TA10.4: Flood Risk Assessment and Drainage Impact Assessment

STRATHY SOUTH WIND FARM

Technical Appendix 10.4

Flood Risk Assessment and Drainage Impact Assessment

Prepared for: SSE Generation Limited

SLR Ref: 428.00660.00070
Version No: 2
August 2020

SLR

BASIS OF REPORT

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1.0 INTRODUCTION

SLR Consulting Ltd (SLR) was appointed by SSE Generation Limited (SSE) to prepare a Flood Risk Assessment (FRA) and Drainage Impact Assessment (DIA) for the Proposed Varied Development, which is located within the Strathy South conifer plantation approximately 12 km. south of the village of Strathy, Caithness.

This report addresses the potential flood risks and drainage impacts associated with the Proposed Varied Development, which comprises 39 wind turbines and associated infrastructure. The scope of the report has been informed by discussion with flood risk and drainage specialists at The Highland Council (THC).

1.1 Policy and Guidance

This assessment has been completed in accordance with relevant policy statements and guidance issued by the Scottish Government, The Highland Council (THC), the Scottish Environment Protection Agency (SEPA), and Construction Industry Research and Information Association (CIRIA), as follows:

- Scottish Planning Policy (SSP)[1],
- the National Planning Framework for Scotland 3 (NPF3)[2],
- the Flood Risk Management (Scotland) Act 2009,
- the Water Environment (Controlled Activities) (Scotland) Regulations 2011,
- the Highland-wide Local Development Plan[3],
- THC's supplementary guidance on flooding and drainage[4],
- SEPA's guidance for stakeholders on flood risk assessment[5],
- CIRIA's guidance on flood risk assessment for development[6], and
- CIRIA's SuDS Manual[7].

1.2 Site Location

The site is located at National Grid Reference (NGR) NC792500 and is shown in Figure 10.4.1.

The main site lies within the headwaters of the River Strathy, which flows north towards the village of Strathy and Strathy Bay, and occupies land in a U shape currently used for forestry. A number of tributaries of the River Strathy also rise within the main site prior to joining the River Strathy, including the Yellowbog Burn, Allt Badain and Allt nan Clach.

The main site is some 4.5 km long in a north-south direction and some 3 km wide east to west.

Access to the site is via existing forestry tracks directly south from the village of Strathy, through the existing Strathy North Wind Farm, and then via new and upgraded tracks.

The main site is surrounded by internationally and nationally important peatlands including: Caithness and Sutherland Peatlands Special Area of Conservation (SAC), Special Protection Area (SPA) and RAMSAR; Strathy

[1] The Scottish Government (2014) Scottish Planning Policy, June 2014
[2] The Scottish Government (2014) National Planning Framework 3, June 2014
[3] The Highland Council, Highland-wide Local Development Plan, 2012
[4] The Highland Council, Supplementary Guidance - Flood Risk and Drainage Impact, January 2013
[5] SEPA, Technical Flood Risk Guidance for Stakeholders (Reference: SS-NFR-P-002) June 2015
[6] CIRIA, Development and Flood Risk – Guidance for the Construction Industry, Report C624, 2004
[7] CIRIA, The SUDS Manual, Report C753, version 5, 2016

Bogs Site of Special Scientific Interest (SSSI); West Halladale SSSI; Skelpick Peatlands SSSI; and Lochan Buidhe Mires SSSI. Refer to EIAR Volume 2: Chapter 10 (Soil and Water) for further details.

1.3 Proposed Varied Development

The layout for the Proposed Varied Development is shown in Figure 10.4.2 and Figure 10.4.3. It consists of the following components:

- 39 wind turbines, each with a reinforced concrete foundation and an adjacent hardstanding area;
- a network of tracks linking each turbine to the main access track – either "cut" tracks founded on the subgrade materials on hard ground, or "floating" tracks where the depth of peat is more than 0.5 m;
- watercourse crossings which would comprise bridges or culverts carrying new or upgraded tracks across watercourses[8] (see further detail below);
- up to seven borrow pits within the main site;
- a substation;
- a temporary concrete batching plant;
- a temporary construction compound and two laydown areas; and
- buried 33 kV electrical cabling connecting the turbines to the substation, generally laid adjacent to tracks.

With regard to watercourse crossings, details of the proposed crossing types are contained in Technical Appendix 10.6: Watercourse Crossing Assessment (EIAR Volume 4: Technical Appendix 10.6). In summary, the proposals comprise:

- a new permanent bridge over the River Strathy in one of two alternative locations (referred to as WX01 and WX03),
- nine new arch culverts (WX02, WX08, WX10 to 15, WX19),
- upgrading of one existing bridge (WX05), and
- upgrading of four existing closed (pipe) culverts (WX04, WX07, WX09, WX16).

1.4 Existing Site and Topography

1.4.1 Local Topography

The site varies in altitude between approximately 130 m and 200 m Above Ordnance Datum (AOD). The topography undulates throughout most of the forest with the lower ground towards the central boggy inner boundary of the U-shaped forest area, which follows the River Strathy valley. Hills in the surrounding area include Cnoc Meala (211 m) 2 km to the north, Cnoc Badaireach (213 m) 3 km to the east, Meall Bad na Cuaiche (337 m), Meall Ceann Loch Strathy (344 m), Cnoc nan Tri-clach (346 m) to the south, and Dunviden Hill (180 m) to the west. The surrounding area is open and undulating in nature, and characterised by lochs, pools and blanket bog. The area to the south rises to more steeply sloping and hilly moorlands.

The following are photographs taken during a site walkover in September 2019 that shows the broad characteristics of the site.

[8] Sixteen watercourse crossings are presented on Figure 10.4.2 and Figure 10.4.3. Of these crossings, 5 are existing crossings and 11 would be new watercourse crossings. It should be noted that WX01 and WX03 represent crossings on the preferred and alternative access routes to the main site, respectively. As only one of these access routes would be constructed the maximum number of watercourse crossings for the Proposed Varied Development would be 15. However, all 16 watercourse crossings are presented in this report.

Photograph 1
Loch nan Clach

Photograph 2
Typical Small Stream on Site

Photograph 3
Yellowbog Burn

Photograph 4
Upstream Reach of River Strathy within the Main Site

1.4.2 Catchment Area

Figure 10.4.1 shows the overall catchment area for the River Strathy to its outfall at the coast.

1.4.3 Geological Setting

The solid geology of the area consists predominantly of Kirtomy and Bettyhill gneisses of the Moine Supergroup. The overlying drift geology consists predominantly of blanket peat overlying Glacial Till or basement. Where the topography is undulating there is almost continuous peat coverage. Alluvial deposits are evident along the valley of the River Strathy and on the shore of Loch nan Clach in the northwest of the site.

1.5 Flood Risk Terminology

Probabilistic flood risks are typically expressed by the probability of the occurrence of a flood event (maximum flood height or other such indicator) of stated magnitude or greater in any one year – termed the Annual Exceedance Probability (AEP). This may be expressed as a percentage (such as 1%, 0.5%, etc.) or by the equivalent chance of occurrence (1 in 100, 1 in 200, etc.).

Where flood events have a Climate Change factor included, the flood event is denoted in this report by "+CC".

2.0 FLOOD RISK REVIEW – SOURCES OF INFORMATION

2.1 National Floodplain Mapping and Risk Assessment

Strategic level information regarding the current flood risk at the site has been obtained from SEPA via the online Indicative Flood Extent Map[9] and National Flood Risk Assessment Portal[10].

2.2 Mapping and Terrain Data

Aerial imagery, Ordnance Survey elevation data (1:50,000 scale), and site inspections by SLR staff have been used to assess the context of the site and its immediate surroundings.

2.3 Planning Considerations

Relevant sections of Scottish Planning Policy (SPP), the Highland-wide Local Development Plan, and associated THC planning guidance (as noted below in Section 3.0 that follows) have been reviewed to inform this assessment.

2.4 Flood History and Records

There is no evidence from an internet search of reports of flooding within or adjacent to the site. As noted in Chapter 10: Soil and Water (EIAR Volume 2), THC reported[11] no flooding events within 5 km of the site and SEPA confirmed[12] it holds no additional information over and above that presented within its online Flood Maps service.

[9] Scottish Environment Protection Agency (2016) Online Interactive Flood Extent Map Tool, available at: http://map.sepa.org.uk/floodmap/map.htm (date accessed 22/11/2019)
[10] Scottish Environment Protection Agency (2016) Online National Flood Risk Assessment Portal, available at: http://map.sepa.org.uk/nfra/map.htm (date accessed 22/11/2019)
[11] THC, email from frm@highland.gov.uk to SLR, dated 15/11/2019
[12] SEPA, letter reference FO191147, dated 27/11/2019

3.0 PLANNING AND CONSULTATION

3.1 Scottish Planning Policy

The policy principles of Scottish Planning Policy (SPP)[1] relating to Managing Flood Risk and Drainage state that the planning system should promote[13]:

- "a precautionary approach to flood risk from all sources, including coastal, water course (fluvial), surface water (pluvial), groundwater, reservoirs and drainage systems (sewers and culverts), taking account of the predicted effects of climate change;
- flood avoidance: by safeguarding flood storage and conveying capacity, and locating development away from functional flood plains and medium to high risk areas;
- flood reduction: assessing flood risk and, where appropriate, undertaking natural and structural flood management measures, including flood protection, restoring natural features and characteristics, enhancing flood storage capacity, avoiding the construction of new culverts and opening existing culverts where possible; and
- avoidance of increased surface water flooding through requirements for Sustainable Drainage Systems (SuDS) and minimising the area of impermeable surface"

and;

"To achieve this the planning system should prevent development which would have a significant probability of being affected by flooding or would increase the probability of flooding elsewhere."

SPP[14] presents a risk framework for planning decision making relating to flood risk. A summary of this risk framework is replicated in **Error! Reference source not found.**.

Table 3-1
SPP Flood Risk Framework

SPP Flood Risk Framework
Little or No Risk *– annual probability of coastal or watercourse flooding is less than 0.1% (1:1000 years):* • *No constraints due to watercourse, tidal or coastal flooding.*
Low to Medium Risk *– annual probability of coastal or watercourse flooding is between 0.1% - 0.5% (1:1000 – 1:200 years):* • *Suitable for most development. A flood risk assessment may be required at the upper end of the probability range (i.e. close to 0.5%), and for essential infrastructure and the most vulnerable uses. Water resistant materials and construction may be required.* • *Generally not suitable for civil infrastructure. Where civil infrastructure must be located in these areas or is being substantially extended, it should be designed to be capable of remaining operational and accessible during extreme flood events.*

[13] Paragraph 255, The Scottish Government (2014) Scottish Planning Policy, June 2014
[14] Paragraph 263, The Scottish Government (2014) Scottish Planning Policy, June 2014

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SPP Flood Risk Framework
Medium to High Risk *– annual probability of coastal or watercourse flooding is greater than 0.5% (1:200 years):* • *May be suitable for:* o *residential, institutional, commercial and industrial development within built-up areas provided flood protection measures to the appropriate standard already exist and are maintained, are under construction, or are a planned measure in a current flood risk management plan;* o *essential infrastructure within built-up areas, designed and constructed to remain operational during floods and not impede water flow;* o *some recreational, sport, amenity and nature conservation uses, provided appropriate evacuation procedures are in place; and* o *job-related accommodation, e.g. for caretakers or operational staff.* • *Generally not suitable for:* o *civil infrastructure and the most vulnerable uses;* o *additional development in undeveloped and sparsely developed areas, unless a location is essential for operational reasons, e.g. for navigation and water-based recreation, agriculture, transport or utilities infrastructure (which should be designed and constructed to be operational during floods and not impede water flow), and an alternative, lower risk location is not available; and* o *new caravan and camping sites.* • *Where built development is permitted, measures to protect against or manage flood risk will be required and any loss of flood storage capacity mitigated to achieve a neutral or better outcome.* • *Water-resistant materials and construction should be used where appropriate. Elevated buildings on structures such as stilts are unlikely to be acceptable.*
Surface Water Flooding • *Infrastructure and buildings should generally be designed to be free from surface water flooding in rainfall events where the annual probability of occurrence is greater than 0.5% (1:200 years).* • *Surface water drainage measures should have a neutral or better effect on the risk of flooding both on and off the Site, taking account of rain falling on the Site and run-off from adjacent areas.*

3.2 Local Development Plans and Guidance

The Highland-wide Local Development Plan[3] sets out broad guidance to inform local planning, as well as providing specific details for certain geographic locations within the Local Government Area.

Policy 64 "Flood Risk" is generally in accord with SPP, but it also expresses a preference for natural flood management methods where flood management is required.

THC has also published a separate guidance document[4] that expands on the policy statements and provides guidance on flood risk assessment, requirements of drainage systems, and requirements for how drainage effects are assessed.

3.3 Consultation

The Proposed Varied Development has been the subject of pre-application discussions with THC prior to the preparation of this report, and the scope and detail of assessment required has been agreed. A scoping response dated 07/06/2019 (THC reference 19/02068/SCOP) noted the following in respect of flooding and water management:

- the Proposed Varied Development will be assessed primarily in terms of the Highland-wide Local Development Plan (HwLDP) 2012, along with relevant policies including Policy 64 "Flood Risk";
- THC noted that Policy 64 states that the Proposed Varied Development should avoid areas susceptible to flooding and promote sustainable flood management; and

- the assessment of development impact should take account of Supplementary Guidance, including "Flood Risk and Drainage Impact Assessment: Supplementary Guidance"[4].

THC was also consulted during the preparation of this FRA and DIA, and provided the following advice[15]:

- for wind farms, the DIA should present a broad strategy for management of drainage;
- there is a recognition that the site is located at the upper end of the catchment, and the focus should be on ensuring that runoff volumes are not increased and times to peak are not decreased to the detriment of downstream locations;
- due to the site's location in the upstream catchment, and in keeping with approaches used on other wind farms, it would not be necessary to calculate pre and post development runoff flows or size features such as storage areas;
- a Drainage/SUDS Masterplan is to be provided for the Proposed Varied Development, that illustrates a possible scheme for management and separation of uncontaminated natural surface runoff and for runoff that originates from the works. This should include an overall site plan showing the catchment areas leading to each site track and turbine area, indicative routes for interception and conveyance of runoff and silt traps, as well as drawings and text describing a "toolbox" of such measures and how they would be used; and
- forestry changes are also important in regard to possible runoff variations.

It should be noted that forestry effects on catchment hydrology are addressed in paragraphs 10.5.46 to 10.5.50 of Chapter 10 Soil and Water (refer to EIAR Volume 2).

[15] Email SLR to THC dated 16/01/2020, summarising discussion with THC Flood Risk Management team of 15/01/2020

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4.0 FLOOD RISK SCREENING

A screening review has been completed to identify whether there are any potential sources of flooding at the site which warrant detailed assessment and /or mitigation.

A summary of the potential sources of flooding and a review of the potential risk posed by each source to the site is presented in **Error! Reference source not found.**. River / fluvial flood risk is the only flood risk source identified and this is assessed further in Section 5.0.

Table 4-1
Flood Risk Screening

Source of Flood Risk	Description	Flood Risk Assessment
Coastal / Tidal	The main site is located some 15 km from the coast and at levels of at least 130 m AOD. With reference to Flood Maps published by SEPA, the site is deemed not to be at risk of coastal flooding. Flooding from this source is therefore considered negligible, and not considered further.	Negligible Risk
River / Fluvial	With reference to Flood Maps published by SEPA, there are no significant floodplain areas within the site that could create an obvious flood risk to infrastructure up to the 1:1,000 AEP level. Parts of the site, including some site tracks and turbines, are relatively close to the River Strathy and its tributaries, and some of the tracks cross these watercourses. However, a 70 m set-back from all watercourses has been applied in the site's design, and this would ensure that infrastructure remains clear of the watercourses and any flood risk. The flow rates, depths, widths and velocities would need to be considered when detailed design of the site track drainage and crossings of the watercourses is undertaken prior to construction. See Technical Appendix 10.6 (EIAR Volume 4) for further details of the proposed watercourse crossing designs. With these measures in place, there is not considered to be a significant risk of fluvial flooding to the Proposed Varied Development. Notwithstanding, this flood risk is considered in more detail below.	Flood Risk To be Reviewed
Surface Water (i.e. direct rainfall)	With reference to Flood Maps published by SEPA, any areas of Surface Water flood risk align with either the watercourses identified under Fluvial risk, or lochs and lochans noted on the OS mapping. Flooding from this source is therefore considered to be addressed by a review of Fluvial flood risk.	Considered under River / Fluvial Flood Risk
Surface Water Flow Paths	Water flow paths within the site would occur along minor drainage channels and from sub-catchments towards the watercourses. Adequate watercourse crossings would be required, and provision for managing these are presented in the site Construction and Environmental Management Plan (Outline CEMP) (see EIAR Volume 4: Technical Appendix 2.1).	Considered under River / Fluvial Flood Risk

Source of Flood Risk	Description	Flood Risk Assessment
Groundwater	With reference to the Groundwater Flood Maps published by SEPA, the site does not lie within an area likely to be at risk of groundwater flooding. Hardstandings, turbine foundations and borrow pits would be excavated below existing ground levels in and could intercept local shallow groundwater. However, standard design and drainage techniques for both site tracks and other excavations would ensure that flows from shallow groundwater are managed such as not to present a flood risk. Flooding from this source is therefore not considered further.	Risk Managed by site Design
Sewers and Artificial Drainage Systems, and Water Supply	Scottish Water has confirmed it has no water or sewerage pipes crossing or in the vicinity of the site (Refer Chapter 10: Soil and Water, EIAR Volume 2). Flooding from this source is therefore considered negligible and is not considered further.	Negligible Risk
Infrastructure Failure (i.e. reservoirs, canals, culvert blockage, etc.)	There are a number of lochs and lochans across and upstream of the site. However, it is understood that these are all natural water bodies, at an elevation below the surrounding topography, without raised embankments or similar features. Flooding from this source is therefore considered negligible and is not considered further.	Negligible Risk

5.0 FLUVIAL FLOOD RISK

5.1 Flood Risk to the Proposed Varied Development

As noted in **Error! Reference source not found.**, there is very little potential flood risk to the parts of the site in which infrastructure for the Proposed Varied Development would be located.

Figure 10.4.2 and 10.4.3 show the approximate extents of the 1:200 AEP flood extents provided in SEPA flood mapping. Figure 10.4.3 also shows the layout of the Proposed Varied Development and four locations on the main site are noted where the infrastructure appears to be close to the mapped potential flood extents:

- the track from T11 westward towards T10 appears to be close and parallel to a watercourse that is noted on the SEPA flood map. However, the track appears to be at the margins of the potentially flooded zone, and given the very low joint probability of occurrence of the 1:1000 flood event and concurrent use of this track, this is considered to be acceptable;
- T10 appears to be reasonably close to the floodplain of the River Strathy. Although it is likely that the hardstanding and working areas for this turbine would be on the east side of the turbine away from the river, the detailed design of the Proposed Varied Development should include an assessment of the likely flood extents and the turbine and all associated infrastructure be sited out with this zone. The 50 m micrositing allowance should provide scope for any such adjustment;
- T28 appears to be close to a junction of the River Strathy and a one of its tributaries and the related floodplain. As for T10, the potential flood risk could be addressed by the proposed micrositing allowance; and
- the track to T49 appears to run close to the edge of low-lying and poorly drained bog. Whilst this area is not shown to be at flood risk based on flood mapping, as for the other areas noted above the detailed design should ensure that the track is sited clear of any ponded areas within micrositing allowances.

For the area north of the proposed turbine area (see Figure 10.4.2), including the access track and grid connection cabling route, notable aspects in this area are related solely to track crossings of the River Strathy:

- there are two options being considered for routing a new track across the River Strathy. The preferred (green) route would use the proposed crossing WX01 (Figure 10.4.2) which is further upstream and at a narrower crossing point than the proposed crossing for the alternative route (WX03). At WX01 crossing point, a new bridge would be required. The detailed design of the bridge would ensure that it provides adequate waterway area so as not to impact on the hydraulic regime of the watercourse at the bridge site; and
- the alternative (purple) route (Figure 10.4.2) makes use of an existing track on the south side of the river, and then turns north off that track to bridge over the river (WX03). A careful study of the floodplain extents would be needed carried out during detailed design for this route, as the SEPA flood mapping shows a possible breakout of flow on the right bank, creating an overland flow route aligned along the track route. As far as possible, the detailed design should micro-site the track to create a perpendicular crossing of the river, and at a point where the flood extent is minimised.

Apart from potential flood risk at these specific locations, the Proposed Varied Development includes peatland restoration measures such as drain blocking (refer to the Outline Habitat Management Plan presented in EIAR Volume 4: Technical Appendix: 9.5). The detailed design of these measures would avoid effects on the integrity of tracks and hardstandings due to changes in surface water and groundwater levels. It is noted that ditch blocking would reduce the peak and volume of rainfall runoff shed from the site. The reduced runoff volumes are expected to result in a reduction in flood risk within and downstream of the site.

5.2 Flood Risk out with the Site

5.2.1 Receptors

The Proposed Varied Development is located at the upstream end of the River Strathy catchment, and any significant receptors for changes in flood risk would be downstream of the site.

Most built development downstream is elevated above the course of the River Strathy (such as the Strathy Village Hall at the A836 bridge and a residential property some 300 m upstream of the A836 – both of which are some 15 km downstream of the main site).

Bowside Lodge is approximately 10 km downstream of the main site, and again is elevated out with the 1:1,000 floodplain shown on SEPA flood mapping.

The buildings at Dallangwell are close to the western extents of the floodplain as mapped by SEPA, but again they are at least 8 km downstream of the main part of the site. Given the attenuating effects of flood routing along a river course, any slight changes in hydrology at the site are unlikely to be reflected in changes in water levels at Dallangwell.

5.2.2 Flood Effects Resulting from the Proposed Varied Development

As noted above, the Proposed Varied Development has been designed to remain clear of the floodplains of the various watercourses that transect the site. Where site tracks cross watercourses, adequate crossings would be designed and constructed to convey up to the 1:200+CC event. The proposed crossing types are provided in Technical Appendix 10.6 Schedule of Watercourse Crossings (EIAR Volume 4).

5.2.3 Conclusion on Flood Risk to Other Development

Based on the discussion above, and assuming the design points noted are adopted, it is considered that the development would not have a significant effect on flowrates, flood levels, or flood volumes downstream. Indeed, the proposed ditch blocking would reduce the peak and volume of rainfall runoff shed from site and therefore be expected to result in a reduction in flood risk within and downstream of the site.

5.3 Access and Egress

Road access to and from the site is via the A836 road that follows the north coast of Scotland, and then via a minor road to the south from the village of Strathy. This continues as an unsealed road south alongside River Strathy past Bowside Lodge towards Loch Strathy.

The identified access route for the site turns west off the main track towards Dallangwell, using the existing track to Strathy North Wind Farm (see Figure 10.4.2)).

The access to the site leaves the Strathy North Wind Farm access track approximately 4 km south of Dallangwell and crosses the River Strathy. As noted above, there are two options under consideration for a route to cross the River Strathy, either the preferred or the alternative routes, with a length of new track, which would then re-join the existing track towards Loch Strathy, which leads to the site.

At Dallangwell, SEPA flood maps indicate that the floodplain in a 1:200 AEP event may be some 300 m wide. In the smaller 1:10 AEP event, the floodplain may be some 200 m wide in total, with at least one "island" of higher ground within this width. Aerial photography indicates that the existing bridge at Dallangwell may be some 20 m long, with at-grade approaches each side. The bridge at this location has a recent CAR consent and has been designed with agreement from SEPA. It is therefore likely that in any significant flood event, the bridge at Dallangwell would be blocked by the River Strathy for some hours while the flood flow passes this location.

At the proposed alternative crossing point of the River Strathy (WX03) further south from Dallangwell, the SEPA flood mapping indicates that the river floodplain may be some 40-80 m wide in a 1:200 AEP event. As this bridge

has not yet been constructed, it could be designed to be elevated above the floodplain, and therefore not be cut off in a flood event.

Further south, towards and into the main site, both existing and new tracks would be used to access the turbines and other infrastructure. With watercourse crossings designed to accommodate a suitable design flood event, there would be no particular constraints to access (see Technical Appendix 10.6: Watercourse Crossing Assessment, EIAR Volume 4).

6.0 DRAINAGE IMPACT ASSESSMENT

6.1 Approach

The requirements for a DIA submitted to THC are given in the above-mentioned THC guidance document**Error! Bookmark not defined.**. The particular requirements as applied to the Proposed Varied Development have been agreed in pre-application discussions with THC (see Section 3.3 of this report).

It is noted that the impacts of drainage methods and systems on the environment arising from wind farms and similar developments which are distributed over wide areas can arise from both the construction and operational phases of the development.

The principal means of regulating construction stage impacts is through the Controlled Activities Regulations noted in Section 1.1 and in particular, the Construction Site Licence required for such developments. This would be implemented on this project as described in paragraphs 5.1.1 – 5.1.3, Section 5 of Technical Appendix 2.1: Outline CEMP (EIAR Volume 4).

The operational stage impacts of wind farms are managed through the application of the principals detailed below, as well as adequate detailed design of the system and effective maintenance. Further details are given in Chapter 10 (Soils and Water) refer to EIAR Volume 2.

6.2 Sustainable Drainage Systems Best Practice

The leading current best practice guidance document - The SuDS Manual (CIRIA Report C753)[16] - promotes sustainable water management through the use of SuDS. There are four main attributes of a successful SuDS, as described in the SUDS Manual:

- control of runoff quantity;
- management of runoff quality;
- creating improved amenity; and
- promoting biodiversity.

The SuDS Manual identifies a "management train" for runoff (also a preference hierarchy):

- **Prevention** – the use of good site design and housekeeping measures on individual sites to prevent runoff and pollution (e.g. minimise areas of hard standing);
- **Source Control** – control of runoff at or very near its source (such as the use of rainwater harvesting);
- **Site Control** – management of water from several sub-catchments (including routing water from roofs and car parks to one/several large soakaways for the whole site); and
- **Regional Control** – management of runoff from several sites, typically in a retention pond or wetland.

The priority for SuDS is to deal with the water at source and pass as little water forward as possible to be managed by downstream systems.

[16] CIRIA (2015). Report C753, The SuDS Manual

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6.3 Proposed Discharge Arrangement

With reference to The SuDS Manual, and with particular reference to large distributed sites such as wind farms, the hierarchy of preferred management options for surface water runoff from development sites, in decreasing order of sustainability, is as follows:

1. Re-use and re-cycling;
2. Infiltration to ground;
3. Discharge to ground surfaces as close as possible to original routes;
4. Discharge to surface waters; or
5. Discharge to Sewer.

summarises these management options for relevance and suitability for the Proposed Varied Development.

Table 6-1
Suitability of Surface Water Disposal Methods

Surface Water Disposal Method (in Order of Preference)	Suitability Description	Method Suitable? (Y / N)
Re-use and recycling	The main sources of surface water runoff on a wind farm site are the site tracks and hardstandings at each turbine. There is no realistic means for capturing and recycling water in these areas. There is the potential for capture and re-use of roof water from substation buildings, and this would be considered during detailed design, but it does not represent a significant proportion of the surface water affected by the Proposed Varied Development.	Yes – but limited in scope
Infiltration to Ground	Infiltration tests have not been carried out at the site. However, given the setting of the Proposed Varied Development within extensive deep peatlands with poor drainage, there is unlikely to be potential for infiltration on a large scale. It is suggested that infiltration be considered for areas such as construction compounds, and alongside water re-use for any buildings.	Yes – but limited in scope
Discharge to Ground Surfaces	This option is well suited to the management of surface water arising from site tracks and hardstands, and is the preferred method, to be used in tandem with discharge to surface waters.	Yes – for majority of site
Discharge to Surface Waters	At various locations across the site, the drainage of runoff from the tracks and hardstands would need to be directed towards a watercourse (e.g. near a watercourse crossing).	Yes – for particular locations

Surface Water Disposal Method (in Order of Preference)	Suitability Description	Method Suitable? (Y / N)
	Discharge to a watercourse has therefore been adopted as part of the strategy.	
Discharge to Sewer	The site is remote from any piped drainage infrastructure. Apart from being the least preferred measure, it would not be possible to connect to any sewers.	No

6.4 Proposed Outline SuDS Principles

The following design criteria (where applicable) has been applied in developing the SuDS strategy and would inform the Construction Site Licence application, as well as CEMP the detailed design and construction of the drainage system:

- SuDS to be constructed prior to, or at the same time as the access roads, turbine foundations, and other elements of the Proposed Varied Development which they are designed to serve;
- minimise any change to the hydrology and groundwater conditions at the site;
- where physically possible, replicate the natural drainage and hydrological characteristics of the area;
- minimise sediment loads in the runoff, through use of infiltration and settling ponds, with particular attention being given to the construction phase of the project;
- maintain the existing hydrology regimes at the site;
- avoid high flow velocities - energy dissipation devices such as check dams and multiple outflow structures should be used to avoid scour and re-suspension of sediment; and
- provide for successive reinstatement of vegetation along the site tracks.

6.5 Description of the Proposed SUDS

Figures 10.4.4 to 10.4.6 provide an overview of one possible layout for a site drainage system, that conforms to the topography and the likely grading of site tracks. It is noted that once the detailed design is carried out for the site tracks and hardstands, etc. (including gradients and directions of fall) it would be possible to refine the layout of the SUDS, and some elements could vary. For example, the flow direction on some drainage lines could vary, or the number of settlement ponds and outfalls to watercourse may be optimised.

The Outline CEMP (EIAR Volume 4: Technical Appendix 2.1) provides a description and drawings of typical drainage provisions to be installed and used during construction, and these drawings are referred to below in regard to appropriate measures to be installed.

6.5.1 Tracks

The following drainage features would be adopted for site tracks (see also Outline CEMP):

- clean water diversion ditches – these would be located up-slope of the footprint of the works, to intercept natural overland flow and allow it to be directed through or past the works site without entraining sediment or other pollutant. Where feasible, these interception ditches would include cross-track culverts leading to dispersion structures on the down-slope side of the tracks, to allow the water to return as close as possible to its natural path. In certain locations, it would be more appropriate to

direct the water laterally towards outfalls at watercourses. For most track lengths, there would be a mixture of these two techniques;

- site tracks drainage - Where the down-slope side of the road is at or around grade, the track drainage would be located on the down-slope side of the road, and the road cross-fall would be towards that side of the road. Where the road is in a cut and fill configuration, the track drainage would be on the up-slope side of the road, with the cross-fall towards that side. The road drainage ditches would be sized to accommodate the runoff anticipated, – generally to be located on one side of the road, but on both if there is a short section with no cross slope;
- silt traps and check dams – silt traps and check dams would be used in the roadside ditches to preserve appropriate long-fall slopes and avoid scour;
- cross drains – where the roadside ditches are on the up-slope side of the road, regular cross drains would be used to take the flow towards the down-slope side and out to silt control devices and back onto the hillside;
- the sizing of the ditches, and the spacing of the cross-road drains, would take account of the up-slope catchments, as well as the longitudinal slope of the drains; and
- settlement ponds – where roadside ditches cannot discharge back to the hillside, they would direct flow into settlement devices, (with secondary screening treatments) prior to discharge into the watercourse – as shown in Figure 10.4.4, and as presented in the Outline CEMP (EIAR Volume 4: Technical Appendix 2.1).

6.5.2 Watercourse Crossings

Watercourse crossings include those that would require authorisation (through Registration or a Licence) under the Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR), as well as smaller crossings below the threshold for such authorisation.

Technical Appendix 10.6 : Schedule of Watercourse Crossings (EIAR Volume 4) provides information on the form of the proposed authorised crossings, and these have been summarised in Section 1.3 of this report.

The design of any new or modified crossings would include consideration of the estimated peak and average flow conditions, as well as the slope and topography of the crossing site. The design objectives would be to minimise effects on the flow regime (afflux, scour, etc.) and provide sustainable crossings that minimise effects on the ecology of the watercourse at the crossing areas.

In terms of downstream drainage impacts, the provision of adequately designed and constructed crossings is considered to be in accordance with SuDS principles.

6.5.3 Construction Compound, Substation Site and Laydown Areas

Permanent facilities such as the substation buildings would include measures to recycle roof water, and to infiltrate surface water back to the adjacent substrate.

Temporary facilities such as laydown areas would be constructed of open graded rockfill which would minimise runoff and allow rainwater to infiltrate and follow natural flow paths.

The Outline CEMP (EIAR Volume 4: Technical Appendix 2.1) shows typical details for the water management that would be adopted at these facilities during construction so as to manage silt mobilisation.

6.5.4 Borrow Pits

The borrow pits would each be graded so as to contain the runoff from disturbed surfaces and active workings. As shown in the Outline CEMP (EIAR Volume 4: Technical Appendix 2.1), the drainage would be designed with a buffer sump pond and pump system so as to return settled water (via sediment control measures) at the greenfield runoff rate.

6.5.5 Turbines and Associated Hardstandings

Drainage provisions for construction of turbine foundations and the associated hardstandings and crane pads would feature similar provisions to those described above for tracks and for worked areas such as borrow pits. Typical provisions are shown in the Outline CEMP (EIAR Volume 4: Technical Appendix 2.1).

6.6 Design Exceedance

The open drains, cross-road culverts, infiltration systems and watercourse crossings would all be designed to function adequately up to their nominated capacity (e.g. 1:30 or 1:200 AEP rainfall/flowrate conditions, including appropriate allowances for climate change). In the event of rainfall or flow conditions that exceed the design conditions, water would pond upstream of crossings and flow out of constructed ditches. The nature of this site (particularly with relatively gentle topography) would allow water to be retained in depressions and to find ready alternative flow paths in these conditions.

The most sensitive time for water quality impacts to occur would be during the one or two years following construction, as vegetation is re-established and compacted surfaces consolidate. In this period, silt controls should be maintained to ensure that water quality is preserved in the existing natural drainage systems.

6.7 Impacts from Surface Water Drainage

Once constructed and established, the drainage provisions as outlined above would preserve as far as possible the existing hydrological regime and ensure that any changes in the hydrology across the site are minimal and would not be experienced at downstream receptors.

It is noted that in terms of water quality effects, the most significant effects can occur during and immediately after construction, when surfaces are exposed, and sediments can be entrained and conveyed into watercourses. Full details of the measures to be employed during construction would be described in the Construction Site Licence application as detailed in the Outline CEMP (EIAR Volume 4: Technical Appendix 2.1), as well as the Pollution Prevention Plan (PPP). The measures described in this DIA, such as the track construction and drainage sequences, and the silt management techniques, are important components of that system. With these features integrated and the construction practices employed, the drainage provisions would meet best practice for sustainable drainage.

It is noted that any drainage system requires regular maintenance in order to continue to function as planned, and key operations and maintenance requirements are addressed in the next section of this report.

7.0 PRINCIPAL OPERATION AND MAINTENANCE REQUIREMENTS

All surface water drainage and pollution control features associated with the site would remain private and would be maintained by the wind farm operator.

During the operational life of the Proposed Varied Development, the infrastructure and the drainage systems would require regular maintenance to ensure they remain fully functional. The wind farm operator would be required to prepare a regular work programme for longer-term maintenance cycles for the various elements. The programme would take into account the following good practice:

- following the construction phase, any accumulations of silt relating to the works to be cleared and suitably disposed either off-site or remote from any water feature or water dependent habitat;
- the site tracks and associated drainage features to be regularly inspected and appropriately maintained. Unless otherwise unavoidable, all maintenance to take place during the summer months;
- track maintenance to include brushing, scraping and targeted re-compaction to address rutting, potholing and loosening of the surface;
- in dry weather, dust suppression methods may be required for track and hardstanding areas;
- a survey of the watercourse crossings to be undertaken at least annually to confirm their hydraulic capacity has not been reduced by blockage or siltation which could diminish system performance;
- any such blockage or siltation should be removed to restore full hydraulic capacity; and
- all site maintenance operations to be carried out in accordance with relevant authorisations and good practice, including scheduling of any in-stream works to avoid fish spawning periods (October to May).

8.0 FOUL WATER DRAINAGE

During the construction phase temporary welfare facilities would be provided. All resultant foul water drainage would be made to sealed tanks and routinely emptied by an authorised contractor.

During the operation phase, foul drainage arisings would be limited to toilet and wash handbasin in the Operation Building (within the substation compound). The anticipated usage is less than 15 equivalent persons (e.p.).

Foul water discharge is proposed to be via gravity pipework from these facilities to a septic tank or equivalent facility located adjacent to the Operation Building. Following treatment, the minor effluent flow would be conveyed to a soakaway.

9.0 SUMMARY AND CONCLUSIONS

SLR Consulting Ltd (SLR) was appointed by SSE Generation Ltd (SSE) to prepare an FRA and DIA in for the Proposed Varied Development at Strathy South Wind Farm.

In accordance with relevant local and national guidance, all potential sources of flooding to the site have been considered.

The flood risk screening carried out in this review concludes that there is a Negligible risk of flooding from sources such as coastal, groundwater or infrastructure failure, but that fluvial and surface water flood risk required further consideration. With appropriate micro-siting of the wind farm turbines, hardstandings and tracks, there would be no significant flood risk to the wind farm infrastructure or to other receptors from fluvial or surface water flood sources.

There is adequate provision for emergency ingress/egress to the site during flood events.

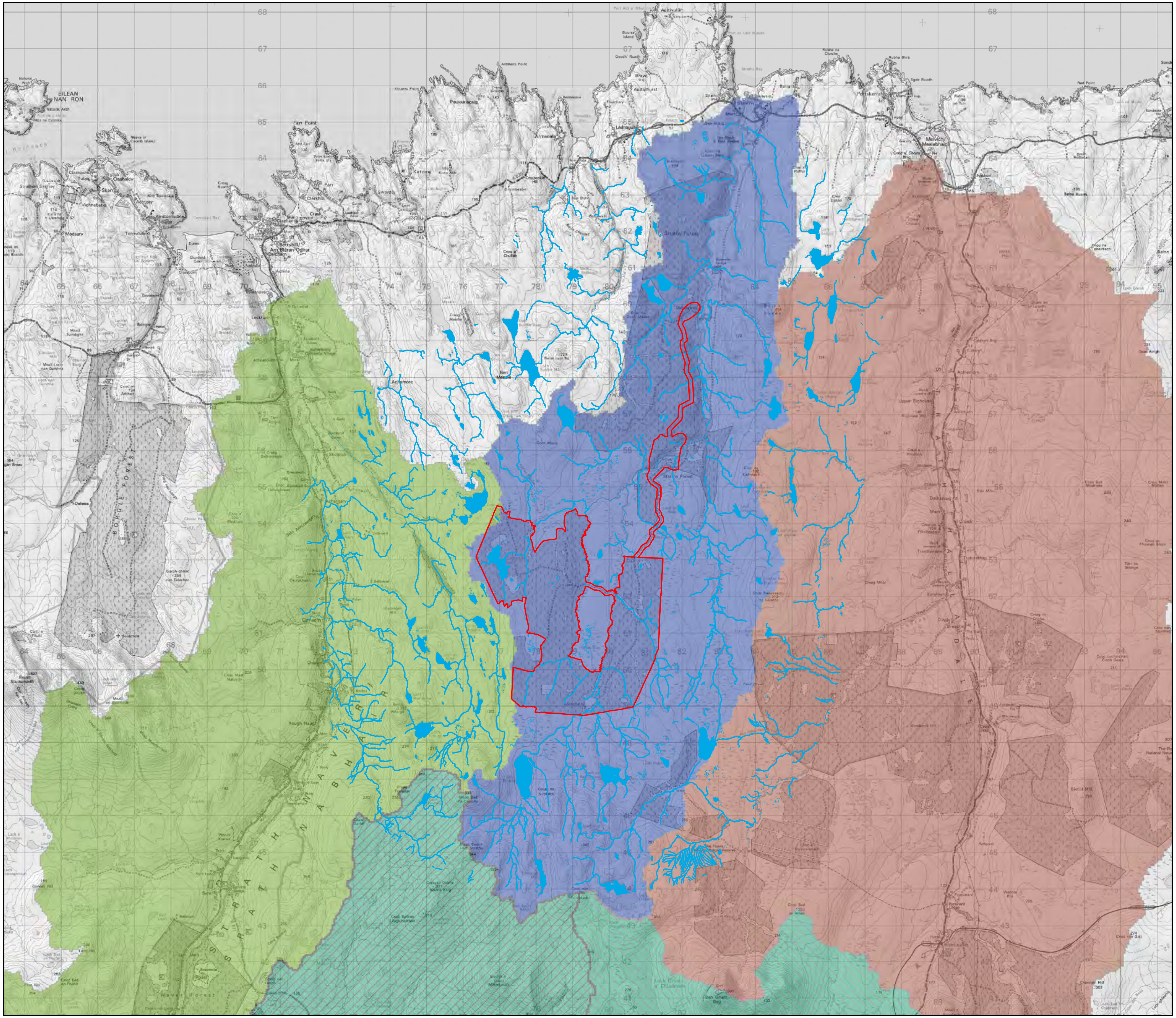
The proposed SuDS have been described in this report and the drainage impacts have been assessed. The SuDS include adequate separation of undisturbed surface runoff from runoff arising from the constructed facilities, and management of surface water close to source. They also include management of the water arisings in order to avoid exacerbating flow rates or sediment loads returning to the network of drainage watercourses on the site.

The SuDS have adequate provision for functioning through a design exceedance event.

The drainage systems would require monitoring and maintenance, and recommendations have been included in this report.

The Proposed Varied Development would generate limited quantities of foul water which would be managed on-site using a packaged treatment facility (e.g. septic tank) during construction and operation.

Management of drainage during construction and operation will be key to ensuring that there is no significant impact of the site drainage systems on the environment and downstream receptors. Proactive management of the site drainage in accordance with the final CEMP and PPP would ensure that the drainage effects are limited during and following construction.



Key

Site Boundary

Watercourse (OS Vectomap Local)

SEPA Water Catchment Areas - Over 100km²

Halladale River - d/s Forsinain Burn

Loch Badanloch / nan Clar / Rimsdale

River Helmsdale - Kinbrace Burn to sea

River Helmsdale - Loch Badanloch to Kinbrace Burn

River Naver - sea to Loch Naver

River Strathy - The Uair to sea

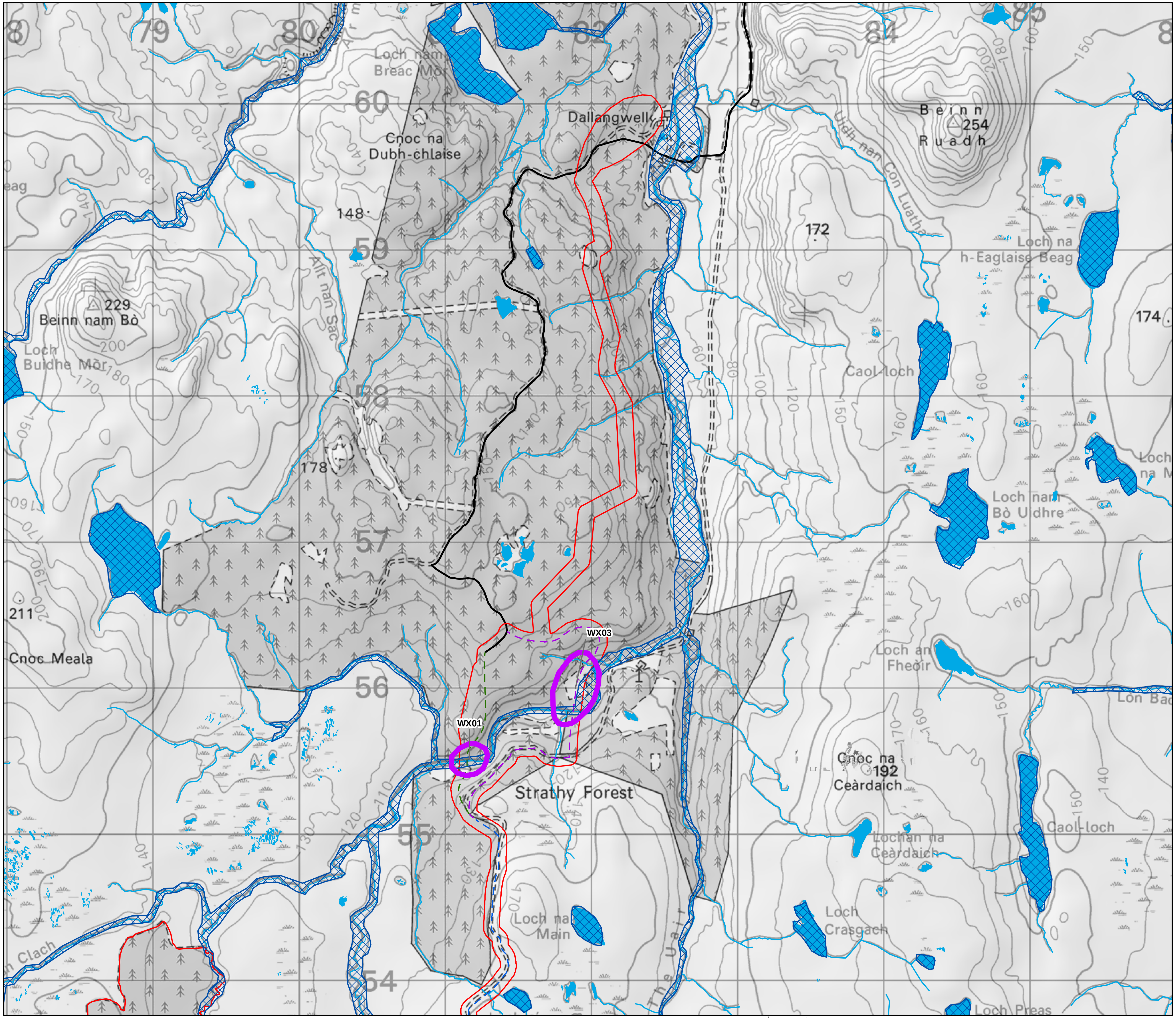
Scale 1:100,000@ A3

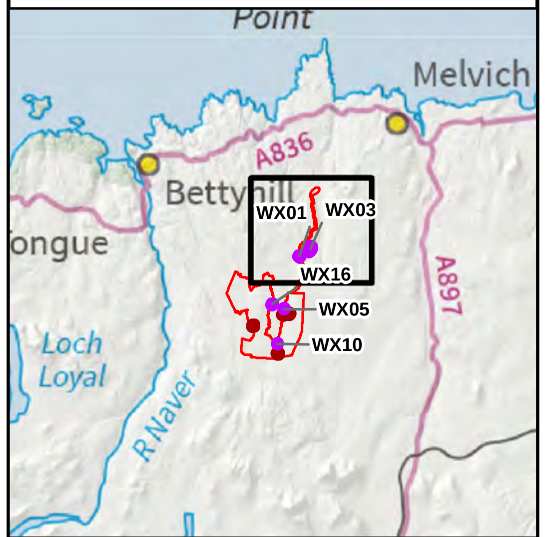
0 2 4 Km

N

Figure 10.4.1
River Strathy and Adjacent Catchment Areas

Strathy South Wind Farm
EIAR 2020





Key

- Site Boundary
- Preferred Access Route
- Alternative Access Route
- Common Access Route
- Strathy North Access Route
- Watercourse (OS Vectomap Local)
- Key Watercourse Crossing
- 1:200 Flood Zone - SEPA [1]

Scale 1:25,000 @ A3

0 0.5 1 Km

N

Figure 10.4.2

Flood Risk Review (North)

Strathy South Wind Farm
EIAR 2020

[1] Estimated from Online SEPA Flood Mapping. Contains public sector information licensed under the Open Government Licence v3.0

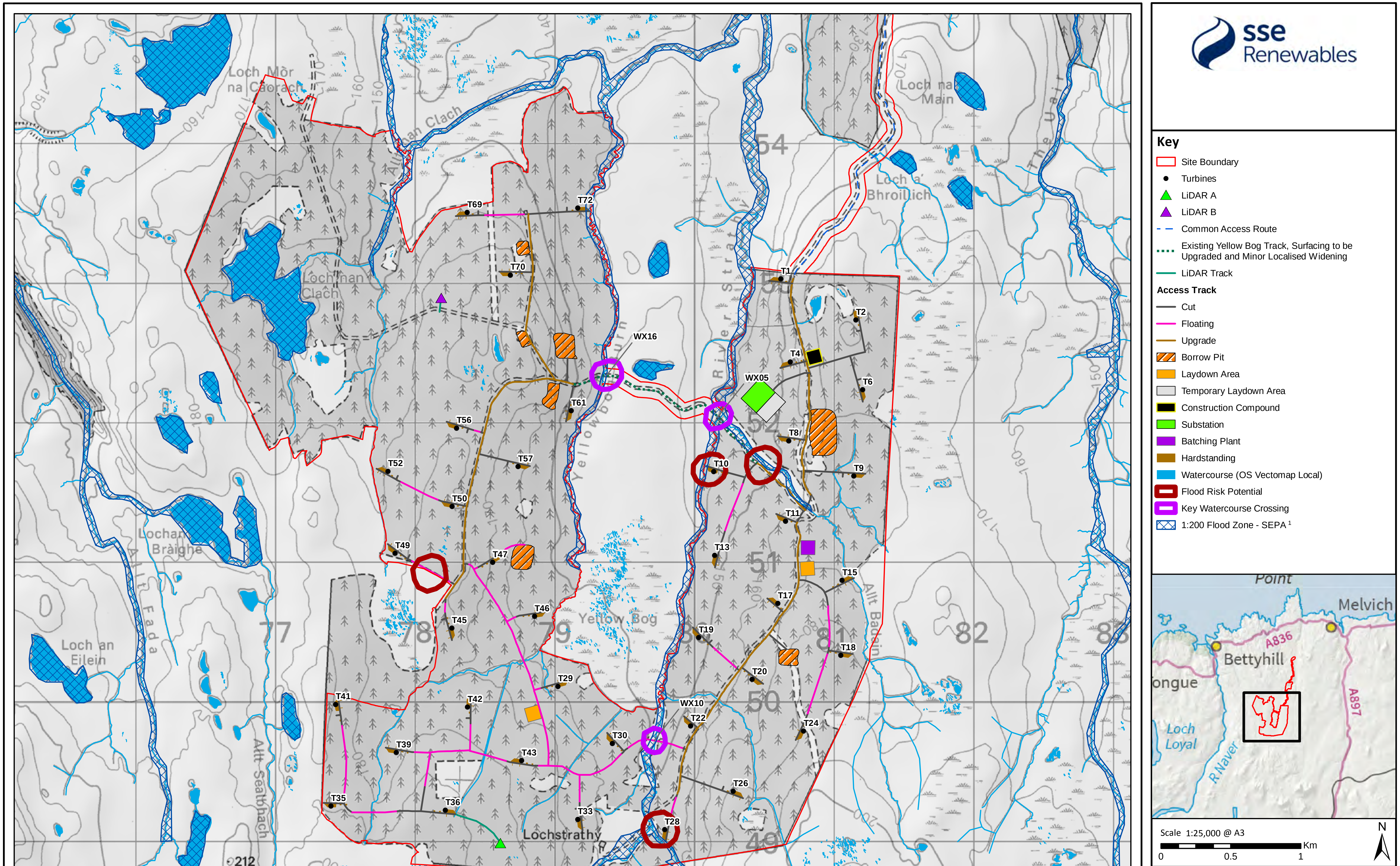
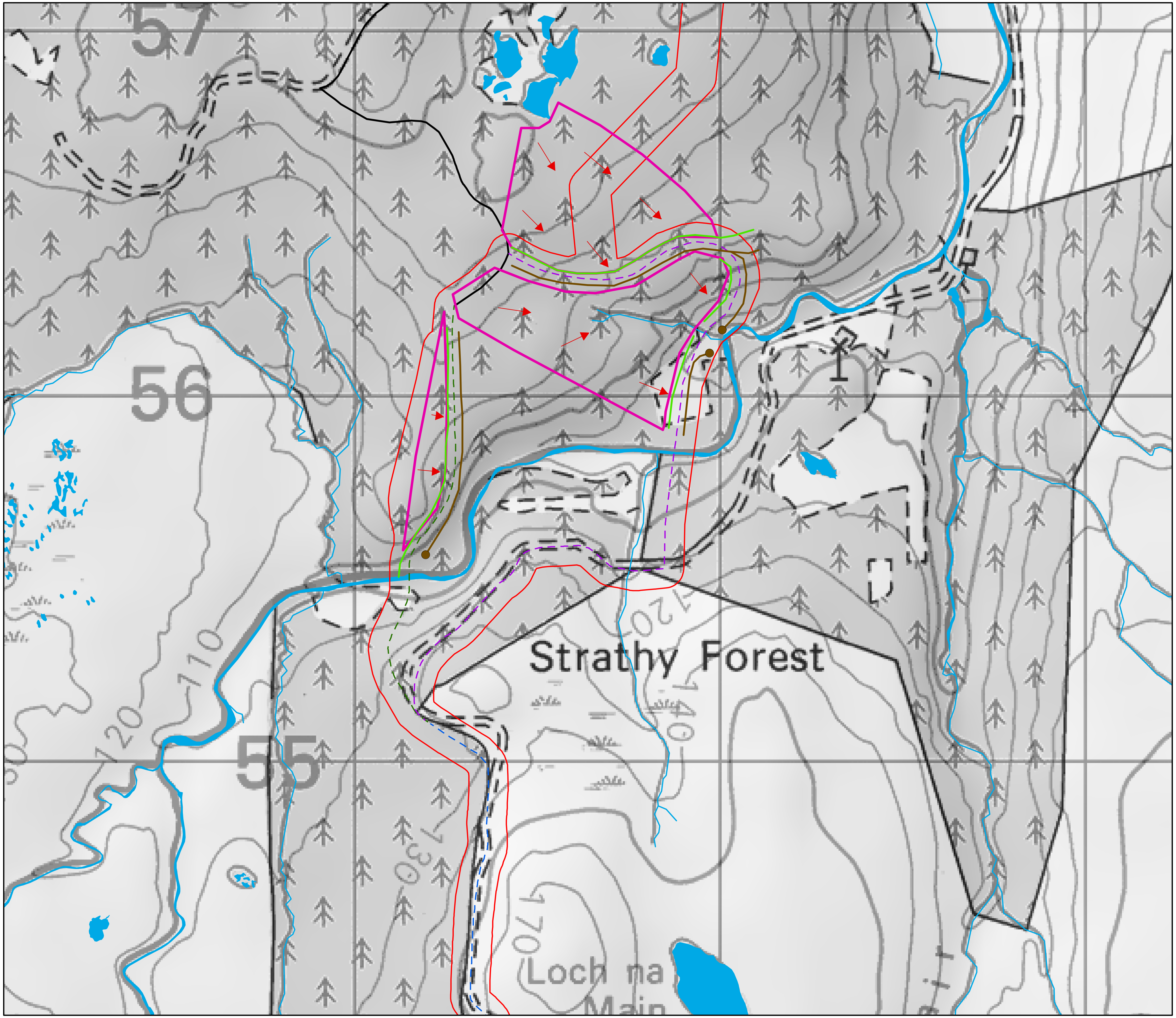


Figure 10.4.3

Flood Risk Review (South)

Strathy South Wind Farm
EIAR 2020

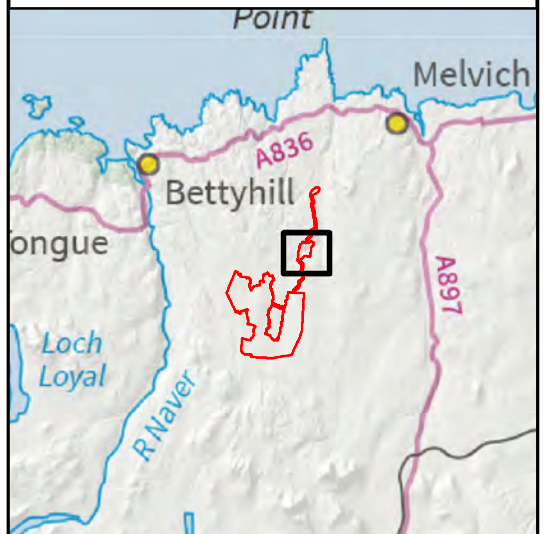
[1] Estimated from Online SEPA Flood Mapping. Contains public sector information licensed under the Open Government Licence v3.0



sse Renewables

Key

- Site Boundary
- Preferred Access Route
- Alternative Access Route
- Common Access Route
- Strathy North Access Route
- Watercourse (OS Vectomap Local)
- Catchment Areas
- Settlement Pond
- Clean Water Drainage
- Dirty Water Drainage
- Slope Direction



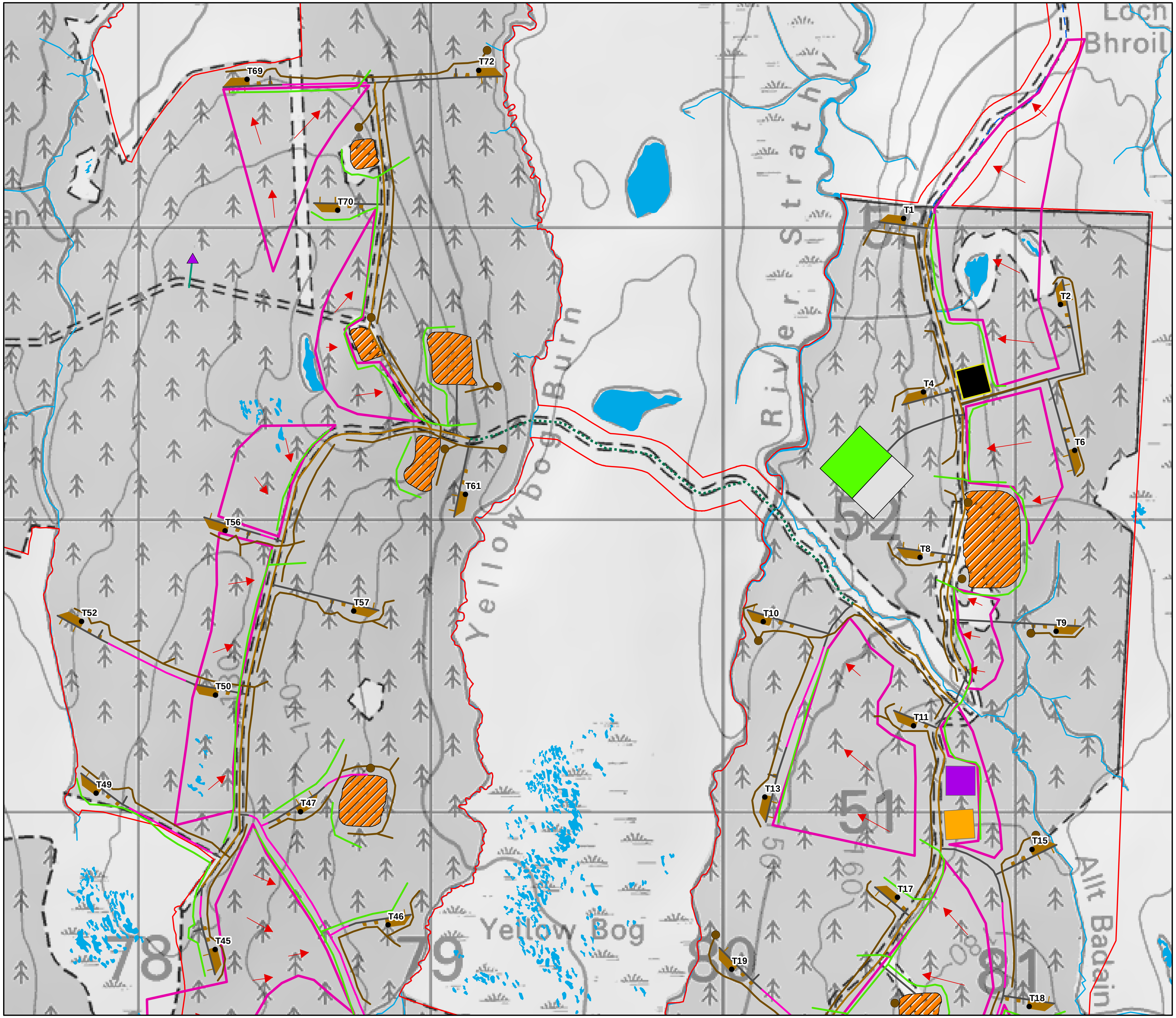
Scale 1:10,000 @ A3

0 0.25 0.5 Km

N

Figure 10.4.4
Indicative Drainage Plan
Sheet 1 of 3

Strathy South Wind Farm
EIAR 2020



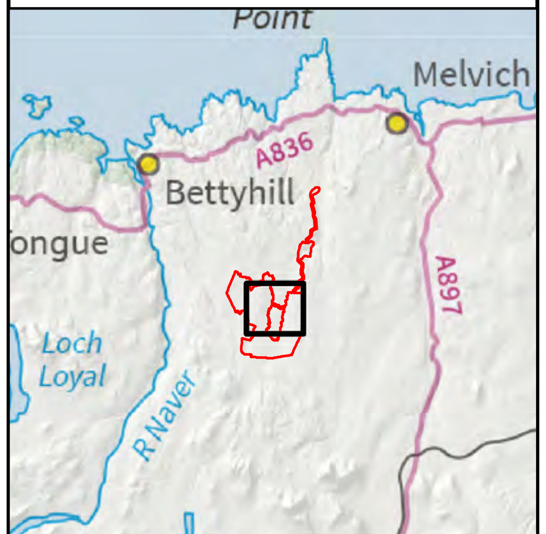
SSE Renewables

Key

- Site Boundary
- Turbines
- LiDAR B
- Common Access Route
- Existing Yellow Bog Track, Surfacing to be Upgraded and Minor Localised Widening
- LiDAR Track

Access Track

- Cut
- Floating
- Upgrade
- Borrow Pit
- Laydown Area
- Temporary Laydown Area
- Construction Compound
- Substation
- Batching Plant
- Hardstanding
- Watercourse (OS Vectomap Local)
- Catchment Areas
- Settlement Pond
- Clean Water Drainage
- Dirty Water Drainage
- Slope Direction



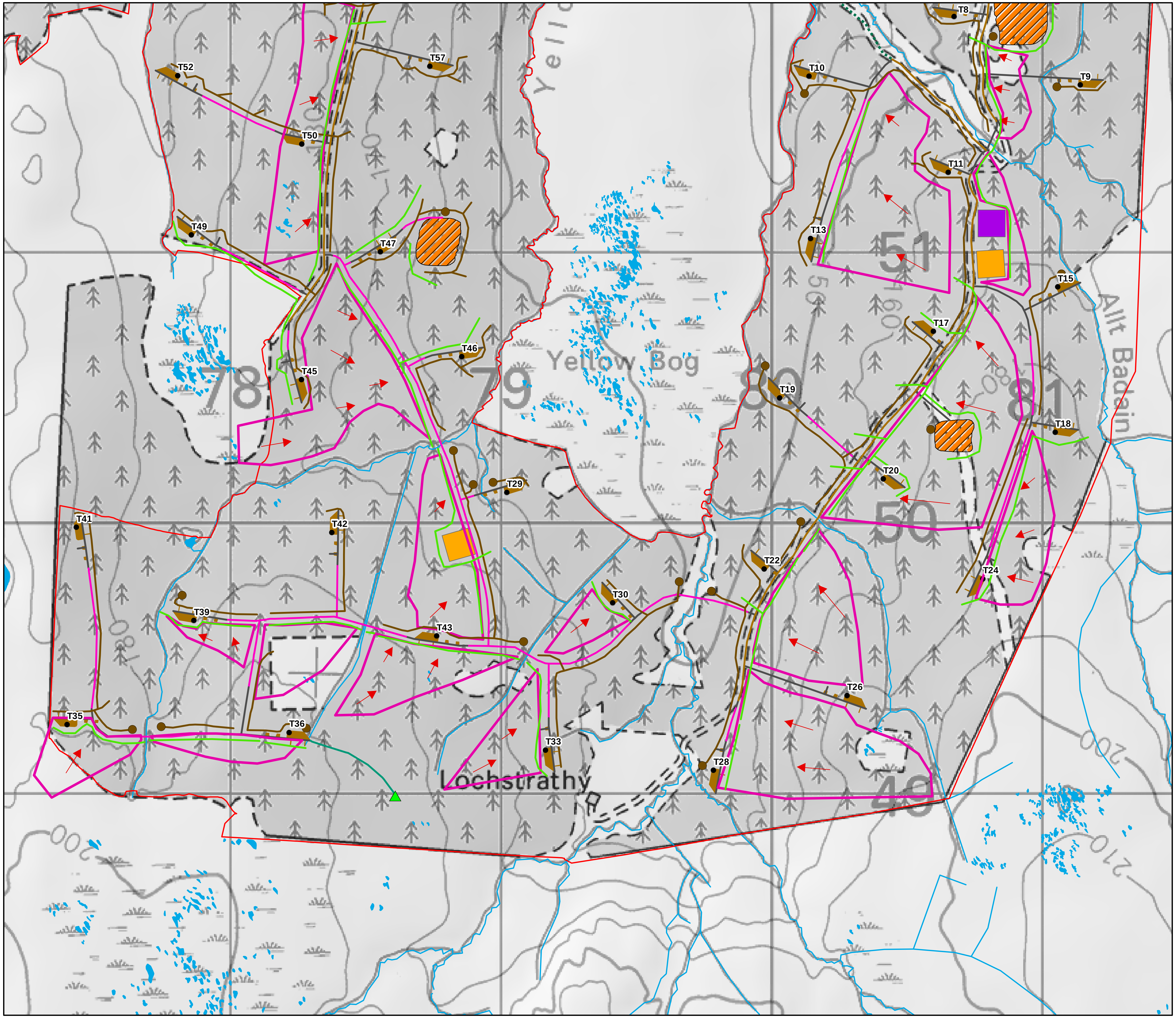
Scale 1:12,500 @ A3

0 0.25 0.5 Km

N

Figure 10.4.5
Indicative Drainage Plan
Sheet 2 of 3

Strathy South Wind Farm
EIAR 2020

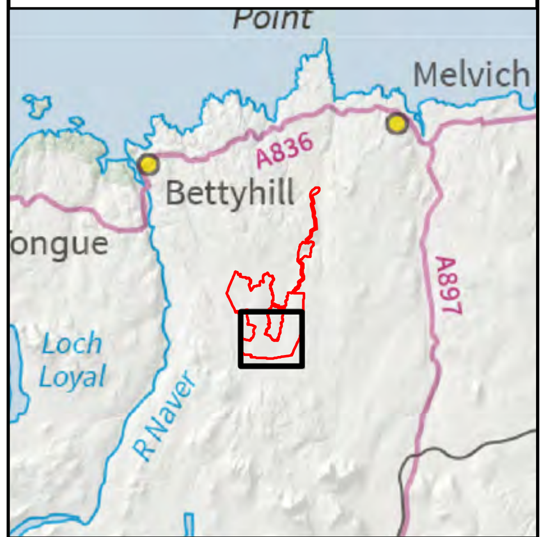


Key

- Site Boundary
- Turbines
- LiDAR A
- Existing Yellow Bog Track, Surfacing to be Upgraded and Minor Localised Widening
- LiDAR Track

Access Track

- Cut
- Floating
- Upgrade
- Borrow Pit
- Laydown Area
- Batching Plant
- Hardstanding
- Watercourse (OS Vectomap Local)
- Catchment Areas
- Settlement Pond
- Clean Water Drainage
- Dirty Water Drainage
- Slope Direction



Scale 1:13,500 @ A3

0 0.25 0.5 Km

N

Figure 10.4.6
Indicative Drainage Plan
Sheet 3 of 3

Strathy South Wind Farm
EIAR 2020

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