Kirkan Wind Farm Limited

Drainage Impact & Watercourse Crossing Assessment, Kirkan Wind Farm

Technical Appendix 8.1

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RSK GENERAL NOTES

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1 INTRODUCTION

1.1 This report provides a Drainage Impact and Watercourse Crossing Assessment for Kirkan Wind Farm and associated development infrastructure.

1.2 The report forms a Technical Appendix to the Environmental Impact Assessment Report (EIAR) for Kirkan Wind Farm and should be read in conjunction with this document. It has been produced to address the requirement for new drainage infrastructure, including new watercourse crossing structures, for the proposed development infrastructure.

1.3 The document covers two interlinked areas, project area drainage and watercourse crossings, both of which are important to understand and have the potential to have significant environmental effects if addressed inadequately.

Drainage impact assessment

1.4 This document will assess how the proposed development may affect the existing drainage regime within the project area, from both a water quality and water quantity perspective. The purpose of this assessment is to identify drainage issues and appropriate mitigation measures to ensure that project area drainage is suitable for the development whilst restricting induced changes to the natural drainage to a practical minimum.

Watercourse crossing assessment

1.5 Watercourse crossings would be required on the proposed access track layout for the project. This document will provide background descriptions of the watercourse crossing locations, the process of layout design that has resulted in these crossings being proposed and will provide sufficient background information to support future applications for authorisation under the *Water Environment (Controlled Activities) (Scotland) Regulations 2011* as amended, known as CAR.

Regulatory background

1.6 Under the terms of CAR, it is an offence to undertake the following activities without an appropriate authorisation in place:

- Discharge to any wetland, surface water or groundwater;
- Disposal to land;
- Abstraction from any wetland, surface water or groundwater;
- Impoundment (dam or weir) of any river, loch, wetland or transitional water;
- Engineering works in any inland water or wetland.

1.7 With respect to drainage infrastructure, any formal discharge to water or to land may require authorisation. The developer has a duty to manage water within the project area and discharging from the project area in a compliant manner. The drainage strategy provided here will establish the design requirements in order to manage post-construction water flows within and deriving from the project area.

1.8 With respect to watercourse crossings, it is the final point that is relevant. The Scottish Environment Protection Agency's document "The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended): A Practical Guide" (SEPA, 2018a) specifies that authorisations are not normally required for engineering works on minor watercourses, where a minor watercourse is defined as one not shown on the 1:50,000 scale Ordnance Survey maps (Landranger series).

1.9 On this basis, some watercourse crossings required to provide access to Kirkan Wind Farm would require authorisation. An additional crossing of a minor watercourse would also be necessary.

1.10 This report is produced in compliance with the requirements of the Highland Council (THC) and the Scottish Environment Protection Agency (SEPA) and is in line with current best practice.

Development proposals

1.11 The Kirkan Wind Farm proposal includes the following key elements:

- 17 turbines, of approximately up to 4.8 MW each and a maximum tip height of 175 m;
- Hardstanding areas at the base of each turbine, with a maximum total area of 1,850 m^2;
- Up to two permanent meteorological masts and associated hardstanding areas;
- 10,835 m of access track with associated watercourse crossings, of which 9,975 m are new access tracks, and 860 m is upgrade to existing track;
- An operations control building with parking and temporary welfare facilities;
- A substation compound;
- A substation construction compound, providing space for a prospective modular energy storage facility;
- Telecommunications equipment, including masts;
- Up to three temporary construction compounds;
- Two borrow pits, to provide suitable rock for access tracks, turbine bases and hard standings; and
- Underground cabling linking the turbines with the substation.

1.12 In addition, felling of approximately 16 hectares of native tree planting would be required to accommodate access for the turbines.

1.13 Full details of the project design are provided in Chapter 2 of the Environmental Impact Assessment Report.

2 DRAINAGE CHARACTERISTICS

2.1 It is important to gain an understanding of the existing drainage characteristics of the project area in order to determine a baseline against which to assess measures required for the development of a robust and effective drainage strategy. Natural drainage characteristics are determined by the site topography, existing drainage and natural catchment areas, site rainfall characteristics, current landuse and any existing drainage infrastructure.

Site topography

2.2 The project area lies on a north-east facing slope draining to the Glascarnoch River/Black Water.

2.3 The highest point within the project area is approximately 425 m above Ordnance Datum (AOD), on the northern ridge of Beinn nan Cabag, on the south-western boundary. The lowest part of the project area is where the access track leaves the A835, at approximately 220 m AOD.

2.4 The project area is characterised by a broad ridge, Druim Donn, between the two main site watercourses Allt Glac an t-Sìthein and Allt Bad an t-Seabhaig. To the west of Allt Glac an t-Sìthein the land rises towards a hill Sìthean nan Cearc, the crest of which is just outwith the western boundary.

2.5 Slopes are mainly variable and undulating. Part of the main turbine area is relatively flat, rising towards the southern and western boundaries. Some steep slopes are present, notably associated with Beinn nan Cabag and in other localised areas adjacent to small hill tops.

2.6 The proposed project area covers 3.25 km^2. Proposed infrastructure has a total landtake of 25.5 ha, of which 15.4 ha would be temporary working areas during the construction phase and 10.0 had would be long-term. The long-term land take includes all impermeable or reduced permeability surfaces including turbine foundations, buildings, hardstanding areas, borrow pits and access tracks.

Existing drainage and natural catchments

2.7 The project area drains overall towards the north-east into the Glascarnoch River/Black Water catchment and the entire site lies within the Glascarnoch/Black Water catchment. Project area drainage is provided principally by three watercourses. Details and project area drained are provided in Table 8.1.1. Catchment areas are shown on Figures 8.2 and 8.3 with Chapter 8 of the EIAR.

Table 8.1.1: Overview of watercourse catchment areas and infrastructure

Catchment	Total area (km^2)	Prop. of project area within catchment	Prop. of catchment within project area	Comments
Glascarnoch/ Black Water (GBW) upstream of Inchbae	180.97	100%	1.79%	Entire site lies within this catchment. Discharges to Cromarty Firth via River Conon approximately 35 km downstream of site.
Allt Giubhais Beag (AGB)	4.53	1.31%	0.94%	Tributary to GBW. Turbine 1 half within catchment. PWS downstream.
Allt Glac an t-Sìthein (AGS)	4.88	54.28%	36.12%	Tributary to GBW. Half of Turbine 1, Turbines 2,3,4,5,6,8 and 9 and half Turbine 10 within catchment plus borrow pit 1, one construction compound, one met mast and half the substation.
Allt Bad an t-Seabhaig (ABS)	5.89	37.49%	20.67%	Tributary to GBW. Turbines 7, 11, 12, 13, 14, 15, 16 and 17 plus half Turbine 10 within catchment, plus borrow pit 2, one met mast, substation compound and half substation.
Minor watercourses	1.61	6.90%	13.94%	Tributaries to GBW. Two construction compounds within catchment.

Rainfall characteristics

2.8 A review of the watercourse catchment and rainfall characteristics was undertaken using data from the FEH web service (CEH, 2018).

2.9 For the overall GBW catchment, standard average annual rainfall (SAAR) is given as 1,810 mm. SAAR values for the site watercourses are as follows:

- AGB: 1,425 mm
- AGS: 1,327 mm
- ABS: 1,315 mm

2.10 The calculations in Section 3 below make use of the figures for Allt Glac an t-Sìthein, as this covers the central part of the site and is considered to be representative.

Catchment landuse

2.11 The project area consists of rough open moorland under rough grazing with an area of mixed native conifer and broadleaf planting. In total, approximately one third of the site is under planted woodland.

2.12 Within the project area boundary, the Allt Giubhais Beag catchment consists entirely of open rough moorland. To the west of the project area, the catchment includes an area of

former, now clear-felled, conifer plantation, which was removed to allow development of the now-operational Corriemoillie Wind Farm. The project area woodland plantation is divided between the catchment areas of the Allt Bad an t-Seabhaig and the Allt Glac an t-Sìthein, covering the area of land between the two watercourses. The Allt Glac an t-Sìthein catchment also includes an extensive area of rough open moorland.

Existing drainage infrastructure

Waste water

2.13 There is no existing waste water infrastructure, either foul drainage or surface water drainage, present within the site area.

Surface water

2.14 The site currently drains naturally via infiltration and overland flow to the existing watercourse network.

2.15 Some, fairly limited, artificial surface drainage infrastructure is associated with the old drover's road which crosses the site catchments and cuts across the slope. The infrastructure is largely in poor condition.

2.16 The plantation area has an extensive drainage ditch network, installed to try and create better drained conditions for tree growth. This has had variable success and tree growth in some areas is notably stunted as a result of waterlogging.

2.17 Roadside drainage infrastructure is present adjacent to the A835. This is mostly located outwith the project area boundary.

Private water supply

2.18 A number of local properties and businesses are noted to have private water supplies near the project area. A risk assessment of these supplies is provided in the EIAR Chapter 8.

2.19 A supply intake for the Aultguish Inn is located on the Allt Giubhais Beag, downstream of the project area boundary. Approximately 1.31% of the total project area is located within this watercourse catchment, which includes approximately one half of the infrastructure for Turbine 1.

2.20 The drainage strategy has been developed to safeguard this water supply intake, as well as to manage surface water discharge from the project area in order to ensure that the wider water environment is not affected by the operation of the wind farm.

3 OUTLINE DRAINAGE STRATEGY

Introduction

3.1 This section provides an outline drainage strategy for the project area. The proposal is to maintain project area runoff within the natural catchment areas, and to maintain drainage to the Allt Glac an t-Sìthein and Allt Bad an t-Seabhaig following treatment and attenuation in order to mimic natural flow as closely as possible.

Waste water drainage

3.2 There are no plans to provide a foul drainage network within the project area.

3.3 Welfare facilities for use during construction would have a suitably sized holding tank and waste water would be removed by tanker for disposal at a licensed disposal facility.

3.4 It is unlikely that ground conditions within the project area would be suitable for a soakaway. Therefore, operational phase welfare facilities at the substation control building would make use either of waterless facilities such as a composting toilet or would have a suitably sized holding tank and waste water would be removed offsite by tanker for disposal at a licensed disposal facility.

Surface water drainage

3.5 The surface water drainage network for the project area would be designed taking into account THC's Interim Supplementary Guidance: Flood Risk and Drainage Impact Assessment (THC, 2013) and CIRIA Publication C687 – the SUDS Manual (CIRIA, 2015).

3.6 The following sections describe the requirements that lead to determination of the proposed drainage strategy and which inform recommendations made in relation to SuDS provision.

Allowable discharge

3.7 Surface water flows from the project area would be directed, following appropriate treatment and attenuation, to the existing site watercourses in order to maintain pre-development water quality characteristics and flow rate. In line with THC's guidelines for development, it is anticipated that the allowable discharge from the site would match that of the existing 1-in-2 year greenfield runoff rate.

Post-development discharge criteria

3.8 Post-development surface water flows would be restricted to the discharge levels in accordance with THC's SuDS guidance document (THC, 2013). The development proposals recognise THC's requirements, within which three key design principles are noted:

- The post-development runoff rate and volume do not exceed … the Greenfield runoff rate for previously undeveloped sites;
- Formal on site storage should be provided up to the 1-in-30 year return period event and attenuation measures should be designed such that SuDS features would not surcharge during a 1-in-30 year return period rainfall event.

- The 1-in-200 year event should be contained on site (unless it can be demonstrated that the 1-in-200 year event could be managed appropriately without causing a flood risk elsewhere).

Greenfield runoff assessment

3.9 A review of the catchment characteristics relating to the site was undertaken using the FEH Web Service (CEH, 2018). This identified the following criteria:

- Standard average annual rainfall (SAAR) of 1,327 mm for the site area;
- Standard percentage runoff (SPR) of 53.25%.

3.10 This information has been used to determine the Greenfield Runoff Rate that corresponds to the project area's existing characteristics. This has been calculated using the online Greenfield Runoff Estimation for Sites tool (HR Wallingford, 2018), which gives the IH124 model results for the project area.

3.11 The 1-in-2 year Greenfield Runoff Rate has been calculated to be 355.3 l/s (0.3 m^3/s) based on a total drained area of 30 ha.

Attenuation

3.12 THC's current guidance document requires that formal on-site storage is provided up to the 1-in-30 year return period event and attenuation measures should be designed such that SuDS features do not surcharge during a storm of this magnitude.

3.13 The drainage strategy for the site aims to promote attenuation within the SuDS proposals to mitigate any additional surface water runoff generated as a result of the development. Attenuation volumes would be reviewed at the detailed design stage in order to ensure compliance with the 1-in-30 year and 1-in-200 year requirements as specified within THC's documents.

3.14 Approximate attenuation and storage volumes have been calculated as follows, using guidance provided in the SuDS Manual (CIRIA, 2015):

- For a 1-in-30 year return period event plus climate change allowance, storage of approximately 2,500 m^3 is required.
- For a 1-in-200 year return period event plus climate change allowance, storage of approximately 3,500 m^3 is required.

4 SUSTAINABLE DRAINAGE SYSTEMS

4.1 The site drainage strategy seeks to implement a design that would match the pre-development site characteristics. Site drainage is intended therefore to provide an appropriate degree of treatment and attenuation such that runoff discharge is no greater than pre-development greenfield runoff for the area and that runoff quality would not risk any reduction in the water quality of the receiving waterbody.

Quality of receiving waterbodies

4.2 SEPA's Water Classification (SEPA, 2018a) and Water Environment Hubs (SEPA, 2018b) have been consulted to determine the existing baseline water quality for the main watercourses and waterbodies within the study area. The three watercourses providing site drainage are not classified and assessed directly as their catchment sizes are too small and fall below the size limit. Based on the water quality of adjacent watercourses, it is assumed that the site watercourses all have 'High' status.

Treatment

4.3 Surface water treatment systems should be based on catchment characteristics and the sensitivity of the receiving watercourse (CIRIA, 2015). Treatment would be required during the entire lifetime of the development, from construction through to decommissioning. Much of the construction phase surface water treatment would provide suitable water treatment for the operational phase.

4.4 It is assumed that all site operations would require at least two levels of treatment prior to discharge, as a result of the high sensitivity of the receiving waterbodies. Areas of the site with a higher pollution risk, notably concrete batching (if used) and any areas used for plant maintenance and refuelling, would require three levels of treatment.

SuDS components

4.5 The following SuDS features have been considered for inclusion within certain sections of the proposed development's drainage network in order to control, manage and treat surface water runoff during construction, operation and decommissioning of the development.

Swales and filter strips

4.6 Swales are linear vegetated drainage features that can be designed to store and/or convey surface runoff as well as providing water treatment. Where soil and groundwater conditions allow, swales can also promote infiltration. Vegetation within swales varies, but is typically grass or dense vegetation that can act to slow down flow rates and trap particulate pollutants in the water.

4.7 Filter strips provide off-the-edge diffuse drainage through vegetated verges. They provide some flow attenuation and treatment, but little or no water storage.

Filter drains

4.8 Filter drains are also linear drainage features, but rather than incorporating vegetation they include coarse graded rock which provides good drain stability whilst also providing water storage and conveyance. Filter drains have a narrower footprint than swales and can be used in areas where space constraints prevent wider swales from being used. Filter drains provide some limited water treatment.

Check dams

4.9 For either swales or filter drains that cross slopes, check dams provide a valuable means of attenuating water flow. These are typically placed across the swale or drain at intervals of 10-20 m. The design is such that the toe of the upstream dam is level with the crest of the next downstream dam. A small opening or pipe is placed at or near the base of each dam to allow limited flow to pass through rather than over the dam, in order to maintain low flow conveyance.

4.10 Check dams should be built into the sides of the swale or filter drain, to ensure that water flow cannot bypass the dam.

Silt fences and straw bales

4.11 Silt fences, constructed from a closely woven synthetic geotextile material, and straw bales both provide flow attenuation and excellent particulate filtration treatment for surface water runoff. These are particularly valuable for sediment management in runoff during construction works, as silt fences and pegged straw bales can be positioned along the main runoff routes to capture, slow and treat runoff. They can also provide temporary check dams if required in short-term drainage infrastructure.

Settlement ponds

4.12 Settlement ponds provide storage for site runoff and are a highly effective method of treatment and attenuation of surface water. They are particularly useful for developments where bulk earthworks form a significant part of the works.

Drainage strategy

4.13 Settlement ponds would be used at the two borrow pit sites, the construction compounds and substation compound for storage, attenuation and treatment of surface water. The ponds would be established during construction to provide water management for the construction phase works. The borrow pit ponds would be retained during operation to provide ongoing water management for these locations. The other ponds may be retained if water storage is required at these locations during the operational phase.

4.14 Swales, filter strips and filter drains would provide attenuation, storage and treatment for access tracks and turbine hardstandings. Where possible, filter strips would be used on downslope sides of tracks to minimise concentration of flows. Areas where larger flow volumes are likely would make use of swales or filter drains in order to provide greater flow attenuation and storage. During construction, small sumps with silt fencing would be established periodically along track routes in order to manage entrained sediment within the surface water. The sumps and silt fencing would be removed at the end of the

construction phase, once vegetation on the filter strips and swales has become established.

4.15 Filter drains would be required along the upslope sides of access tracks, turbine base excavations, borrow pit sites and hardstanding areas, to capture clean runoff and divert it around construction areas. Filter drains around turbine bases may not be required for drainage and attenuation during operation, although drains in other situations are likely to be retained throughout the operational phase of the wind farm.

4.16 Indicative drainage for the access tracks is shown on Figure 8.1.1.

Authorisation

4.17 Where proposals have potential to affect the water environment, the design of any works required to mitigate these effects must also take into account the site's characteristics and existing drainage conditions. Treatment and discharge of surface water to the water environment is regulated under CAR and forms an additional requirement to planning consent. Any formal authorisations under CAR that are needed for the drainage strategy would be put in place prior to work beginning on site.

5 WATERCOURSE CROSSING ASSESSMENT

Route Selection

5.1 Prior to consideration of watercourse crossings in detail, SEPA would wish to satisfy themselves that 'good practice' has been followed, which in their terms means avoidance or minimisation of the number of crossings. The number of crossings is a function of the access route, to connect the turbines and other essential infrastructure for construction and operational purposes. Route selection takes into consideration a number of key factors including:

- Maximum track gradient suitable for the required traffic and loads for construction purposes;
- Track geometry including bend radii, junction layouts, passing infrastructure and turning circles;
- Stability and bearing capacity of the ground and adjacent slopes;
- The volumes of 'cut' and 'fill' required to ensure a suitable horizontal and vertical track alignment;
- Land take, determined by route length and other aspects of track geometry;
- The type and nature of bridging structures;
- Sensitivity of environmental receptors including areas of deep peat, habitats and potential receptors downstream of crossing structures;
- Whole-life costs for construction and maintenance.

5.2 With these factors in mind, a preferred track geometry has been determined to connect the turbines and other essential development infrastructure. Compromise is always required between competing constraints and concerns. The desire to site turbines and associated hardstanding areas on areas of shallow peatland, plus a series of environmental and engineering constraints requiring avoidance of sensitive areas and steep or unstable slopes, means that the track geometry is constrained by ecological and topographical features.

5.3 There is no direct link between 'optimum', in terms of a balance between environmental and engineering constraints, and 'best practice' in the WFD context, which is oriented towards the water environment. However, there should not be obvious redundant crossings or crossings that are readily avoidable.

Access track design

5.4 The water environment and associated concerns formed an integral part of the track design process, which developed in an iterative manner in parallel with the turbine layout and associated infrastructure. As part of this process, the proposed track route has significantly fewer crossings than the initial design submitted for consideration at design meetings.

Access route

5.5 As discussed in Section 2.6 of the EIAR, the preferred access to the wind farm is expected to leave the A835 adjacent to the existing access to the car park and mobile telephone masts at NH 3575 7019. From here a short section of new track would give access to the existing drover's road which would be followed for a distance of 0.86 km. The wind farm access would diverge from the drover's road to link into the construction compound and access to Turbine 3.

5.6 From Turbine 3, the track would head down to cross the Allt Glac an t-Sìthein, leading to a circuit giving access to most of the turbines. A link at Turbine 4 would give access to Turbines 1 and 2. A second link would give access to Turbines 6, 10, 13 and 16. Small approach links would be needed for Turbines 5, 7, 8, 11 and 17 for engineering reasons, principally to allow sensible positioning of the associated crane pad hardstanding areas for these turbines in order to minimise incursion into deeper peat and to manage the amount of ground work required to provide a level platform.

5.7 The circuit of track would require two watercourse crossings, between Turbines 11 and 14, and between Turbines 12 and 15. The circuit has to be retained as two-way access is required in this area for safety reasons as well as to avoid incursion into ecological and hydrological constraints associated with sensitive habitats and watercourses, and the engineering requirement to avoid sections of over-steep gradient on the tracks.

5.8 One additional watercourse crossing would be required on the track link giving access to Turbines 1 and 2.

5.9 The new track required for the development would be a total of 9.975 km.

Removal of existing structures

5.10 Where a proposed new crossing is located adjacent to an existing crossing, it is considered best practice to remove the redundant structure.

5.11 There are no plans to remove or otherwise modify any existing crossing structures.

Cable crossing locations

5.12 As cables would generally be laid alongside access tracks, cable crossings would normally be incorporated as part of track crossing structures. There are no plans for additional crossings of watercourses shown on Ordnance Survey 1:50,000 mapping.

Crossing descriptions

5.13 The crossings have been assessed using a catchment-based approach, involving a desk study and walkover survey.

Desk study

5.14 The desk study consisted of a review of the information regarding Kirkan Wind Farm, principally involving an examination of the proposed track layout and the identification of watercourses marked on the OS 1:50,000 scale maps which would require crossings.

5.15 Following issue of the initial track layout, discussions were held with the design team in order to revise the layout to reduce the number of watercourse crossings required for the development.

Walkover survey

5.16 Subsequent to the issue of the revised track layout, a walkover survey of the site was undertaken, during which the identified crossings were visited to obtain specific information about each crossing location. This work was undertaken in August 2018, following a prolonged dry period. Information regarding previous high-water activity including flooding was recorded in order to allow an informed decision-making process with regard to crossing structures and sizing.

5.17 A second walkover was undertaken in November 2018 following minor further adjustments to the track design, requiring adjustment to the location of one of the crossings.

5.18 During both walkover surveys, photographs and detailed field notes were taken to record dimensions of the watercourse channel and flood channel, where apparent, the type of substrate and any other local information required to inform the proposed crossing type. Locations were recorded using a hand-held GPS unit, with better than 5 m accuracy.

Ecological provision

5.19 Upland watercourses such as those found at Kirkan Wind Farm are often home to fish species, many of which migrate on a local scale. These include brown trout. In addition, the watercourses may be used by mammal species such as otter and water vole.

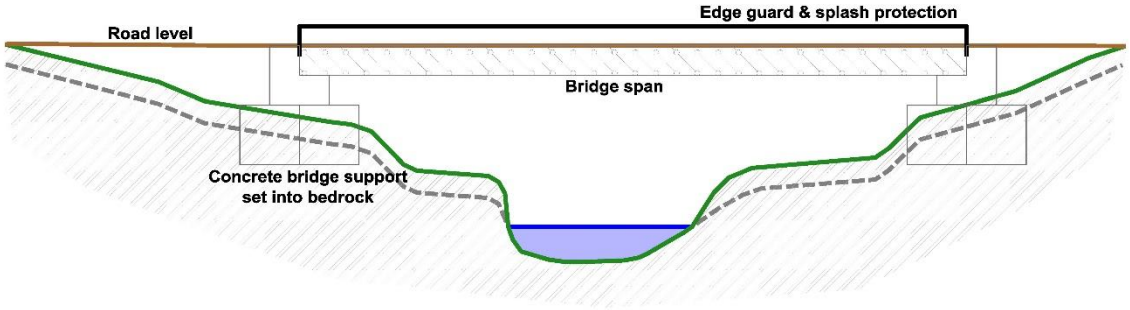
5.20 Brown trout were identified during the walkover in one of the watercourses to be crossed and have been assumed to be present in or adjacent to all other crossing locations. This has been taken into account when proposing crossing structures.

Crossing details

5.21 The following table includes details of all the crossings which require authorisation, together with photographs of the watercourse and a recommendation of the crossing type to be used. All crossings are shown on Figure 8.1.2.

Watercourse Crossing Details

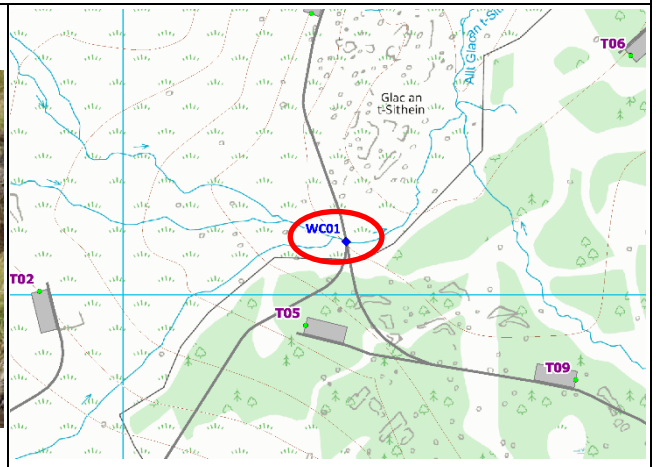
Crossing:	WC01
Location:	Between T03 and T05
Watercourse:	Allt Glac an t-Sìthein
NGR:	NH 3634 6808
Description:	Moderate watercourse with well-defined incised channel. Variable width, 1-4 m wide with pools up to 6 m long. Fish noted to be present. Banks unstable with signs of regular collapse. Banks expose sections of glacial sediments, no peat deposits, bank height 1-2 m. Signs of flooding with significant flood debris including rocks in channel.
Catchment Area:	0.86 km^2
Crossing Type:	Bridge



Indicative cross-section, not to scale

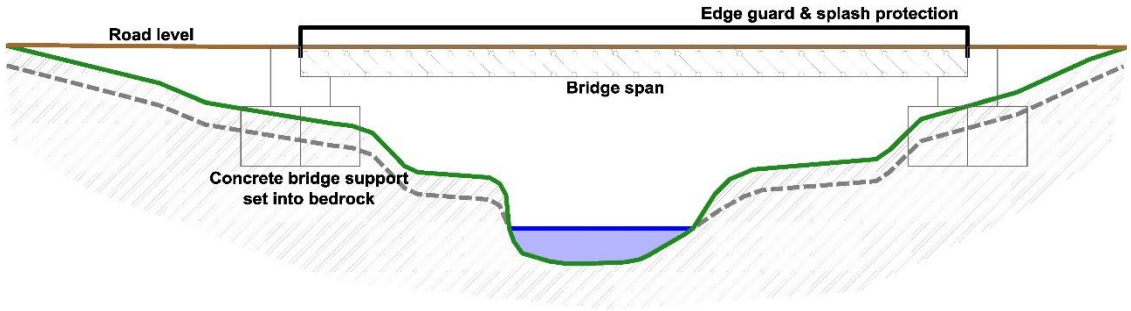
View downstream (west) from NH 3634 6808 showing variable channel width and rocky debris.

View upstream (east) at NH 3634 6808 showing incised channel with unstable banks and rocky debris.



Watercourse Crossing Details

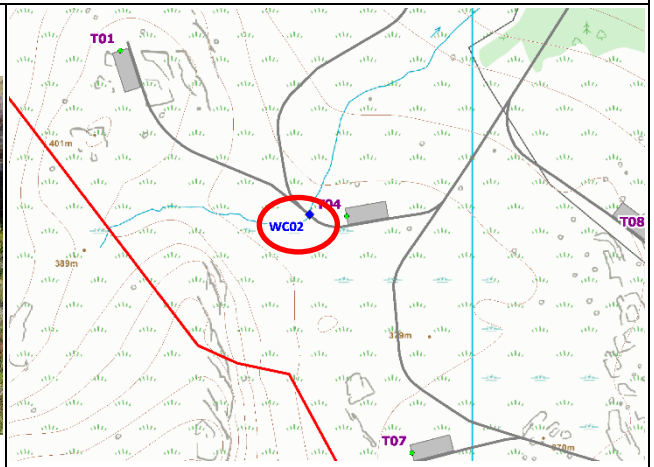
Crossing:	WC02
Location:	Between T01 and T04
Watercourse:	Allt Glac an t-Sìthein
NGR:	NH 3575 6756
Description:	Small watercourse in headwaters, with narrow well-defined and meandering channel within a wider channel area in the peat. Flow channel 0.1-0.3 m wide, peat channel variably 12-18 m wide. Bank height 1-2 m. Signs of flooding within main peat channel but not beyond. Limited exposure of bare peat in and around channel.
Catchment Area:	0.07 km^2
Crossing Type:	Bridge or bottomless arch culvert



Indicative cross-section, not to scale

View upstream (west) from NH 3575 6756 showing channel development in peat. Main flow channel is on the near side of the peat channel.

View downstream (north-east) at NH 3575 6756 showing narrow flow channel within wider peat channel.



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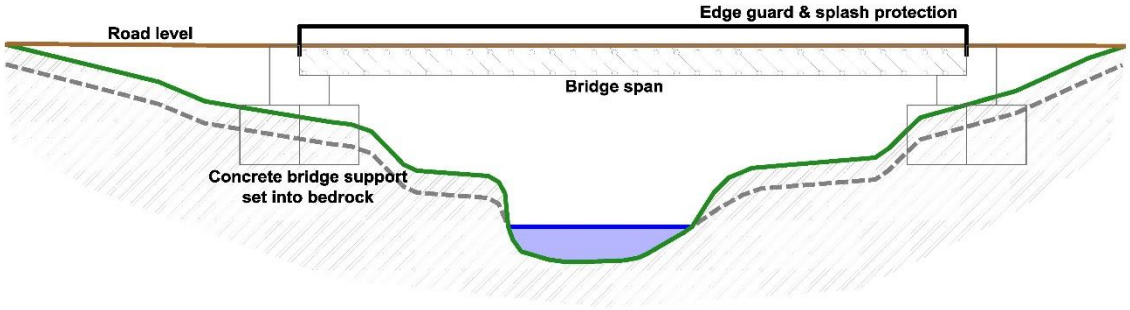
Watercourse Crossing Details

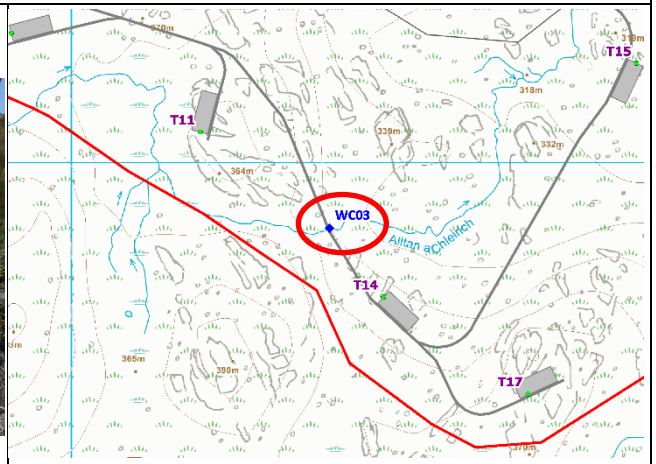
Crossing:	WC03
Location:	Between T11 and T14
Watercourse:	Alltan a' Chleirich, tributary to Allt Bad an t-Seabhaig
NGR:	NH 3639 6689
Description:	Moderate watercourse with well-defined deeply incised channel. Width variable 2-6 m, mostly cut to bedrock. Banks unstable with signs of regular collapse. Banks expose glacial sediments, no peat deposits, bank height 1-2 m. Signs of significant flooding with extensive flood debris within channel, including boulders, and debris fan c. 20 m downstream where slope shallows.
Catchment Area:	0.60 km^2
Crossing Type:	Bridge



Indicative cross-section, not to scale

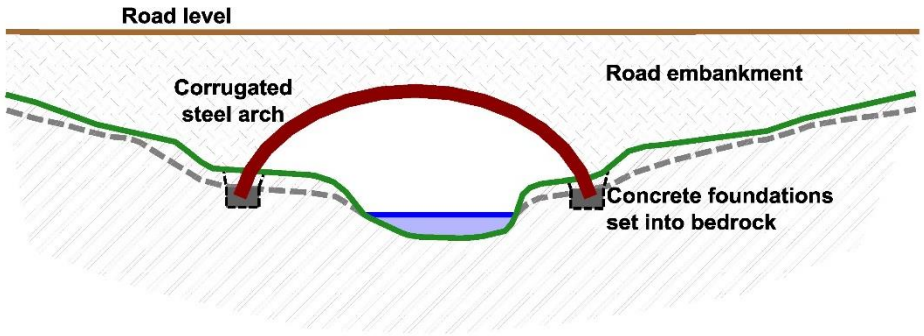
View downstream (east) from NH 3639 6689 showing bedrock channel bed, bank instability and extensive flood debris fan on flatter ground.

View upstream (west) at NH 3639 6689 showing incised bedrock channel with unstable banks and substantial rocky debris.



Watercourse Crossing Details

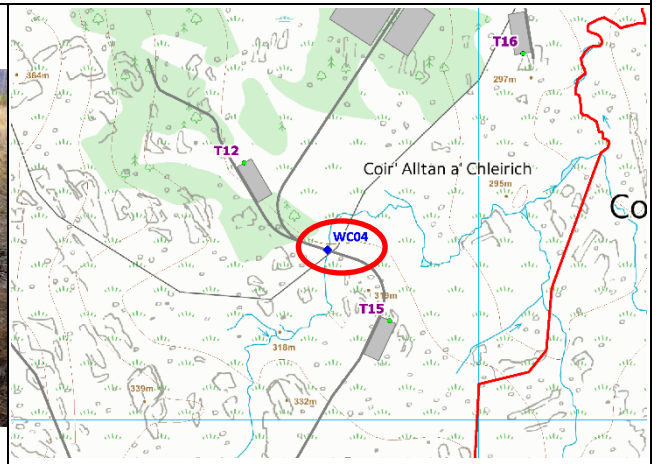
Crossing:	WC04
Location:	Between T12 and T15
Watercourse:	Alltan a' Chleirich, tributary to Allt Bad an t-Seabhaig
NGR:	NH 3676 6724
Description:	Moderate watercourse with well-defined incised channel. Variable width, 1-3 m wide. Banks unstable with signs of regular collapse on both sides. Banks expose sections of glacial sediments with shallow peaty soils above, bank height 1.5-2 m. Signs of flooding with significant flood debris including rocks in channel.
Catchment Area:	0.96 km^2
Crossing Type:	Bottomless arch culvert or bridge



Indicative cross-section, not to scale

View upstream (south) from NH 3676 6724 showing incised channel with boulder debris and bank instability.

View downstream (north) at NH 3676 6724 showing widening channel and boulder debris. Flood debris is found on the flat ground approximately 20 m north.



Additional watercourse crossings

5.22 In addition to the four watercourse crossings detailed above, one crossing of a minor watercourse would be required.

5.23 This crossing is located at NH 3571 7008, on the main access route into the site. The watercourse is a small well-defined channel approximately 0.2-0.3 m wide by 0.3 m deep. Downstream of the crossing location, the watercourse has been culverted under the A835 to join the Glascarnoch River. This crossing is anticipated to be a circular culvert.

5.24 There would be further drainage requirements along the access track route, including crossings of peat hags which may act as drainage channels during periods of wetter weather; however, no other defined watercourse channels have been identified during the site surveys.

6 CONCLUSIONS

6.1 This report has assessed the relevant aspects of drainage associated with the proposed wind farm at Kirkan. It sets out a drainage strategy on which to base detailed design plans, recognising the requirements of THC and SEPA and taking account of current best practice guidance.

6.2 The site currently drains naturally via overland flow and drainage ditches to the existing watercourses in and around the site. The proposed drainage strategy promotes maintenance of natural runoff characteristics where possible, and drainage infrastructure to mimic these characteristics where required. Runoff attenuation and treatment proposals are designed to prevent any detrimental effects to the water quality or quantity of existing waterbodies. The proposed strategy makes use of SuDS features within the detailed engineering design to mimic the existing runoff characteristics.

6.3 Proposed SuDS include use of settlement ponds, swales, filter strips, filter drains, check dams and silt fences/straw bales at different stages of the development.

6.4 Watercourse crossing locations have been identified and assessed, and appropriate conceptual crossing designs have been suggested to ensure that the watercourses retain their natural hydromorphology and ecological characteristics. Crossing design would take account of flood water conveyance. Details would be provided within the detailed design specifications.

6.5 All necessary authorisations under CAR would be put in place prior to any site works taking place.

7 REFERENCES

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