing. Heavy vegetation or shrub/tree growth - roots displacing walls. Missing railing, badly damaged safety rails, substantially reduced iron or steel cross-section through rusting.	Missing railing or parapet, danger of accident.

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COMPONENT	RATING (cCR)				
	1	2	3	4	5
	Coarse Damage and Repair equivalence				
	Insignificant Damage (VL)	Some Damage (L) *Repair when convenient*	Significant Damage (M) *Repair needed very soon*	Critical Damage (H) *Repair needed immediately. Consider Load restriction/propping*	Ultimate Damage (U) *Bridge closure/lane restriction needed*
Embankment and Revetments	Minor stone loss, light vegetation.	Some stone loss, vegetation growth at joints, significant mortar loss. Slight scour to base or at drainage outlets.	Embankment material starting to break down, isolated base displacements, shrubs growing, Scour evident. Minor flanking erosion. Masonry walling isolated stone loss.	Localised failure of slope and construction, masonry collapsing, Tree growth deforming structure, Major erosion at base or flanking. clear settlement/movement self-arching and breaches, rock armour moving away from base, base rotation, severe scour Road pavement failing.	Undermining of approach road, partial collapse of structure, road pavement collapsing.
Wingwalls and Retaining walls	Very minor bulging, leaning, cracking.	Minor: bulging, cracking, mortar loss, vegetation. Slight spalling of concrete. Slight rotting in crib walls.	Cracking, bulging, leaning, tilting, mortar loss, some stone loss. Shrubs and roots slightly moving stones. Spalling of concrete, exposure of reinforcement. Isolated timber member's failure, infill escaping.	Significant: leaning, bulging, cracking, impact damage (some parts broken off), sliding, heaving, undermining. Isolated stone work areas collapsing or falling off bulges and leaning walls. Isolated areas of crib walling, reinforced earth failing.	Extreme bulging, leaning, tilting, cracking, sliding. Partial collapse of any type of wall.

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COMPONENT	RATING (cCR)				
	1	2	3	4	5
	Coarse Damage and Repair equivalence				
	Insignificant Damage (VL)	Some Damage (L) *Repair when convenient*	Significant Damage (M) *Repair needed very soon*	Critical Damage (H) *Repair needed immediately. Consider Load restriction/propping*	Ultimate Damage (U) *Bridge closure/lane restriction needed*
Abutments (also see riverbed)	No cracks, loss of mortar. No concrete issues.	Minor cracking, loss of mortar, Small cracks in concrete, exposure of reinforcement.	Cracking, loss of mortar, isolated stones, displaced or missing stones. Very minor cracks in masonry. Exposed steel reinforcement, significant spalling and staining.	Large cracks, possibly separated into sections, substantial mortar loss, missing stonework, piping water, isolated stone areas failing, deformation and bulging, wash out of core. Corroded steel reinforcement, spalling, structural cracking.	Large Cracks separating sections, collapsed portions, missing concrete and totally corroded steel reinforcement.
Piers (also see riverbed)	No cracks, loss of mortar. No concrete issues.	Minor Cracking, loss of mortar, small exposed steel reinforcement slight cracking.	Cracking, significant loss of mortar, abrasion, missing isolated stones, movement, exposed steel reinforcement, significant spalling.	Large cracks, washed out joints, stone slippage, voids evident and water flowing through pier. Exposed partially corroded steel reinforcement, missing or failed areas of stone.	Large cracks causing separation of element, collapsed portions, self-spanning sections, missing concrete and totally corroded steel reinforcement exposed, deformation of section.
Spandrels	No cracks bulges, mortar loss.	Minor cracking, tilting, bulging, water egress, minor vegetation.	Cracking, bulging, leaning, sliding, mortar loss, substantial vegetation/shrub growth.	Extensive cracking, stone loss, rotation, substantial bulging, tilting, leaning with stones falling, sliding. Shrub and tree growth moving masonry.	Portions collapsing, extreme leaning bulging, compression failure, separation and articulation.

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COMPONENT	RATING (cCR)				
	1	2	3	4	5
	Coarse Damage and Repair equivalence				
	Insignificant Damage (VL)	Some Damage (L) *Repair when convenient*	Significant Damage (M) *Repair needed very soon*	Critical Damage (H) *Repair needed immediately. Consider Load restriction/propping*	Ultimate Damage (U) *Bridge closure/lane restriction needed*
Arch Barrels and External Voussoirs	No cracks, no loss of mortar, no distortion, no sagging.	Minor Cracking, loss of mortar. Small amount of exposed steel reinforcement (concrete arch).	Arch distortion, cracking (longitudinal, transverse, diagonal), loss of mortar, evident, slight slippage. Porous concrete, exposed reinforcement, staining.	Large cracks, multiple cracks, deformed arch including flattening and bulging, open joints little to no mortar present), stones displaced, slipping and or missing from intrados and or springings Large exposed areas of steel reinforcement(concrete) structural cracking.	Extreme cracking, and structure breaking into sections, sections of arch missing, heavily deformed/flattened arch, open transverse cracking. Heavily corroded main steel reinforcement (concrete arch) severe cracking.
Beams/ Girders	Very minor cracks in concrete. Paint rusting on steel girders and beams.	Minor cracks in concrete soffit and beam webs or reinforcement visible, metal beams showing rust and paint heavily flaking.	Cracks in concrete, minor concrete spalling, staining, some rebar exposed. Leaching. Extensive areas of beams without paint (protective coating), rusting steel work.	Concrete heavily spalling, structural main reinforcement rusting, evidence of structural distress at supports or midspan. Structural steel members losing cross-section due to extent of rust, distortion of members, rivets or welds breaking down.	Deflection of beams discernible, steel reinforcement heavily rusted and reduced in cross-section. Substantial structural cracking. Steel beams extensive corrosion and reducing load carrying capacity. Flanges and webs only partially existing.

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COMPONENT	RATING (cCR)				
	1	2	3	4	5
	Coarse Damage and Repair equivalence				
	Insignificant Damage (VL)	Some Damage (L) *Repair when convenient*	Significant Damage (M) *Repair needed very soon*	Critical Damage (H) *Repair needed immediately. Consider Load restriction/propping*	Ultimate Damage (U) *Bridge closure/lane restriction needed*
Slab/Deck	None or very minor cracks, no spalling in concrete. No rust.	Minor crack and slight evidence of concrete surface breakdown or carbonisation of concrete soffit walls. Paint missing on steel trough units Minor light rusting of steel or iron.	Cracks in concrete, porous concrete, minor concrete spalling some rebar exposed. Extensive areas of soffit without paint (protective coating), rusting steel work.	Concrete heavily spalling, structural main reinforcement rusting, evidence of structural distress, Structural steel work corroding through significant thickness of member, rivets or welds breaking down Composite decks: materials separating, some components in-effective.	Deflection of slab discernible, fracture in concrete, sagging, steel reinforcement heavily rusted and reduced in cross-section, substantial areas of spalling. Steel soffits suffering from extensive corrosion and reducing load carrying capacity. Failure of some components in composite decks.
Riverbed	No Erosion or scour evident.	Minor bed or bank erosion, minor scour evident. River bed below structure base. Bed protection showing minor issues.	Evidence of minor undermining of abutments, piers, cutwaters or training Bed protection showing isolated areas of failure: pitching stones missing, concrete portions missing.	Serious erosion and scour. Bed protection failed over a substantial area. Abutments, piers, cutwater etc. undermined and scour holes at piers visible, foundations exposed Masonry blocks missing and water seeping through the structure between spans.	Major erosion & scour. Substantial bed erosion, foundations exposed or partially missing. Piers deforming, tilting, suspended, partially missing Abutments only partially founded, structure redistributing load, cantilevering, failure imminent.

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COMPONENT	RATING (cCR)				
	1	2	3	4	5
	Coarse Damage and Repair equivalence				
	Insignificant Damage (VL)	Some Damage (L) *Repair when convenient*	Significant Damage (M) *Repair needed very soon*	Critical Damage (H) *Repair needed immediately. Consider Load restriction/propping*	Ultimate Damage (U) *Bridge closure/lane restriction needed*
Bearings and Expansion Joint	No damage or insignificant. Clear any blocked associated drainage systems, if necessary.	Minor cracks in rubber. Steel components starting to rust. Water ponding evident on bearing shelf-etc. Surface cracks in joint in road.	Loose, cracked rubber pads. Steel components rusting. Surfacing starting to break up at expansion joints.	Rubber bearing pads delaminating or starting to break down. Steel bearings heavily rusted into steel components and bearing plinths. Damaged expansion joint, twisting, lifting, jammed, carriageway has large pot holes at joint, foot path broken up.	Bearing components excessively reduced in cross-section due to rust, bending, buckling of elements, nuts shearing. Road surface depressed or disintegrating: unsafe. Road should be closed.
Other Elements and Special features. Other elements may occasionally be present-the user can input descriptions of the component and its condition in the appropriate column. E.g. channel blockages.					
OVERALL BRIDGE CONDITION RATING (CR)	**1**	**2**	**3**	**4**	**5**

Table 5.3 – The Ratings Assistance Table

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APPENDIX 3

NORDEX DOCUMENT "TRANSPORT, ACCESS ROADS AND CRANE REQUIREMENTS - WIND TURBINE CLASS K08 DELTA" REFERENCE 2001709EN REV 01 / 2020-04-15

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Appendix 3.6 (2 of 2)

Delivery Route Bridge Inspection Report

Keerglen Wind Farm

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Sales document

Transport, access roads and crane requirements
Wind turbine class K08 delta



2001709EN

Revision 01 / 2020-04-15

- Translation of the original customer document (E0004929172, rev. 01) -

This is a translation from German. In case of doubt, the German text shall prevail.

Document will be distributed electronically.

Signed original at Nordex Energy GmbH, Engineering Department.

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Turbine generation	Product series	Product
Delta	Delta	N100/3300 N117/3000 controlled N117/3600 N117/3675 N131/3000 N131/3000 controlled N131/3300 N131/3600 N131/3900

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1. Basic information

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This document contains basic information for planning road construction and crane hard standing areas, delivery, storage and installations in the course of establishing the infrastructure for wind farms of the K08 delta wind turbine class (N100, N117 and N131 with the specified hub heights). Component dimensions for the design of transport equipment and cranes are also included.

In principle, it must be ensured that during the entire project phase, especially during delivery, storage, installation and for the subsequent service and maintenance work, all trades are accessible at all times throughout the entire construction site, so that all necessary work can be carried out to the full extent. Furthermore, measures on occupational health and safety and environmental protection must be observed at all times and monitored and coordinated by the client.

The planning parameters specified in this document are minimum requirements. Observing these requirements is to ensure a smooth process throughout the entire project phase and permanent compliance with occupational health and safety regulations.

Detailed information on the infrastructure planning is also project-specific and must be agreed upon by all persons involved prior to project start.

Each project location must be analyzed and planned individually taking into account the local and general safety regulations. Project-specific justified and comprehensible changes to and/or deviations from the following specifications can be examined beforehand or in the early planning phase in cooperation with Nordex and implemented after written agreement. In this context, the safety of persons and material is given top priority. If there is no coordination with Nordex project management, the minimum requirements set out below apply.

All data contained in this document describe the current development status of the wind turbine. These data are subject to change due to continuous development. In this case Nordex will provide an updated version of this document.

If the minimum requirements are exceeded, in particular with regard to see chapter 3.2 “Slopes and vertical radii” and see chapter 5 “Crane hard standing area”, additional safety measures or more cost-intensive logistics concepts might be necessary (e.g. internal reloading of main components on the wind farm to reduce the clearing areas in forest locations). The measures are to be agreed upon with Nordex in advance.

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NOTE

We expressly point out that all values must be regarded as standard values only.

During the planning and execution of the work to be executed by the client, the valid national technical regulations, statutory provisions and standards must be taken into account in accordance with the current state-of-the-art technology. If the valid national regulations, statutory provisions and standards go beyond the minimum requirements specified below, then these must be observed accordingly.

Further instructions for transport can be requested from Nordex.

The layout of access roads and hard standing areas depends on the transport and erection method.

- The design must be modified for each individual erection site.
- Depending on the site different variants are possible.
- Transport weights may also vary with the erection site.

The exact design of access roads, crane hard standing areas and assembly areas must be agreed with Nordex prior to starting the erection work!

Improper design or execution of access roads and crane hard standing areas may subsequently cause considerably higher logistics and erection costs, for example, due to downtimes or additional personnel and/or equipment.

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2. Weights, dimensions and handling instructions

2.1 Nacelle

During nacelle transport the drive train, rotor hub and further exterior assemblies (obstacle lights, wind sensors, lightning arresters, etc.) are not assembled yet. The transport frame for the nacelle consists of 4 individual supports, which must be used for transport. All components must always be transported on anti-slip mats, except for sea transport.

All turbine components must always be placed on compacted ground or on crane mats.



Fig. 1 Nacelle (view from the left) with transport supports

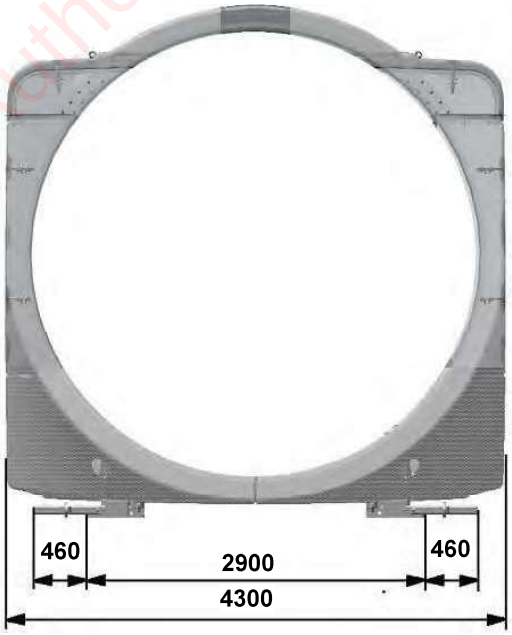


Fig. 2 Nacelle (front view) with transport supports

2.2 Drive train

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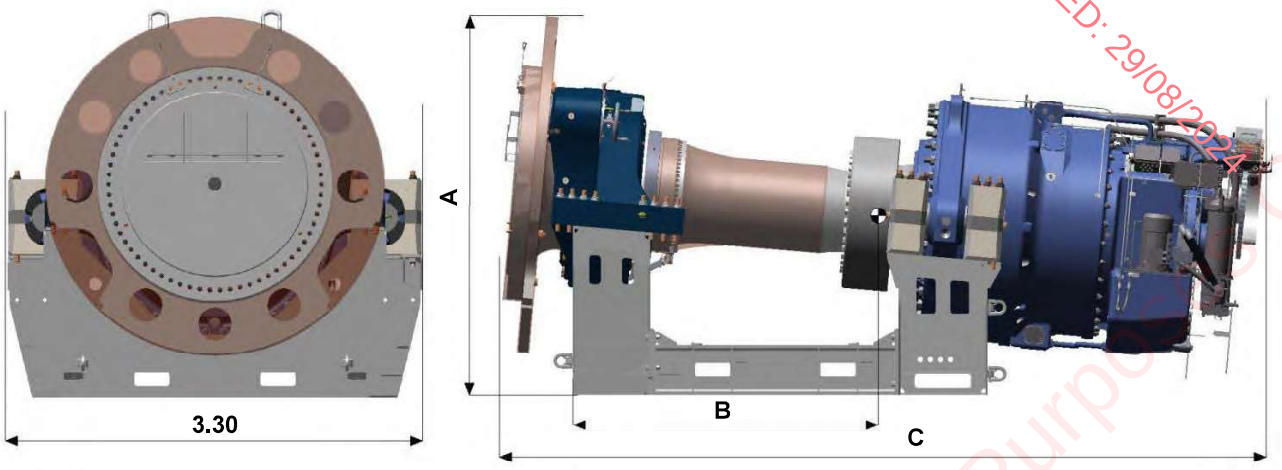


Fig. 3 Dimensions of the drive train on the transport frame (all dimensions in m)

	N100/N117	N131/3300	N131/3600 N131/3900
A	2.95	3.00	3.00
B	2.00-2.40	2.55-2.81	1.9-2.3
C	6.10-6.15	approx. 6.25	approx. 6.25

Values depend on gearbox specifications and oil filling capacity

The rear section of the gearbox will be protected for transport with a wooden cladding. This cladding is included in the overall length.

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2.3 Rotor hub

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Rotor hub N100 and N117

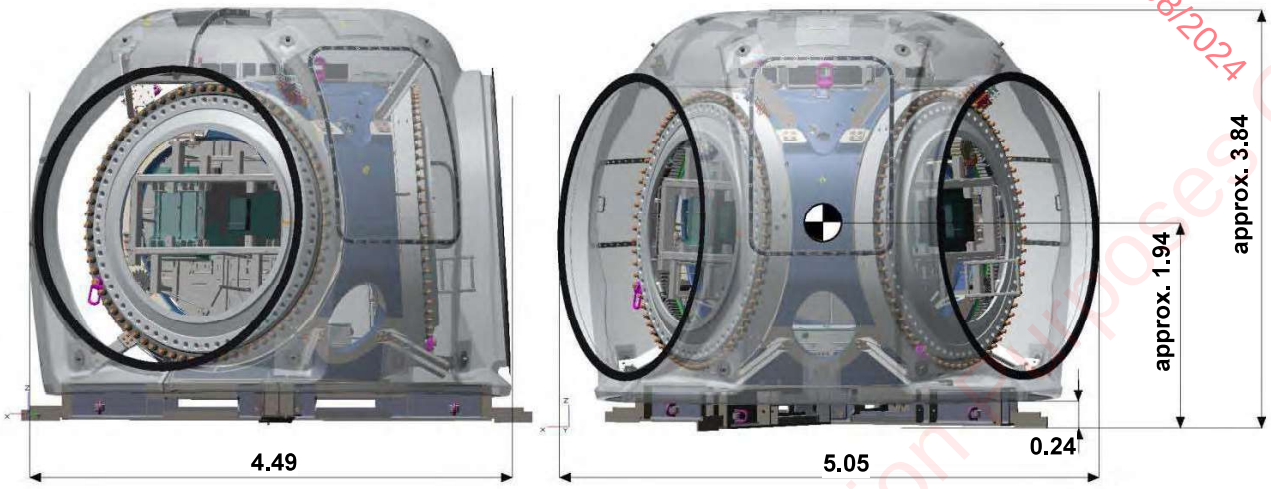


Fig. 4 Rotor hub N100, N117 on the transport frame (dimensions in m)

N131 rotor hub



Fig. 5 Rotor hub N131 on the transport frame, ready for transport (dimensions in m)

The rotor hubs are delivered on a divisible transport frame.

Anti-slip mats must be used for transport.

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2.4 Rotor blade

Each rotor blade is delivered on two transport frames using a trailer. One of the transport frames is fastened to the blade root, the other one to the support point.

In addition to the center of gravity and support point, the drawing shows the defined points where the webbing slings can be attached. The blade must only be lifted at these points as the wall thickness is reinforced in these areas.

When using a blade lifter for single blade assembly, this will be attached to point C.

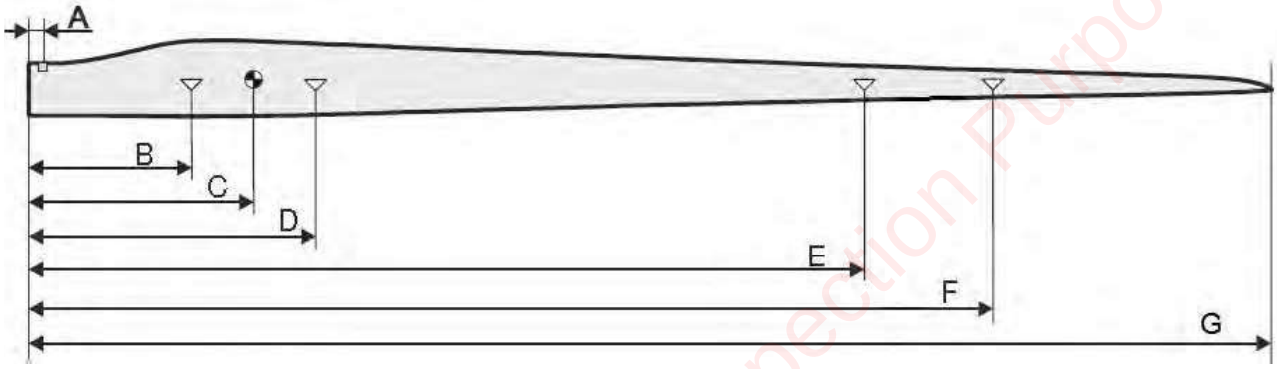


Fig. 6 Blade transport dimensions – side view

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Rotor blade		NR50	NR58.5	NR65.5
A	Lifting point root	0.3/1.01	0.32/1.0[1]	0.30/0.9[1]
B	Lifting point for single blade assembly (SBA)	Upon request	Upon request	
C	Center of gravity	14.40	15.90	17.80
D	Lifting point SBA	Upon request	Upon request	
E	Start of handling area	33.55	38.00	42.50
F	End of handling area	36.00	43.00	53.50
G	Length	48.7	57.60	64.70
J	Transport width	3.36		4.20
	Road transport	-	3.36	-
	Sea transport	-	3.22	-
K	Transport height	3.46		3.18/3.32[2]
	Road transport	-	2.51	-
	Sea transport	-	3.30	-

1 Lifting point with/without rain deflector

2 Depends on the use of an additional base frame

Examples, all dimensions in meters [m].

Details are to be agreed upon with Nordex in advance.

Single-blade assembly with the aid of lifters at the center of gravity.

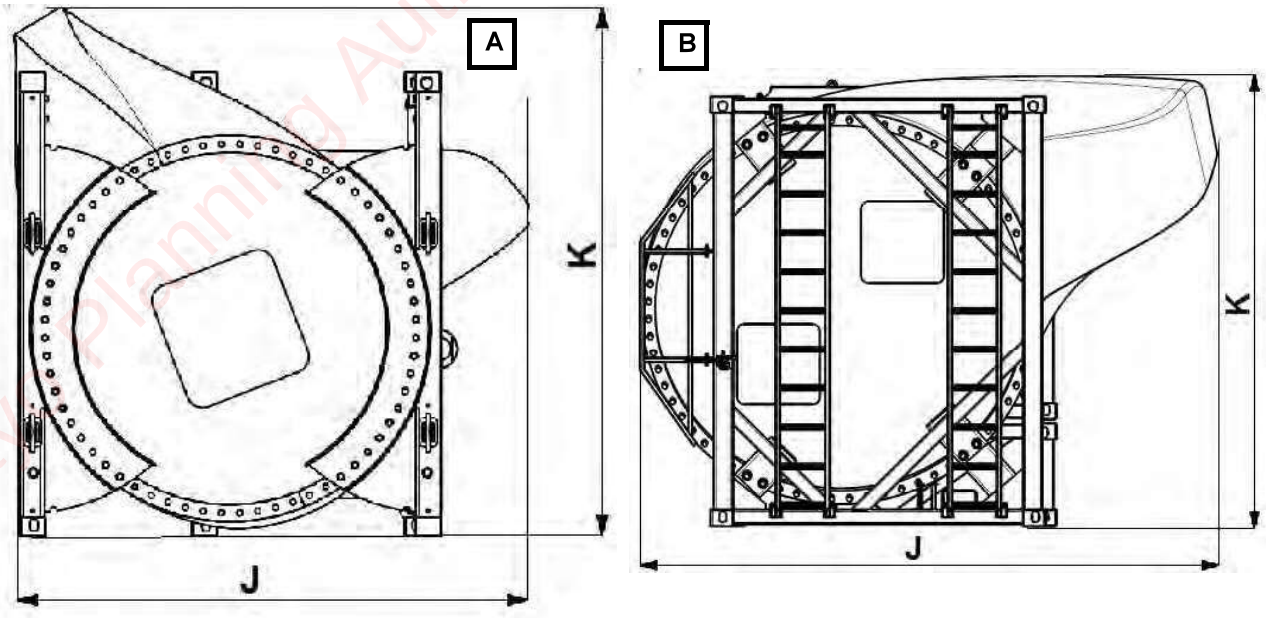


Fig. 7 Blade transport dimensions, view from the blade root; example for sea transport (A) and road transport (B)

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2.5 Weights and dimensions of the components

2.5.1 Weights and dimensions with transport frames

Nacelle	N100/3300	N117	N131
Length/ width/ height (without roof structures)	12.81 m/ 4.30 m/ 4.00 m		
Weight of nacelle without drive train*	max. 59.86 t		
Weight of drive train only*	max. 64.37 t		max. 69.85 t

Rotor hub	N100/3300	N117	N131
Dimensions (L x W x H) Overall spinner dimensions	4.49 m x 5.05 m x 3.84 m		4.82 m x 5.39 m x 3.96 m
Weight*	max. 37.56 t		max. 46.98 t

Rotor blade	N100	N117	N131
Length with/without blade bolts	49 m/ 48.7 m	57.6 m/ 57.3 m	64.7 m/ 64.4 m
Weight per blade*	max. 13.14 t	max. 13.14 t	max. 17.6 t

Bottombox switch cabinet	N100, N117 and N131
Dimensions (L x W x H)	2.2 m x 1.2 m x 2 m
Weight	approx. 2.9 t

* The weights depend on the selected variant and weight tolerance of the components

2.5.2 Weights and dimensions during erection (without transport frame)

Nacelle	N100	N117	N131
Length/ width/ height (without roof structures)	12.81 m/ 4.30 m/ 4.00 m		
Weight of nacelle without drive train*	max. 60.53 t		
Weight of drive train only*	max. 62.4 t	max. 62.4 t	max. 67.87 t

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Rotor hub	N100	N117/3600	N131
Dimensions (L x W x H) Overall spinner dimensions	4.49 m x 5.05 m x 3.60 m		4.82 m x 5.39 m x 3.72 m
Weight*	max. 36.73 t	max. 36.73 t	max. 44.76 t

Rotor blade	N100	N117	N131
Weight per blade*	max. 11.7 t	max. 11.7 t	max. 15.7 t

Transformer	N100, N117 and N131
With the transformer installed in the tower the transformer substation is omitted Individual components per wind turbine:	
Transformer	approx. 10.0 t 2.7 m x 1.3 m x 2.85 m (L x W x H)
Medium-voltage switchgear	approx. 2.0 t 2.3 m x 1.2 m x 2.3 m (L x W x H)

* The weights depend on the selected variant and weight tolerance of the components

Transformer substation
The transformer substation and wind turbine must not be erected at the same time. For exact dimensions and weights refer to the manufacturer as these are project-specific.

2.6 Transport devices

Transport devices for all wind turbines	Weight
Nacelle	approx. 1.19 t
Drive train	approx. 3.17 t
Rotor hub	N100/N117: approx. 2.14 t N131: approx. 3.64 t
Rotor blade (blade root/tip) depending on transport method	N100/N117: approx. 600 kg / approx. 840 kg N131: approx. 430 kg / 1070 (1450) kg*
Switch cabinet/converter spreader bars	Approx. 100 kg (transport spreader bars remain on switch cabinet)

* without (with) underframe for tip frame

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2.6.1 Transport devices for the nacelle N100, N117 and N131

- Front bearing surface: 500 x 400 mm
- Rear bearing surface: 500 x 420 mm
- Load per front support: 18.8 t (incl. acceleration)
- Load per rear support: 29.2 t (incl. acceleration)

The screws for fastening the nacelle are part of the transport supports and must be returned together with the transport supports to Nordex.

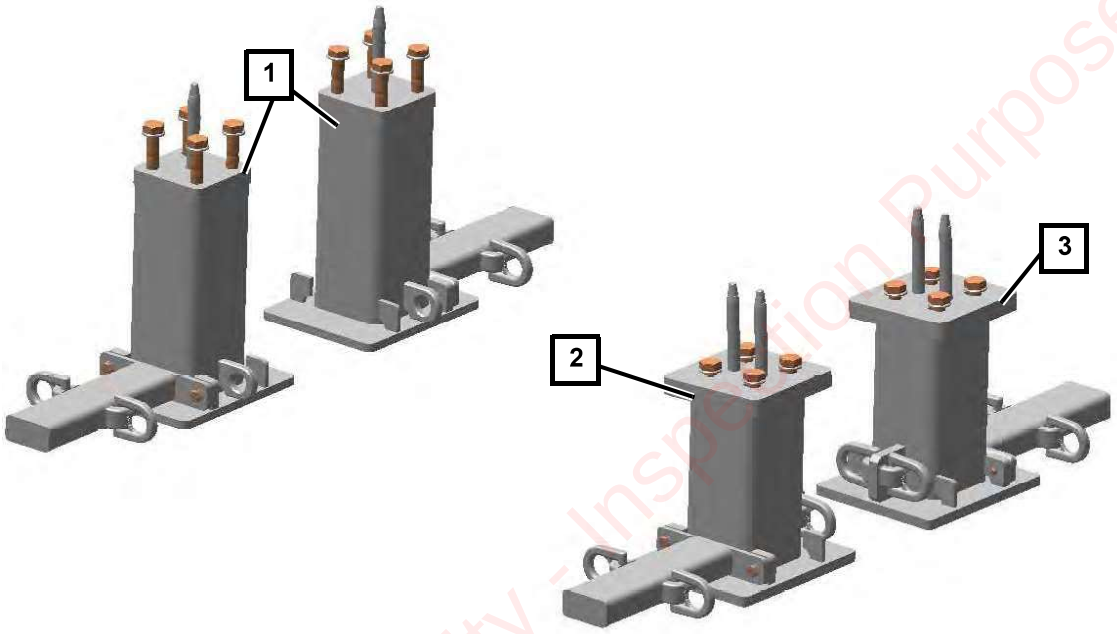


Fig. 8 Nacelle transport supports

1 Front with hollow section
2 Rear left with hollow section
3 Rear right with hollow section

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2.6.2 Transport device for the drive train N100, N117 and N131

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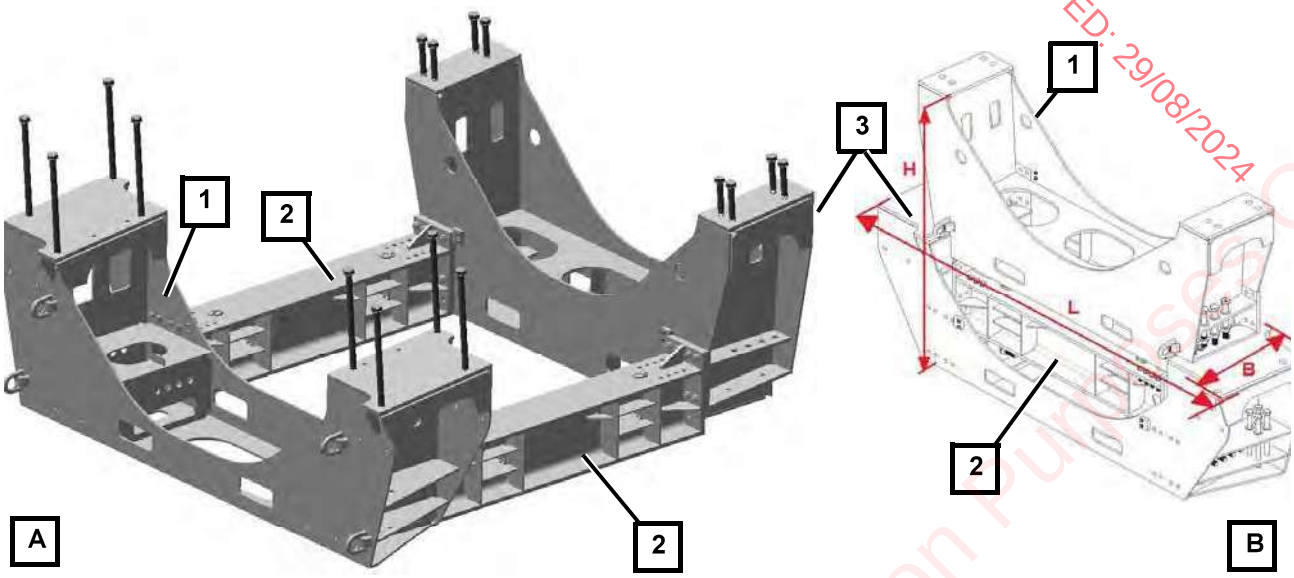


Fig. 9 *Transport frame drive train and lanyard (A) and assembled in space-saving way for return transport (B)*

1 Rotor bearing support
2 Longitudinal beam
3 Gearbox support

The transport device for the gearbox supports can be disassembled into 3 large sections and must be re-assembled in a space-saving way for return transport, see fig.9B.

All fastening screws are part of the transport device and must be returned to Nordex together with the transport frames.

Note: For N100/N117 wind turbines, it may also be possible to use the old transport devices with the dimensions L: 4.31 m; W: 2.30 m; H: 2.24 m for 3 folded and stacked frames.

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2.6.3 Transport device for the rotor hub

The transport devices can be stacked and screwed together for return transport. The round wood plate must also be returned as long it is not damaged.

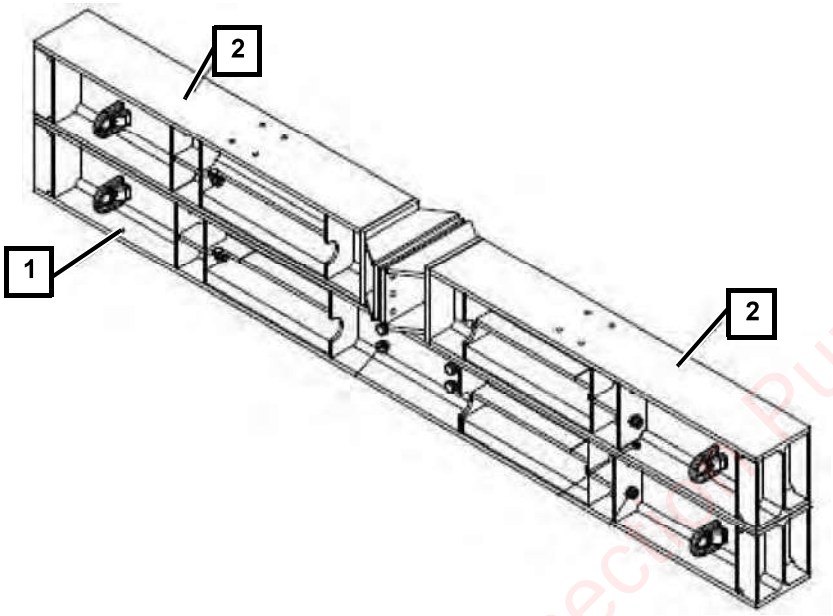


Fig. 10 Rotor hub transport frame assembled for return transport

1 Beam, long
2 Beam, short

Note: For N100/N117 wind turbines, it may also be possible to use the old transport devices with the dimensions H: 0.50 m; W: 2.07 m; L: 3.00 m.

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2.7 N100/3300 towers

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Hub height		75 m	85 m	100 m
Tower type		Tubular tower MT5	Tubular tower MTR5	Tubular tower MTR5
1st tower section (TOP)				
Length	m	31.2	30.0	29.8
Ø top	m	3.26	3.26	3.26
Ø bottom	m	4.02	4.02	4.27
Weight	t	47.6	41.8	50.0
2nd tower section (MID3)				
Length	m			24.0
Ø top	m			4.27
Ø bottom	m			4.27
Weight	t			60.0
3. Tower section (MID2)				
Length	m		24.0	18.1
Ø top	m		4.02	4.27
Ø bottom	m		4.02	4.29
Weight	t		48.7	63.7
4. Tower section (MID1)				
Length	m	24.0	15.1	12.2
Ø top	m	4.02	4.02	4.29
Ø bottom	m	4.03	4.03	4.29
Weight	t	54.8	47.2	60.4
5. Tower section (Bottom)				
Length	m	16.7	12.8	12.7
Ø top	m	4.03	4.03	4.29
Ø bottom	m	4.00	4.02	4.00
Ø T flange	m	4.30	4.30	4.30
Weight (TIT/TAT)	t	59.0/59.2	54.3	74.2/71.9

Due to transport equipment, the transport height may exceed the tower diameter by 7 cm. Each lifting tackle has an overall height of 15 cm and thus extends the tower sections.

Changes in weight of up to 2 % must be considered. The centers of gravity may deviate from the center of the tower sections by up to 5 %.

TAT: Transformer outside tower

TIT: Transformer inside tower

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2.8 N117/3600, N117/3675 and N117/3000 Controlled towers

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Hub height		76 m	84 m*	91 m	106 m	120 m	141 m
Tower type		Tubular tower TS76	Tubular tower TS84	Tubular tower TS91	Tubular tower TS106	Tubular tower TS120	Hybrid tower TCS141
Tower section TOP							
Length	m	29.05	34.02	35.06	35.00	34.21	30.91
Ø top	m	3.26	3.26	3.26	3.26	3.26	3.26
Ø bottom	m	4.01	4.02	4.02	4.23	4.02	4.29
Weight	t	45.7	50.2	52.4	58.3	52.8	46.6
Tower section MID3							
Length	m					29.94	
Ø top	m	-	-	-	-	4.02	-
Ø bottom	m					4.26	
Weight	t					66.4	
Tower section MID2							
Length	m				29.92	21.04	
Ø top	m	-	-	-	4.25	4.26	-
Ø bottom	m				4.26	4.26	
Weight	t				76.8	66.4	
Tower section MID1							
Length	m	26.97	26.95	29.95	22.54	18.12	
Ø top	m	4.01	4.02	4.02	4.26	4.26	-
Ø bottom	m	4.02	4.02	4.02	4.28	4.27	
Weight	t	53.3	55.8	63.8	- 79.7	- 67.1	
Tower section Bottom							
Length	m	16.87	19.86	22.83	15.38	13.53	29.95
Ø top	m	4.02	4.02	4.02	4.28	4.27	4.29
Ø bottom	m	4.03	4.04	4.04	4.05	4.05	4.29
Ø T flange	m	4.30	4.30	4.30	4.30	4.30	4.29
Weight (TIT/TAT)	t	54.4	68.8/66.8	74.8	80.8/78.7	73.8/71.5	62.9

* N117/3675 only

Due to transport equipment, the transport height may exceed the tower diameter by 7 cm. Each lifting tackle has an overall height of 15 cm and thus extends the tower sections.

Changes in weight of up to 2 % must be considered. The centers of gravity may deviate from the center of the tower sections by up to 5 %.

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2.9 N131/3300 towers

Hub height		134 m	164 m
Tower type		Hybrid tower PH134	Hybrid tower PH164
1st tower section (TOP) Length Ø top Ø bottom Weight	 m m m t	 28.3 3.26 4.28 40.8	 35.00 3.26 4.29 53.0
2nd tower section (MID3) Length Ø top Ø bottom Weight	 m m m t		
3. Tower section (MID2) Length Ø top Ø bottom Weight	 m m m t		
4. Tower section (MID1) Length Ø top Ø bottom Weight	 m m m t	 23.0 4.28 4.29 41.8	 26.36 4.29 4.29 54.4
5. Tower section (Bottom) Length Ø top Ø bottom Ø T flange Weight	 m m m m t		

Due to transport equipment, the transport height may exceed the tower diameter by 7 cm. Each lifting tackle has an overall height of 15 cm and thus extends the tower sections.

Changes in weight of up to 2 % must be considered. The centers of gravity may deviate from the center of the tower sections by up to 5 %.

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2.10 N131/3600, N131/3000 Controlled and N131/3900 towers

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Hub height		84 m	99 m*	106 m*	114 m	120 m	134 m	134 m
Tower type		Tubular tower TS84	Tubular tower TS99	Tubular tower TS106	Tubular tower TS114	Tubular tower TS120	Tubular tower TS134	Hybrid tower TCS134
Top section (TOP)								
Length	m	34.02	30.00	35.00	31.53	34.21	32.93	30.91
Ø top	m	3.26	3.26	3.26	3.26	3.26	3.26	3.26
Ø bottom	m	4.02	4.02	4.23	4.02	4.02	4.02	4.29
Weight	t	50.2	43.0	58.3	47.3	52.8	50.2	45.6
MID4 section								
Length	m						29.41	
Ø top	m	-	-	-	-	-	4.02	-
Ø bottom	m						4.26	
Weight	t						62.5	
MID3 section								
Length	m				26.96	29.94	24.01	
Ø top	m	-	-	-	4.02	4.02	4.26	-
Ø bottom	m				4.02	4.26	4.27	
Weight	t				54.8	66.4	68.7	
MID2 section								
Length	m		25.00	29.92	23.07	21.04	18.15	
Ø top	m	-	4.02	4.25	4.02	4.26	4.27	-
Ø bottom	m		4.26	4.26	4.26	4.26	4.27	
Weight	t		49.7	76.8	65.0	66.4	67	
MID1 section								
Length	m	26.95	25.00	22.54	17.34	18.12	14.72	23.00
Ø top	m	4.02	4.26	4.26	4.26	4.26	4.27	4.29
Ø bottom	m	4.02	4.26	4.28	4.27	4.27	4.06	4.29
Ø (bottom) T flange	m	-	-	-	-	-	4.30	-
Weight	t	55.8	65.4	79.7	60.4	67.1	71.5	43.9
Bottom section								
Length	m	19.86	15.84	15.38	11.95	13.53	11.63	
Ø (top) T flange	m	-	-	-	-	-	4.30	
Ø top	m	4.02	4.26	4.28	4.27	4.27	4.06	-
Ø bottom	m	4.04	4.04	4.05	4.05	4.05	4.07	
Ø T flange	m	4.30	4.30	4.30	4.30	4.30	4.30	
Weight (TIT/TAT)	t	68.8/66.8	68.3/65.4	80.8/78.7	60.3/59.1	73.8/71.5	74,1/72.8	

* not for N131/3900

Due to transport equipment, the transport height may exceed the tower diameter by 7 cm. Each lifting tackle has an overall height of 15 cm and thus extends the tower sections. Changes in weight of up to 3 % must be considered. The centers of gravity may deviate from the center of the tower sections by up to 5 %.

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2.11 Anchor cages

Nordex delivers modular anchor cages which vary in dimensions and weight depending on the turbine type. The anchor cages are delivered as an assembly set and are assembled on site and according to Nordex specifications by the responsible construction company.

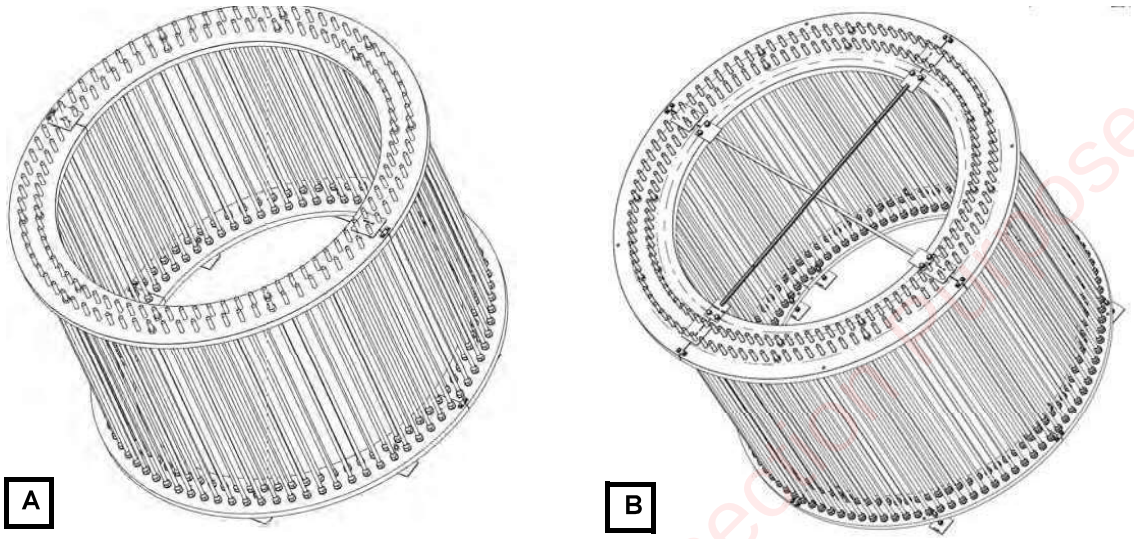


Fig. 11 Example of an anchor cage with 2 x 80 (A), 4 x 50 (B)

Table 1: Example of an anchor cage for N100 R75 and N117 TS91 and N131 TS84 (similar to see fig.11A)

WT	Designation	Parts	Thickness	Dimensions Maximum	Weight Maximum
N100 R75 N117 TS91 N131 TS84	Load-spreading plate	2	77 mm	outside Ø 4500 mm	approx. 3.0 t
	Anchor plate	2	70 mm	outside Ø 4460 mm	approx. 1.6 t
	Anchor bolts	160	M42	L=3071 mm	approx. 4.6 t
	Washers, nuts, small parts				approx. 0.4 t

This anchor cage, including transport equipment, weighs approx. 9.6 t.

Table 2: Anchor cage for N100 R85 (similar to see fig.11A)

WT	Designation	Parts	Thickness	Dimensions Maximum	Weight Maximum
N100 R85	Load-spreading plate	2	94 mm	outside Ø 4572 mm	approx. 5.2 t
	Anchor plate	2	50 mm	outside Ø 4350 mm	approx. 1.7 t
	Anchor bolts	160	M42	L=3025 mm	approx. 4.7 t
	Washers, nuts, small parts				approx. 0.5 t

This anchor cage, including transport equipment, weighs approx. 12.1 t.

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Table 3: Anchor cage for N100 R100 (similar to see fig.11B)

WT	Designation	Parts	Thickness	Dimensions Maximum	Weight Maximum
N100 R100	Load-spreading plate	4	160 mm	outside Ø 4720 mm	approx. 11 t
	Anchor plate	4	100 mm	outside Ø 4550 mm	approx. 5.2 t
	Anchor bolts	200	M42	L=3190 mm	approx. 6.2 t
	Washers, nuts, small parts				approx. 0.5 t

This anchor cage, including transport equipment, weighs approx. 22.9 t and is divided into four parts

Table 4: Anchor cage for N117 TS76 (similar to see fig.11B)

WT	Designation	Parts	Thickness	Dimensions Maximum	Weight Maximum
N117 TS76	Load-spreading plate	4	60 mm	outside Ø 4450 mm	approx. 2.5 t
	Anchor plate	4	40 mm	outside Ø 4400 mm	approx. 1.5 t
	Anchor bolts	160	M42	L=2850 mm	approx. 4.6 t
	Washers, nuts, small parts				approx. 0.5 t

This anchor cage weighs approx. 9.2 t and is divided into four parts

Table 5: Anchor cage for N117 or N131 TS120 (divided into four parts, similar to see fig.11B) (DIBt version)

WT	Designation	Parts	Thickness	Dimensions Maximum	Weight Maximum
N117 TS120 N131 TS120	Load-spreading plate	4	100 mm	outside Ø 4690 mm	approx. 6.6 t
	Anchor plate	4	60 mm	outside Ø 4490 mm	approx. 2.7t
	Anchor bolts	200	M42	L=3560 mm	approx. 7.2 t
	Washers, nuts, small parts				approx. 0.5 t

The complete anchor cage assembly set, including transport equipment, weighs approx. 17.0 t.

Table 6: Anchor cage for N117 TS120, N131 TS120 or N131/TS114 (divided into four parts, similar to see fig.11B) (IEC version)

WT	Designation	Parts	Thickness	Dimensions Maximum	Weight Maximum
N117 TS120 N131 TS120 N131 TS114	Load-spreading plate	4	100 mm	outside Ø 4620 mm	approx. 5.9 t
	Anchor plate	4	60 mm	outside Ø 4410 mm	approx. 2.3t
	Anchor bolts	200	M42	L=3560 mm	approx. 7.2 t
	Washers, nuts, small parts				approx. 0.5 t

The complete anchor cage assembly set, including transport equipment, weighs approx. 15.9 t.

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Table 7: Anchor cage for N117 or N131 TS106 and N131 TS99 (divided into four parts, similar to see fig.11B)

WT	Designation	Parts	Thickness	Dimensions Maximum	Weight Maximum
N117 TS106 N131 TS106 N131 TS99	Load-spreading plate	4	100 mm	outside Ø 4690 mm	approx. 6.6 t
	Anchor plate	4	60 mm	outside Ø 4490 mm	approx. 2.7t
	Anchor bolts	200	M42	L=3325 mm	approx. 6.7 t
	Washers, nuts, small parts				approx. 0.5 t

The complete anchor cage assembly set, including transport equipment, weighs approx. 16.5 t.

Table 8: Anchor cage for N131 TS112 (divided into four parts, similar to see fig.11B)

WT	Designation	Parts	Thickness	Dimensions Maximum	Weight Maximum
N131 TS112	Load-spreading plate	4	55 mm	outside Ø 4605 mm	approx. 3.1 t
	Anchor plate	4	50 mm	outside Ø 4410 mm	approx. 1.9 t
	Anchor bolts	200	M42	L=3325 mm	approx. 6.7 t
	Washers, nuts, small parts				approx. 0.5 t

The complete anchor cage assembly set, including transport equipment, weighs approx. 12.2 t.

Table 9: Anchor cage for N131 TS134 (divided into four parts, similar to see fig.11B) (IEC version)

WT	Designation	Parts	Thickness	Dimensions Maximum	Weight Maximum
N131 TS134	Load-spreading plate	4	100 mm	outside Ø 4620 mm	approx. 5.9 t
	Anchor plate	4	60 mm	outside Ø 4410 mm	approx. 2.3 t
	Anchor bolts	200	M42	L=3560 mm	approx. 7.2 t
	Washers, nuts, small parts				approx. 0.5 t

The complete anchor cage assembly set, including transport equipment, weighs approx. 15.9 t.

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Table 10: Anchor cage for N131 TS134 (divided into four parts, similar to see fig.11B) (DIBt version)

WT	Designation	Parts	Thickness	Dimensions Maximum	Weight Maximum
N131 TS134	Load-spreading plate	4	110 mm	outside Ø 4710 mm	approx. 7.4 t
	Anchor plate	4	60 mm	outside Ø 4490 mm	approx. 2.7 t
	Anchor bolts	200	M42	L=3560 mm	approx. 7.2 t
	Washers, nuts, small parts				approx. 0.5 t

The complete anchor cage assembly set, including transport equipment, weighs approx. 18.0 t.

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3. Requirements for the access roads

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Planning the wind farm infrastructure on the basis of the minimum requirements stipulated in this document is generally the responsibility of the customer/client. In order to prevent subsequent problems during transport and erection, the planning must be agreed to with Nordex prior to starting the construction work. The infrastructure planning must contain at least the following information:

- Analyses of load-carrying capacity and bearing capacity must be submitted to Nordex before starting construction, see chapter 3.3.6 “Quality inspections, access roads and crane hard standing areas”
- WT sites
- Route planning incl. elevation profile and longitudinal profile with slopes and vertical radii, cross profile, curve radii and obstacles in the clearance area
- Turning areas and turnouts
- Crane hard standing areas regarding foundation and WT site
- Location of the site office/site facilities with possible temporary storage area for main components
- Emergency and assembly routes, which must be accessible for cars, ambulance and rescue vehicles, vans and construction site vehicles
- In the event of restricted visibility, darkness or fog, as well as in adverse weather conditions, no driving operations may be carried out
- Depending on the season and weather the accessibility of the roads must be ensured. For example, the roads must be clear of snow and ice in the winter during the entire construction period and irrigated in the summer to prevent dust developing. These specifications must also be adhered to during a service or maintenance deployment.

To avoid problems during the erection of the wind turbine, the following minimum requirements for the access roads must be met under normal soil conditions.

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NOTE

The transport routes must be designed for the entire project period, from the construction phase to the dismantling phase. A distinction is made between “permanent” roads and “temporary” roads. Extensively constructed curve areas for the erection can be dismantled for maintenance operation so that at least accessibility for service vehicles, ambulance vehicles and rescue vehicles or fire-fighting vehicles is ensured.
It must also be taken into account that the heavy-duty vehicles used are not intended for off-road use and are designed for driving on paved roads. Thus, it is not only necessary to ensure the load-carrying capacity of the internal access roads, but also their usability under all weather conditions.

3.1 Loads

The access road for each WT must be capable of supporting the following loads:

Vehicles per wind turbine

- Up to 200 vehicles for tubular steel towers (TS), of which 80 - 120 concrete transport trucks and construction vehicles
- Up to 270 vehicles for tubular steel towers (TS), of which 80 - 120 concrete transport trucks and construction vehicles
- Approx. 15 to 55 heavy trucks for crane erection (depending on the hub height)
- Approx. 8 to 11 heavy trucks with the turbine components (2 to 6 for tower sections, three for rotor blades, three for nacelle, rotor hub and drive train, and several standard trucks for items such as switch cabinet, small parts and erection containers)
- Maximum truck length of 73.5 m for rotor blade transport and 49 m for tower transport
- Required clearance width on public roads, from the construction site access 5 m (for tubular steel towers), 6 m (for hybrid towers)
- Various construction vehicles

Weight of vehicles

- Max. load per axle approx. 12 t (for roads that are used only for transporting components)
- Max. load per axle approx. 16 t (for roads that are used for relocating cranes between two WT sites)
- Max. overall weight: approx. 180 t

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3.2 Slopes and vertical radii

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3.2.1 Slopes

In compliance with the surface described in Chapter 3.3 “Curves, opportunities for turning, and funnel lanes”, slopes of approx. 10 % (with unbound wearing course) or 12 % (bonded wearing course/asphalt) should not be exceeded under ideal road and weather conditions. In case of steeper slopes, Nordex must always be consulted.

At extra costs, additional tractor units and pushing vehicles as well as tractor units with a suitable hitch (register coupling) must be used so that steeper slopes can also be overcome under the provision of suitable surface conditions/bonded construction. As the length of the entire tractor unit becomes larger this must be considered in road construction planning, especially in terms of curve radii. Additional load securement, where applicable, for slopes in excess of 10 % must be coordinated with Nordex in advance.

Uphill slopes of up to 10 % can only be handled when driving forward. In case that the transport vehicles can handle some of the uphill slopes only by driving backwards (due to local conditions) the maximum grade must not exceed 1.5 % without additional tractor units. The road foundation must also be considered for the respective sections (see the following chapters), as in this case the traction is completely transferred to the front axle of the tractor unit. An adapted design and/or the use of other materials for road construction may be required for the relevant sections.

The lateral downhill slope must not be greater than 2 %. This must not be exceeded especially in areas with curves.

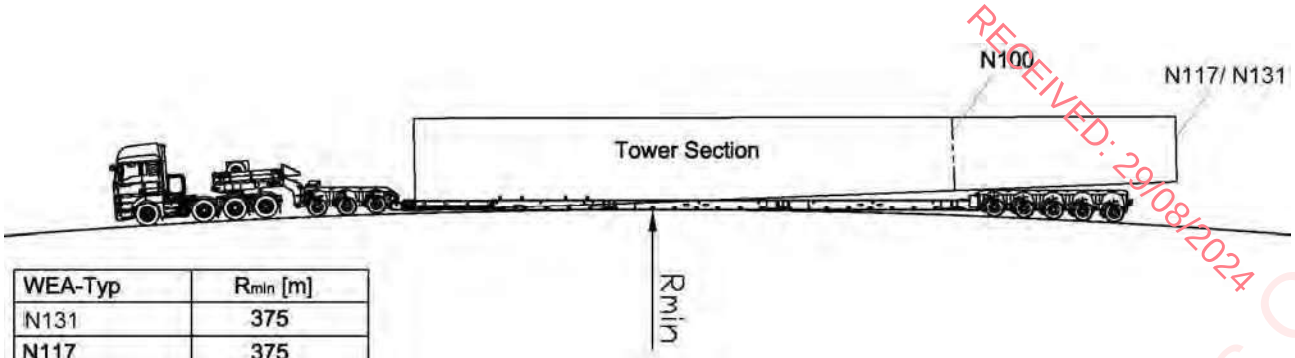
Depending on season and weather the requirements for slopes may vary so that additional tractor units or vehicles for deceleration must be used.

3.2.2 Vertical radii

The radii (vertical) for crests and valleys must be at least R375 m for N117 and N131 and R350 m for N100. Over a length of 30.0 m (longest relevant wheelbase) the height difference between two points must not exceed 0.30 m.

If the required minimum radii can be achieved only hardly or not at all due to associated construction measures, on-site inspection must be performed to discuss possible alternatives regarding routes or transport methods.

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WEA-Typ	Rmin [m]
N131	375
N117	375
N100	350

Fig. 12 Vertical radius – crest

3.2.3 Clearance profile on a straight route

For all hub heights (see fig.17)		
H	Clearance height	Approx. 4.50 m to 6.00 m (depending on transport method)
W	Clearance width	5.00 m (concrete hybrid tower: 6.00 m)

The clearance height on public roads generally is approx. 4.5 m due to bridges. On the access roads to the construction site a clearance height of 5 m to 6 m and a clearance width of at least 5 m must be ensured, depending on the project and location. For concrete hybrid towers a clearance width of at least 6 m must be ensured to enable the transport of pre-fabricated concrete elements.

If it is not possible to adopt the method of transport employed for the route to the construction site access for the internal access roads due to local conditions (topography, roadway arrangement, obstacles) components may be transshipped to other means of transport, if required, which enable the delivery to the crane hard standing area. The crane capacities needed for such purposes and the transshipping areas near or on the construction site must be agreed to with Nordex in advance. A corresponding transport, reloading, and storage concept must be prepared, taking into account the local conditions and the feasibility of measures to be taken. In this case, the minimum requirement for the clearance profile (height) is 6 m.

Any obstacles along the route inside the wind farm must be clearly marked for traffic. Especially when crossing gas and/or water pipes, this must be appropriately examined before the beginning of the transport. The results must be submitted to Nordex for inspection. The client is fully responsible for the marking.

Any obstacles in the clearance area (e.g. when crossing under power lines) must be clearly marked by a guard structure made of non-conductive material on both sides of the power line, at adequate safety distance (see “Table 11: Mandatory safety distances to power lines”). Posts and crossbars must be marked with signal colors to prevent damage from construction site traffic of any kind. In addition, warning signs that indicate electrical hazards and the ground clearance

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must be put up at the entrances. During darkness and restricted visibility, the signs must be illuminated accordingly.

NOTE

Independent of the above mentioned safety instructions, at least the national safety regulations of the grid operator must be observed.

Table 11: Mandatory safety distances to power lines

Voltage	Safety distance (in accordance with DIN VDE 0105 or comparable country-specific standard)
Up to 1 kV	1 m
up to 110 kV	3 m
up to 220 kV	4 m
up to 380 kV	5 m

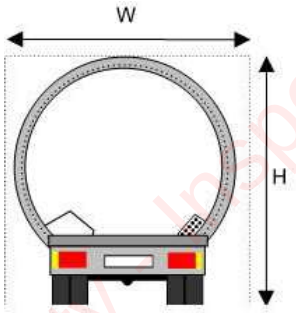


Fig. 13 Clearance profile

3.3 Curves, opportunities for turning, and funnel lanes

3.3.1 Curves

Examples for the space required by turbine components in different curves. The examples apply to left and right curves.

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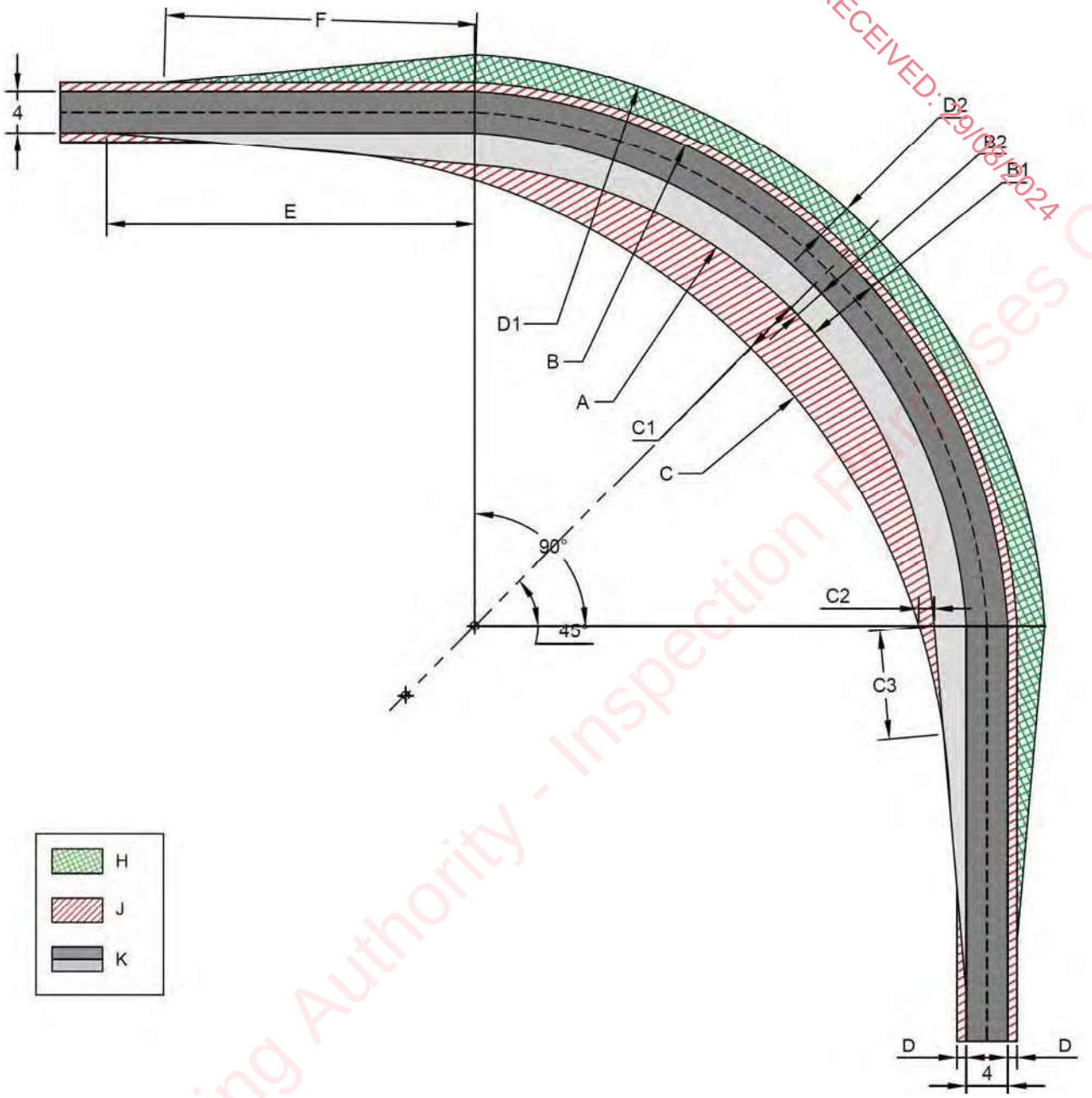


Fig. 14 *Minimum required structural support for 90° curves, general, without using an additional towing vehicle*

H – Outer slewing area / rotor blade projection 1.50 m above ground level (GL)

J – Inner slewing area + clearance profile / tower section projection 0.20 m above ground level (GL)

K – Roadway / roadway extension = GL

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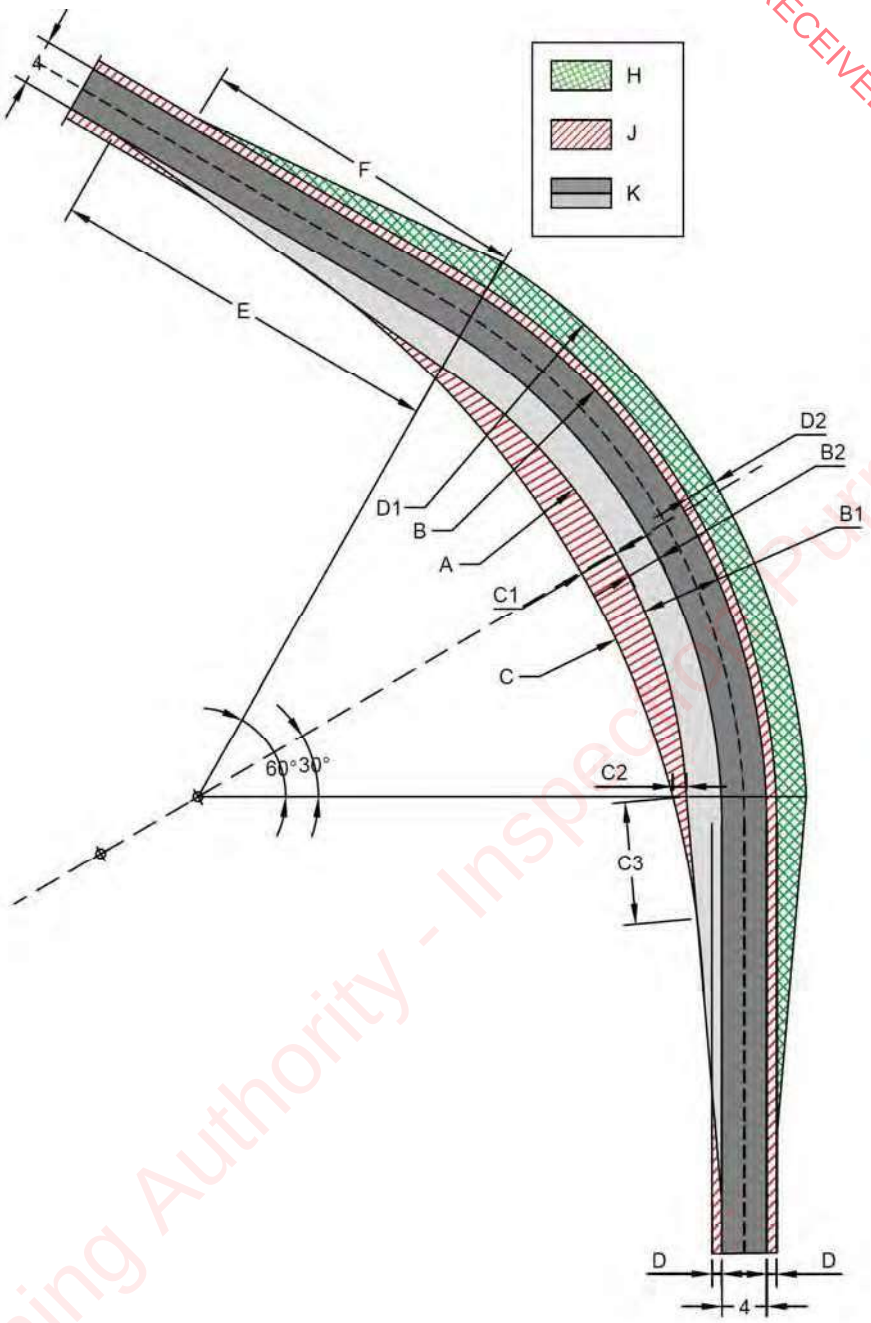


Fig. 15 *Minimum required structural support for 120° curves, general, without using an additional towing vehicle*

H – Outer slewing area / rotor blade projection 1.50 m above ground level (GL)

J – Inner slewing area + clearance profile / tower section projection 0.20 m above ground level (GL)

K – Roadway / roadway extension = GL

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Table 12: Traversing and slewing areas for N100

	N100/90°	N100/120°	r 50 m ≤ r min ≤ r 150m m			
A	r 35 m	r 35.5 m	r 75 m	r 100 m	r 125 m	r 150 m
B	r 42.5 m	r 42.5 m	r 82 m	r 106 m	r 130.5 m	r 155 m
B1	7.50 m	7 m	7 m	6 m	5.5 m	5 m
B2	3.50 m	3 m	3 m	2 m	1.5 m	1 m
C	r 50 m	r 50 m	-	-	-	-
C1	5.40 m	3.60 m	4.5 m	3 m	2 m	1 m
C2	1.50 m	2 m	-	-	-	
C3	35 m	35 m	30 m	20 m	10 m	-
D	1 m	1 m	1 m	1 m	1 m	1 m
D1	r 47.5 m	r 47.5 m	-	-	-	-
D2	5 m	5 m	5 m	4 m	3.5 m	3 m
E	35 m	35 m	30 m	20 m	15 m	10 m
F	35 m	35 m	30 m	25 m	20 m	15 m
G*	55 m	-	-	-	-	-

Table 13: Traversing and slewing areas for N117

	N117/90°	N117/120°	r 50 m ≤ r min ≤ r 150m m			
A	r 50 m	r 50.5 m	r 75 m	r 100 m	r 125 m	r 150 m
B	r 57.5 m	r 57.5 m	r 82 m	r 106 m	r 130.5 m	r 155 m
B1	7.50 m	7 m	7 m	6 m	5.5 m	5 m
B2	3.50 m	3 m	3 m	2 m	1.5 m	1 m
C	r 58 m	r 58 m	-	-	-	-
C1	2.60 m	3.30 m	4.5 m	3 m	2 m	1 m
C2	2 m	2 m	-	-	-	
C3	25 m	25 m	20 m	15 m	10 m	-
D	1 m	1 m	1 m	1 m	1 m	1 m
D1	r 62.5 m	r 62.5 m	-	-	-	-
D2	5 m	5 m	5 m	4 m	3.5 m	3 m
E	45 m	45 m	30 m	20 m	15 m	10 m
F	40 m	40 m	30 m	25 m	20 m	15 m
G*	65 m	-	-	-	-	-

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Table 14: Traversing and slewing areas for N131

	N131/90°	N131/120°	r 50 m ≤ r min ≤ r 150 m			
A	r 53.5 m	r 54 m	r 75 m	r 100 m	r 125 m	r 150 m
B	r 61 m	r 61 m	r 82 m	r 106 m	r 130.5 m	r 155 m
B1	7.50 m	7 m	7 m	6 m	5.5 m	5 m
B2	3.50 m	3 m	3 m	2 m	1.5 m	1 m
C	r 74m	r 93 m	-	-	-	-
C1	6 m	4 m	4 m	3 m	2.5 m	2 m
C2	2 m	2 m	-	-	-	
C3	12 m	12 m	15 m	10 m	5 m	-
D	1 m	1 m	1 m	1 m	1 m	1 m
D1	r 66 m	r 66 m	-	-	-	-
D2	5 m	5 m	4 m	3.5 m	3 m	2.5 m
E	45 m	45 m	30 m	20 m	15 m	10 m
F	40 m	40 m	30 m	25 m	20 m	15 m
G*	75 m	-	-	-	-	-

The continuous lines depict the route of the truck. The dashed lines mark the areas covered by the vehicle and the rotor blade. The outer area covered is determined by the length of the rotor blade protruding at the rear.

The covered area (dashed) must be free of all obstacles and must be max. 20 cm above the sealed surface of the accessible road.

Due to the maximum steering angle of the rear axles of approx. 60°, curves that will be approached backwards must be constructed in a way that the respective turbine types are able to access the specified covered radii. The capacity of the normally deployed vehicles matches the loads that must be moved. The deployment of additional tractors and/or other vehicles, however, cannot be excluded due to local conditions. In case of pushing, different forces act on the vehicle and the load and the vehicle's steering behavior cannot be optimally influenced. Thus, accompanying damage to the road surface within the construction site cannot be excluded and must be repaired immediately or before access of successive heavy trucks. The exact values depend on the deployed vehicles and the individual conditions on site.

The maximum downhill slope or grade in curve radii/curve areas is < 2 %. A curve with downhill slope/grade shall be constructed in such a manner that the road surface is on an even level to protect the components from hitting the ground. The area within a radius of 50 m from the apex is in this case called the curve area and must be constructed as a level surface.

NOTE

If the minimum requirements for the curve construction cannot be met due to local conditions, it is possible to deviate from the minimum requirements by using different/special vehicles. These deviations may result in additional costs and must be agreed with Nordex in writing in advance.

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3.3.2 Opportunity for turning and funnel lanes

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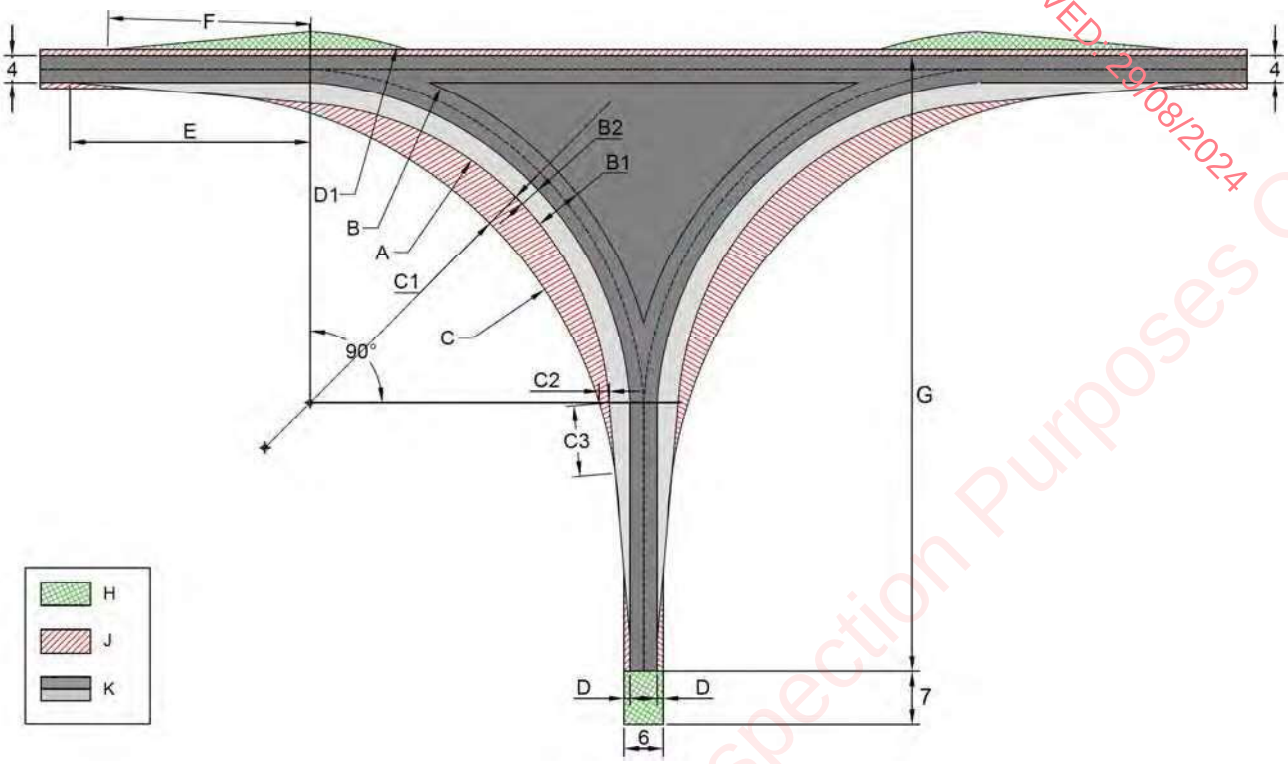


Fig. 16 *Structural support of funnel lanes; see previous chapter for explanation of variables*

* G – Depth of funnel lane = transport length + 5 m (N100=55 m; N117=65 m; N131=75 m)

Depending on the size of project and the access situation double funnel lanes enabling the vehicles to turn shall be constructed at strategic and central crossroads or preferably at access points to individual turbines.

These double funnel lanes shall enable the vehicles to turn and to leave the construction site forward. The lanes shall be located at strategic crossroads to avoid reversing over a distance of more than 500 m as these movements are very time-consuming and may affect the traffic on the construction site or the erection process. In addition, certain components must be transported to the respective site with forward or backward transport direction, depending on the used crane or assembly method. The transport and erection concept must be determined individually on site.

The dimensions of the funnel lanes result from the component length (see previous chapters) + 5 m = length of the funnel lane. The curve radii must be implemented as specified below. The width of the narrowest part (front side) is at least 4.5 m. If a funnel lane will be used as a parking area for more than one vehicle, the funnel lane must be expanded by 4.5 m per vehicle. Depending on the location it should be considered if four funnels in junction areas are required and feasible.

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NOTE

The structural support of funnel lanes can be minimized depending on the transport and erection concepts. For example: In the case of a planned single blade assembly, the entrance funnel can be constructed according to the above-mentioned curve examples and the exit funnel for the empty vehicles with a radius of R35. A different construction method and the individual transport and crane concepts may result in additional costs, which have to be agreed with Nordex in writing in advance.

3.3.3 Road construction

Generally, the access roads shall be planned to enable secure transport for the respective wind turbine class and to achieve the load-carrying capacities described in Chapter 3.1 “Loads”. For that purpose, the site-specific ground conditions must be taken into account. Planning and execution must be adapted accordingly. The structure described below serves only for illustration and does not release the ordering party from project-specific design and planning.

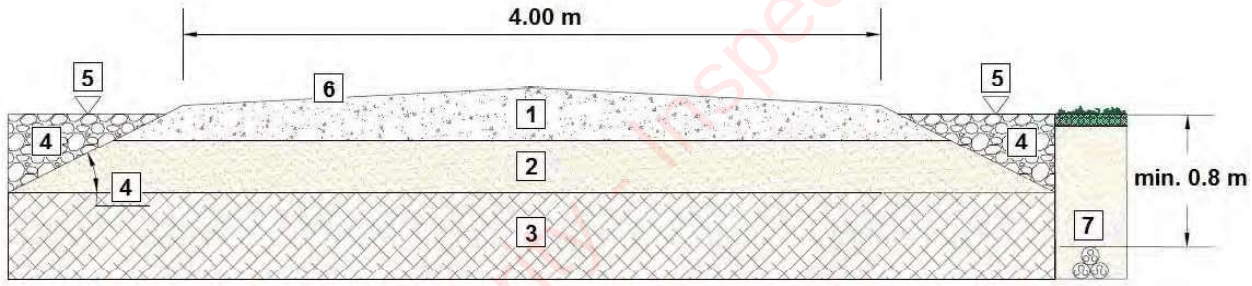


Fig. 17 Exemplary access road structure

1 Base layer compacted, gravel: 15-30 cm
2 Base compacted, 30 cm to 100 cm
3 Stable ground
4 Embankment 1: 2
5 Ground level
6 Camber ≤ 2 %
7 Cable trenches

- Once the roads have been completed, quality inspections must be carried out, see chapter 3.3.6 “Quality inspections, access roads and crane hard standing areas”.
- Cable trenches must only have the corresponding depth along the access road. If cables must cross the access road, conduits must be laid at the corresponding locations. The cable trenches must be embedded and filled with adequate material in the appropriate design in accordance with Nordex requirements.

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- On straight, even road sections (project-specific), an accessible width of 4 m is sufficient. The width must not fall below this value. Otherwise, the specified minimum requirements apply. In this context, the areas alongside the roadway must be stable and constructed with a minimum slope of 1:2. It is essential that the load transfer angle is observed.
- A minimum access road width of 4.5 m is required if the inclination is greater than 8 % and for road sections where reversing in a loaded or empty state is required.
- Instead of gravel, base and top layer may be made of broken bricks or concrete (free of other demolition waste)
- Existing asphalt/concrete roads with a smaller accessible width than specified above must be expanded to the appropriate width on one side.
- The rubble and gravel base layers may consist of mixed building materials with a grain size of 32 mm, 45 mm or max. 56 mm. The fine content (<0.063 mm) must not exceed 5 % and 7 % in the assembled state.
- All layers and the subsoil must be compacted using proper machinery to allow for heavy trucks
- Even road surface
- Proper drainage for all access roads must be ensured (cross slope of 1 to 2 %)
- Proper water transport, e.g., in lateral trenches or under access road junctions, must be ensured in order to permanently prevent undercutting, erosion, cavity formation and landslides.
- If road sections of the internal access roads are below the level of the surrounding fields, etc. suitable measures to drain the roads must be taken.
- Before starting road construction, a project- and site-specific design/execution plan for the access roads must be prepared. In doing so, the detailed requirements specified by the structural engineer, geotechnical engineer, haulage contractor and by Nordex must be fulfilled. If the required measures are not implemented, this could cause delays and additional costs for the use of other adequate transport methods.
- Access roads and crane hard standing areas must have the required load carrying capacity and be accessible for heavy-duty vehicles under any possible weather conditions during the entire construction period. Occurring damages to the road surfaces must be repaired by the ordering party immediately.
- Crawler cranes may require special transport and travel roads. Track width of up to 12 m might be necessary.

3.3.4 Turnouts

Turnouts serve as parking areas for arriving trucks or already unloaded trucks and as turnouts for oncoming vehicles. These turnouts must ensure an unobstructed accessibility of assembly areas during the delivery and erection stage and help to

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maintain smooth traffic flow during the entire construction phase. The positioning of these areas must individually be agreed upon with Nordex for each project.

The following two illustrations show an exemplary construction of the parking and turnout areas. These areas can be temporarily supported with gravel or laid out with traversable bolted panels. The lateral inclination must not exceed 2 %. Depending on the layout of the internal wind farm infrastructure, the parking and turnout areas can be integrated into the auxiliary crane areas (crane hard standing area for the crane jib installation), see fig.19. Turnouts must be arranged in such a way that they can also be used as resting areas for empty vehicles.

In general, at least one turnout/parking area near the entrance to the wind farm must be planned. In this way, arriving heavy trucks can leave the public road and can be individually guided to the respective WT site at daybreak/when starting work.

For longer one-lane main access roads (from approx. 750 m), turnouts (parking bays) of the dimensions L=60 m (N100), L=70 m (N117), L=80 m (N131) must be provided every 500 m in addition to the existing main access road, enabling oncoming vehicles to move aside. This applies to all vehicles.

Due to the specific location and design of the access roads, turnouts must be provided for access roads to assembly areas where the access road is used for traveling to and from the site (dead end). These turnouts must be built on one side, in longitudinal direction, with the dimensions L=180 m (N100), L=210 m (N117) or L=240 m (N131), in addition to the existing roads. This will allow other vehicles such as rescue services to access the site unobstructed during the erection and delivery stage.

If the access road to the WT site is shorter than the required length of the turnout, the length can be divided into up to three sections of 60, 70 or 80 m each and, for example, run along the left and right of the entrance. The extension of an access road behind or past the assembly area is recommended only for one vehicle length (approx. 60, 70 or 80 m).

Parking with direct connection to the WT site for at least 3 rotor blade vehicles must be ensured.

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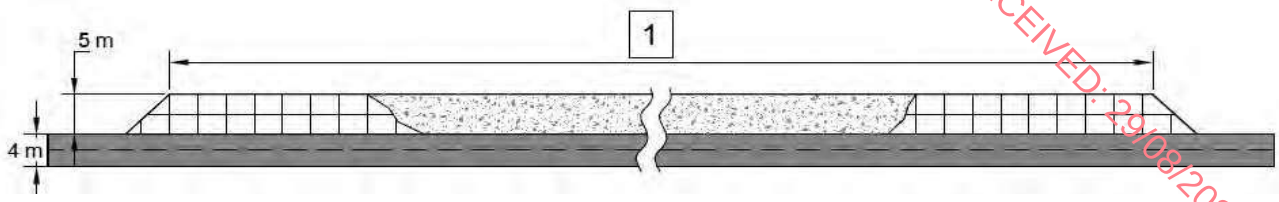


Fig. 18 Normal turnouts (without integration into the auxiliary crane areas)

1 Length of the turnout:
N100: 3 x 60 m or 180 m
N117: 3 x 70 m or 210 m
N131: 3 x 80 m or 240 m

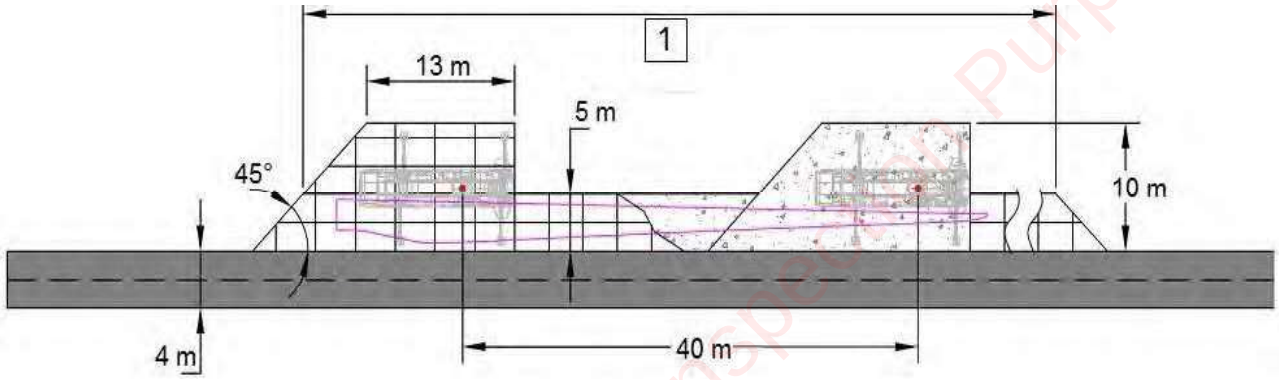


Fig. 19 Turnouts with integration into the auxiliary crane areas

1 Length of the turnout:
N100: 3 x 60 m or 180 m
N117: 3 x 70 m or 210 m
N131: 3 x 80 m or 240 m

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3.3.5 Storage areas and site office

The following sketch shows a general illustration of a Nordex site office, which must be designed specifically for each project:

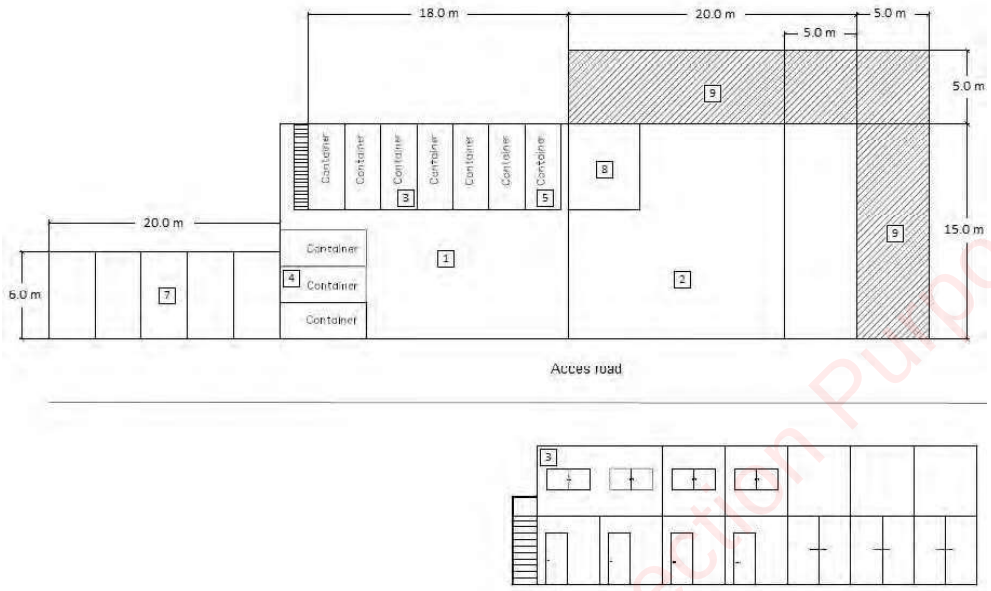


Fig. 20 Nordex site office (example)

1 Office area & assembly point
2 Storage/handling area for small components & material
3 Container village – two stories
4 Containers – erection team / crane team & optional
5 Storage container for hazardous substances
6 Container village staircase
7 Car parking area
8 Storage area for tank system & garbage container
9 Extension area for TIT or >10 WTs

Office area requirements:

- The area must be outside of the danger area (wind turbine height).
- It should be located in the area of the wind farm entrance (main entrance) on a straight road section, at which all transports enter the wind farm (entry check, check-in, check-out and driver guide point).
- The construction is carried out in the same way as the access roads (see chapter 3.1 “Loads”)
- The office area can be constructed with an inclination of up to 2 %.
- The entire office area is a temporary construction for the entire project phase and can be deconstructed after wind farm commissioning.

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The client must provide an area of 720 m² to accommodate the following equipment and facilities:

- Nordex office – 20-ft container
- Construction company office – 20-ft container
- Office for meetings – 20 ft container
- Generator with drip tray
- Recycling
- Free space for material on euro-pallets (14 m x 2.5 m)
- Restroom
- Empty area for material (fenced if applicable (recommended)): 14 m x 2.5 m)
- 4x 20 ft material container (2x for material/1x for cables/1x for storing material in a dry and heated area)
- At least eight parking spaces for cars

3.3.6 Quality inspections, access roads and crane hard standing areas

The customer is responsible for performing the following minimum required quality inspections of access roads and crane hard standing areas in the form of a soil investigation report, including analyses of load-carrying capacity and bearing capacity. The inspection results must be submitted to Nordex no later than four weeks before delivery starts:

Quality inspections	**Minimum number/ comments**
Degree of compaction (Dpr) according to DIN 18127 (or comparable local standard) of the access roads in layers (bed, base layer, top layer)	1 test (every 500 m)
Degree of compaction (D_{pr}) according to DIN 18127 (or comparable local standard) of the **Crane hard standing area** layered (substructure, base layer and top layer)	4 tests (per crane hard standing area)
Static plate load test according to DIN 18134* (or comparable local standard) of the **access roads** in layers (bed, base layer, top layer)	3 tests (every 5000 m²)
Static plate load test according to DIN 18134* (or comparable local standard) of the **crane hard standing areas** in layers (bed, base layer, top layer)	2 tests (per crane hard standing area)

* The following conditions must be met:

- Ev2 ≥ 100 MN/m² and Ev2/Ev1 ≤ 2.3
- If the Ev1 value has already reached 60 MN/m² the ratio Ev2/Ev1 can also be higher.

All test results must be thoroughly documented in a professional manner, illustrated with tables and diagrams and submitted to Nordex. The positions and

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heights of the test points must be presented in diagrams. The soil profile of access roads and crane hard standing areas also require neat presentation.

NOTE

During maintenance the load-carrying capacity of the access roads and the crane hard standing areas must be regularly checked and verified in accordance with the above-mentioned quality inspections. If a component must be replaced, the quality inspections incl. the verification must be performed before commencing the transport. Any repair measures must have been completed before commencing the crane movement

3.4 Friction cable guying

Provisions must be made to allow for enough space for installing the friction cable guying during assembling and disassembling works on tubular steel towers. Two guyings are required which must be placed in a 90° angle from one another. To guide the ropes for the frames, two flat surfaces plus a 4 m wide access road are required in defined areas. These areas must be at least 3 x 3 m in size (10 x 10 m clearance/working area).

For each specific construction site, the responsible person will determine which of these positions does not conflict with lifting plans. Rotating the nacelle by 180°, meaning that the hub is positioned behind the tower when viewed from the crane hard standing area, must be coordinated and agreed with the local crane company, for example.

Requirements deviating from general provisions may be possible for specific projects after such specifications have been reviewed and approved by Nordex.

This applies to the following towers:

Table 15: Guying radii of the towers

Tower	Guy angle [m]
N131/3600 TS99	45
N131/3600 TS106	45
N131/3600 TS114 N131/3900 TS114	45
N117/3600 TS120	45
N131/3600 TS120 N131/3900 TS120	45
N131/3600 TS120 N131/3900 TS120	45
N131/3900 TS105	55

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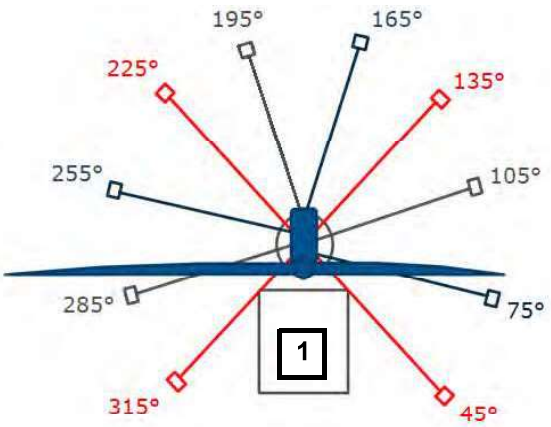


Fig. 21 Top view, general case, erection variants for frames

1 Crane hard standing area

3.5 Public roads

The client is always responsible for access roads from the port of destination or a suitable motorway exit to the construction site. Any necessary structural measures must also be planned, approved and executed by the client.

Here, Nordex can be of support when performing feasibility studies and listing required constructive measures. Depending on the complexity of the access roads, it may be necessary to obtain a test permission at an early stage or perform a “dummy run” prior to starting the heavy duty transports.

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4. Crane requirements

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One main crane and at least one auxiliary crane are required for the wind turbine erection. The auxiliary crane must be able to change position several times before, during and after wind turbine erection. The given masses take the variants with the maximum weight into account.

The required hook height is:

- Towers without tuned mass damper: Hub height + 14 m
- Towers with tuned mass damper: Hub height + 20 m

The main crane radius is at least 15-30 m (depending on the crane type)

The auxiliary crane radius is 6-12 m (depending on the crane type)

The weight specifications include the maximum weight tolerances of the components:

Hub height	75 m	85 m	100 m
Wind turbine type	N100	N100	N100
Performance class [kW]	3300	3300	3300
Main crane - Maximum hook load - Maximum hook load at hub height Star assembly Single blade assembly	69 t 69 t 62 t	69 t 69 t 62 t	73 t 69 t 62 t
Auxiliary crane Required hook load	35 t	35 t	40 t

Hub height	91 m	106 m	114 m	120 m	141 m
Wind turbine type	N117	N117	N117	N117	N117
Main crane - Maximum hook load for an individual module (single blade assembly)	75 t	80 t	71 t	78 t	68 t
- Maximum hook load at hub height Star assembly Single blade assembly	68 t 64 t	68 t 64 t	68 t 64 t	68 t 64 t	68 t 64 t
Auxiliary crane Required hook load	40 t	40 t	40 t	40 t	40 t

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Hub height	84 m	99 m	106 m	114 m	120 m	134 m	164 m
Wind turbine type	N131	N131	N131	N131	N131	N131	N131
Main crane - Maximum hook load for an individual module (single blade assembly)	69 t	68 t	80 t	71/76 t*	78 t	90/80 t**	90 t
- Maximum hook load at hub height Star assembly Single blade assembly	92 t 67 t	92 t 67 t	92 t 67 t	92 t 67 t	92 t 67 t	90/92 t** 67 t	90 t 67 t
Auxiliary crane Required hook load	40 t	40 t	40 t	40 t	40 t	40 t	40 t

* maximum weights for N131/3600 and N131/3000 Controlled or N131/3900

** maximum weights for N131/3300 or N131/3600, N131/3000 Controlled and N131/3900

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5. Crane hard standing area

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The crane hard standing area must be planned and laid out according to the local conditions and the cranes that are used. The crane hard standing area must withstand the soil pressure of the crane outriggers and tracked vehicles. The amount of the surface pressure depends on the max. weight of components and size of the crane used (mobile crane, crawler crane) and must be at least 250 kN/m².

The entire area of the crane hard standing area must be level, must not have any slope and must be planned such that the height difference shown in the respective turbine-related foundation plan between hard standing area and foundation top edge is not exceeded (tubular steel towers: 1.10 m, hybrid towers: 1.80 m). If these values are exceeded, larger, more cost-intensive crane technology is required. The top foundation edge should not be less than 0.5 m below the top terrain edge or top edge of the crane hard standing area. The height difference shown in the foundation plan is also part of the hub height.

In the case of hybrid towers, the transition (access ramp see fig.24) between the crane footprint and the backfilled foundation must be made with a maximum slope of 10° in a gravel construction with a load-bearing capacity of 120 kN, so that construction site vehicles can access the foundation area for the assembly. The ramp must be attached in a way that the main crane can operate unrestricted and the emergency roads are also maintained unrestricted. For tubular steel towers, a staircase see fig.25 (table + figure (item 4a/4b) may be constructed instead of a ramp.

The crane hard standing area and the erection and working area (e.g. clearance) of the crane must be free of obstacles, which might interfere with the erection and operation of the crane (see following drawings). The length of the rotor blades and the space for the assembly of the crane jib must in particular be considered for crane operation.

Excavated material must be stored only behind the foundation (see fig.22) or outside the illustrated assembly areas and the curve areas including slewing areas (see chapter 3.3.1 “Curves”).

The transformer substation must not be placed on the crane hard standing area or the assembly area of the crane jib. To prevent dirt from entering the wind turbine, access to foundation and the ground must be compacted and covered with gravel to ensure a dry and clean surface.

A walkable working area, approx. 2 m wide, must be provided directly around the foundation. The nacelle must only be placed on the crane hard standing area or, using crane mats/wooden supports, on suitable stable ground.

For the assembly of the crane jib of lattice boom cranes, a long, level area with a minimum width of 5 m is required that can be accessed with 8 t. It must be gravel or covered with bolted panels. The minimum length is shown in the following examples, depending on the tower height. The auxiliary crane must be able to move parallel to the entire length of the assembly area.

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The assembly areas overlap with the compacted areas of the access roads and the crane hard standing areas. These areas are dashed and marked as aisles or storage areas.

The crane hard standing areas can be adapted to the individual site conditions for a particular project. The required space can be optimized by using adequate crane, transport and assembly technology. Any deviations from the following examples of crane hard standing areas may cause additional costs. Individual modifications or transport/assembly/crane concepts must be agreed with Nordex in writing in advance.

To ensure a smooth assembly process, storage areas for all components must be planned/provided at all crane hard standing areas. In the examples below these areas are shown as storage areas for rotor blades, for example. Tower sections can also be deposited outside the paved crane hard standing area on adequate supports. Any deviation leads to higher logistics costs due to added effort. Furthermore, any deviation must be coordinated individually with Nordex in advance. **Notice:** No components must be deposited in the jib assembly area that prevent the sudden lowering of the crane jib.

At forest locations ore sites with demanding topography where no storage areas can be provided, at least one central area must be provided where components can be deposited. The auxiliary crane areas may be stabilized with gravel or temporary with bolted panels. Alternatively, two crane hard standing area must be dimensioned in a way that tower sections and rotor blades can be deposited on the crane hard standing area and/or in the area for the jib assembly. In these cases, higher costs must be expected due to greater logistics effort.

Sufficient space for at least two Nordex erection containers must be provided (for power generator and tools) as well as additional space for a Nordex material container for temporary material storage, garbage containers, staff containers, construction vehicles, etc.

The access roads to the wind turbine must always be kept free for ambulance and rescue, assembly and site vehicles. The escape paths must be designed for crane hard standing areas according to the following examples. A reliable escape route concept must be presented prior to commencing construction.

The following examples show crane hard standing areas for forest and open country for turbines up to 170 m tower height. The detailed layout for the specific site must be planned after the site has been inspected.

In addition to the areas shown in the examples, a clear assembly area for the rotor (for star assembly, N117 only) is also required. This area depends on the local conditions and must be specified in cooperation with Nordex. Sufficient space for at least two Nordex erection containers must be provided (for power generator and tools) as well as additional space for a Nordex material container for temporary material storage, garbage containers, staff containers, construction vehicles, etc.

The following two examples show the design of a modular crane hard standing area (see fig.22, optimized forest crane hard standing area and see fig.23, optimized crane hard standing area for unobstructed locations). The examples

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shown illustrate the optimum crane hard standing areas including all modules (storage areas). Dependent on location, topographical conditions or the available area, individual modules might be removed or moved. It should be noted that movements might result in additional costs if the modules are not within the handling area of the large crane. For the turbine-specific dimensions, refer to the Table below, see “Table 16: Values for crane hard standing areas”.

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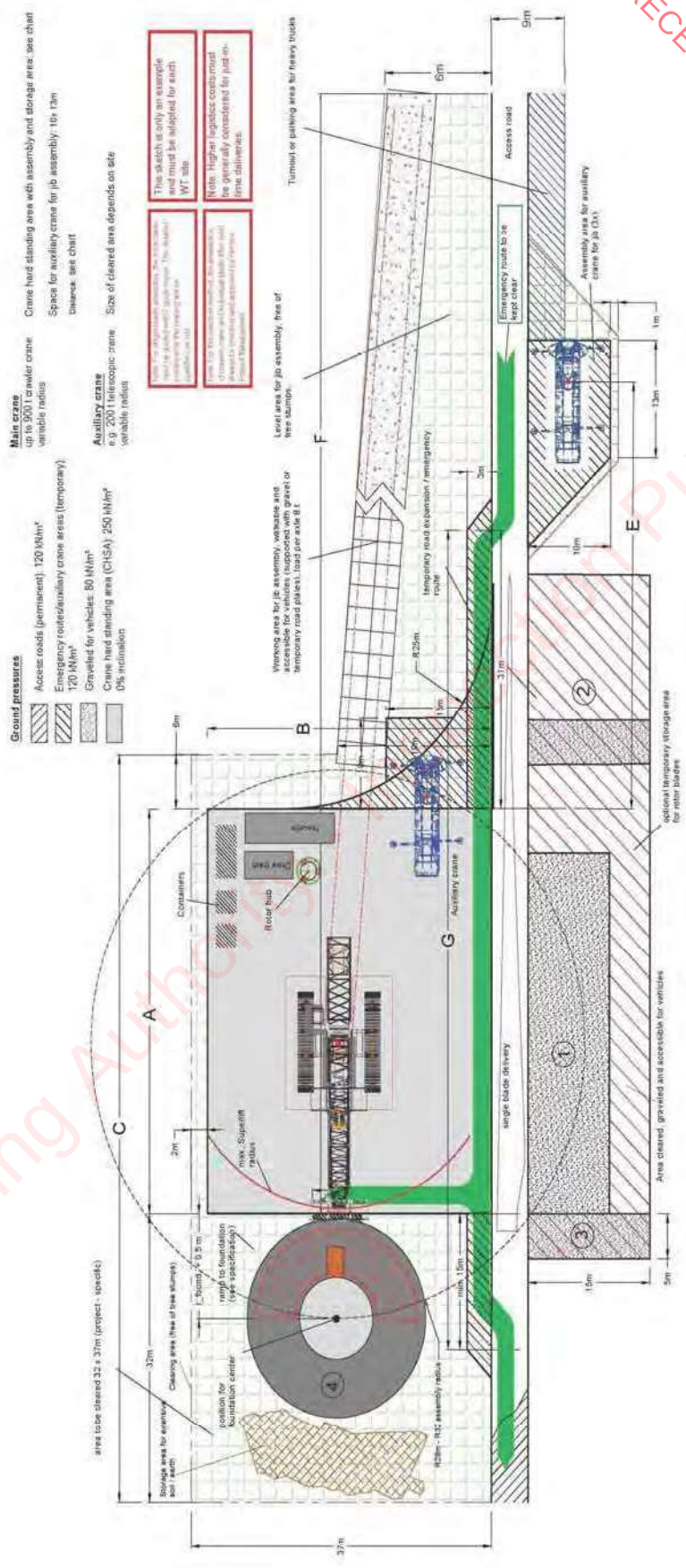


Fig. 22 Optimized crane hard standing area for forest sites (single blade assembly) for WTs of up to 170 m hub height

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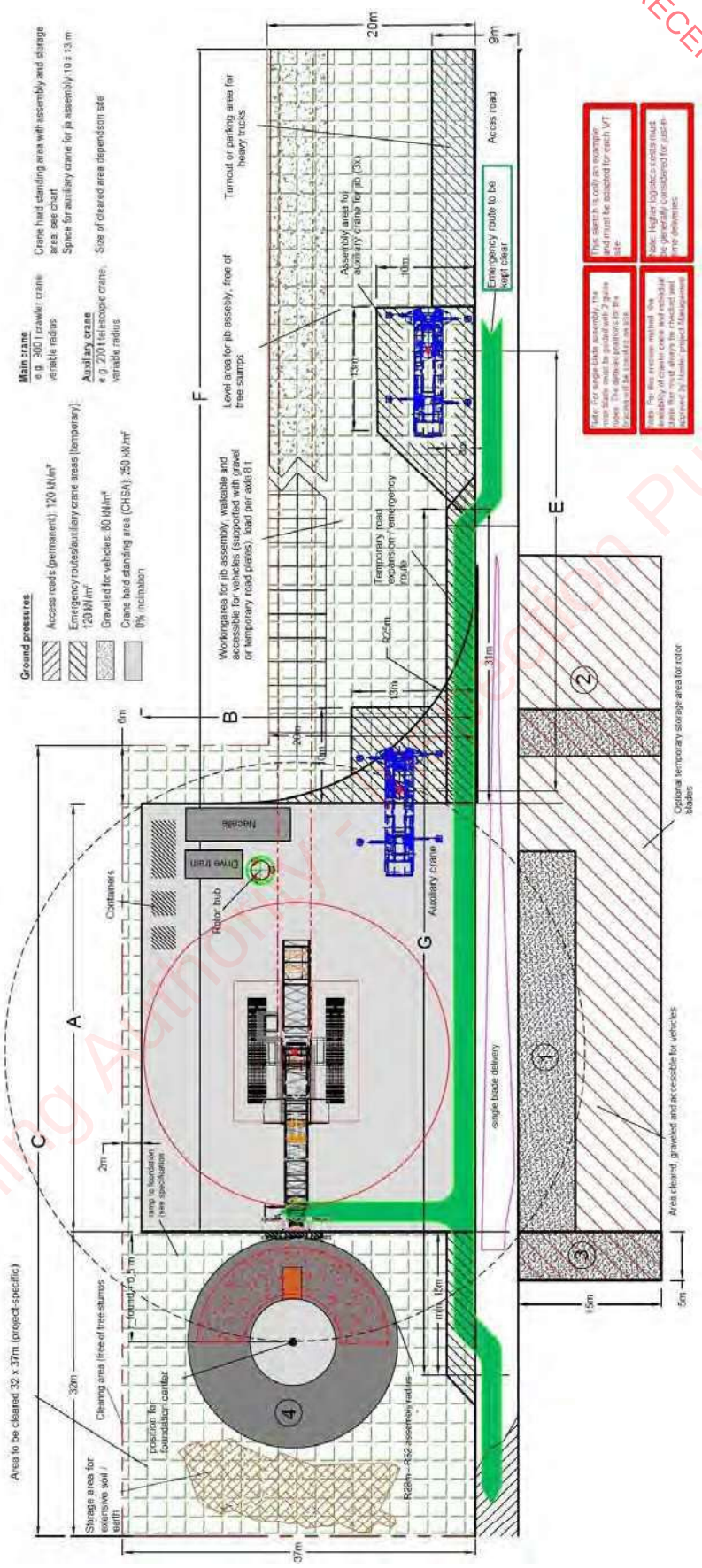


Fig. 23 Optimized crane hard standing area for open country sites (single blade assembly) for WTs of up to 170 m hub height

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Alternative design variants:

- Within the wind farm, a central area at the wind farm entrance (preferably open space) may be chosen. If necessary, panels must be laid out for the auxiliary cranes; the components may be deposited on wooden supports. Surface damage will be inevitable.
- The blade storage areas may be integrated into the jib assembly areas (in the area of the first two auxiliary crane pockets / the depth here corresponds approximately to the required depth and length “2”). In this case, at least two crane hard standing areas must be provided for this purpose (The components can be deposited only where either no WT has yet been erected or where a WT has already been erected; the deposited components must not prevent the jib assembly/disassembly).

The working areas around the tubular steel tower must be constructed as follows:

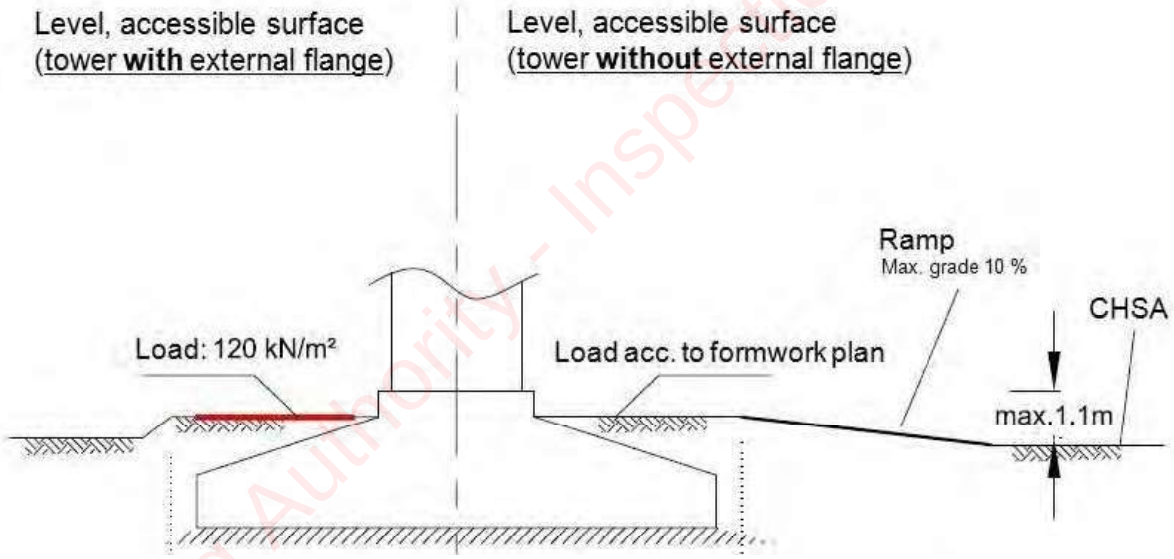


Fig. 24 Area around the tower – sectional view

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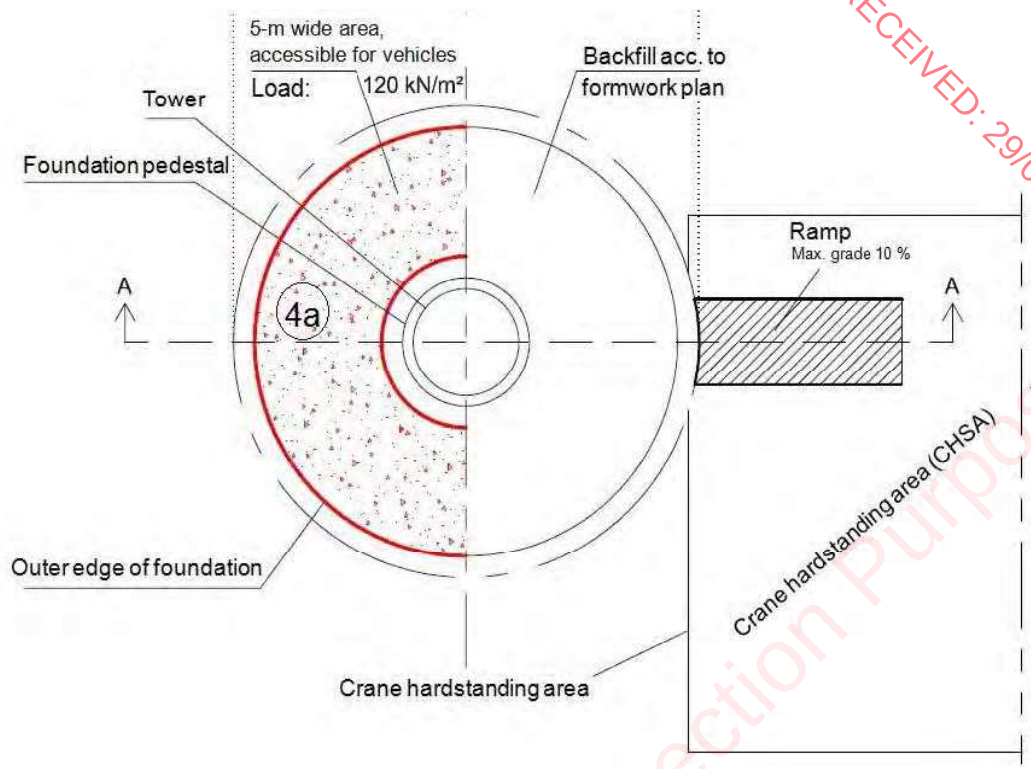


Fig. 25 Area around the tower (tubular steel tower) – top view

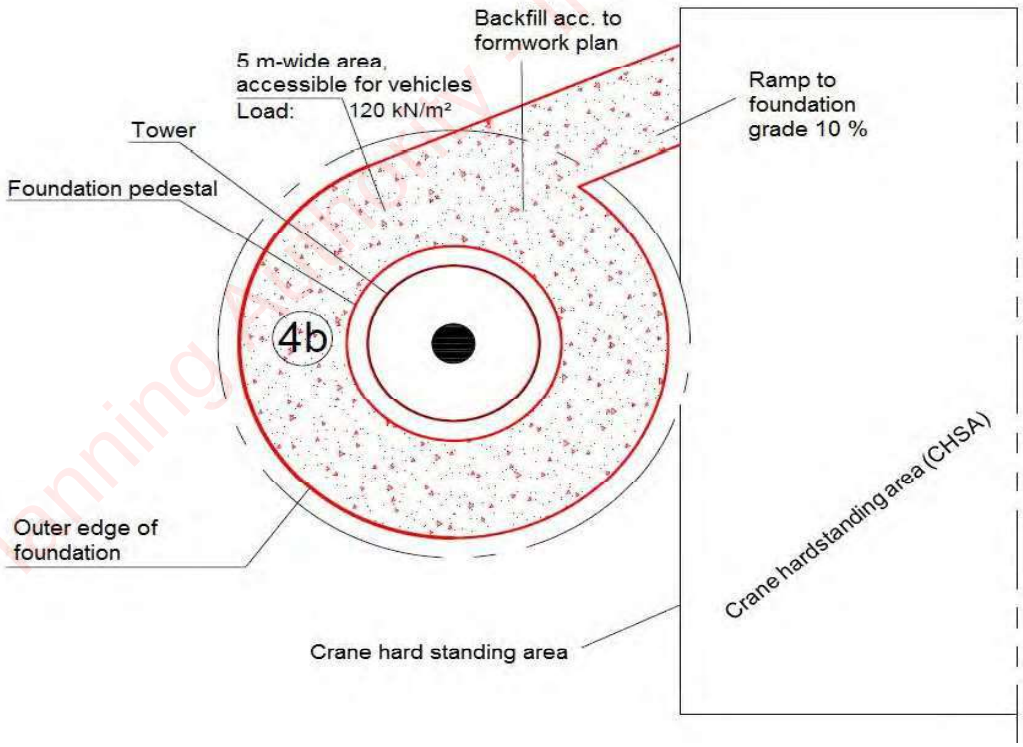


Fig. 26 Area around the tower (hybrid tower) – top view

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Table 16: Values for crane hard standing areas

Crane hard standing area		R100 TS99 R99 TS76 TS91 TS84 R85 R75	TS120 TS114 TS106	PH164 TCS141 TS134 TCS134 PH134
A (Length crane hard standing area)	m	40	45	45
B (Width crane hard standing area)	m	25	30	35
B1 (width of optional tower storage space) only for locations on open space)	m	10	15 - 20	10
C (length of clearing area) (for crane hard standing area only)	m	74	74	74
E (distance of auxiliary crane pockets / each to the center point)	m	40	40	40
F (length of the jib assembly area / measured from the transition of the foundation edge / crane hard standing area)	m	110	130 - 160	180
G (length of emergency lane / it must be possible to drive around the longest vehicle (NR 65.5 (N131) / blade length 64.7 / transport length 73.5m / current worst-case assumption))	m	70/80	70/80	70/80
1 (pre-assembly area / handling area)	m	x	x	6 x 40
2 (blade storage area / optional)*	m	12 x 50/ 12 x 60/ 15 x 67	12 x 60/ 15 x 67	12 x 50/ 12 x 60/ 15 x 67
3 (blade fingers / support points for the rotor blade transport frames (distance in acc. with table, item 2.4))	m	5 x 12/ 5 x 15	5 x 12/ 5 x 15	5 x 12/ 5 x 15
4a (staircase to the foundation / table: inclination up to 10°: gravel / 11°-30° handrail + graveled steps / 31°-45° = steps + handrail	m	required	required	required
4b (ramp to the side of the crane hard standing area on the foundation/gravel on the gravel/accessible foundation area / load capacity 120 kN)	m	required	required	required

* If present, no additional costs, if not present directly at the crane hard standing area: Additional costs for logistics (driving around the components / within the wind farm) must be included in the calculation.

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