MWP

Chapter 03 Civil Engineering

Ballycar Wind Farm

3. Civil Engineering

3.1 Introduction

This chapter provides additional information to **Chapter 2 Description of the Proposed Development** on the civil engineering design rationale and works for the various elements of the proposed development. All drawings to the appropriate scale as required by the Planning and Development Regulations 2001 to 2023 (as amended) can be found in the planning pack accompanying the planning application. The purpose of this chapter is to provide additional information in relation to construction of the following items:

- Local Access Routes;
- Site Entrances;
- Internal Wind Farm Access tracks;
- Wind Turbine and Hardstand Infrastructure;
- Internal Wind Farm Site Cable System;
- External Grid Connection;
- Substation Compound and Buildings;
- Meteorological Mast;
- Temporary Site Construction Compound;
- Borrow Pit;
- Spoil Storage;
- Construction Material Volumes;
- Watercourse / Drainage Crossing Design;
- Site Drainage Systems Design; ans
- Sediment and Erosion Plan.

3.2 Local Access Routes

The components for the 12 no. turbines will be delivered by cargo ships to Foynes Port in County Limerick. The components for each turbine will be delivered in separate loads, some of which are abnormal in terms of their width and length. The components will be transported from Foynes Port to the site along the National, Regional and Local road network.

Refer to the Turbine Delivery Route Assessment (**Appendix 2C**) of **Volume III** of the **EIAR** for further details.

The delivery of turbine components to the proposed development will require temporary works on sections of the public road network along the delivery route including hedge or tree cutting, relocation of powerlines/poles, lampposts, signage and temporary local road widening. Such works are temporary for the delivery of turbine components and are not included in the planning application boundary. Construction methods for temporary public road widening will follow those outlined in **Section 3.4.1.3** New Floating Tracks where applicable. The exposed surface will be levelled out and will be overlain with a layer of crushed stone. The finished surface will be formed with a layer of Clause 804 or similar aggregate imported from local quarries.

3.3 Site Entrances

Access to the site during the construction phase will be from a new permanent site entrance off the local road to the east of the site (Access Junction A – Permanent Site Entrance), and from a temporary construction entrance also off the local road (Access Junction B – Temporary Site Entrance) (**Figure 3-1**). Access Junction B onto the local road is proposed as a temporary access to be used during the early construction phase only. Access Junction A is proposed as the main access point to the wind farm until decommissioning.

The site entrances on the local roads require appropriate sight distance in both directions which are available.

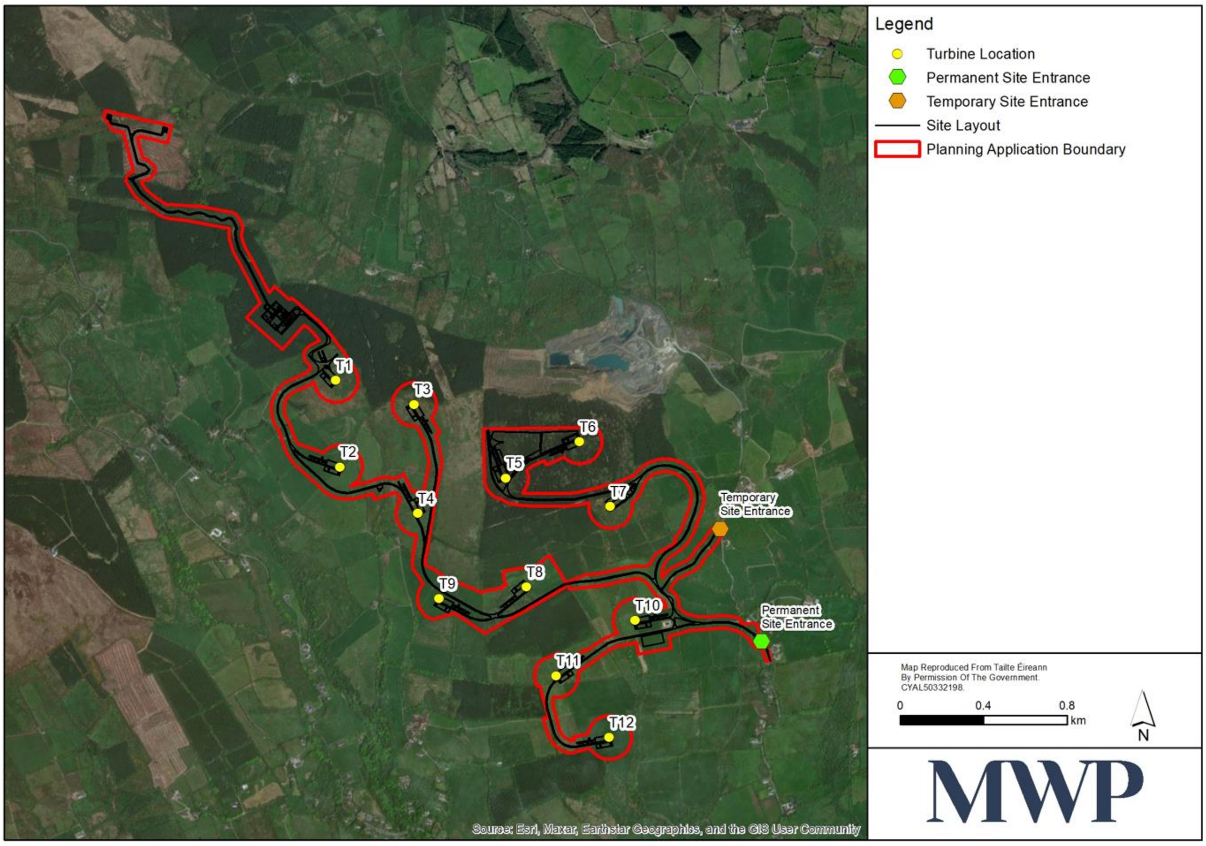

Figure 3-1: Site Entrance Points

The requirements for junction sight distance are set out in Transport Infrastructure Ireland (TII) '*DN-GEO-03060: Geometric Design of Junctions (priority junctions, direct accesses, roundabouts, grade separated and compact grade separated junctions)*'. Sight distance is measured from a point 2.4m from the near edge of the major road along the centre of the minor approach road. This distance is referred to as the 'x-distance'. The visibility distance along the major road is referred to as the 'y-distance' and is measured to the near edge of the major road in both directions. The required sight distance in the vertical plane is based on eye and object heights of 1.05m. The 'y-distance' requirement depends on the design speed of the major road. This is the 85th percentile speed which is the speed below which 85% of vehicles travel.

The statutory speed limit on the local road is 80km/h but the design speed is likely to be somewhat lower. Based on observations on site and professional judgement and experience, a design speed of 60km/h has been taken as being appropriate at these locations with a sight distance of the order of 90m due to the restricted horizontal alignment of the local road.

The sightline distance will be achieved by installing a timber post and rail fence and keeping an area outside the fence free of vegetation or other obstructions. The sight distance splays in both directions with the modifications in place are shown in Chapter 2 Description of the Proposed Development and Planning Drawings 22156-MWP-00-00-DR-C-5007 and 22156-MWP-00-00-DR-C-5008. These improvements will remain in place permanently and will benefit users of the wind farm when exiting the site onto the public road. A photograph of a typical wind farm entrance with sightlines improved is given in Figure 3-2.

Drainage will be provided, as appropriate to prevent water from the site entrances flowing onto the public road. The site entrance will be designed to facilitate access for all vehicles associated with the construction and subsequent maintenance of the wind farm.

Figure 3-2: Typical Wind Farm Entrance

3.4 Internal Wind Farm Site Tracks

The internal site access track design objectives and design rationale for the proposed wind farm development are outlined below. The access track drawings are presented in A1 format in the planning application pack. These include:

- Proposed Internal Access Track Layout is shown on Planning Drawing 22156-MWP-00-00-DR-C-5005 and 22156-MWP-01-00-DR-C-5005 to 22156-MWP-11-00-DR-C-5005;
- Proposed Internal Access Track Details (refer to Planning Drawing 22156-MWP-00-00-DR-C-5405);
- Junction Sight Distances (refer to Planning Drawings 22156-MWP-00-00-DR-C-5007 and 22156-MWP-00-00-DR-C-5008); and
- Proposed areas of clear fell associated with access track infrastructure (refer to **Figure 2-15** in Chapter 2 Description of the Proposed Development.

Internal access tracks are required to interconnect elements of the site and allow access to all wind turbines and wind farm infrastructure. The proposed wind farm will use approximately 1.5km of existing tracks and 10.6km of new tracks will be constructed within the development site.

The new access tracks will have a running width of generally 5.0m along straight sections, with localised wider areas at bends to accommodate the efficient transport of the wind turbine components. These tracks will be constructed using either excavated or floating track techniques. These methods of construction are outlined in the following sections below.

The existing routes were identified initially from high resolution aerial photography and thereafter from site visits, where the existing tracks were assessed in terms of their width, gradient and associated drainage. The remaining tracks will be a combination of either floated or excavated tracks in various parts of the site to suit the ground conditions.

The following outlines the internal access track design rationale:

- The access track design was based on the necessity to deliver wind turbines with a maximum blade length of 68m.
- Track gradients throughout most of the site are 12% or less which is sufficient for turbine delivery.
- The maximum camber and crossfall gradient on the access tracks is 2.5%.
- As turbines are normally grouped and linked in electrical circuits, consideration was given to cable circuit layouts in the internal access tracks route selection process. It is planned to run all cables along the internal access tracks; it is important to ensure that access tracks facilitate efficient cabling.
- The construction of turbines immediately adjacent to the main access tracks was avoided with the exception of T11 and T4 because of the potential conflict with construction traffic and the associated safety issues. All turbines apart from T11 and T4 will be accessed from short spur tracks linked to the main access tracks. A relevant construction plan will ensure health and safety issues are minimised when constructing these turbines.
- Avoidance of stream crossings and water bodies, where possible.
- New sections of access tracks were selected minimising steep ground and natural drainage features.

- Access track alignments were selected that will have adequate turning radii for delivery of turbines; and;
- Aerial photography, Ordnance Survey Ireland (OSI) contour data and LiDAR data were used to inform the internal access track design.

The following constraints were taken into account in the final design of the internal access track layout within the site:

1. Site topography (OSI contour data and LiDAR data) to avoid steep slopes for turbine delivery vehicles;
2. A hydrology buffer map where streams were buffered by 50m, as outlined in **Section 4.3.1 Chapter 4 Alternatives** of this **EIAR**, except where water crossings and other minor works are required;
3. Avoidance of ecologically sensitive areas, as outlined in **Section 4.3.1** Identification of Environmental Sensitivities, of this **EIAR**;
4. Avoidance of archaeological features, as outlined in **Section 4.3.1** Identification of Environmental Sensitivities, of this **EIAR**;
5. Reduction of visual impact – tracks along contours where possible.

The overall site layout is shown on **Planning Drawings 22156-MWP-00-00-DR-C-5005** and **22156-MWP-01-00-DR-C-5005** to **22156-MWP-11-00-DR-C-5005**.

A network of existing access tracks, which will be upgraded and widened, together with new excavated and new floating tracks will be used to access each of the turbines, the substation compound, borrow pit, deposition areas and the meteorological mast. Larger splays will be required at the wind farm access points and at spur junctions for the large turbine component delivery trucks. The splayed junctions at the windfarm access points will be coned off to 12m radii to ensure the safety of the junction for regular construction traffic. See **Planning Drawings 22156-MWP-00-00-DR-C-5007** and **22156-MWP-00-00-DR-C-5008** for details of the proposed junction layouts.

The design of any length of site access track will depend on local geotechnical, topographical, and hydrological conditions. Both excavated and floating track construction methods will be employed to achieve an access track structure appropriate to the site conditions.

The stone required for the construction of the internal access tracks, hardstands and substation compound will be sourced from a combination of the proposed on-site borrow pit, suitable excavated stone material obtained from the wind farm works and local quarries. A total volume of 265,150m^3 of stone will be required of which 165,000m^3 will be won from an onsite borrow pit. The access tracks will be finished with a top layer of imported limestone to give a clean hardwearing running surface for the delivery of turbines.

Overall, the internal site layout design is an optimal one in terms of its minimal impact on the existing public road network in the vicinity of the site, the low risk in terms of associated environmental impacts, the use of a well-developed drainage network and good access and connectivity to the public road network.

3.4.1 Internal Wind Farm Access Track Construction Methods

3.4.1.1 Upgrading and Widening of Existing Tracks

For the construction of the wind farm, it is proposed to utilise existing internal tracks where possible. These tracks will be widened by removing organic material and soft subsoil to formation level and constructing a track on a layer of geogrid or geotextile. This access track construction will be similar in build up to the excavated track construction which is outlined in detail in **Section 3.4.1.2**. The new width of track and the existing track surface, where required, will be capped with a 150mm layer of crushed stone of Clause 804 or similar aggregate type material.

This access track type will have a crossfall of 2.5% from one edge to the other. The existing or new trackside drains on the lower side of the track will be used as part of the dirty water drainage system for the site. The existing or new access trackside drains on the higher side of the track will be retained as clean water drains.

Typically, the sequence for upgrading and widening existing access tracks will comprise the following:

1. The appointed contractor will liaise with the wind turbine supplier prior to the commencement of the works to ensure that the design of the tracks conforms with the wind turbine supplier's specifications and no works beyond that which have received planning permission will be undertaken.
2. The appointed contractor will survey the area for any unforeseen hazards prior to the commencement of works and set up warning signage as appropriate.
3. The appointed contractor will mark out the line of the upgraded/widened track using a GPS / total station.
4. Drainage measures to ensure the separation of overland clean water flow from construction run-off will be implemented as outlined in Section 3.13.
5. The material required for widening and upgrading the existing site tracks is proposed to be used from either the proposed on-site borrow pit, suitable excavated stone material within the wind farm site and imported stone from the nearby quarries. All tracks will be finished with imported 150mm crushed stone of Clause 804, or similar aggregate type material. Sufficient passing bays will need to be constructed to allow for the safe movement of site traffic along the existing tracks. Volumes of excavation and construction materials are outlined in Table 3-2.
6. Where the extraction of stone aggregate from the proposed borrow pit is used, it will be undertaken by 30-60 Ton 360° excavators and loaded onto articulated dumper trucks that will deliver the aggregate to the required access track widening / upgrading locations.
7. Widening works will begin with the use of excavators that will first remove any topsoil / vegetative layer which may be present. This material will be transported to an agreed temporary storage area (within turbine hardstand areas) and maintained for re-use during the restoration phase of the wind farm construction. Topsoil / vegetative removal will be kept to a minimum to prevent any runoff of silt during heavy rainfall.
8. Excavators will continue to strip and excavate the soft subsoil underneath, which will be temporarily stored adjacent to the access tracks in accordance with approved methods with the use of an articulated dumper truck. Excavated material will only be temporarily stored on slopes under 5° and to a maximum height of under 1.0m until they are transported to the selected deposition areas where they will be permanently stored.
9. Once a section of the widened access track is exposed to suitable formation; a layer of geogrid or geotextile material may be placed along its formation depending on ground conditions.
10. The stone to be used for the widening works will be delivered to the required work area and spread out locally with the use of excavators on top of the geogrid / geotextile material. This will be compacted with the use of a roller which will roll the stone aggregate in maximum 250mm layers to achieve the required design strength.
11. The access track upgrading works will involve the use of a roller compacting the site won stone aggregate in maximum 250mm layers laid over the existing track pavement. A layer of geogrid or geotextile material

may be placed along the existing track pavement prior to the placement of the stone aggregate to achieve the required design strength.

12. All upgraded / widened access tracks will be constructed to a minimum drivable width of 5.0m with a maximum crossfall of 2.5% in order that water can flow off the tracks and reduce the risk of rutting / potholes occurring.
13. Trackside drains as per **Section 3.13** will be constructed to manage clean and dirty water runoff along widened and upgraded access tracks.
14. The final running surface of the new widened / upgraded access tracks will be capped with a minimum 150mm layer of crushed stone Clause 804 material or similar using a road grader.
15. Any surplus spoil material generated from the track widening works will be transported back to the borrow pit to aid final reinstatement. Excavated topsoil and subsoil will be kept separate at the excavation and storage areas.
16. All excavations to be carried out will be battered back to a safe angle of repose (typically a max slope angle of 45°).
17. Where drop offs greater than 1.0m in height occur alongside track edges; physical edge protection will be constructed to reduce the risk of vehicles overturning. Marker posts will also be erected to delineate track edges in poor weather.
18. The appointed contractor will ensure that all on-site personnel are aware of environmental constraints / sensitive areas within the wind farm site in which works are to be avoided.

Figure 3-3: Typical upgraded track on a wind farm

3.4.1.2 New Excavated Tracks

New excavated tracks will be constructed using stone aggregate obtained from either the proposed on-site borrow pit or imported from the nearby quarries. The stone aggregate will be placed over a layer of geogrid, where required, after all organic and soft subsoil material is excavated to formation level. Geotextile material, used to separate the track building material from the subsoil, will also be laid at formation level. The track will be finished with imported 150mm crushed stone of Clause 804, or similar aggregate type material.

Typically, the sequence of constructing new excavated access tracks will comprise the following:

1. The appointed contractor will liaise with the wind turbine supplier prior to the commencement of the works to ensure that the design of the new excavated tracks conforms with the wind turbine supplier's specifications and no works beyond that which have received planning permission will be undertaken.
2. The appointed contractor will survey the area for any unforeseen hazards prior to the commencement of works and set up warning signage as appropriate.
3. The appointed contractor will mark out the line of the new excavated track using a GPS / total station.
4. Drainage measures to ensure the separation of overland clean water flow from construction run-off will be implemented as outlined in **Section 3.13**.
5. Excavators will first remove any topsoil / vegetative layer which may be present. This material will be transported to an agreed temporary storage area and maintained for re-use during the restoration phase of the wind farm construction. Topsoil / vegetative removal will be kept to a minimum to prevent any runoff of silt during heavy rainfall.
6. Excavators will continue to strip and excavate the soft subsoil underneath, which will be temporarily stored adjacent to the access tracks in accordance with approved methods with the use of an articulated dumper truck. Excavated material will only be temporarily stored on slopes under 5° and to a maximum height of under 1.0m until they are transported to the selected deposition areas where they will be permanently stored.
7. All excavations to be carried out will be battered back to a safe angle of repose (slope angle of 45°) but where excavations are in solid rock the safe angle of repose may be increased to a slope angle of 60°.
8. Once a section of the excavated access track is exposed to suitable formation; a layer of geogrid or geotextile material may be placed along its formation depending on ground conditions which will be covered with site won aggregate stone as required compacted in maximum 250mm layers.
9. The material required for the excavated access tracks is proposed to be used from either the proposed on-site borrow pit, suitable excavated stone material within the wind farm site and imported stone from the nearby quarries. All tracks will be finished with imported 150mm crushed stone of Clause 804, or similar aggregate type material. Sufficient passing bays will be constructed to allow for the safe movement of site traffic along the tracks.
10. Where the extraction of stone aggregate from the proposed borrow pit is used it will be undertaken by 30-60 Ton 360° excavators and loaded onto articulated dumper trucks that will deliver the aggregate to the required access track widening / upgrading locations.
11. The stone will be delivered to the required work area and spread out locally with the use of excavators and compacted with the use of a roller which will roll the stone aggregate in maximum 250mm layers on top of the geogrid / geotextile material to achieve the required design strength.
12. All new excavated access tracks will be constructed to a finished carriageway width of 5.0m with a maximum crossfall of 2.5% in order that water can flow off the tracks and reduce the risk of rutting / potholes occurring.

13. Trackside drains as per **Section 3.13** will be constructed to manage clean and dirty water runoff along excavated access tracks.
14. The final running surface of the new excavated access tracks will be capped with a minimum 150mm layer of crushed stone Clause 804 material or similar using a road grader.
15. Any surplus spoil material generated from the excavated access track works will be transported back to the borrow pit to aid final reinstatement. Excavated topsoil and subsoil will be kept separate at the excavation and storage areas.
16. Where drop offs greater than 1.0m in height occur alongside track edges; physical edge protection will be constructed to reduce the risk of vehicles overturning. Marker posts will also be erected to delineate track edges in poor weather.
17. The appointed contractor will ensure that on site personnel will be aware of environmental constraints / sensitive areas within the wind farm site in which works are to be avoided.

Figure 3-4: Typical new excavated access track on a wind farm

3.4.1.3 New Floating Tracks

Floating tracks will be utilised where gradient and topographical conditions permit. The use of floating access track methods will minimize the excavation of material and reduce interference with the existing drainage regime in these areas of the site. A combination of geogrid and geotextile will be placed over the vegetation on the existing surface to be traversed with the floating track. A minimum thickness of 450mm of site won stone, will be placed over the bottom layer of geogrid / geotextile. This will be overlain with a 150mm surface layer of Clause 804 or similar material.

Where new access tracks will be constructed through forested areas, the felled trees will be used in the construction of the floating tracks as outlined in the Coford Forest Road Manual (2004, see references at end of document). This construction method involves layering the brash from the felling process on the existing ground surface and placing the felled trees perpendicular to the direction of travel to benefit from the load spread thereby provided. A combination of geogrid and geotextile will be placed on top of the felled trees and the track construction completed using the same construction method as that outlined above. Refer to **Planning Drawing 22156-MWP-00-00-DR-C-5405** for further details.

Typically, the sequence of constructing floating access tracks will comprise the following as per guidance from the Scottish Natural Heritage / Forestry Commission Scotland (Forestry Civil Engineering - FCE) on the construction of floated tracks:

1. The appointed contractor will liaise with the wind turbine supplier prior to the commencement of the works to ensure that the design of the tracks conforms with the wind turbine supplier's specifications and no works beyond that which have received planning permission will be undertaken.
2. The appointed contractor will survey the area for any unforeseen hazards prior to the commencement of works and set up warning signage as appropriate.
3. The appointed contractor will mark out the line of the proposed floated track using a GPS / total station.
4. Drainage measures to ensure the separation of overland clean water flow from construction run-off will be implemented as outlined in **Section 3.13**.
5. The intended floating track area is cleared of major protrusions such as rocks, trees, bushes etc. down to ground level but residual stumps and roots are left in place.
6. The local surface vegetation and soils are left in place where possible as the existing vegetation and root mat may be the strongest layer in the system and care will be taken to preserve this layer if possible.
7. Any local hollows and depressions are filled in with a suitable local lightweight fill such as tree brash, logs, or geogrid / geotextile material with stone aggregate.
8. A formation, 7 to 8m, wide is prepared where a layer of geogrid / geotextile is laid out by hand along the line of the proposed floated track.
9. The specification for geotextiles will be finalised by the design engineer at construction stage but past empirical experience on previous constructed wind farms within Ireland and Scotland has proven the suitability of floated access track construction.
10. Where there is a drainage requirement, suitably sized HDPE drainage pipes shall be laid on top of the installed geogrid / geotextile prior to the placement of stone aggregate. Cross drains will be laid at appropriate intervals to maintain the existing drainage regime on the site.
11. The material required for the floated access tracks is proposed to be used from either the proposed on-site borrow pit, suitable excavated stone material within the wind farm site and imported stone from the nearby quarries. All tracks will be finished with imported 150mm crushed stone of Clause 804, or similar aggregate type material. Volumes of excavation and construction materials are outlined in **Table 3-2**.
12. Where the extraction of stone aggregate from the proposed borrow pit is used it will be undertaken by 30-60 Ton 360° excavators and loaded onto articulated dumper trucks that will deliver the aggregate to the required access track widening / upgrading locations.
13. Wide tracked 360° excavators will be used for constructing the floated tracks by cascading a minimum 450mm thickness of stone aggregate over the geogrid / geotextile. The stone aggregate will be suitably

sized to achieve a sound interlock with the geogrid / geotextile material. It is common practice for floated access track construction on wind farms that the compaction of the stone aggregate is done by the wheels and tracks of construction plant alone.

14. An additional layer of geogrid / geotextile may be placed over the stone aggregate, if necessary, before a minimum capping layer of 150mm of Clause 804 or similar material is laid out with excavators.
15. All floated access tracks will be constructed to a minimum drivable width of 5.0m with a maximum crossfall of 2.5% in order that water can flow off the tracks and reduce the risk of rutting / potholes occurring.
16. Trackside drains as per **Section 3.13** will be constructed to manage clean and dirty water runoff along floated tracks.
17. Where drop offs greater than 1.0m in height occur alongside track edges; physical edge protection will be constructed to reduce the risk of vehicles overturning. Marker posts will also be erected to delineate track edges in poor weather.
18. To allow for the safe movement of site traffic during the construction of floated tracks; a site traffic management plan will be prepared by the appointed contractor in accordance with the TMP (**Volume III, Appendix 2D**) submitted with this application. Care will be taken when reversing vehicles on floating tracks to ensure that they do not run along the edge of the track but stay within the delineated safe running zone.
19. The appointed contractor will ensure that on site personnel will be aware of environmental constraints / sensitive areas within the wind farm site in which works are to be avoided.

Figure 3-5: Typical floated track on a wind farm

3.5 Wind Turbines

3.5.1 Wind Turbine Locations

The proposed wind turbines were positioned to minimise the volume of excavated spoil and to achieve as close as possible to a balance of cut and fill of the underlying strata at each turbine location. This was achieved by orientating the turbine base and crane hardstanding area with its long axis parallel to the ground contours as much as possible while taking account of access criteria for delivery of turbine components. This generally required some adjustment to the position of the access track on the approach to the turbine site. **Table 3-1** outlines information of the site, ground slope and peat depth at and in the vicinity of each of the proposed turbines.

Table 3-1: Ground Parameters at Turbine Sites

Turbine	Land Use Category	Slope	Peat Depth
T1	Agricultural Grassland	4.9°	0.0m
T2	Agricultural Grassland	7.4°	0.0m
T3	Agricultural Grassland	5.1°	0.0m
T4	Agricultural Grassland	7.6°	0.0m
T5	Coniferous Forestry	0.7°	0.0m
T6	Coniferous Forestry	10.6°	0.0m
T7	Agricultural Grassland	9.6°	0.0m
T8	Agricultural Grassland	12.4°	0.0m
T9	Agricultural Grassland	6.0°	0.0m
T10	Agricultural Grassland	4.5°	0.0m
T11	Agricultural Grassland	4.0°	0.0m
T12	Agricultural Grassland	4.4°	0.0m

3.5.2 Turbine Crane Hardstands

The layout of the crane hardstand is designed to accommodate the delivery of the turbine components prior to their erection and to support the cranes during erection. Hardstands are also used for maintenance during the operation of the turbines. The hardstands will be rectangular in shape with additional hardstand set down areas to lay the turbine blades across once delivered. The area of a single hardstand is approximately 68m long by 25m wide with depths varying depending on ground conditions and topography. Refer to **Planning Drawing 22156-MWP-00-00-DR-C-5403** for further details. Due to the significant loads that will be imposed by the outriggers of the main lifting crane during the turbine erection process; it is intended that the hardstands will be constructed using excavation methods over the footprint of the hardstand area / turbine base.

The proposed works will be restricted to the turbine locations and will comprise the following:

1. Each crane hardstand will be formed on competent subgrade of the underlying subsoil / rock which will comprise of stone aggregate (obtained from either the on-site borrow pit, excavated works, or imported from the nearby quarries) laid on a geotextile filter membrane.
2. Any existing unsuitable soil found within the footprint of the turbine hardstand will be excavated out during formation works. The excavation works will be carried out using hydraulic excavators where surplus subsoil material will be transported to the on-site deposition areas via articulated dumper trucks or tractor and trailer for subsequent reuse in the permanent reinstatement of the borrow pit.
3. The stone aggregate for the turbine hardstands will be compacted in 250mm layers and will vary from approximately 300mm to 900mm deep depending on the gradient of the underlying subgrade.
4. Temporary set down areas will be formed to facilitate the storage of the turbine components at each crane hardstand (e.g., the turbine blades, the turbine towers, and nacelle). Each temporary set down area will be constructed using compacted stone aggregate which will be fully removed and reinstated after all turbines have been erected.
5. Plate bearing test results will be undertaken on the finished hardstand surface to check if ground bearing strengths are to the wind supplier's specifications. Once complete the assembly cranes will be set up on the hardstand and will erect the wind turbine into place.
6. Where drop offs greater than 1.0m in height occur alongside hardstand edges; physical edge protection will be constructed to reduce the risk of vehicles overturning or persons falling.

Figure 3-6: Typical finished hardstand on a wind farm

3.5.3 Turbine Bases

It is proposed the 12 no. wind turbines will have a reinforced concrete base pad foundation with a central pedestal above the base, that will in turn support the wind turbine tower. Each turbine base will bear onto rock or other such suitable bearing stratum and will be constructed utilising a spread foundation, which is wide and shallow. A typical foundation will be approximately 28m in diameter and will generally be installed to a depth of approximately 3.0m below ground level. Approximately 900m^3 of concrete and 100 tonnes of steel will be used in the construction of each turbine base. Estimated material quantities required for the construction of the turbine bases are shown in **Section 3.12**. Refer to **Planning Drawing 22156-MWP-00-00-DR-C-5402** for further details.

The proposed works will be restricted to the turbine locations and will comprise the following:

1. The extent of the excavation will be marked out and will include an allowance for trimming the sides of the excavation to provide a safe working area and slope batter;
2. Any existing subsoil found within the footprint of the turbine base will be excavated out during formation works at the adjacent crane hardstand area. The excavation works will be carried out using hydraulic excavators where surplus subsoil material will be transported to the on-site deposition areas via articulated dumper trucks or tractor and trailer for subsequent reuse in the permanent reinstatement of the borrow pit;
3. Blasting at turbine locations and hardstands may be necessary to enable excavation of the rock if encountered at less than 3m depth. Any blasting will be carried out by a suitably qualified specialist under licence with a suite of mitigation measures in place. Blasting, and mitigation measures associated with the process, is discussed in further detail in **Chapter 9 Land and Soils**.
4. Standing water in turbine base excavations is likely to contain an increased concentration of suspended solids. Dewatering of turbine base excavations can result in significant flow rates to the drainage and settlement system if high-capacity pumps are used. To avoid the need for pumping, it is proposed to provide drainage channels from the excavations to prevent a build-up of water. Where this is not feasible, temporary storage will be provided within the excavations and dewatering carried out at a flow rate that is within the capacity of the settlement ponds;
5. The excavated surface will be levelled and adequate drainage measures will be put in place along with suitable set back areas to facilitate placing of stone and ultimately the erection of shuttering for the turbine base;
6. If poor ground conditions are encountered during excavation and a significant depth to sub-formation is required, a piled foundation may be considered. A piled foundation requires the use of a piling machine equipped with an auger drill to rotary bore a number of holes around the area of the turbine base to the sub-formation depth determined at construction stage. Once all the holes have been bored, reinforcement steel is inserted into each with concrete poured afterwards. Piling if required, will be limited and localised.
7. Suitable stone aggregate will be used to form a solid level working foundation surface. The stone will be rolled and compacted to a suitable formation level;
8. Shutters and steel reinforcement will then be put in place and the foundation of the turbine will be prepared for pouring of concrete;
9. A layer of concrete blinding approximately 75mm thick will be laid directly on top of the newly exposed formation, tamped and finished with a screed board to leave a flat level surface. The concrete will be

protected from rainfall during curing and all surface water runoff from the curing concrete will be prevented from entering surface water drainage directly;

10. High tensile steel reinforcement will be fixed in accordance with the design drawings and schedules. The foundation anchorage system will be installed, levelled and secured to the blinding using steel box section stools;
11. Ductwork will be installed as required, and formwork erected around the steel cage and propped from the backside as required;
12. The foundation anchorage system will be checked both for level and line prior to the concrete being installed in the base. These checks will be passed to the turbine supplier for their approval;
13. Ready-mix concrete will be delivered to each turbine base by a fleet of ready-mix concrete trucks via the internal access tracks. Concrete will be placed into each base by means of a concrete pump where vibrating pokers will be used to ensure that full and proper compaction of the concrete around the reinforcement in the turbine base has been made. Upon completion of the concreting works the foundation base will be covered and allowed to cure;
14. Steel shutters will be used to pour the circular chimney section;
15. Following curing, the shuttering around the turbine base will be struck and removed;
16. Earth wires will be placed around the base; and,
17. The foundation will be backfilled with a cohesive material, where possible using the material arising during the excavation and landscaped using the vegetated soil set aside during the excavation. A gravel footpath will be formed from the access track to the turbine door and around the turbine for maintenance.

Figure 3-7: Typical construction of a wind turbine base

3.6 Internal Site Cables

A network of underground cabling serving each turbine with electrical power and signal transmission will be installed within the site. The distribution system will electrically connect the wind turbines to the onsite substation. Cable jointing bays will be required to allow cables to be jointed from the turbines to the onsite substation.

Cabling on site is likely to consist of single or twin cable trenches for open ground sections and for trenches within internal access tracks. A cable marker post will typically be installed on top to protect and identify the cable trench underneath. The typical build up for the internal site cable trenches will consist of selected excavated backfill on top of bedding material. The minimum cover depth over the ducts will be 750mm which is measured from the top of the cable duct to existing ground level. Where ducting is within internal access tracks; the cable trench will be backfilled with lean-mix concrete to protect ducting from being damaged by heavy axle loads that will pass above. The excavated material generated from the trenches will be reused as backfill where possible or alternatively it will be deposited within the proposed on-site borrow pit as part of their reinstatement.

Where an open drain or watercourse is encountered during the installation of the internal site cable trenches; the cable trenches will cross the open drain or watercourse within the track carriageway via new or existing track crossing points to minimise the requirement for in-stream works. Marker tapes of non-corrodible material in bright red and yellow colour will be placed within the trench after backfilling for identification and safety purposes in accordance with ESB Networks guidelines. An earth berm will be placed over the cable trench with a marker post installed on top in a secure and robust manner to prevent the post from being damaged by animals or prevailing ground conditions. Cable marker posts will either be made of concrete, recycled plastic, or timber material. Each marker post will contain appropriately worded warning signage highlighting to persons the presence of high voltage electricity cables underneath. Refer to Planning Drawing 22156-MWP-00-00-DR-C-5407 for further details.

3.7 Grid Connection Route

The grid connection route consists of an underground electrical cable from the wind farm site to a new loop-in substation to facilitate a new connection to an existing overhead 110kV line approximately 1.5km north of the main wind farm site. The overall 110 kV connection cable route will be approximately 1.5km and is outlined below in **Figure 3-8**.

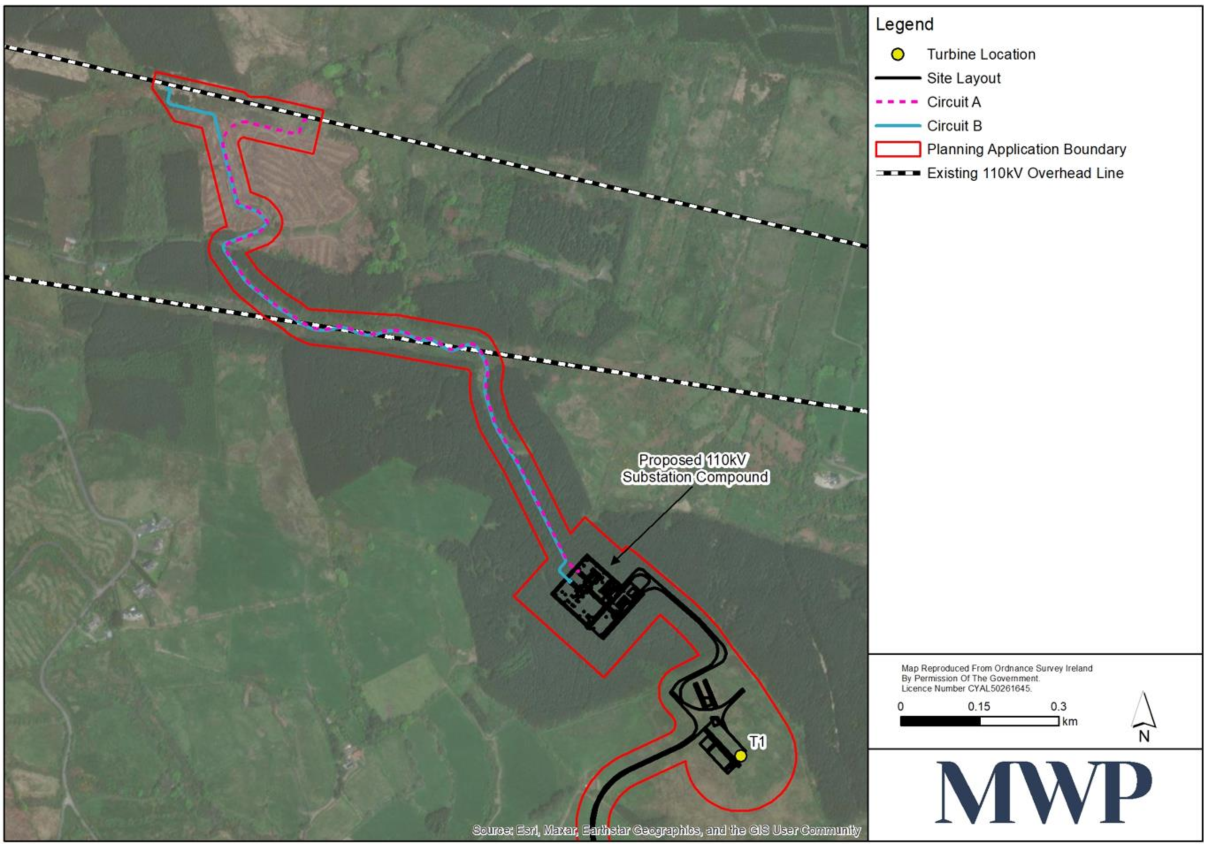

Figure 3-8: Grid Connection Route

3.7.1 Excavation and Duct Installation

The proposed grid connection cable will be carried within a single cable trench as shown on **TLI Drawing No. 05923-DR-101**.

The installation of the grid connection involves the following process.

- Prior to works commencing the area where excavations are planned will be surveyed and all existing services will be confirmed. All relevant bodies i.e., ESB Networks, EirGrid, Gas Networks Ireland, Eir, Clare County Council, etc. will be contacted and drawings for all existing services sought. A road opening licence will be obtained where required from Clare County Council for the relevant road section. All plant operators and general operatives will be inducted and informed as to the location of any services.
- Prior to works commencing a dilapidation survey will be carried out photographing and noting any existing damage or defects to road surfaces. A copy of this survey will be submitted to Clare County Council prior to works commencing.

- Prior to works commencing the route will be inspected and marked out on the ground. Standard good practice preparatory measures are then put in place along the extent of the route. This will include any required warning notices, temporary barriers, etc.
- Prior to works commencing a traffic management plan will be prepared by the appointed contractor and agreed with Clare County Council. A traffic management plan is included in Appendix 2D of Volume III of the EIAR.
- During construction works, the trench will be excavated down through the existing stone in the road/topsoil using an excavator machine (or down through soil in the sections). As stone fill/topsoil is removed it is temporarily stockpiled adjacent to the trench for re-use in backfilling. In some instances, some soil or unsuitable material may be encountered in the trench and this is removed from site and brought to an appropriate licensed facility for disposal.
- The trench is then prepared to receive concrete bedding and surround for the ducts. The ducts are surrounded by concrete with adequate cover over the duct.
- Once the concrete is set, appropriate imported stone material is placed over the concrete surround and filled back up to the top of trench. Suitable warning tapes will also be installed in the trench. Once the trench is filled, the trenching and ducting process will move along the route in planned stages.
- Where the route is within the public road, the trench surface receives a temporary surface dressing of either spray and chip or macadam. Once the overall scheme is completed, the relevant area of the grid connection route and associated road will receive a new permanent macadam finish as agreed with Clare County Council. A new unbound stone access track will be constructed over the route which is not within the public road.
- Joint bays will be installed where required along the grid connection route.
- The as-built location of the ducting will be surveyed using a total station / GPS. Marker posts will be installed along the grid connection route to also denote the location of ducting on the ground.
- A condition survey will be carried out on the public road impacted by the grid connection route, both pre and post construction.

3.7.2 Grid Construction - Watercourse Crossings

The 110kV grid connection route crosses 1 watercourse. The crossing is within a conifer forestry area.

An access track will be provided over the cable and the crossing point of the cable will coincide with the crossing point of the proposed access track. A new bottomless culvert will be installed to carry both the access track and the cable over the crossing. No instream works will be required. Details of the crossing methodologies for the track and cables within the wind farm are provided in Section 3.13.3. The same methodology will be applied for this cable crossing.

Overall, in-stream works are not required along the proposed grid connection route.

3.7.3 Grid Connection Construction - Land Drainage Ditches

Where land drains are encountered on the proposed grid connection route there are two scenarios, as follows:

1. If there is adequate cover over the drain crossing, then the new ducts and trench will pass over the drain without interruption to the drain. No works will be required within the drain at these locations. The trench at these locations will be installed in the existing access track.
2. In the event where there is insufficient cover over a drain crossing point, the new grid connection route will have to be installed underneath the existing drain crossing. To do this the following approach is adopted:
    - The drain is blocked upslope of the crossing and a sump is formed using sandbagging and stable clay soil material. This sump will accumulate water flow in the drain and will facilitate the use of a 50mm or 100mm submersible pump to over pump (fluming) the drain water across the track and back into the drain on the down flow section below the track.
    - Two silt fences and filters will be put in place on the downslope of the crossing point to prevent siltation/sedimentation. Once the sump and over-pumping mechanism is in place, then the service trench excavation will progress.
    - A section of drain crossing (pipe or stone culvert) is temporarily removed to allow the trench and duct to continue. The duct will pass under the drain and once in place it will be surrounded with lean mix concrete and then the trench will be backfilled with suitable stone from excavations or imported.
    - The drain will then be put back in place, surrounded with stone/lean mix concrete and the track restored to its finished level. The over-pumping measure can then be removed and normal drain flow resumes. The duct/trench work can then progress over the remaining length of the access track.

3.7.4 Grid Connection Construction – Existing and Proposed Underground Services

All relevant bodies i.e., ESB Networks, EirGrid, Gas Networks Ireland, Eir, Clare County Council etc. will be contacted and drawings for all existing underground services along the grid connection route sought. Any underground services encountered will initially be surveyed for levels to determine if there is adequate cover available for ducting to pass over these services. A minimum clearance of 300mm is required from the bottom of the ducting to the top of any underground service as per ESB Networks requirements. If this clearance cannot be achieved, the ducting will pass below the service with a minimum 300mm clearance maintained from the top of the ducting to the bottom of the service.

If the required separation distances cannot be achieved by either going above or below the underground service, then a number of alternative construction options are available as outlined in the previous sections for watercourse and drain crossings.

The proposed underground grid connection route, refer to **Figure 3-8**, is approximately 1.5km in length between two radial UGC circuits, from the proposed Ballycar Wind Farm 110kV Substation location, carrying towards the interface points where the circuits split between Circuit A and Circuit B. It is proposed to transition from an overhead line (OHL) to UGC at two tower locations. These locations have been identified along the Ennis – Ardnacrusha 110kV overhead line from a technical perspective. The identified locations will be mid span between Polesets 34 and 37 within the Northern periphery of the development site.

The exact location of the underground HV ducting may be subject to minor modification following confirmatory site investigations, to be undertaken prior to construction and following consultation with Clare County Council and all other relevant stakeholders, having regard to all environmental protection measures outlined in the planning application and accompanying technical reports. Any such minor modification will be within the planning boundary.

3.7.5 Grid Connection Construction - Joint Bays and Communication Chambers

Joint bays are pre-cast concrete chambers that will be required along the grid connection route over its entire length. They are required to join cables together to form one continuous cable. They will be located at various points along the grid connection route approximately every 500 - 1,000 metres depending on gradients, bends etc. It is proposed to install approximately 4 no. joint bays and communication chambers along the proposed grid connection route.

Joint bays for the 110kV gridline on this project will not be located in public roads. They will be located in existing forestry and forestry tracks along the proposed grid line.

The joint bays and communication chambers will be either precast or cast *in situ*. In order to place the boxes, the area of excavation will first be marked out on the ground and any necessary preparatory protection measures put in place to avoid any runoff or loss of soil materials. These include appropriate siltation measures (silt fences, check dams etc.).

The material excavated from the joint bay chambers will be removed from the area to the onsite deposition areas. Prior to the chamber being installed in a compacted layer of suitable stone or lean mix concrete, appropriate material will be placed in the excavation to a level surface. The boxes are then positioned *in situ* and backfilled around them with imported crushed stone material. The precast concrete joint bay chamber cover is then put in place. Figure 3-9 shows a typical joint bay installation.

Figure 3-9: Typical joint bay construction

3.8 Substation Compound and Buildings

This section describes the construction methodologies that will be used for both the EirGrid and Independent Power Provider (IPP) substation buildings as well as the substation compound.

The proposed works will comprise the following:

- Prior to construction, interception drains will be installed upslope of the proposed substation compound to intercept any existing overland flows (clean water) and convey it downslope to limit the extent of surface water coming into contact with the works. The clean water conveyed will be discharged via a level spreader downslope of the works over existing vegetation.
- The area of the substation compound will be marked out using ranging rods or wooden posts and the soil stripped and removed to a temporary storage area (in development footprint) for later use in landscaping. All remaining excavated material will be brought to the on-site borrow pit / storage areas for final deposition. The area will be surveyed and all existing services will be identified. All plant operators and general operatives will be inducted and informed as to the location of any services.
- Perimeter drains will be installed or upgraded to collect surface water run-off from the substation compound which will include the installation of check dams, silt traps and level spreaders to cater for surface run-off.

- Following the installation of drainage, a cut-fill earthworks operation will be carried out to provide a level platform to facilitate the construction of the substation buildings and electrical equipment.
- All soils on the substation site will be removed and replaced with site won compacted crushed rock or granular fill.
- Formation of the substation compound will be achieved where the compound will be constructed with compacted layers of suitable hardcore.
- The foundations for both substation buildings will be excavated and appropriately shuttered. Reinforced concrete will be laid over it.
- The blockwork walls for each building will be built up from the footings to DPC level and the floor slab constructed, having first located any ducts or trenches required by the follow on mechanical and electrical contractors.
- The blockwork will then be raised to wall plate level and the gables and internal partition walls formed. Scaffold will be erected around the outside of the two buildings for this operation.
- The concrete roof slabs will be lifted into position using an adequately sized mobile crane.
- The construction and components of the substation buildings will be to EirGrid and ESB Networks specifications.
- The timber roof trusses at each building will then be lifted into position using a telescopic loader or mobile crane depending on site conditions. The roof trusses will then be felted, battened, tiled, and sealed against the weather.
- Installation of a domestic wastewater holding tank will take place to hold effluent from the toilets within the substation buildings.
- A Class 1 full retention oil separator will be installed to collect and treat oil spills within the substation compound.
- Installation of a rainwater harvesting tank will take place to collect rainwater from the roofs of the substation buildings for toilet flushing and hand washing.
- Civil works associated with the construction of the transformer bund, equipment plinths etc. within the substation compound will commence.
- Civil works associated with construction of underground cable ducts and trenches within the substation compound will commence.
- The installation of electrical equipment within the substation compound and buildings including transformers, busbars, circuit breakers, cable supports, switchgear, panels etc. and all associated cabling will occur.
- The installation of palisade fencing and associated gates to the perimeter of the substation compound will proceed.

Figure 3-10: Typical substation building and compound

3.9 Permanent Meteorological Mast

A permanent meteorological mast is proposed for the site to monitor the wind regime while the wind farm is in operation. The mast will be located adjacent to the turbine access track at the western side of the site. Appropriate control measures, including berms will be installed to protect adjacent water courses. The meteorological mast will be installed to a height of 90m which will be representative of the hub height of the turbines. The meteorological mast will be surrounded by a galvanised steel palisade fence, 2.4m in height. Details of the meteorological mast are shown in Planning Drawing 22156-MWP-00-00-DR-C-5404. Excavated material will be reused for backfill/adjacent landscaping or will be relocated to the on-site deposition areas.

Figure 3-11: Typical meteorological mast on a wind farm

3.10 Temporary Site Construction Compound

The temporary site construction compound will be used for the construction phase of the wind farm. The compound will have dimensions of 100m x 50m as shown on Planning Drawing 22156-MWP-00-00-DR-C-5408. All excavated material will be taken to the on-site deposition areas.

The exposed surface will be levelled out by cutting and filling and will be overlain with a layer of crushed stone from the proposed on-site borrow pit. The finished surface will be formed with a layer of Clause 804 or similar aggregate imported from a local quarry. The site compound will be graded and compacted out before the welfare container facilities are installed.

The compound will be constructed early in the development to provide site offices and accommodation for staff and for the delivery of materials. Any surface water management, bunding, waste management measures etc.

will also be put in place at the outset. Site security will be put in place adjacent to the entrance and will be maintained throughout all phases of the construction work. The compound will be in place for the duration of the construction phase and will be removed once commissioning is complete.

Areas within the compound will be constructed as access tracks and used as vehicle hardstanding during deliveries and for parking;

1. A bunded containment area will be provided within the compound for the storage of lubricants, oils, and site generators etc.
2. The compound will be fenced and secured with locked gates.
3. During the construction phase, a self-contained port-a-loo with an integrated waste holding tank will be used on site for toilet facilities. This will be maintained by the service contractor on a regular basis and will be removed from the site on completion of the construction phase.
4. Upon completion of the construction phase, the compound will be decommissioned by backfilling the area with the material arising during excavation, landscaping with topsoil as required.

Figure 3-12: Typical temporary site construction compound on a wind farm

3.11 Borrow Pit

The borrow pit proposed within the site will be used to obtain approximately 165,000m^3 site won stone aggregate for use in the construction of the wind farm. The volumes are summarised in **Table 3-2**. This borrow pit will be located within the northern area of the site where it will be used as a source of hardcore for the construction of access tracks, crane hardstands, substation and construction compounds. The proposed location of the borrow pit is shown on Planning Drawing 22156-MWP-00-00-DR-C-5411.

Prior to felling of trees over the area of the proposed borrow pit; an interceptor drain will first be excavated upslope to intercept existing overland flows and divert them around the borrow pit prior to discharge via a buffer zone on the downslope side. Any subsoil material overlying the rock will be excavated and stockpiled. The stockpile will be sealed, and a perimeter drain installed to intercept any run-off so that it can be discharged through an appropriately designed silt trap.

Standing water, any surface water runoff or water pumped from within the borrow pit is likely to contain an increased concentration of suspended solids. Runoff or pumped water from the borrow pit will be isolated from the clean catchment runoff by means of a series of open drains that will be constructed within the area. These drains will be of check dams that will attenuate the flow and provide storage for the increased runoff from exceptional rainfall events. The settlement ponds have been designed to a modular size where if larger areas of runoff must be catered for at a single discharge point the size of the settlement pond will be increased pro rata.

Large volumes of groundwater are not anticipated within the borrow pit. The proposed borrow pit is at a high point within the site with ground falling away to the west. A high groundwater table at an elevated site with a fall in ground adjacent to the site is not anticipated. The proposed base level of the borrow pit is 240mAOD. The base level of the existing Ballycar Quarry, to the north of the site is approximately 165mAOD. The existing quarry is likely to have already depressed the ground water table in the area to a level less than the proposed borrow pit base level.

Inspections of the borrow pit will be made by a geotechnical engineer through regular monitoring of the opening works. The appointed contractor will review work practices at the borrow pit. Where periods of heavy rainfall are expected, work will be stopped to prevent excessive runoff from being generated. Excavators will extract the stone using buckets and a ripper attachment, or rock-breaker attachments may be utilised in the borrow pit location. It is expected that 30-60 Ton 360° excavators will be utilised in tandem in the extraction of rock from the borrow pit. The larger excavators will extract rock from the face and floor of the excavation using digging buckets and rock rippers and will be assisted by smaller excavators, removing rock as it is broken, stockpiling locally within the excavation as well as loading articulated dumper trucks removing rock as required for distribution within the wind farm site. The sides of the excavations will be battered back to a suitable angle of repose to be determined by the nature of the rock present. Regular examination of these batters will be carried out by a geotechnical engineer to assess the stability of the rock face and slopes on an ongoing basis. There will be no public access permitted to or within the borrow pit. Secure edge protection and fencing will be erected around the borrow pit with warning signage erected. A berm will be constructed as required, at the leading edge to ensure that articulated dumper trucks are stopped at a safe distance from the edge of the borrow pit during loading of extracted stone aggregate.

Blasting at the borrow pit may be necessary to enable excavation of the rock in the borrow pit and increase production rates to match the construction programme. Any blasting will be carried out by a suitably qualified specialist under licence. Blasting, and mitigation measures associated with the process, are discussed in further detail in Chapter 9 Land and Soils and Chapter 10 Noise and Vibration of this EIAR.

On completion of extraction activities at the borrow pit; it will be used for the permanent storage of some of the excavated material from the turbine bases, crane hardstands, internal access track construction and other associated infrastructure. Following reinstatement, a decision on the replanting of the borrow pit with commercial trees will be made based on suitability.

3.12 Spoil Management and Material Volumes

3.12.1 Excavated Spoil Storage

Excavated spoil will be reused for backfilling, landscaping, and restoration around wind farm infrastructure such as turbines and hardstands.

The calculated volume of excavated material is summarised in Table 3-2.

Dedicated spoil storage areas and a borrow pit are proposed within the site. These will be used for generating material for the construction of access tracks and hardstands and for spoil storage. The proposed locations for the borrow pit and spoil storage are shown on Planning Drawing 22156-MWP-00-00-DR-C-5411.

Spoil will also be stored around the turbines to a maximum height of 1m. The felled areas around the turbines have been identified as a potential additional area that will be used to store material; however, priority will be given to restoration of the borrow pit and the dedicated spoil storage areas.

Berms will be formed along sections of access tracks and hardstands that will act as a physical edge protection measure to prevent vehicles falling off where a drop off greater than 1m exists from the track / hardstand edge. Spoil generated onsite will be used to create these berms.

A summary of the construction material and spoil storage volumes are shown in Table 3-2.

Drainage and siltation control measures will be put in place in all spoil storage areas. This will include a dedicated drainage network, temporary silt fences and settlement ponds designed to cater for the size of each storage area. Further details of the drainage philosophy that will be applied as well as siltation control systems and attenuation systems is given in Section 3.13 of this report.

Table 3-2: Spoil Excavation and Construction Material Volumes

Excavations		
Total Excavation Volume	**m^3**	**418,300**
Excavated Material Stored or Reused Onsite	m^3	402,000
Excavated Material Removed from Site	m^3	16,300*
Imported Material		
Total Volume of Stone Required	**m^3**	**265,150**
Imported Stone	m^3	100,150

Site Won Stone	m^3	165,000
Concrete for bases (12 @ 900 m^3 each)	m^3	10,800
Concrete for substation and met mast foundations	m^3	250
Concrete for cable route	m^3	281,450
Reinforced steel for turbine bases (12 @ 100 tonnes each)	tonnes	1,200

*This material will be reused on site as preference in trackside berms etc. It is however included in the table above as material to be removed from site as a precautionary measure.

3.12.2 Temporary Storage of Excavated Material

No permanent stockpiles will be left on site after the completion of the construction phase works with the exception of material placed in the designated permanent storage areas. After completion of the turbine base reinstatement works all remaining stockpiles will be removed for permanent disposal at the proposed deposition areas within the site.

Any materials excavated during the construction phase which are to be used in the site reinstatement and landscaping process shall, in the first instance, be stored on site in an environmentally safe manner that will not result in the pollution of waters or the smothering of ecologically sensitive habitats.

The following principles will be adhered to when considering the temporary storage of excavated materials;

- Spoil disposal will take place within a 30m radius of each structure.
- Preparation of the spoil disposal site will involve the removal of the “top mat” which will be transplanted to a suitable area and maintained for re-use during restoration operations.
- Spoil will be deposited, in layers of 0.5m and will not exceed a total thickness of 1m.
- Spoil will only be deposited on slopes of less than 5 degrees to the horizontal and greater than 10m from the top of a cutting. The exact location of such areas will be confirmed on consultation with the geotechnical engineer.
- Once reinstatement is complete the disposal sites will be re-vegetated with the “top mat” removed at the commencement of disposal operations.
- Upon commencement of the restoration phase, guidance from a suitably qualified environmental professional will be sought to confirm the methodology and programme.

It is proposed that any temporary onsite stockpiles of soil, rock and other excavated material shall be removed and utilised in the site reinstatement programme to infill any excavated areas which will then be mounded and capped with sod prior to the completion of works.

3.12.3 Permanent Deposition Areas

Three deposition areas are proposed on the site. The borrow pit will act as a deposition area following extraction of the rock. Two other deposition areas are proposed adjacent to the proposed borrow pit.

On completion of extraction activities in any cell at the borrow pit; the pit will be used for the permanent storage of the excavated spoil material from the turbine bases, crane hardstands, substation and internal access track construction. The proposed deposition areas will be subdivided into a series of cells. Each cell will be bunded by an embankment of engineered fill material capable of allowing a tracked excavator to move between the cells during deposition activities. The size of each cell will be dictated by the maximum working length of the excavators working the borrow pit. Each cell will be bunded on all downslope sides. The bund will be of adequate strength to retain the spoil stored within each cell.

Water build up within the disposal area will not be permitted. Water will free drain to the sump of the pit from where it will be discharged utilising a 6” pump discharging to a settlement pond constructed for this purpose. Permanent design features are proposed to allow drainage function correctly over the deposition areas. Upon completion of each cell the surface of the deposited spoil will be profiled to a gradient not exceeding 5%. Following completion, a decision on the replanting of the deposition areas with commercial trees will be made based on suitability.

3.13 Site Drainage

3.13.1 Design Principles

The site drainage system was designed integrally with the wind farm infrastructure layout as a measure to ensure that the proposal will not change the existing flow regime across the site. It will not cause a deterioration of water quality and will safeguard existing water quality status of the catchments identified in Chapter 8 Water and as assigned by the EPA in line with the Water Framework Directive.

A fundamental principle of the drainage design is that clean water flowing in the upstream catchment, including overland flow and flow in existing drains, is allowed to bypass the works areas without being contaminated by silt from the works. This will be achieved by intercepting the clean water and conveying it to the downstream side of the works areas either by piping it or diverting it by means of new drains or earth mounds.

This process will cause the normally dispersed flow to be concentrated at specific discharge points downstream of the works. To disperse this flow, each clean water drain will be terminated in a discharge channel running parallel to the ground contours that will function as a weir to disperse the flow over a wider area of vegetation. An alternative method is to allow the water to discharge through perforated pipes running parallel to the ground contours. Both methods will prevent erosion of the ground surface and will attenuate the flow rate to the downstream receiving waters. The specific drainage measures to be used at each location are shown on the drainage drawings included with the planning application. The clean water interceptor drains, or earth mounds are all positioned upslope to prevent any mixing of the clean and dirty water. The outflow from these drains is then piped under the access track at suitable intervals and at low points depending on the site topography.

Separating the clean and dirty water will minimise the volume of water requiring treatment. The dirty water from the works areas will be collected in a separate drainage system and treated by removing the suspended solids before overland dispersal. Dirty water drains will be provided on one or both sides of the access tracks and along the periphery of the turbines, crane hardstands, substation compound, met mast, borrow pit, deposition areas and the temporary site construction compound.

The treatment system will consist of a series of settlement ponds at designated locations throughout the site (refer to Section 3.13.4.11). The outflow from the treatment system will be dispersed over vegetation in the same manner as the clean water dispersion and will become diluted through contact with the clean water runoff in the buffer areas before eventually entering the downstream watercourses.

The clean water interceptor drains, or earth mounds are all positioned upslope to prevent any mixing of the clean and dirty water. Refer to Figure 3-13. The outflow from these drains is then piped under the track at suitable intervals and at low points depending on the site topography. In the illustration 'dirty water' drains collect all incident rainwater that falls on the infrastructure. This water then drains to settlement ponds for removal of sediment before it is discharged via overland dispersal to the downstream watercourse.

The site drainage layout is presented in Planning Drawings 22156-MWP-01-00-DR-C-5006 to 22156-MWP-11-00-DR-C-5006 with further drainage details presented in Planning Drawing 22156-MWP-00-00-DR-C-5406. The drainage layout is overlaid on background OSI mapping in the A1 drawings that accompany the planning application.

Figure 3-13: Separation of Clean and Dirty Water Drainage on A Wind Farm Site

3.13.2 Flood Attenuation

The creation of impermeable areas within a development site has the effect of increasing rates of runoff into the downstream drainage system and this may increase flood risk and flood severity downstream. This applies particularly to urban areas that drain to closed pipe systems which do not have the capacity to cater for increased hydraulic loads. The proposed development is located within a large rural catchment with an open drainage system. The footprint of the impermeable areas and the associated increase in runoff rate is very small in the context of the catchment size and therefore represents a negligible increase in downstream flood risk. However, it is proposed to provide some attenuation to limit the flow rate into the settlement ponds during high intensity storm events so that they do not become overloaded. This will also attenuate the flow to the downstream watercourses.

The volume of water requiring attenuation relates to direct precipitation on the access tracks and other infrastructure footprint only. The developed surfaces have some permeability and this reduces the attenuation requirement. Conventional attenuation systems use proprietary flow control units but these can become blocked with debris and vegetation and require regular maintenance. They are, therefore, not appropriate for use within agriculture/forestry environments or where long-term routine maintenance would not be practical.

It is proposed to provide temporary storage within the drainage channels by creating stone dams within them at regular intervals. The spacing of the dams is typically 100 metres but depends on the channel slope, with steeper channels requiring shorter intervals. The dams, which are constructed with small sized aggregate held in place by large aggregate, also reduce the flow rate through the drainage system and are an effective means of providing flow control. Silt fences will also provide storage and flow control.

3.13.3 Drainage / Stream Channel Crossings

No work will take place within the 50m buffer zones of EPA mapped watercourses identified in **Chapter 8 Water** of the **EIAR**, except for drainage / stream crossings, associated track construction and minor works. Working near watercourses during or after intense or prolonged rainfall events will be avoided and work will cease entirely near watercourses when it is evident that there is a risk that pollution could occur. All construction method statements will be developed in consultation with Inland Fisheries Ireland and in accordance with the details in the CEMP accompanying this application.

The selection criteria for crossing natural / artificial drains and streams within the site were:

- Avoid crossing drains or streams at acute angles where possible;
- Avoid meanders at the crossing location;
- Cross where foundations could be constructed without excess excavation;
- Consider vertical alignment requirements.

Where crossings are cut into relatively deep channels, these channels would require significant upfill to maintain vertical alignment criteria for turbine deliveries along access tracks. Clear span pre-cast concrete culverts are advantageous in several manners for this type of installation. As spans increase, the height can increase accordingly allowing significant light penetration under the culvert. The increase in height is complimentary to the vertical alignment requirements for access track design. Refer to **Planning Drawing 22156-MWP-00-00-DR-C-5412** for further details.

The design of a clear span pre-cast concrete culvert crossings will ensure that:

- The existing channel profile within the watercourse is maintained;
- Gradients within the watercourse are not altered;

- There is unrestricted passage for all size classes of fish by retaining the natural watercourse stream / riverbed;
- There are no blockages within the watercourse. The large size of a clear span culvert allows for the passage of debris in the event of flood flow conditions;
- The watercourse velocity is not changed;
- The clear span of a culvert will ensure that the existing stream / riverbank is maintained during construction which will in turn avoids the occurrence of in-stream works.

Construction of any clear span crossings will be supervised by the Construction Manager, a suitably qualified engineer, the project manager, and the Environmental Manager in accordance with Inland Fisheries Ireland *"Guidelines on Protection of Fisheries During Construction Works in and Adjacent to Waters, 2016"*.

Typically, the proposed installation works for a clear span pre-cast concrete culvert will comprise the following:

1. Upon design approval, the extent of the excavations required for the culvert foundations at either side of the watercourse will be marked out. The foundations are to be set to an agreed minimum distance by IFI from the existing watercourse so as not to impact on the riparian habitat. Health and safety measures such as lifebuoys on stakes will be installed and where appropriate life jackets will be provided to persons working near the watercourse;
2. Appropriate environmental control measures such as silt curtains, silt traps, mats etc. will be erected on both sides of the watercourse. These environmental control measures will reduce the potential for sedimentation of the watercourse;
3. Excavators will begin to excavate the foundations to formation level where all excavations will be battered back to a safe angle of repose (minimum slope angle of 45°) and comply with the final Construction and Environmental Management Plan (CEMP) to be produced by the appointed contractor for the proposed development. All excavation works will stop in the event of heavy rainfall.
4. All excavated material will be transported to the on-site deposition areas located outside of the 50m hydrology buffer zone and at the proposed borrow pit. Some of the excavated material will subsequently be reused as backfill around the culvert abutments and structure upon installation. Bare ground will be minimised;
5. Once formation is reached at suitable ground conditions; steel reinforcement and shuttering will be installed. The culvert abutments will be prepared for the pouring of concrete by dewatering standing water within the excavations, which is likely to contain suspended solids, via a pump to an adequately sized settlement pond located outside of the 50m hydrology buffer zone. The standing water will be treated through the settlement pond and clean filtration stone prior to outfall over vegetation away from the watercourse;
6. Ready-mix concrete will be delivered to the culvert abutments by ready-mix concrete trucks and placed into each abutment by means of excavators. During the concreting works the watercourse will be temporary covered over with a tarpaulin to protect the watercourse from concrete spills. Upon completion the abutments will be covered and allowed to cure;
7. Following curing, the shuttering around the abutments will be struck and removed. A small temporary hardstand will be constructed so that a lifting crane, which will install the pre-cast concrete culvert components onto the abutments, can be set up;
8. Deliveries of the pre-cast concrete culvert components will arrive to site (see **Figure 3-14** and **Figure 3-15**). These components will be individually fitted and manoeuvred into position by the lifting crane

onto the concrete abutments. The components will be inspected to ensure that each unit is level and secure;

9. Backfilling on either side of the culvert will commence using excavated material, in particular larger rock of a uniform size will be placed along the edge;
10. The access track surface will be laid over the culvert structure using stone aggregate and compacted in maximum 250mm layers with the use of 10-20 Ton rollers. An internal cable trench will be installed within the carriageway of the culvert so that it can cross over the watercourse;
11. Vegetated soil bunds will be installed to divert dirty water generated on the section of track over the culvert crossing into the dirty water system outside of the 50m hydrology buffer zone. This will ensure that dirty water will not enter the clean watercourse;
12. Steel parapet railings and timber post and rail fencing will be installed at the sides and on the approaches to the culvert. This will prevent persons or vehicles falling into the watercourse while travelling across the culvert.

Figure 3-14: Typical clear span pre-cast concrete arch units in place over an existing watercourse

Figure 3-15: Typical clear span pre-cast concrete box culvert over an existing watercourse

Alternatively precast concrete or HDPE pipes may be used for crossing existing natural or artificial drainage / stream channels. All crossings will be designed for a minimum 1 in 200-year return rainfall event. The invert of the pipe is submerged approximately $^{1}/_{4}$ of its diameter below the original drainage bed. Where natural gradients allow, a nominal back fall in the pipe will be incorporated to prevent scour and promote the settling of natural material along the invert of the pipe. An example of a permanent drain crossing is illustrated in Figure 3-16. New turbine service tracks will be required to cross several minor drains within the site. All such crossings will be in accordance with this application and/or conditions attached to a grant of planning permission and agreed with the OPW and Inland Fisheries Ireland prior to construction.

Figure 3-16: Typical concrete pipe channel crossing

Figure 3-17 shows a typical measure to be put in place at drainage and watercourse crossings to ensure dirty water does not enter clean watercourses. Vegetated soil bunds will be used to divert dirty water generated on the section of access track over the crossings to the dirty water system. Alternatively silt curtains, as shown in Figure 3-18 will be placed along the tracks within the 50m buffer zone. These silt curtains will run longitudinal to watercourses with a layer of stone placed along the bottom to prevent any seepage if there is a risk of silted runoff. These silt curtains will also be used to reduce any risk of silted runoff at temporary local road widening locations.

Figure 3-17: Dirty water containment at watercourse crossings

Figure 3-18: Silt curtain containment along tracks near watercourses

3.13.4 Water Quality Management Systems

3.13.4.4 General

Sediment such as clay or silt can cause pollution during the construction phase of a civil engineering project due to the erosion of exposed soil by surface water runoff. The water quality management system has been prepared in order to control erosion and prevent sediment runoff during the construction phase of the proposed development. The implementation of sediment and erosion control measures is essential in preventing sediment pollution. The system was designed having regard to:

- Knowledge of the site's environmental conditions;
- Previous experience of environmental constraints and issues from construction of wind farms in similar environmental conditions;
- Technical guidance and best management practice manuals (see references).

The following site-specific information was used in the design of the drainage and treatment system:

- High resolution aerial photography;
- LiDAR ground surface information;
- Wind farm infrastructure layout (turbines, access tracks and ancillary development);
- Hydrology maps (watercourses and buffer zones);
- Soil and land use maps;
- Baseline water quality assessments; and
- Met Éireann extreme rainfall data.

The settlement ponds and check dams described in the following subsections provide the essential mechanism for the removal of silt from construction related runoff and the controlled return of the treated runoff to the downstream watercourses.

The drainage and treatment system will ensure that the construction and early post-construction phases of the proposed development will not create adverse effects on the aquatic environment. As a result there will be no significant adverse effects.

3.13.4.5 Construction Works Area

Runoff from the internal access tracks, hardstands and other wind farm infrastructure will be isolated from the clean catchment runoff by means of a series of open drains that will be constructed within the works areas. These drains will be directed to settlement ponds that will be constructed throughout the site, downhill from the works areas and as shown on the drainage layout planning drawings submitted with this application. Each drain will incorporate a series of check dams that will attenuate the flow and provide storage for the increased runoff from exceptional rainfall events. The ponds have been designed to a modular size to cater for a single turbine and hardstand area or a 1,200m^2 area of internal access track (240m).

Dewatering of turbine base excavations can result in significant flow rates to the drainage and settlement system if high-capacity pumps are used. To avoid the need for pumping, drainage channels from the excavations will be provided to prevent a build-up of water. Where this is not feasible, temporary storage will be provided within the excavations and dewatering carried out at a flow rate that is within the capacity of the settlement ponds.

Figure 3-19: Stone check dam with large aggregate on downstream side

3.13.4.6 Treatment Process

Contaminated runoff can be generated on the site access tracks, borrow pit, met mast, construction compound, substation site and turbine hard standing areas and is mainly due to excavation for the infrastructure or movement of delivery vehicles and on-site traffic.

Drains carrying construction site runoff will be diverted into settlement ponds that reduce flow velocities, allowing silt to settle and reducing the sediment loading. A modular approach has been adopted for the design of the settlement ponds which have been sized to cater for a catchment area of 1,200m^2 works area. This is equivalent to a access track length of 240m or the area of a typical turbine base.

The settlement ponds have been designed as a three-stage tiered system and this has been proven to work effectively on wind farm construction sites. The three-stage system also facilitates effective cleaning with minimal contamination of water exiting the pond.

The settlement ponds have been designed with regard to the following:

- Runoff flow rate for the modular catchment area;
- Met Éireann Extreme Rainfall Data (statistical rainfall intensity / duration table);
- Character of the impermeable areas (runoff coefficients); and
- Design particle size and density.

The treatment process consists of primary, secondary and tertiary treatment as follows:

- The *primary treatment* consists of a three-stage settlement pond with an over-topping weir at each stage. The first chamber will remove most of the sediment load, while the remaining two chambers will remove most of the remaining load.
- Before the water is released onto the existing ground surface, it passes through a *secondary treatment* system in the form of a graded gravel filter bed.
- The outflow from each interceptor is dispersed across a wide area of vegetation so that the velocity is minimised and the vegetation can filter out the residual sediment. This is the final or *tertiary* stage of the treatment process. Existing rills and collector drains within the tertiary treatment area are blocked off to prevent concentration of the flow.

Each sediment treatment unit has been micro-sited using the contour maps and aerial photos to avail of any locally level areas and to ensure that the outflow is spread over as much vegetation as possible before entering an aquatic buffer zone.

Settlement ponds will require inspection and cleaning when necessary. This will be carried out under low or zero flow conditions so as not to contaminate the clean effluent from the pond. The water level will first be lowered to a minimum level by pumping without disturbing the settled sediment. The sediment will then be removed by mechanical excavator and disposed of in areas designated for deposition of spoil. Settlement ponds will require perimeter fencing and signage to ensure that there are no health and safety risks.

Figure 3-20 below shows a well-constructed and maintained tiered settlement pond. This example is in an upland environment with significant ground surface slope and operates efficiently when well maintained. The design has been developed in conjunction with Inland Fisheries Ireland personnel and local authority engineers.

Figure 3-20: Multi-tiered settlement pond with stone filter

The design of the settlement pond system for the proposed development is detailed in the Planning Drawing 22156-MWP-00-00-DR-C-5406. The hydraulic design of the settlement ponds is outlined in Section 3.13.4.11.

The effluent from each settlement pond will discharge to an open channel, running parallel to the ground contours. This will form a weir that will overflow on its downhill side and disperse the flow across the existing vegetation. A minimum buffer width of 20m is specified between the overflow weir and downstream watercourses. Buffer widths are designed in line with *Forests and Water, UK Forestry Standard Guidelines (Forestry Commission, 2011)* on protection of watercourses during forestry operations and management. This method buffers the larger volumes of run-off discharging from the drainage system during periods of high precipitation, further reducing suspended sediment load to surface watercourses. The outflow weirs will not be located on slopes steeper than 3:1. Existing drains within the dispersion zone will be blocked off where necessary to provide additional attenuation, disperse the flow across a larger area of ground and prevent the re-concentration to a single flow.

3.13.4.7 Inspection and Maintenance

The drainage and treatment system for the proposed wind farm will be managed and monitored at all times and particularly after heavy rainfall events during the construction phase. The drainage and treatment system will be regularly inspected and maintained to ensure that any failures are quickly identified and repaired so as to prevent water pollution. A programme of inspection and maintenance will be designed and dedicated construction personnel assigned to manage this programme. A checklist of the inspection and maintenance control measures will be developed and records kept of inspections and maintenance works. These drainage controls will be kept in place during the operational phase of the wind farm until the vegetation is re-established.

3.13.4.8 Weather Monitoring

Weather monitoring is a key input to the successful management of the drainage and treatment system during the construction of the wind farm. This, at a minimum, will involve 24 hour advance meteorological forecasting (Met Éireann download) and on site rain gauge linked to a trigger-response system. When a pre-determined rainfall trigger level is exceeded (e.g., 1 in 5 year storm event), planned responses will be undertaken. These responses will involve control measures including the cessation of construction until the storm event has passed over and flood flows have subsided. Dedicated construction personnel will be assigned to monitor weather.

3.13.4.9 Water Quality Monitoring

A programme for water monitoring will be prepared in consultation with Inland Fisheries Ireland prior to the commencement of the construction of the wind farm. The plan will include monitoring of water during the pre-construction, throughout and post construction phases. For additional details please see Chapter 8 Water.

Further baseline water quality monitoring of all streams near the development site will be undertaken prior to construction to confirm existing conditions at the time of construction. This baseline data will include the main components of a full hydrograph for the streams including both high spate flow and base flow where possible.

Water quality field testing and laboratory analysis will be undertaken prior to commencement of felling and construction at the site. The monitoring programme will be subject to agreement with Clare County Council but will be based on the planning stage programme already outlined in the EIAR and CEMP and presented herein.

In order to ensure a comprehensive understanding of baseline water quality conditions including during low and high flow water conditions, upstream and downstream of the proposed development site, baseline water quality measurements will be undertaken prior to commencement of construction.

Analysis will be for a range of parameters with relevant regulatory limits along with Environmental Quality Standard's (EQSs).

The analytical determinants of the monitoring programme (including limits of detection and frequency of analysis) will be as per S.I. No. 272 of 2009 European Communities Environmental Objectives (Surface Waters) Regulations, the Surface Waters (Amendment) Regulations 2015 to 2023 and European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009 to 2018. The likely suite of determinants will include:

- pH (field measured);
- Electrical Conductivity (field measured);

- Temperature (field measured);
- Dissolved Oxygen (field measured);
- Total Phosphorus;
- Chloride;
- Nitrate;
- Nitrite;
- Total Nitrogen;
- Orthophosphate;
- Ammonia N;
- Biochemical Oxygen Demand; and
- Total Suspended Solids.

Continuous, in-situ, monitoring equipment will be installed at selected locations. The monitoring equipment will provide continuous readings for turbidity levels, flow rate and water depth in the watercourses.

During the construction phase of the project, water quality in the streams and outflow from the drainage and attenuation system will be monitored, field-tested and laboratory tested on a regular basis during different weather conditions. This monitoring, together with visual monitoring will help to ensure that the mitigation measures that are in place to protect water quality are working effectively.

During the construction phase of the project, the development areas will be monitored regularly for evidence of groundwater seepage, water ponding and wetting of previously dry spots, and visual monitoring of the effectiveness of the constructed drainage and attenuation system to ensure it does not become blocked, eroded, or damaged during the construction process.

3.13.4.10 Surface Water Quality and Cementitious Material

It is important to prevent raw cement from entering waterways within and near the proposed development.

Cement is required as a constituent for concrete. Concrete will be used for construction of the 12 no. turbine bases, the substation buildings, any culvert crossings and a small quantity will be needed for the meteorological mast foundation.

The primary method of reducing the potential impact from cementitious material on the hydrology of the wind farm site is the selection of ready-mixed concrete as opposed to site batching of concrete. Site batching requires the delivery and storage on site of significant quantities of raw cement. The chemical reactivity of cement is at its most vigorous in the early stages of its activation by water (hydrolysis, typically in the first 15 minutes). In the batching plant water is added to the cement at the correct water/cement ratio to fully activate the cement hydration process.

By removing cement in its raw state from the site the potential for a significant effect from hydrolysis of cement in the surrounding watercourses is eliminated. When ready-mixed concrete is used, the hydrolysis stage of the cement process has already been completed during the batching process and the chemical reaction undergoes a dormancy period during which it enters a plastic state. During this period the concrete is delivered and placed. After approximately 3 hours the cement in the concrete enters a third stage of the chemical process where it hardens, primarily due to the hydration of tricalcium silicate. This process increases in activity for approximately 12 hours and then decreases over the following 20 hours. After approximately 36 hours the concrete is considered to have set.

As part of the curing process the top exposed surface of poured concrete is covered in a curing blanket which eliminates the effect of rain washing down uncured cement from the top surface. Concrete placement for a truck load is typically complete within 3 hours of batching. It is normal for the truck operator to wash out the drum and chutes of the truck on site. This typically requires approximately 250 litres of water to complete. This concrete washout contains cement that has not fully completed the hydration process and as a result can have an elevated pH level (higher alkalinity).

Concrete truck washouts for the proposed development will be limited to washing down chutes only, reducing water volume to approximately 25 litres. The chute wash down area, which will retain the washout water, will be located within the construction compound and there will be no other chute wash down activity on any other part of the wind farm site.

Washout of concrete truck drums will be carried out at the source quarry. There will be no on-site batching of concrete; concrete requirements will be met by ready-mix suppliers.

The environmental manager will monitor the pH of the water in the chute wash out bund and will dose with CO_2 or acidic water from the drains until the wash out water achieves neutrality before discharge. Any overflow of water will be collected in the site compound drainage system which will be connected to a settlement pond for treatment prior to discharge to the external drainage system. The concrete sediment in the construction compound washout area will be removed at regular intervals.

3.13.4.11 Sediment Pond Design

Generally, high-intensity rainfall events have a short duration and lower-intensity rainfall events tend to have a longer duration. The Met Éireann Extreme Rainfall Data for the area demonstrate that the chance of occurrence of a storm event of a given duration decreases (higher return period) as intensity increases.

Table 3-4 shows the Point Rainfall Frequency and the total rainfall for each duration and return period in millimetres. Table 3-5 shows the same data converted to a rainfall rate in mm/hour. For a given return period the total depth of rainfall increases with storm duration but the actual rainfall rate over that period of time decreases. For the operation of the settlement ponds, it is the rate of flow rather than the total rainfall that is relevant. The return period is a measure of the likelihood that a storm of a particular intensity will occur in a given year. However, it is important to note that the chances of occurrence of a storm event with a particular return period are the same in each year but should on average occur once in that time period. For instance, a storm event with an intensity of 168mm/hour and a 5-minute duration would be expected to occur once in a 100-year period (the first row of Table 3-5). This is more appropriately expressed as an annual exceedance probability (AEP) of 1%; that is, it has a 1% chance of being equalled or exceeded in any year.

The runoff control measures for the wind farm site have been designed in the context of storm events of varying duration and intensity. The settlement ponds have been designed to cater for a maximum continuous flow rate associated with a medium-intensity rainfall event. Higher intensity runoff will be attenuated by the open drain collection system which provides temporary storage and limits the rate at which it enters the settlement ponds. This is achieved by the use of check dams within the open drains as described in Section 3.13.4.17. Longer duration storms of 24 hours or more, generally have very low intensity rainfall and are not critical in terms of the runoff rates that they generate.

The modular settlement ponds are designed to operate effectively for the runoff rate associated with a continuous high rainfall rate of 20 mm/hour. This is approximately equal to a 60-minute duration storm event with a 10-year return period (M10-60). These rates are taken from the Met Éireann Point Rainfall Frequency table for the site location.

The design runoff rate, used for the drainage design, is calculated using the Modified Rational Approach formula:

Q = $2.78\ C_v\ C_r\ I\ A_i$

where c_v is the volumetric coefficient which is dependent upon the catchment characteristics. It is assumed to be 0.84 for the winter profiles as stated in the Flood Studies Report,

c_r is the routing coefficient, the Wallingford recommends this to be 1.3.

i is the rainfall intensity in mm/hr, and

A_i is the impervious area drained surface area in ha. The percentage imperviousness (PIMP) obtained by dividing the total directly connected impervious area (A_i) by the total contributing area (A). PIMP is assumed to be equal to 70% for the hardcore surface. (A_i =PIMP x A)

For a rainfall intensity of 20mm/hour and a total drained area of 1,200m^2 the runoff rate is:

Q = 2.78 x 0.84 x 1.3x 20 x (0.70 x 1,200) litres/second

= 5.10 litres/second (0.0051m^3/s)

The main design parameter for the settlement pond is the water surface area. The required surface area is the design flow rate in m^3/s divided by the particle settlement velocity (V_s) in m/sec (Area = Q/V_s m^2)

The particle settlement velocity is determined using the formula derived by Stokes in 1851 as follows:

V_s = $2\ r^2\ (D_p - D_f)\ /\ (9\ n)$

where V_s is the particle settlement velocity (m/sec),

r is the radius of the particle (metres),

D_p is the density of the particles (kg/m^3),

D_f is the density of the fluid (kg/m^3), and

n is the viscosity of the fluid (0.000133 kg sec/m^2 @ 10°C).

For a particle density of 2,400kg/m^3, water density of 1,000kg/m^3 and particle diameter of 20 microns (radius=1*10^{-5} metres) the settlement velocity, V_s, is:

V_s = $2 \times (10^{-5})^2 \times (2{,}400 - 1{,}000) / (9 \times 0.000133)$

= $2 \times 10^{-10} \times 1{,}400 / 0.001197$

= 0.000234 m/sec.

The required settlement pond surface area is

A_p = Q/V_s

= 0.0051/0.000234

= 21.79m^2

Theoretically, the pond depth is not relevant but in practice, a minimum depth is required to ensure laminar flow and to allow temporary storage of settled silt. The modular settlement pond has been designed with a surface area of $24m^2$ (12m x 2m) and a depth of 1m. This is divided into three chambers of equal length and in practice, it has been found that most of the settlement occurs in the first chamber with very low turbidity levels being achieved in the final effluent. The design is conservative and therefore has sufficient redundancy to cater for occasional higher runoff rates or sediment loads.

3.13.4.12 Attenuation Design

For rainfall intensities above the design value of 20mm/hour, the excess runoff needs to be temporarily stored. The storage can be provided in the drainage channels by installing check dams at intervals along the channel as described below.

The storage volumes required for 10-year storm events of various durations are shown in Table 3-3. The volumes are based on a catchment area of $1,200m^2$ and a runoff coefficient of 0.70. The maximum storage volume required is $6.61m^3$ for 15 minutes storm duration. This is equivalent to 24 minutes of flow through the settlement pond at the design-through flow rate of 5.10 litres/second. The stored water will drain off gradually as runoff from the works area subsides. The storage volume represents an average depth of 0.055m in a 200m long, 0.60m wide open drain and can therefore be easily accommodated in the drainage system.

Table 3-3: Calculated Drainage Storage Volumes

Storm Event	Duration (minutes)	Rainfall rate (mm/hour)	Excess (mm/hour)	Storage Volume (m^3)
M10-60min	60	19.60	00.00	0.00
M10-30min	30	30.8	10.80	4.96
M10-15min	15	48.80	28.80	6.61
M10-10min	10	62.40	42.40	6.49
M10-5min	5	88.80	68.80	5.26

The ability to limit flow rates is fundamental to the control of sediment during extreme storm events. It is not proposed to use any proprietary mechanical devices for this purpose but instead to rely on the check dams to effectively limit flow rates to the required values. The check dams will be constructed with gravel or other suitable material and will be of sufficient length and height to provide the required attenuation rates. The number of dams will vary depending on the gradient of the drainage channel with higher gradients requiring a greater number of dams with larger dimensions. Their ability to retain water and release it slowly can be confirmed visually.

Table 3-4: Met Éireann point rainfall frequency table (rainfall depth in mm)

Storm Duration	Return Period (Years)							
	0.5	1	2	5	10	20	50	100
5 min	2.6	3.6	4.2	6	7.4	9	11.6	14
10 min	3.6	5	5.8	8.4	10.4	12.6	16.2	19.5
15 min	4.2	5.9	6.8	9.9	12.2	14.8	19	22.9
30 min	5.6	7.7	8.9	12.6	15.4	18.7	23.7	28.3
60 min	7.4	10.1	11.5	16.1	19.6	23.5	29.5	35
2 hours	9.8	13.2	14.9	20.6	24.8	29.5	36.7	43.2
3 hours	11.5	15.4	17.4	23.8	28.5	33.7	41.8	49
4 hours	12.9	17.2	19.4	26.3	31.5	37.1	45.8	53.5
6 hours	15.2	20	22.5	30.4	36.1	42.4	52	60.5
9 hours	17.9	23.4	26.2	35.1	41.5	48.5	59.2	68.5
12 hours	20.1	26.1	29.2	38.8	45.8	53.4	64.8	74.8
18 hours	23.6	30.5	34	44.8	52.6	61	73.7	84.7
24 hours	26.6	34.1	37.9	49.6	58.1	67.1	80.7	92.5

Table 3-5: Met Éireann point rainfall frequency table (rainfall intensity rate in mm per hour)

Storm Duration	Return Period (Years)							
	0.5	1	2	5	10	20	50	100
5 min	31.2	43.2	50.4	72.0	88.8	108.0	139.2	168.0
10 min	21.6	30.0	34.8	50.4	62.4	75.6	97.2	117.0
15 min	16.8	23.6	27.2	39.6	48.8	59.2	76.0	91.6
30 min	11.2	15.4	17.8	25.2	30.8	37.4	47.4	56.6
60 min	7.4	10.1	11.5	16.1	19.6	23.5	29.5	35.0
2 hours	4.9	6.6	7.5	10.3	12.4	14.8	18.4	21.6
3 hours	3.8	5.1	5.8	7.9	9.5	11.2	13.9	16.3
4 hours	3.2	4.3	4.9	6.6	7.9	9.3	11.5	13.4
6 hours	2.5	3.3	3.8	5.1	6.0	7.1	8.7	10.1
9 hours	2.0	2.6	2.9	3.9	4.6	5.4	6.6	7.6
12 hours	1.7	2.2	2.4	3.2	3.8	4.5	5.4	6.2
18 hours	1.3	1.7	1.9	2.5	2.9	3.4	4.1	4.7
24 hours	1.1	1.4	1.6	2.1	2.4	2.8	3.4	3.9

3.13.4.13 Access Track Construction

On-site experience in wind farm construction and forestry development across the country has shown that the single most effective method of reducing the volume of sediment created by construction is the finishing of all access tracks with high quality, hard wearing crushed aggregate such as basalt, granite or limestone laid to a transverse grade. When storm water drains transverse across a track constructed from hard wearing aggregate, as opposed to low class aggregate, the level of suspended solids is reduced significantly. The internal access tracks will be finished with a hard-wearing aggregate. This can have the added benefit of contributing a balancing pH to help protect water quality from acidic runoff. The proposed development and grid route area is serviced by a limestone quarry which can be used as a source of hard-wearing aggregate for road construction. The nearest quarry to the site is O'Connell's Quarry and has the potential to supply these materials given its proximity to the site.

3.13.4.14 Wheel Washes

Wheel washes will be provided for heavy vehicles exiting the site to ensure that public roads outside of the site boundary are clean. These can take the form of dry or wet wheel wash facilities. In the case of a wet wheel wash a designated bunded and impermeable wheel wash area will be provided, and the resultant wastewater will be diverted to a settlement pond for settling out of suspended solids.

3.13.4.15 Engineered Deposition Areas

Temporary engineered deposition areas will be designated where necessary at the turbine and hardstand locations to hold temporary stockpiles. These will be located away from drains and watercourses. Stockpiles that are at risk of erosion will be protected by a silt trapping apparatus such as a geo-textile silt fence to prevent contamination of runoff.

3.13.4.16 Tree Felling

Felling of conifer forestry is required within and around wind farm infrastructure to accommodate the construction of foundations, hardstands, substation, grid connection and access tracks as well as to facilitate assembly of turbines. It is proposed to fell to a distance of up to 95m around turbines. The proposed felled areas are shown on Figure 2-14 in Chapter 2 Description of the Proposed Development.

All tree felling will be undertaken in accordance with a tree felling licence, using good working practices as outlined by the Forest Service in their *"Standards for Felling & Reforestation 2019"*. All conditions associated with a felling licence will be complied with.

3.13.4.17 Check Dams

Check dams will be placed at regular intervals, based on gradient, along all drains to provide flow attenuation, slow down runoff to promote settlement and to reduce scour and ditch erosion. Check dams are relatively small and constructed with gravel, straw bales, or other suitable material. They will be placed at appropriate intervals and heights, depending on the drain gradient, to allow small pools to develop behind them. Examples of check dams or swales are shown below in Figure 3-21.

Figure 3-21: Examples of check dams along access track drainage channels

3.13.4.18 Silt Fences

Silt fences placed along drains are an alternative method of reducing the volume of suspended sediment. They will be placed at the end of any locally steep section of drain. They have the double benefit of effectively producing a localised swale to reduce scour effects and attenuating and filtering the discharge. An example of a typical silt fence installation is shown in Figure 3-22.

Figure 3-22: Example of a silt fence used in conjunction with check dams along access track drainage channels

3.13.4.19 Operational Phase

The measures for control of runoff and sediment relate to the construction phase of the project when there is continuous movement of site vehicles and delivery vehicles moving around the wind farm site. Following construction, the amount of on-site traffic will be very low and there will be negligible risk of sediment runoff. It is therefore proposed to partly fill the sediment ponds with stone so that they will not present a long-term safety risk. Runoff from the access tracks, hard-standings, and other works areas will continue to be directed to these ponds and from there to the outfall weirs. Check dams within the drainage channels will also remain in place. The retention of this drainage infrastructure will ensure that runoff continues to be attenuated and dispersed across existing vegetation before reaching the downstream receiving waters. This infrastructure will be inspected regularly by the operational maintenance personnel. Monthly water monitoring will continue post construction and into the operational phase until the appointed ECoW is satisfied there is no adverse impacts to the natural watercourses and that surface water quality parameters are in line with baseline levels.

The regular inspections during the operational phase will ensure culverts are free from blockages, and there is no damage or erosion of the stream crossing wing walls, particularly after storm events. Silt ponds will also be inspected and maintained before the drains and verges have vegetated.

3.14 Decommissioning and Restoration

3.14.5 Wind Farm

The wind farm has been designed to have an operational life of 35 years and any further proposals for wind farm development at the site after this time will be subject to a new planning permission application. If planning permission is not sought after 35 years, the site will be decommissioned and reinstated with all wind turbines and towers removed. Upon decommissioning, all that will remain will be the access tracks. The substation will likely remain in place as part of the permanent electrical infrastructure.

When the site is to be decommissioned, cranes of similar size to those used for construction will disassemble each turbine. The towers, blades and all components will then be removed. The turbines and monitoring mast will also be removed from site. It is likely that where possible, turbine components will be reused as they have a life well in excess of the wind farm proposal i.e., greater than 35 years. Wind farm components may also be recycled.

Underground cables within the wind farm will likely be cut back and left underground as removal may do more harm than leaving them *in situ*.

Hardstand areas will be remediated to match the existing landscape thus requiring reforestation or return to grassland by placing topsoil and grass seed. Access tracks will be left for use by the landowner. The current view is that the disturbance associated with the removal and disposal of the elements (hard core and sediment) would be more deleterious than leaving them in place.

Any structural materials suitable for recycling will be disposed of in an appropriate manner.

Prior to wind turbine removal, due consideration will be given to any potential impacts arising from these operations. Some of the potential issues include:

- Potential disturbance by the presence of a crane, heavy goods vehicles and personnel on-site;
- On-site temporary compound will be located appropriately;
- Time of year and time-scale (to be outside sensitive periods); and
- Access tracks (tracks may remain in use for the benefit of the landowner).

Prior to the decommissioning work, a plan will be drawn up to ensure the safety of the public and workforce and the use of best available techniques at the time.

Prior to the decommissioning work, a comprehensive reinstatement proposal, including the implementation of a program that details the removal of all structures and landscaping, will be submitted to the planning authority for approval.

Wastes generated during the decommissioning phase will be taken off site and disposed of appropriately by a licensed waste operator.

3.14.6 Grid Connection

The grid cable will remain a permanent part of the national grid and therefore decommissioning is not foreseen. In the event of decommissioning, it will involve removing the cable from the ducting but leaving the ducting and associated supporting structure in place. The ducting will not be removed if the environmental assessment of the decommissioning operation demonstrates that this would do more harm than leaving them in situ. The assessment will be carried out closer to the time to take into account environmental changes over the project life. The removal of the ducts would also cause some limited disruption to road users. Leaving the ducts in place would avoid disruption to road users without compromising the structure of the roadway.

It is also likely the substation will remain in place and will previously have been taken in charge by the system operator, after the wind farm is connected to the national electricity grid.

3.15 References

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